NUREG-1840

Safety Evaluation Report
for an Early Site Permit (ESP) at the Grand Gulf ESP Site

Docket Nos. 52-009

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

AVAILABILITY OF REFERENCE MATERIALS IN NRC PUBLICATIONS

NRC Reference Material

As of November 1999, you may electronically access NUREG-series publications and other NRC records at NRC's Public Electronic Reading Room at http://www.nrc.gov/reading-rm.html. Publicly released records include, to name a few, NUREG-series publications; *Federal Register* notices; applicant, licensee, and vendor documents and correspondence; NRC correspondence and internal memoranda; bulletins and information notices; inspection and investigative reports; licensee event reports; and Commission papers and their attachments.

NRC publications in the NUREG series, NRC regulations, and *Title 10, Energy*, in the Code of *Federal Regulations* may also be purchased from one of these two sources.

1. The Superintendent of Documents
   U.S. Government Printing Office
   Mail Stop SSOP
   Washington, DC 20402–0001
   Internet: bookstore.gpo.gov
   Telephone: 202-512-1800
   Fax: 202-512-2250
2. The National Technical Information Service
   Springfield, VA 22161–0002
   www.ntis.gov
   1–800–553–6847 or, locally, 703–605–6000

A single copy of each NRC draft report for comment is available free, to the extent of supply, upon written request as follows:

Address: Office of the Chief Information Officer,
Reproduction and Distribution
Services Section
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
E-mail: DISTRIBUTION@nrc.gov
Facsimile: 301–415–2289

Some publications in the NUREG series that are posted at NRC's Web site address http://www.nrc.gov/reading-rm/doc-collections/nuregs are updated periodically and may differ from the last printed version. Although references to material found on a Web site bear the date the material was accessed, the material available on the date cited may subsequently be removed from the site.

Non-NRC Reference Material

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, and transactions, *Federal Register* notices, Federal and State legislation, and congressional reports. Such documents as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings may be purchased from their sponsoring organization.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at—

The NRC Technical Library
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852–2738

These standards are available in the library for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from—

American National Standards Institute
11 West 42nd Street
New York, NY 10036–8002
www.ansi.org
212–642–4900

Legally binding regulatory requirements are stated only in laws; NRC regulations; licenses, including technical specifications; or orders, not in NUREG-series publications. The views expressed in contractor-prepared publications in this series are not necessarily those of the NRC.

The NUREG series comprises (1) technical and administrative reports and books prepared by the staff (NUREG–XXXX) or agency contractors (NUREG/CR–XXXX), (2) proceedings of conferences (NUREG/CP–XXXX), (3) reports resulting from international agreements (NUREG/IA–XXXX), (4) brochures (NUREG/BR–XXXX), and (5) compilations of legal decisions and orders of the Commission and Atomic and Safety Licensing Boards and of Directors' decisions under Section 2.206 of NRC's regulations (NUREG–0750).

NUREG-1840

Safety Evaluation Report
for an Early Site Permit (ESP) at
the Grand Gulf Site

Docket No. 52-009

Manuscript Completed: October 2005
Date Published: April 2006

Division of New Reactor Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Safety Evaluation of Early Site Permit Application in the Matter of System Energy Resources, Inc., a Subsidiary of Entergy Corporation, for the Grand Gulf Early Site Permit Site

Docket No. 52-009

April 2006

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

ABSTRACT

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission staff's technical review of the site safety analysis report and emergency planning information included with the early site permit (ESP) application submitted by System Energy Resources, Inc. (SERI or the applicant), a subsidiary of Entergy Corporation, for the Grand Gulf ESP site. By letter dated October 16, 2003, SERI submitted the application for the Grand Gulf ESP site in accordance with Subpart A, "Early Site Permits," of Title 10, Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," of the *Code of Federal Regulations* (10 CFR Part 52). The Grand Gulf ESP site is in Claiborne County in southwestern Mississippi. The ESP site identified in the application is collocated with the Grand Gulf Nuclear Station, Unit 1, near Port Gibson, Mississippi. In its application, SERI seeks approval of an ESP that could support a future application to construct and operate additional nuclear unit(s) at the ESP site, with total nuclear generating capacity of up to 8600 megawatts thermal (MWt), with a maximum 4300 MWt per unit.

This SER presents the results of the staff's review of information submitted in conjunction with the ESP application. The staff has identified, in Appendix A to this SER, certain site-related items that will need to be addressed at the combined license or construction permit stage, should an applicant desire to construct one or more new nuclear reactors on the Grand Gulf ESP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Section 1.7 of this SER, more appropriately addressed at later stages in the licensing process. Appendix A to this SER also identifies the proposed permit conditions that the staff recommends the Commission impose, should an ESP be issued to the applicant.

CONTENTS

In accordance with U.S. Nuclear Regulatory Commission Review Standard (RS)-002, “Processing Applications for Early Site Permits,” the chapter and section layout of this safety evaluation report is essentially consistent with the format of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants” (hereafter referred to as the SRP), Regulatory Guide 1.70, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants,” and the applicant’s site safety analysis report. Numerous sections and chapters in the SRP are not within the scope of or addressed in an early site permit (ESP) proceeding. The reader will therefore note “missing” chapter and section numbers in this document. The subjects of chapters and sections in the SRP not discussed herein will be addressed, as appropriate and applicable, in other licensing actions (design certification, construction permit, and/or combined license) for a reactor(s) that might be constructed on the Grand Gulf ESP site.

Appendices

Figures

Tables

EXECUTIVE SUMMARY

Title 10, Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," of the *Code of Federal Regulations* (10 CFR Part 52) contains requirements for the licensing, construction, and operation of new nuclear power plants.[1] These regulations address early site permits (ESPs), design certifications, and combined licenses (COLs). The ESP process (Subpart A, "Early Site Permits," of 10 CFR Part 52) is intended to address and resolve site-related issues. The design certification process (Subpart B, "Standard Design Certifications," of 10 CFR Part 52) provides a means for a vendor to obtain U.S. Nuclear Regulatory Commission (NRC) certification of a particular reactor design. Finally, the COL process (Subpart C, "Combined Licenses," of 10 CFR Part 52) allows an applicant to seek authorization to construct and operate a new nuclear power plant. A COL may reference an ESP, a certified design, both, or neither. It is incumbent on a COL applicant to resolve issues related to licensing that were not resolved as part of an ESP or design certification proceeding before the NRC can issue a COL.

This safety evaluation report (SER) describes the results of the NRC staff review of an ESP application submitted by System Energy Resources, Inc. (SERI or the applicant), a subsidiary of Entergy Corporation, for the Grand Gulf ESP site. The staff's review verified the applicant's compliance with the requirements of Subpart A of 10 CFR Part 52. This SER serves to identify the matters resolved in the safety review and to identify remaining items to be addressed by a future COL applicant referencing this ESP.

As required by 10 CFR Part 52, an applicant must submit an environmental report pursuant to 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Activities." The NRC reviews the environmental report as part of its responsibilities under the National Environmental Policy Act of 1969, as amended. The NRC presents the results of that review for public comment in a draft environmental impact statement, which is a report separate from this SER.

By letter dated October 16, 2003, SERI submitted ESP application (ADAMS Accession No. ML032960315)[2] for the Grand Gulf ESP site. The Grand Gulf ESP site is near Port Gibson, Mississippi, approximately 25 miles south of Vicksburg, Mississippi, and is adjacent to the existing nuclear power reactor operated by Entergy Operations, Inc.

In accordance with 10 CFR Part 52, the SERI ESP application includes (1) a description of the site and nearby areas that could affect or be affected by a new nuclear unit(s) located at the

---

[1] Applicants may also choose to seek a construction permit and operating license in accordance with 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," instead of using the 10 CFR Part 52 process.

[2] The Agencywide Documents Access and Management System (ADAMS) is the NRC's information system that provides access to all image and text documents that the NRC has made public since November 1, 1999, as well as bibliographic records (some with abstracts and full text) that the NRC made public before November 1999. Documents available to the public may be accessed via the Internet at http://www.nrc.gov/reading-rm/adams/web-based.html. Documents may also be viewed by visiting the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. Telephone assistance for using Web-based ADAMS is available at (800) 397-4209 between 8:30 a.m. and 4:15 p.m., eastern standard time, Monday through Friday, except Federal holidays. The staff is also making this SER available on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/grand-gulf.html.

site, (2) a safety assessment of the site on which the unit(s) would be located, including an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site, and (3) the proposed major features of emergency plans. The application describes how the site complies with the requirements of Subpart A of 10 CFR Part 52 and the siting criteria of 10 CFR Part 100, "Reactor Site Criteria."[3]

This SER presents the conclusions of the staff's review of information the applicant submitted to the NRC in support of the ESP application. Additionally, the staff has reviewed the information SERI provided to resolve the open and confirmatory items identified in the draft safety evaluation report (DSER) for the Grand Gulf ESP, issued on April 7, 2005. In Section 1.6 of this SER, the staff provides a brief summary of the process used to resolve these items; specific details on the resolution for each open item is presented in the corresponding section of this report.

The staff has identified, in Appendix A to this SER, the proposed permit conditions that it will recommend the Commission impose, should an ESP be issued to the applicant. Appendix A also includes a list of COL action items or certain site-related items that will need to be addressed should this ESP be referenced as a part of a COL or construction permit application. The staff determined that these deferred items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Section 1.7 of this SER, more appropriately addressed at later stages in the licensing process. In addition, Appendix A lists the site characteristics and the bounding parameters identified by the staff for the ESP site.

NRC inspections have verified, where appropriate, the conclusions in this SER. The scope of the inspections consisted of selected information in the ESP application and its references. This SER identifies applicable inspection reports as reference documents.

The NRC's Advisory Committee on Reactor Safeguards (ACRS) also reviewed the bases for the conclusions in this report. The ACRS independently reviewed those aspects of the application that concern safety, as well as the safety evaluation report, and provided the results of its review to the Commission in an interim report dated June 14, 2005, and in a final report dated December 23, 2005. This SER incorporates the ACRS comments and recommendations, as appropriate. Appendix E includes a copy of the report by the ACRS on the final safety evaluation, as required by 10 CFR 52.23, "Referral to the ACRS," and a copy of the two memoranda the staff sent the ACRS responding to their comments and recommendations.

---

[3]SERI also submitted information intended to partially address some of the general design criteria (GDC) in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50. Only GDC 2, "Design Bases for Protection Against Natural Phenomena," applies to an ESP application, and it does so only to the extent necessary to determine the safe-shutdown earthquake (SSE) and the seismically induced flood. The staff has explicitly addressed partial compliance with GDC 2, in accordance with 10 CFR 52.17(a)(1) and 10 CFR 50.34(a)(12), only in connection with the applicant's analysis of the SSE and the seismically induced flood. Otherwise, an ESP applicant need not demonstrate compliance with the GDC. The staff has included a statement to this effect in those sections of the SER that do not relate to the SSE or the seismically induced flood. Nonetheless, this report describes the staff's evaluation of information submitted by SERI to address GDC 2.

ABBREVIATIONS

ABWR	advanced boiling-water reactor
acre-ft	acre-foot/feet
ACR	Advanced CANDU Reactor
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Management System
ALARA	as low as reasonably achievable
ALI	annual limit on intake
ALWR	advanced light-water reactor
ANS	alert and notification system
ANS	American Nuclear Society
ANSI	American National Standards Institute
ANSS	Advanced National Seismic System
ANST	American Society for Nondestructive Testing
AP1000	Westinghouse Advanced Plant 1000
APE	annual probability of exceedance
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testings
ASTM	American Society for Testing and Materials
ASU	Alcorn State University
BE	best estimate
BRH	Bureau of Radiological Health
BWR	boiling-water reactor
CAR	corrective action report
CDE	committed dose equivalent
CEUS	central and eastern United States
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CH	fat clay
CL	clay layer
Co	cobalt
COL	combined license
COV	coefficient of variation
CP	construction permit
CPT	cone penetrometer test
Cs	cesium
CSP	corporate standard procedure
CU	consolidated undrained
DAC	derived air concentration
DBA	design-basis accident
DBE	design-basis event
DCD	design control document
DEIS	draft environmental impact statement
DHH	Department of Health and Hospitals
DOE	Department of Energy

DOT	Department of Transportation
DPF	design project flood
DRG	digital raster graph
DSER	draft safety evaluation report
EAB	exclusion area boundary
EAL	emergency action level
EAS	emergency alert system
ECFS	East Coast fault system
EGC	Exelon Generation Company
EDS	engineering design spectrum
EIS	environmental impact statement
EMI	Emergency Management Institute
ENPC	Entergy Nuclear Potomac Company
ENS	emergency notification system
EOC	emergency operations center
EOF	emergency operations facility
EPA	Environmental Protection Agency
EPIP	emergency plan implementing procedure
EPRI	Electric Power Research Institute
EPRI-TR	Electric Power Research Institute Technical Report
EPZ	emergency planning zone
ER	environmental report
ERDS	Emergency Response Data System
ERO	emergency response organization
ESBWR	economic and simple boiling-water reactor
ESE	east-southeast
ESP	early site permit
EST	earth science team
ETE	evacuation time estimate
ETSZ	Eastern Tennessee Seismic Zone
Eustis	Eustis Engineering Company, Inc.
FAA	Federal Aviation Administration
Fe	iron
FEMA	Federal Emergency Management Agency
fps	feet/foot per second
FRP	Federal Response Plan
FRERP	Federal Radiological Emergency Response Plan
FS	factor of safety
FSER	final safety evaluation report
ft^2	square feet
ft/mi	foot/feet per mile
ft/yr	foot/feet per year
GDC	general design criterion/criteria
GGNS	Grand Gulf Nuclear Station
gpd	gallons per day
gpm	gallons per minute
GSA	Geological Society of America
GT-MHR	gas turbine modular helium reactor

HEAR	hospital emergency and administrative radio
HMR	hydrometeorological report
Hz	hertz
in./h	inch(es) per hour
INPO	Institute of Nuclear Power Operations
IRIS	international reactor innovative and secure (project)
ISFSI	independent spent fuel storage installation
K_d	distribution coefficients
kg/m^3	kilogram(s) per cubic meter
KI	potassium iodide
km^2	square-kilometers
k_o	stress ratio parameter
km/s	kilometer(s) per second
kPa	kiloPascals
kW/m^2	kilowatt(s) per square meter
LB	lower bound
lbf/ft^2	pounds per square foot
LDEQ	Louisiana Department of Environmental Quality
LEOP	Louisiana Emergency Operations Plan
LLNL	Lawrence Livermore National Laboratory
LOA	letter of agreement
LOCA	loss-of-coolant accident
LOEP	Louisiana Office of Emergency Preparedness
LPRRP	Louisiana Peacetime Radiological Response Plan
LPZ	low-population zone
LSU	Louisiana State University
LWR	light-water reactor
M&TE	measuring and test equipment
Ma	million years before present
MAE	Mid American Earthquake
m_b	body-wave magnitude
MDOT	Mississippi Department of Transportation
MEERL	mobile environmental emergency response lab
MEMA	Mississippi Emergency Management Agency
MIDAS	meteorological information and dose assessment system
mi/hr	mile(s) per hour
mm/yr	millimeter(s) per year
mph	miles per hour
mrem/hr	millirem per hour
mrem/yr	millirem per year
MREPP	Mississippi Radiological Emergency Preparedness Plan
m/s	meter(s) per second
MSDH/DRH	Mississippi State Department of Health/Division of Radiological Health
MSL	mean sea level
mSv/yr	millisievert per year
Mw	moment magnitude
MWe	megawatt electric
MWt	megawatt thermal

NAD	North American Datum
NACOM	national communication system
NAWAS	national warning system
NCDC	National Climatic Data Center
NE	northeast
NEI	Nuclear Energy Institute
NEP	nuclear emergency preparedness
Ni	nickel
NIST	National Institute of Standards and Technology
NMSZ	New Madrid Seismic Zone
NNE	north-northeast
NOAA	National Oceanic and Atmospheric Administration
NPSEPT	nuclear power station emergency preparedness training
NRC	U.S. Nuclear Regulatory Commission
NSSL	National Severe Storms Laboratory
NSSS	nuclear steam supply system
NUPIC	Nuclear Procurement Issues Committee
NWS	National Weather Service
OBE	operating-basis earthquake
OCA	owner-controlled area
OL	operating license
OSC	operational support center
OW	observation well
P	compression
PAA	protection action area
PAG	protective action guide
PAR	protective action recommendation
PAZ	protective action zone
PBMR	pebble bed modular reactor
pcf	pound(s) per cubic feet
PDS	plant data system
pga	peak ground acceleration
PGCCCD	Port Gibson/Claiborne County Civil Defense
PGCCREPP	Port Gibson/Claiborne County Radiological Emergency Preparedness Plan
PI	project instruction
PMF	probable maximum flood
PMH	probable maximum hurricane
PMP	probable maximum precipitation
PMWP	probable maximum winter precipitation
PNNL	Pacific Northwest National Laboratory
PPBA	proposed powerblock area
PPE	plant parameter envelope
P-S	compression and shear
psf	pound(s) per square feet
PSHA	probabilistic seismic hazard analysis
psi	pound(s) per square inch
Q	seismic attenuation parameter
PWR	pressurized-water reactor

QA	quality assurance
QAPM	quality assurance program manual
QAPPD	quality assurance project planning document
RAA	remote assembly area
RACES	radio amateur civil emergency service
rem	roentgen equivalent man
RAI	request for additional information
RC	resonant column
REP	radiological emergency plan
RERP	radiological emergency response plan
RERT	radiological emergency response team
RG	regulatory guide
ROB	River Operations Branch
RQD	rock-quality designation
RS	review standard
S	shear
Sa	spectral acceleration
SC	clayey sand
SCR	stable continental region
SCS	Soil Conservation Service
SE	southeast
SEI	Structural Engineering Institute
SEOC	State emergency operations center
SER	safety evaluation report
SERI	System Energy Resources, Inc.
SF	scale factor
SMEPA	South Mississippi Electric Power Association
SMRAP	Southern Mutual Radiation Assistance Plan
SOG	Seismicity Owners Group
SOP	standard operating procedure
SP	poorly grade sand
SPF	standard project flood
SPT	standard penetration test
Sr	strontium
SRCC	Southern Regional Climate Center
SRP	Standard Review Plan
SRSZ	Saline River Source Zone
SSAR	site safety analysis report
SSC	structure, system, and component
SSE	safe-shutdown earthquake
SSI	soil structure iteration
SWR	service water reservoir
TEDE	total effective dose equivalent
TID	technical information document
TLD	thermoluminescent dosimeter
TS	torsional shear
TSC	technical support center

UB	upper bound
UFSAR	updated final safety analysis report
UHF	ultrahigh frequency
UHS	ultimate heat sink
UHRS	uniform hazard response spectrum
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
USCS	unified soil classification system
UT	University of Texas
UTM	universal transverse mercator
V/H	vertical-to-horizontal
WHTF	waste heat treatment facility
WLA	William Lettis & Associates
WUS	western United States
YMCA	Young Men's Christian Association

1. INTRODUCTION AND GENERAL DESCRIPTION

1.1 Introduction

System Energy Resources, Inc. (SERI or the applicant), filed an application with the U.S. Nuclear Regulatory Commission (NRC), docketed on October 16, 2003, for an early site permit (ESP) for a site the applicant designated as the Grand Gulf ESP site. The proposed site is located near Port Gibson, Mississippi, approximately 25 miles south of Vicksburg, Mississippi.

The staff has completed its review in the areas of seismology, geology, meteorology, and hydrology, as well as in the area of hazards to a nuclear power plant that could result from manmade facilities and activities on or in the vicinity of the site. The staff also assessed the risks of potential accidents that could occur as a result of the operation of a nuclear power plant(s) at the site and evaluated whether the site would support adequate physical security measures for a nuclear power plant(s). The staff evaluated whether the applicant's quality assurance measures were equivalent in substance to the measures discussed in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50). The NRC has found that such measures provide reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of structures, systems, and components (SSCs) important to safety would support satisfactory performance of such SSCs once in service. The staff also evaluated the adequacy of the applicant's program for compliance with the requirements of 10 CFR Part 21, "Reporting of Defects and Noncompliance." Finally, the staff reviewed the proposed major features of the emergency plan that SERI would implement if a new nuclear unit(s) were eventually to be constructed at the ESP site.

The SERI ESP application includes the site safety analysis report (SSAR), which describes the safety assessment of the site, as required by 10 CFR 52.17, "Contents of Applications." The public may inspect copies of this document via the Agencywide Documents Access and Management System (ADAMS)[1] using ADAMS Accession No. ML060830203. The documents are also available for public inspection at the NRC Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland, and at the Harriette Person Memorial Library in Port Gibson, Mississippi. This SER is available on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/grand-gulf.html. This SER is also available in ADAMS under Accession No. ML052860041. SERI revised its application to address the NRC staff requests for additional information (RAIs); updated versions of the ESP application are also available at these same locations. The NRC verified that revision of the SERI ESP application is consistent with information provided in the applicant's RAI responses.

---

[1] The Agencywide Documents Access and Management System (ADAMS) is the NRC's information system that provides access to all image and text documents that the NRC has made public since November 1, 1999, as well as bibliographic records (some with abstracts and full text) that the NRC made public before November 1999. Documents available to the public may be accessed via the Internet at http://www.nrc.gov/reading-rm/adams/web-based.html. Documents may also be viewed by visiting the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. Telephone assistance for using Web-based ADAMS is available at (800) 397-4209 between 8:30 a.m. and 4:15 p.m., eastern standard time, Monday through Friday, except Federal holidays. The staff is also making this SER available on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/grand-gulf.html.

This verification closed Confirmatory Item 1.1-1 identified in the draft safety evaluation report (DSER) for the Grand Gulf ESP site, issued April 7, 2005.

This report summarizes the results of the NRC staff's technical evaluation of the suitability of the proposed Grand Gulf ESP site for a nuclear power plant or plants falling within the plant parameter envelope (PPE) that SERI specified in its application. This SER delineates the scope of technical matters the staff considered in evaluating the suitability of the site. NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," issued May 2004, provides additional details on the scope and bases of the staff's review of the radiological safety and emergency planning aspects of a proposed nuclear power plant site. This review standard contains regulatory guidance based on NUREG-0800, Revision 3, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," issued July 1981 (hereinafter referred to as the Standard Review Plan). The Standard Review Plan reflects the many years of experience the NRC staff has had in establishing and promulgating guidance to enhance the safety of nuclear facilities, as well as in evaluating safety assessments. In addition, this SER documents the resolution of the open and confirmatory items identified in the DSER.

The applicant also filed an environmental report for the Grand Gulf ESP site in which it evaluated those matters relating to the environmental impact assessment that can be reasonably reviewed at this time. The staff discussed the results of its evaluation of the environmental report for the Grand Gulf ESP site in a draft environmental impact statement issued on April 21, 2005 (ADAMS Accession No. ML051110531; also available on the NRC reactor licensing public web site). The applicant has no plans to perform activities at the Grand Gulf ESP site under 10 CFR 50.10(e)(1) after receiving an ESP; therefore, it did not provide a site redress plan.

As described above, the applicant supplemented the information in the SSAR by providing revisions to the document. The staff reviewed these revisions to determine their impact on the conclusions in this SER. On October 21, 2005, the NRC issued its SER for the Grand Gulf ESP site and in light of a concern raised by the ACRS on the nature of the proposed site, the staff requested that SERI provide additional information to demonstrate compliance with 10 CFR Part 100. By letter dated March 8, 2006, SERI provided Revision 3 to the Grand Gulf ESP application. The changes reflected in Revision 3 of the application include SERI's alternate methodology for demonstrating compliance with 10 CFR Part 100. The majority of the differences between the October 21, 2005 FSER and this report are documented in section 2.2.3 of this report. The staff completed its review of the most recent version, Revision 3 of the SSAR, as documented throughout this report and, for the reasons set forth herein, finds it to be acceptable. The staff notes that the site characteristic of bluff height previously included in Appendix A no longer plays a role in the staff's evaluation , and has been deleted.

Appendix A to this SER contains the list of site characteristics, permit conditions, combined license (COL) action items, and the bounding parameters that the staff is recommending that the Commission include in any ESP that might be issued for the proposed site. Appendix B to this SER details a chronology of the principal actions and correspondence related to the staff's review of the ESP application for the Grand Gulf ESP site. Appendix C lists the references for this SER, Appendix D identifies the principal contributors to this report, and Appendix E includes a copy of the report by the ACRS.

1.2 General Site Description

The ESP site is a parcel of land on the Grand Gulf Nuclear Station (GGNS) site in Claiborne County in southwestern Mississippi. The site is on the east side of the Mississippi River about 25 miles south of Vicksburg, Mississippi, 6 miles northwest of Port Gibson, Mississippi, and 37 miles north-northeast of Natchez, Mississippi. The Grand Gulf Military Park borders a portion of the north side of the property, and the community of Grand Gulf is approximately 1.5 miles to the north.

The applicant stated that the GGNS site encompasses approximately 2100 acres of property. The site and its environs consist primarily of woodlands and farms. Within this area are two lakes, Gin Lake and Hamilton Lake. These lakes were once the channel of the Mississippi River and average about 8 to 10 feet in depth.

SERI, owner of the proposed site, is a wholly owned subsidiary of the Entergy Corporation. Other existing nuclear facilities licensed by the NRC are located on the GGNS site, including GGNS Unit 1 (Docket No. 50-416, NRC Facility Operating License No. NPF-29) and the Grand Gulf Independent Spent Fuel Storage Installation (ISFSI) (NRC Docket No. 72-50).

The ESP site is adjacent to the existing GGNS Unit 1, which is a single-unit nuclear generating plant capable of producing 3898 megawatt thermal (approximately 1353 megawatt electric gross). This boiling-water reactor, designed by General Electric, has been producing electricity since 1985.

The nearest communities include Port Gibson, Mississippi, approximately 6 miles southeast of the site; Newellton, Louisiana, approximately 12 miles west of the site; and St. Joseph, Louisiana, approximately 13 miles west-southwest of the site.

The transportation infrastructure within the region includes the Mississippi River, U.S. Interstate Highway 20 (a portion of which lies approximately 28 miles north of the GGNS site), and U.S. Interstate Highway 55 (a portion of which lies approximately 40 miles east of the GGNS site). U.S. Highway 65 runs north to south in Louisiana and lies approximately 9 miles to the west of the site, connecting to U.S. Highway 84 approximately 27 miles to the southeast of the site.

Recreational facilities near the site include the Grand Gulf Military Park, which borders a portion of the north side of the property, Lake Bruin State Park, Warner-Tully YMCA Camp, and several hunting and fishing clubs.

No military installations are located near the GGNS site area, and no missile sites are located in either Mississippi or Louisiana. The nearest military facility was England Air Force Base in Alexandria, Louisiana, approximately 100 miles to the southwest; however, it officially closed in 1993.

The nearest natural gas pipeline is 4.75 miles east of the site. No mining operations occur within the vicinity of the GGNS site.

No commercial airport facilities are located within 10 miles of the GGNS site. The nearest commercial airport is located in Jackson, Mississippi, approximately 65 miles northeast of the site. Five general/public aviation airports are located within the vicinity of the site and are only used for small planes.

1.3 Plant Parameter Envelope

The regulations at 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria," that apply to an ESP do not require an ESP applicant to provide specific design information. However, some design information is required to address 10 CFR 52.17(a)(1), which calls for "an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in § 50.34(a)(1) of this chapter."

In Section 1.3 of the ESP SSAR, SERI provided a list of postulated design parameters, referred to as the plant parameter envelope (PPE). The applicant stated that the PPE approach provides sufficient design details to support the NRC's review of the ESP application, while recognizing that new reactor technologies, not envisioned at the time SERI submitted its ESP application, may become available in the future. Therefore, the applicant stated that it based the PPE on data from selected reactor designs and that the PPE is intended to bound multiple reactor designs. The applicant also stated that the actual reactor design selected would be reviewed at the COL stage to ensure that the design fits within the PPE.

The applicant stated that it based the listing of plant parameters necessary to define the plant-site interface on previous industry-and Department of Energy-sponsored work performed in the early 1990s as part of the ESP Demonstration Program, as well as current reactor vendor design input data. As a result of earlier and current efforts, the applicant identified appropriate design parameters to include in the PPE through a systematic review of regulatory criteria and guidance, ESP application content requirements, and experience with previous site suitability studies. The plant parameters characterize (1) the functional or operational needs of the plant from the site's natural or environmental resources, (2) the plant's impact on the site and surrounding environs, and (3) the site-imposed requirements on the plant. The PPE values are generally based on certified design information and the best available information for as yet uncertified designs. Some of the values have been modified to include margin.

SERI developed a set of plant parameter values by considering the values provided by various reactor vendors and by applying appropriate conservatism, when required, to characterize the surrogate facility. As applicable, the most limiting (maximum or minimum) bounding value is selected. The complete set of plant parameter values describes, or envelops, the site-facility interface.

Tables 1.3-1 through 1.3-3 of the applicant's SSAR present the listing of parameters employed, the PPE values selected, and the site characteristic values used to assess the safety and environmental impact of constructing and operating the Grand Gulf ESP facility.

The applicant has stated that, through its PPE, it had sufficient design information to allow it to perform the evaluation required by 10 CFR 52.17(a)(1) to determine the adequacy of the proposed exclusion area and low-population zone (LPZ) for the site. Section 3.3 of the SSAR reports the results of this evaluation. In the evaluation, the applicant used design information limited to the rate of release of radioactivity to the environment as a result of a design-basis accident for hypothetical reactors similar to the two representative reactor types from different vendors.

In addition to the information supporting the dose consequence evaluation, the applicant provided other design information in its PPE. Because the applicant is not requesting that an ESP be issued referencing a particular reactor design, the staff's review criterion for the PPE is that the values be reasonable for a reactor(s) that might be constructed on the ESP site. The applicant's PPE is based on various reactor designs that are either certified by the NRC, are in the certification process, or may be submitted for certification in the future. The PPE references the following designs:

- Advanced Canada Deuterium Uranium (CANDU) Reactor (ACR-700) (Atomic Energy of Canada, Ltd.)
- Advanced Boiling-Water Reactor (General Electric)
- AP1000 (Westinghouse Electric Company)
- Economic and Simplified Boiling-Water Reactor (General Electric)
- Gas Turbine Modular Helium Reactor (General Atomics)
- International Reactor Innovative and Secure (IRIS) Project (consortium led by Westinghouse)
- Pebble Bed Modular Reactor (PBMR (Pty) Ltd.)

The staff reviewed the applicant's PPE values and found that they were not unreasonable. As previously noted, the applicant identified certain PPE values as appropriate for inclusion in an ESP, should one be issued. The staff also reviewed the applicant's proposed list of PPE values and identified certain PPE values as bounding parameters or controlling PPE values as discussed in the individual sections of this SER. A controlling PPE value, or bounding parameter value, is one that necessarily depends on a site characteristic. As the PPE is intended to bound multiple reactor designs, the NRC staff would review the actual design selected in a COL or construction permit (CP) application referencing any ESP that might be issued in connection with this application to ensure that the design fits within the bounding parameter values. Appendix A to this SER lists the bounding parameters identified for the Grand Gulf ESP site.

Should an ESP be issued for the Grand Gulf ESP site, an entity might wish to reference that ESP, as well as a certified design, in a COL or CP application. Such a COL or CP applicant must demonstrate that the site characteristics established in the ESP bound the postulated site parameters established for the chosen design, and that the design characteristics of the chosen design fall within the bounding parameter values specified in the ESP. Otherwise, the COL or CP applicant must demonstrate that the new design, given the site characteristics in the ESP, complies with the Commission's regulations. Should an entity wish to reference the ESP and a design that is not certified, the COL or CP applicant must demonstrate that the characteristics of the chosen design, in conjunction with the site characteristics established for the ESP, comply with the Commission's regulations.

1.4 Identification of Agents and Contractors

SERI is the applicant for the Grand Gulf ESP application; SERI authorized Entergy Nuclear Potomac Company (ENPC) (another Entergy subsidiary) to prepare the application. Furthermore, ENPC was the only participant in the review of the suitability of the Grand Gulf ESP site for a nuclear power plant. Enercon Services, Inc., under contract to ENPC, served as primary contractor for development of the ESP application, supplying personnel, systems, and project management.

Several subcontractors also assisted in developing the ESP application. William Lettis and Associates, Inc., performed geotechnical field investigations, geologic mapping and characterization of seismic sources, and sensitivity analyses. Black Diamond Consultants, Inc., provided emergency planning evaluations.

1.5 Summary of Principal Review Matters

This SER summarizes the results of the staff's technical evaluation of the Grand Gulf ESP site. The staff's evaluation included a review of the information and data the applicant submitted, with emphasis on the following matters:

- population density and land use characteristics of the site environs and the physical characteristics of the site, including seismology, meteorology, geology, and hydrology, to evaluate whether these characteristics were adequately described and were given appropriate consideration to determine whether the site characteristics are in accordance with the Commission's siting criteria (Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997," of 10 CFR Part 100)

- potential hazards to a new nuclear unit(s) that might be constructed on the ESP site posed by manmade facilities and activities (e.g., mishaps involving storage of hazardous materials (toxic chemicals, explosives), transportation accidents (aircraft, marine traffic, railways, pipelines), and the existing nuclear power plant)

- potential capability of the site to support the construction and operation of a new nuclear unit(s) with design parameters falling within those specified in the applicant's PPE under the requirements of 10 CFR Part 52 and 10 CFR Part 100

- suitability of the site for developing adequate physical security plans and measures for a new nuclear unit(s)

- proposed major features for an emergency plan to be developed, should the applicant decide to seek a license to construct and operate a new nuclear unit(s) on the ESP site, any significant impediments to the development of emergency plans for the Grand Gulf ESP site, and a description of contacts and arrangements made with Federal, State, and local government agencies with emergency planning responsibilities

- quality assurance measures applied to the information submitted in support of the applicant's ESP application and safety assessment

- the acceptability of the applicant's proposed exclusion area and LPZ under the dose consequence evaluation factors of 10 CFR 50.34(a)(1)

During its review, the staff held several meetings with representatives of the applicant and the applicant's contractors and consultants to discuss various technical matters related to the staff's review of the Grand Gulf ESP site (see Appendix B to this report). The staff also visited the site to assist in its evaluation of safety matters.

1.6 Summary of Open and Confirmatory Items

As a result of its review of SERI's application for the Grand Gulf ESP, the staff identified several issues that remained open at the time the DSER was issued. The staff considers an issue to be open if the applicant has not provided requested information and the staff is unaware of what will ultimately be included in the applicant's response. The staff assigned each of these issues a unique identifying number for tracking purposes that indicates the section of this report in which it is described. The resolution of each open item is discussed in the SER section in which it appears. For example, Section 2.1 of this report discusses Open Item 2.1-1.

In addition, the staff identified two confirmatory items in the DSER. An item is identified as confirmatory if the staff and the applicant have agreed on a resolution of the particular item, but the resolution has not yet been formally documented. The confirmatory item identified by the staff, which is discussed in detail in Section 17.3 of this SER, required verification of information obtained from the Internet. The staff determined that the applicant provided adequate quality assurance measures to authenticate and verify data retrieved from Internet Web sites and thus considers this confirmatory item complete.

The DSER was issued with 23 open items and two confirmatory items. As set forth in this report, all open items have been resolved and the confirmatory items have been completed. This SER documents the resolution of all the open and confirmatory items identified in the DSER.

1.7 Summary of Combined License Action Items

The staff has also identified certain site-related items that will need to be addressed at the COL or CP stage, should a COL or CP applicant desire to construct one or more new nuclear reactors on the Grand Gulf ESP site. This report refers to these items as COL action items. These COL action items relate to issues that are outside the scope of the SER. The COL action items do not establish requirements; rather, they identify a set of information to be included in the site-specific portion of the safety analysis report submitted by a COL or CP applicant referencing the Grand Gulf ESP. An applicant for a COL or CP should address each of these items in its application. The staff determined that the COL action items do not affect its regulatory findings at the ESP stage and are, for reasons specified in this report for each item, more appropriately addressed at later stages in the licensing process.

At the time the DSER was issued, there were 18 COL action items. The staff reviewed the responses to open items provided by the applicant and identified a number of new COL action items as a result. This report highlights these COL action items, and the staff explains them in the applicable sections of this SER. Appendix A to this SER includes a list of COL action items that must be addressed by a future COL or CP applicant. The staff identified COL action items with respect to individual site characteristics to ensure that particularly significant issues are tracked and considered during the COL or CP stage. The list of COL action items is not and should not be considered exhaustive.

1.8 Summary of Permit Conditions

The staff has identified certain permit conditions that it will recommend the Commission impose, should an ESP be issued to the applicant. Appendix A to this SER summarizes these conditions. These permit conditions, or limitations on the ESP, stem from the provisions of 10 CFR 52.24, "Issuance of Early Site Permit."

At the time the DSER was issued, the staff had proposed a total of 10 permit conditions. This report discusses these permit conditions, which are identified with a unique assigned number to indicate the corresponding section of the DSER in which the condition was described. The applicant provided responses to the DSER open items which resulted in the resolution of some proposed DSER permit conditions. In addition, the staff determined that a permit condition is not necessary when an existing NRC regulation requires a future regulatory review and approval process to ensure adequate safety during design, construction, or inspection activities for a new plant. Based on this criterion, the staff removed a number of permit conditions proposed in the DSER and, in some cases, added new permit conditions, COL action items, or site characteristics, as appropriate, to account for the concern.

Appendix A to this SER contains the final list of permit conditions which have been highlighted throughout this report. Each permit condition has been reassigned a number identifying the sequence in which it appears in the SER. An explanation of each permit condition is provided in the applicable section of this report.

2. SITE CHARACTERISTICS

2.1 Geography and Demography

2.1.1 Site Location and Description

2.1.1.1 Technical Information in the Application

In Section 2.1.1.1 of the site safety analysis report (SSAR) for the Grand Gulf Nuclear Station (GGNS) early site permit (ESP) site, the applicant presented information concerning site location and site area that could affect the design of structures, systems, and components (SSCs) important to the safety of a nuclear power plant(s) falling within the applicant's plant parameter envelope (PPE) that might be constructed on the proposed ESP site.

The applicant provided the following information on site location and site area:

- the site boundary for a new unit(s) in the proposed ESP site with respect to the location of GGNS, Unit 1
- the site location with respect to political subdivisions and prominent natural and manmade features of the area within the 2-mile low-population zone (LPZ) and 50-mile population zone
- the topography surrounding the proposed ESP site
- the distance from the proposed ESP site to the nearest exclusion area boundary (EAB), including the direction and distance
- the location of potential radioactive material release points associated with a proposed new unit(s)
- the distance of the proposed site from regional U.S. and State highways
- confirmation that no physical characteristics unique to the proposed ESP site were identified that could pose a significant impediment to the development of emergency plans

2.1.1.2 Regulatory Evaluation

Sections 1.4 and 2.1.1 of the SSAR identify the applicable U.S. Nuclear Regulatory Commission (NRC) regulations and guidance regarding site location and description, as defined in Title 10, Section 52.17, "Contents of Applications," of the *Code of Federal Regulations* (10 CFR 52.17); 10 CFR Part 100, "Reactor Site Criteria"; and 10 CFR 50.34(a)(1), as well as NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," issued May 2004. The staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance, as identified above.

The staff considered the following regulatory requirements in reviewing the site location and site area:

- 10 CFR Part 100, insofar as it requires consideration of factors relating to the size and location of sites

- 10 CFR 52.17, insofar as it requires the applicant's submission of information needed to evaluate factors involving the characteristics of the site environs

According to Section 2.1.1 of RS-002, an applicant has submitted adequate information if it satisfies the following criteria:

- The site location, including the exclusion area and the proposed location of a nuclear power plant(s) of specified type falling within a PPE that might be constructed on the proposed site, is described in sufficient detail to determine that the requirements of 10 CFR Part 100 and 10 CFR 52.17 are met, as discussed in Sections 2.1.2, 2.1.3, and 3.3 of this safety evaluation report (SER).

- Highways, railroads, and waterways that traverse the exclusion area are sufficiently distant from planned or likely locations of any structures of a nuclear power plant(s) of specified type falling within a PPE that might be constructed on the proposed site to ensure that routine use of these routes is not likely to interfere with normal plant operation.

2.1.1.3 Technical Evaluation

The proposed new ESP site is located within the existing GGNS site property boundary. Figure 2.1-2 of the SSAR depicts the site boundary for a new unit(s) in the proposed ESP site with respect to the existing GGNS. The applicant identified the universal transverse mercator (UTM) grid coordinates for the new unit(s) in the proposed ESP site as N3,542,873 meters and E684,021 meters. In Request for Additional Information (RAI) 2.1-1, the staff asked the applicant to provide the latitude and longitude of the proposed new reactor site, complete with UTM zone numbers. In response, the applicant stated that the UTM coordinates for UTM Zone 15 correspond to a latitude and longitude of 32°00′23.565415″ N and 91°03′06.420908″ W using the International Ellipsoid.

The applicant elected to define the EAB as a circular radius of 2760 feet (0.52 miles) and the LPZ as a circular radius of 2 miles, both from the circumference of a 630-foot circle encompassing the proposed powerblock housing the reactor containment structure for new unit(s). The EAB of a new unit(s) is wholly contained within the GGNS site property boundary. The applicant established the EAB and the LPZ to ensure that the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) and the siting evaluation factors in Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997," of 10 CFR Part 100 are met. No residents are within the proposed EAB. The staff has verified that the exclusion area distance is consistent with the distance used in the radiological consequence analyses performed by the applicant in Section 3.3 of the SSAR.

The existing GGNS and the proposed ESP site are in Claiborne County in southwestern Mississippi. The proposed ESP site is on the east side of the Mississippi River about 25 miles south of Vicksburg, Mississippi, and 37 miles north-northeast of the town of Natchez, Mississippi. The town of Port Gibson is about 6 miles southeast of the proposed ESP site. The GGNS site, which includes one existing nuclear power unit and the proposed ESP site, encompasses approximately 2100 acres. The largest community within 50 miles of the proposed ESP site is Vicksburg with a 2000 population of 26,407. No highways, railroads, and waterways traverse the proposed ESP exclusion area site boundary.

The applicant stated that the gaseous effluent release point is assumed to be within the proposed construction area designated for the new facility powerblock, and the liquid effluent release point for the new units would apply at the river downstream of the new facility intake to preclude recirculation to the embalmment area and intake pipes. The staff finds that these release points are acceptable for determining that the radiation exposures to the public to meet the criterion "as low as is reasonably achievable," cited in Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable,' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." (See discussion of this subject in Section 5.9 of the staff's environmental impact statement for the Grand Gulf ESP application.)

For the reasons set forth in Section 13.3 of this SER, the staff further finds that the applicant did not identify any physical characteristics unique to the proposed ESP site that could pose a significant impediment to the development of emergency plans.

2.1.1.4 Conclusions

As set forth above, the applicant has provided and substantiated information concerning site location and site area that could affect the design of SSCs important to safety of a nuclear power plant(s) of specified type falling within the applicant's PPE that might be constructed on the proposed ESP site. The staff has reviewed the applicant's information as described above and concludes that it is sufficient for the staff to evaluate compliance with the siting evaluation factors in 10 CFR Part 100 and 10 CFR 52.17, as well as with the radiological consequence evaluation factors in 10 CFR 50.34(a)(1). The staff further concludes that the applicant provided sufficient details about the site location and site area to allow the staff to evaluate, as documented in Sections 2.1.2, 2.1.3, and 3.3 of this SER, whether the applicant has met the relevant requirements of 10 CFR Part 100 and 10 CFR 52.17.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Technical Information in the Application

In SSAR Section 2.1.2.1, the applicant presented information concerning its plan to obtain legal authority to determine all activities within the designated exclusion area, if it decides to proceed with the development of a new reactor unit(s) at the proposed ESP site. The applicant stated the following:

> For all practical purposes, SERI (the applicant) controls the surface right, and The applicant has authorized Entergy Operations (for GGNS, Unit 1) to maintain control of ingress to and egress from the exclusion area and provides for evacuation of individuals from the area in the event of an accident.... A similar

> arrangement would be made for exercise of authority over the area within the exclusion area for the new facility on the site property....

In RAI 2.2-1, the staff asked the applicant for additional information regarding its approach for making such arrangements before issuing the Grand Gulf ESP. In its response, the applicant stated that, “this arrangement would not be made prior to issuance of the Grand Gulf ESP. Such arrangement would be made associated with a Combined License application.”

2.1.2.2 Regulatory Evaluation

In SSAR Table 1.4-1 and in RAI 1.4-1, the applicant identified the applicable NRC regulations and regulatory guidance regarding exclusion area authority and control related to Subpart A, “Early Site Permits,” of 10 CFR Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants,” and 10 CFR Part 100.

In reviewing the applicant’s legal authority to determine all activities within the designated exclusion area, the staff considered the relevant requirements of 10 CFR 100.3, “Definitions,” which state the following:

> Exclusion area means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety.... Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

2.1.2.3 Technical Evaluation

Figure 2.1-1 of the SSAR depicts the boundary lines of the current exclusion area and of the proposed exclusion area for the new unit(s). The exclusion area for the new unit(s) is larger than the current GGNS exclusion area and includes a majority of the GGNS exclusion area. The EAB for the new unit(s) consists of a circle of approximately 2760-feet radial distance from the circumference of a 630-foot circle encompassing the proposed powerblock housing the reactor containment structure for the new unit(s). No U.S. or State highways, railways, or waterways traverse the proposed ESP exclusion area for the new unit(s).

One county road (Grand Gulf Road) runs through the GGNS plant site property and another county road (Bald Hill Road) traverses the proposed ESP EAB. The applicant stated that Entergy Operations currently allows access to parts of the plant site property for recreational purposes and that arrangements have been made for control of traffic on the county road during a declared emergency involving GGNS Unit 1. With respect to the proposed exclusion area, the applicant stated that it would make similar arrangements with the appropriate law enforcement authorities for control of traffic on the county road in the event of a declared emergency involving the new unit(s). The emergency plan (see Section 13.3.3.3 of this SER) describes these arrangements in more detail. The applicant further stated that because the portion of

Bald Hill Road that traverses the exclusion area is also located within a potential construction usage area, it may become necessary to relocate that portion of the road during construction of any new nuclear units.

The applicant stated that it has authorized Entergy Operations to maintain control of ingress and egress from the current exclusion area for GGNS Unit 1 and to evacuate individuals from the area in the event of an emergency. The applicant further stated that it would make a similar arrangement to authorize the operator of the new unit(s) to maintain control of ingress to and egress from the new proposed ESP exclusion area and to provide for evacuation of individuals from the new proposed ESP exclusion area in the event of an emergency.

The applicant has surface ownership of the land within the plant site property boundary, with certain exceptions described herein. South Mississippi Electric Power Association (SMEPA) maintains a 10-percent undivided ownership interest in the property associated with the existing GGNS power plant and support facilities. SMEPA also maintains certain easement rights associated with the property. Pursuant to the Grand Gulf Nuclear Station Operating Agreement, signed on June 6, 1990, Systems Energy Resources, Inc. (SERI), is authorized to act as the general agent for SMEPA with respect to construction and operation of GGNS.

Additionally, Entergy Mississippi, Inc., owns the 52-acre plant switchyard area, which is partially located within the plant exclusion area. The applicant, however, has authority to exercise complete control and determine all activities in the exclusion area, including exclusion of Entergy Mississippi, Inc., personnel and third parties. The applicant has transferred such rights to Entergy Operations. The applicant stated that it would arrange to authorize the operator of the new unit(s) to exercise similar control in the exclusion area. Entergy Mississippi, Inc., also has easements or rights of way for two transmission lines, neither of which are located within the proposed exclusion area.

The applicant owns most of the mineral interests within the exclusion area. However, no evidence exists to suggest that third parties will exercise their rights to such minerals. Therefore, based on its review, the staff concludes that it is extremely unlikely that such third party interests would ever be exercised so as to create an exception to the applicant and Entergy Operation’s control of the exclusion area.

The applicant has stated that for all practical purposes, it controls the surface rights within the ESP exclusion area. The applicant has further stated that at such time as it elects to apply for a combined license (COL), it intends to have entered into an agreement with the selected operator of the new unit(s) to authorize the operator to exercise complete control and determine all activities within the exclusion area, including maintaining control of ingress to and egress from the exclusion area, and to provide for the evacuation of individuals from the area in the event of an emergency. The applicant stated that this agreement will be similar to its agreement with Entergy Operations, the operator of GGNS Unit 1. The applicant stated that at the time an application for a COL is submitted, arrangements would also be in place with the selected operator and the appropriate State and local law enforcement authorities for control of traffic on county roads traversing the ESP exclusion area in the event of an emergency.

To meet the exclusion area control requirements of 10 CFR 100.21(a) and 10 CFR 100.3, the applicant does not need to demonstrate total control of the property before issuance of the ESP. In the draft safety evaluation review (DSER), the NRC staff stated that the applicant must provide reasonable assurance that it can acquire the required control (i.e., that it has the legal right to obtain control of the exclusion area). The staff had not then obtained information sufficient to enable it to determine whether the applicant had such a legal right. Accordingly, the NRC staff identified DSER Open Item 2.1-1, which required the applicant to demonstrate that it "has control over the exclusion area or has a right to obtain such control."

In its response to the open item, the applicant indicated that at the time it applies for a COL referencing the Grand Gulf ESP to construct and operate any new unit(s) at the Grand Gulf ESP site, it will have arrangements in place authorizing the operator of the new unit(s) to exercise control within the ESP exclusion area, to maintain control of ingress to and egress from the ESP exclusion area, and to evacuate individuals from the exclusion area in the event of an emergency.

Based on the above information, the staff concludes that the applicant appears to have sufficient authority to determine all activities in the exclusion area, including the ability to exclude or remove individuals and property from the area. The staff has determined that the applicant is prepared to secure the arrangements described above, and there does not appear to be any reason why the ESP holder could not obtain control of the exclusion area in this manner. In addition, there does not appear to be any legal impediment to the applicant securing the described arrangements.

Accordingly, the NRC staff will include a condition in any ESP that might be issued regarding the Grand Gulf site to govern exclusion area control as **Permit Condition 1**. This permit condition requires an applicant for a COL referencing this ESP to demonstrate that it has been granted the right to exercise sufficient control within the exclusion area identified in the ESP, including the authority to maintain ingress to and egress from the exclusion area and to evacuate individuals from the exclusion area in the event of an emergency. The permit condition also requires a COL applicant referencing this ESP to secure any necessary arrangements to provide, in the event of a declared emergency, for the control of traffic on county roads and the evacuation of individuals within the ESP exclusion area. The condition requires that these arrangements be obtained and executed before the granting of an application referencing the ESP. Therefore, DSER Open Item 2.1-1 is closed.

2.1.2.4 Conclusions

As set forth above, the applicant has provided information concerning its plan to obtain legal authority to determine all activities within the designated exclusion area. The staff has reviewed the applicant's information and concludes that it is sufficient to assure compliance with the exclusion area control requirements of 10 CFR 100.21(a) and 10 CFR 100.3. In addition, the applicant has appropriately described the exclusion area and the methods by which it will control access and occupancy of this exclusion area during normal operation and in the event of an emergency situation.

The applicant has demonstrated that it currently has the authority to determine all activities, including exclusion or removal of personnel and property from the proposed exclusion area, as required by 10 CFR Part 100. Additionally, the staff concludes that the proposed permit condition provides reasonable assurance that if the ESP is referenced as part of an application for a COL or construction permit (CP), the applicant has adequate control of the exclusion area.

2.1.3 Population Distribution

2.1.3.1 Technical Information in the Application

In SSAR Section 2.1.3, the applicant estimated and provided the population distribution surrounding the proposed ESP site, up to a 50-mile radius from the center of the proposed powerblock location for a new facility on the proposed ESP site, based on the most recent U.S. census. The applicant also provided in this section the resident population distribution within the LPZ, the nearest population center, and population densities up to a 30-mile radius from the proposed ESP site.

The population distribution provided by the applicant encompasses 9 concentric rings at various distances up to 50 miles and 16 directional sectors from the proposed ESP site. The applicant projected population estimates up to 2070, 5 years beyond the projected year for end of new plant life. The applicant also estimated and provided transient population based on recreational use of Grand Gulf Military Park, Warner-Tully YMCA camp, Lake Claiborne, hunting camps, and fishing.

The applicant described the LPZ and illustrated it in Figure 2.1-5 of the SSAR. The LPZ for a new unit(s) includes a 2-mile radial distance measured from the circumference of a 630-foot circle encompassing the proposed powerblock location for a new unit. The applicant listed facilities and institutions within 5 miles of the proposed ESP site in SSAR Table 2.1-3. In Tables 2.1-1 and 2.1-2 of the SSAR, the applicant provided the cumulative population in 2002 and the projected cumulative population in 2070, as functions of the 10-mile to 50-mile radial distance from the proposed ESP site.

In Tables 2.1-5 and 2.1-6 of the SSAR, the applicant provided the population densities in 2030 and 2070 at distances of 10, 20, and 30 miles from the proposed ESP site. In RAI 2.1.3-3, the staff requested that the applicant clarify whether the current and projected population data shown in SSAR Tables 2.1-1 and 2.1-2 include the weighted transient population. In its response dated August 16, 2004, the applicant stated that the data do not include the weighted transient population.

Subsequently, in its response to the Grand Gulf ESP DSER open items dated June 21, 2005, the applicant provided projections of estimated total population for 2002, 2030, and 2070, including weighted transient population, for the Grand Gulf ESP site.

The applicant described the LPZ in Section 2.1.3.4 of the SSAR. The LPZ is defined in 10 CFR 100.3 as “the area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident.” The LPZ for the ESP site is essentially the same as the LPZ for the existing GGNS Unit 1; it consists of a circle with a radius of 2 miles measured from the circumference of a 630-foot circle encompassing the proposed powerblock location for a new unit. The LPZ for GGNS Unit 1 is a circle with a radius of 2 miles centered on the GGNS Unit 1 reactor.

The applicant described the population center in Section 2.1.3.5 of the SSAR. The population center is defined in 10 CFR 100.3 as a densely populated area containing more than 25,000 residents. The applicant stated that the nearest population center with a population greater than 25,000 people that is likely to exist over the lifetime of the proposed ESP site is the city of Vicksburg, Mississippi, with a 2000 population of 26,407. The closest point of Vicksburg, Mississippi, is 25 miles north-northeast of the ESP site. The next closest population center is Jackson, Mississippi, which is 55 miles to the northeast of the proposed ESP site and has a population of 184,256.

In RAI 2.1.3-2, the staff asked the applicant to describe appropriate protective measures that could be taken on behalf of the populace in the LPZ in the event of a reactor accident. In its response, the applicant stated that offsite protective measures are the responsibility of the applicable State and local governments and referred to the emergency plan included in its June 3, 2004, submission to the staff.

2.1.3.2 Regulatory Evaluation

In SSAR Table 1.4-1 and in its response to RAI 1.4-1, the applicant identified the applicable NRC regulations and regulatory guidance regarding population distribution, as described in 10 CFR 52.17; 10 CFR Part 100; Regulatory Guide (RG) 4.7, Revision 1, "General Site Suitability Criteria for Nuclear Power Stations," issued April 1998; and RS-002. The staff finds that the applicant correctly identified the applicable regulations and guidance.

The staff considered the following regulatory requirements in its review of this section of the SSAR:

- 10 CFR 52.17, as it relates to each applicant providing a description and safety assessment of the site, with special attention to the site evaluation factors identified in 10 CFR Part 100

- 10 CFR Part 100, insofar as it establishes requirements with respect to population density

In particular, the staff considered the population density and use characteristics of the site environs, including the exclusion area, LPZ, and population center distance. The regulations in 10 CFR Part 100 also provide definitions and other requirements for determining an exclusion area, LPZ, and population center distance.

As stated in Section 2.1.3 of RS-002, the applicable requirements of 10 CFR 52.17 and 10 CFR Part 100 are deemed to have been met if the population density and use characteristics of the site meet the following criteria:

- Either there are no residents in the exclusion area, or if residents do exist, they are subject to ready removal, in case of necessity.

- The specified LPZ is acceptable if it is determined that appropriate protective measures could be taken on behalf of the enclosed populace in the event of a serious accident.

- The population center distance is at least 1 1/3 times the distance from the reactor to the outer boundary of the LPZ. The population center distance is defined in 10 CFR 100.3 as "the distance from the reactor to the nearest boundary of a densely populated center consisting of more than about 25,000 residents."

- The population center distance is acceptable if there are no likely concentrations of greater than 25,000 people over the lifetime (plus the term of the ESP) of a nuclear power plant(s) of specified type or falling within a PPE that might be constructed on the proposed site closer than the distance designated by the applicant as the population center distance. The boundary of the population center will be determined upon considerations of population distribution. Political boundaries are not controlling.

- The population data supplied by the applicant in the safety assessment are acceptable if (1) they contain population data for the latest census, projected year(s) of startup of a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site (such date or dates reflecting the term of the ESP), and projected year(s) of end-of-plant life, all in the geographical format given in Section 2.1.3 of RG 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition," issued November 1978, (2) they describe the methodology and sources used to obtain the population data, including the projections, (3) they include information on transient populations in the site vicinity, and (4) the population data in the site vicinity, including projections, are verified to be reasonable by other means, such as U.S. Census Bureau publications, publications from State and local governments, and other independent projections.

- If the population density at the ESP stage exceeds the guidelines given in RG 4.7, special attention to the consideration of alternative sites with lower population densities is necessary. A site that exceeds the population density guidelines of Regulatory Position C.4 of RG 4.7, can nevertheless be selected and approved if, on balance, it offers advantages compared with available alternative sites when all of the environmental, safety, and economic aspects of the proposed and alternative sites are considered.

2.1.3.3 Technical Evaluation

The staff reviewed the data on the population in the site environs, as presented in the applicant's SSAR, to determine whether the exclusion area, LPZ, and population center distance for the proposed ESP site comply with the requirements of 10 CFR Part 100 and the acceptance criteria in Section 2.1.3.2 of this SER. The staff also evaluated whether, consistent with Regulatory Position C.4 of RG 4.7, the applicant should consider alternative sites with lower population densities. The staff also reviewed whether appropriate protective measures could be taken on behalf of the enclosed populace within the emergency planing zone (EPZ), which encompasses the LPZ, in the event of a serious accident.

The staff compared and verified the applicant's population data against U.S. Census Bureau Internet data. As documented in Section 13.3 of this SER, the staff reviewed the projected population data provided by the applicant, including the weighted transient population for 2002, 2030, and 2070. If the NRC were to approve and issue the ESP in 2006, assuming a COL application is submitted near the end of the ESP term, with a projected startup of new units in about 2025 and an operational period of 40 years for the new units, the projected year for end-of-plant life is about 2065. Accordingly, the staff finds that the applicant's projected population data cover an appropriate number of years and are reasonable.

The staff reviewed the transient population information provided by the applicant in SSAR Section 2.1.3.3. The transient population is based on recreational use of Grand Gulf Military Park, Warner-Tully YMCA camp, Lake Claiborne, hunting camps, and fishing. In RAI 2.1.3-3, the staff requested that the applicant clarify whether the current and projected population data shown in Tables 2.1-1 and 2.1-2 of the SSAR include the weighted transient population. In its response, the applicant stated that they do not include the weighted transient population. This was the Grand Gulf DSER Open Item 2.1-2.

Subsequently, in its response to the Grand Gulf ESP DSER open items dated June 21, 2005, the applicant provided projections of estimated total population for 2002, 2030, and 2070, including weighted transient population for the Grand Gulf ESP site. Tables 2.1-5 and 2.1-6 of the GGNS SSAR, Revision 2, present this information. Therefore, DSER Open Item 2.1-2 is closed.

The staff reviewed the transient population data provided by the applicant. The transient population up to a 10-mile radius includes transient work force, recreation transients, and special facilities. GGNS Unit 1 is the most significant employer within the 10-mile EPZ. Therefore, the majority of the transient workforce within 10 miles of the ESP site commutes to GGNS. No other major industry, employing more than 250 people, is located within a 10-mile radius of GGNS. Recreational transients include visitors to Grand Gulf State Park, Lake Claiborne, various other recreation areas, and hunters/fishermen. Special facilities include schools and nursing homes. The transient population up to a 30-mile radius of the ESP site includes the Vicksburg National Military Park, the National Cemetery, the historic downtown area, and numerous gambling facilities docked on the Mississippi or Yazoo Rivers.

The applicant collected information concerning transient population from a number of organizations involved in monitoring recreational tourist traffic, the Vicksburg Convention and Visitor's Bureau, and the Louisiana Office of Tourism. Based on this information, the staff finds that the applicant's estimate of the transient population is reasonable.

The applicant evaluated representative design-basis accidents (DBAs) in Section 3.3 of the SSAR. The staff independently verified the applicant's evaluation in Section 3.3 of this SER to demonstrate that the radiological consequences of DBAs at the proposed LPZ would be within the dose consequence evaluation factors set forth in 10 CFR 50.34(a)(1).

The nearest population center with a population greater than 25,000 people which is likely to exist over the lifetime of the proposed ESP site is the city of Vicksburg, Mississippi, with a 2000 population of 26,407. The closest point of Vicksburg, Mississippi, is 25 miles north-northeast of the ESP site. The next closest population center is Jackson, Mississippi, which is 55 miles to the northeast of the proposed ESP site and has a population of 184,256. The distances to Vicksburg and Jackson, the nearest population centers, are well in excess of the minimum population center distance of 2.7 miles (1 1/3 times the distance of 2.06 miles from the reactor to the outer boundary of the LPZ). In addition, no population centers are closer than the population center distance specified by the applicant.

Therefore, the staff concludes that the proposed ESP site meets the population center distance requirement, as defined in 10 CFR Part 100. The staff has determined that no realistic likelihood exists that there will be a population center with 25,000 people within the 7.8-mile minimum population center distance during the lifetime of any new unit(s) that might be constructed on the site. The staff based this conclusion on projected cumulative resident and transient population within 10 miles of the site during the lifetime of any new unit(s) (i.e., 2025–2065).

The staff evaluated the site against the criterion in Regulatory Position C.4 of RG 4.7 regarding whether it is necessary to give special attention to the consideration of alternative sites with lower population densities. The criterion is whether the population densities in the vicinity of the proposed site, including weighted transient population, projected at the time of initial site approval and within about 5 years thereafter, would exceed 500 persons per square mile averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the area at that distance).

The staff determined that such population densities for the proposed site would be well below this criterion. Therefore, the staff concludes that the site conforms to Regulatory Position C.4 in RG 4.7. Based on the assumption that construction of a new nuclear reactor(s) at the proposed site would begin near the end of the term of the ESP, as well as its review of the applicant's population density data and projections, the staff finds that the site also meets the guidance of RS-002 regarding population densities over the lifetime of facilities that might be constructed at the site because the population density over that period would be expected to remain below 500 persons per square mile averaged out to 20 miles from the site.

The staff reviewed information provided by the applicant regarding its ability to take appropriate protective measures on behalf of the populace in the LPZ in the event of a serious accident. In RAI 2.1.3-2, the staff asked The applicant to describe appropriate protective measures that could be taken on behalf of the populace in the LPZ in the event of a reactor accident. In its response, the applicant stated that offsite protective measures are the responsibility of the applicable State and local governments and referred to the emergency plan included in its June 3, 2004, submission to the staff.

The staff finds that the applicant's response is satisfactory because it is consistent with emergency planning for the 10-mile plume exposure EPZ. The LPZ is located entirely within the 10-mile EPZ. Comprehensive emergency planning for the protection of all persons within the 10-mile EPZ, as addressed in Section 13.3 of this SER, would include those persons within the LPZ. Based on the information the applicant presented on this subject, and on the staff's conclusions discussed in Section 13.3 of this SER, the staff concludes that appropriate protective measures could be taken on behalf of the enclosed populace within the LPZ in the event of a serious accident.

2.1.3.4 Conclusions

As set forth above, the applicant has provided an acceptable description of current and projected population densities in and around the site. These densities projected at the time of initial plant operation (if one were to be constructed on the site), and within about 5 years thereafter, are within the guidelines of Regulatory Position C.4 of RG 4.7. The applicant has properly specified the LPZ and population center distance. The staff finds that the proposed LPZ and population center distance meet the definitions in 10 CFR 100.3. Therefore, the staff concludes that the applicant's population data and population distribution are acceptable and meet the requirements of 10 CFR 52.17 and 10 CFR Part 100. In Chapter 15 of this SER, the staff documents that the radiological consequences of bounding DBAs at the outer boundary of the LPZ meet the requirements of 10 CFR 52.17.

2.2 Nearby Industrial, Transportation, and Military Facilities

2.2.1–2.2.2 Identification of Potential Hazards in Site Vicinity

For its ESP application, the applicant provided information on the relative location and separation distance of the site from industrial, military, and transportation facilities and routes. Such facilities and routes include air, ground, and water traffic; pipelines; and fixed manufacturing, processing, and storage facilities. Section 2.2 of the SSAR presents information concerning the industrial, transportation, and military facilities in the vicinity of the proposed ESP site. The NRC staff focused its review on potential external hazards or hazardous materials that are present or which may reasonably be expected to be present during the projected lifetime of a nuclear power plant(s) that might be constructed on the proposed site. The staff has prepared Sections 2.2.1–2.2.2 and 3.5.1.6 of this SER in accordance with the procedures described in RS-002 using information presented in SSAR Section 2.2, responses to staff RAIs, and the reference materials described in the applicable sections of RS-002.

2.2.1.1–2.2.2.1 Technical Information in the Application

In SSAR Section 2.2, the applicant presented information concerning the industrial, transportation, and military facilities in the vicinity of the proposed ESP site. The applicant further stated that the proposed site is located in Claiborne County, Mississippi, which is a rural and agricultural area where forest products are the leading industry. In Section 2.2.1 of the SSAR, the applicant stated that no military installations, industrial facilities, mining operations, or airports exist within 5 miles of the ESP site. Table 2.2-6 of the SSAR details the location of commercial or municipal airports in the wider region around the ESP site. The applicant stated that the Mississippi River passes 1.1 miles west of the proposed ESP facility location, and State Route 61 passes within 4.75 miles of the ESP site. The applicant also identified several airports in the region, located from 11 to 65 miles from the ESP site, as well as two commercial airways, V245 and V417, that cross the wider region around the ESP site. Airway V245 passes closest to the ESP site, about 10 miles to the southeast.

In Section 2.2.2.1 of the SSAR, the applicant stated that the closest operating industrial facilities are located 6 miles to the southeast of the ESP site in southeast Port Gibson. In Section 2.2.2.2 and Table 2.2-4 of the SSAR, the applicant reported the amount of hazardous chemicals transported by river in 2000. The applicant also discussed the operation of Port Claiborne, a small barge port at river mile 404.8, used for shipping forest and agricultural products. In SSAR Table 2.2-5, the applicant detailed the storage of hazardous chemicals at the GGNS site, including significant volumes of gaseous and liquid hydrogen, sulfuric acid, and diesel fuel, among other substances. In SSAR Table 2.2-3, The applicant identified the shipments of hazardous materials on State Route 61.

Section 2.2.2.3 of the SSAR described a 4-inch natural gas underground pipeline that passes as close as 4.75 miles to the east of the ESP site. No other pipelines are located within 5 miles of the ESP site. In SSAR Section 2.2.2.4, the applicant noted that Mississippi River water would be withdrawn at river mile 406 for many uses, including cooling tower and service water cooling system makeup. In Section 2.2.2.6 of the SSAR, The applicant stated that there are no plans at this time for industrial expansion or development in the ESP site vicinity or for hazardous materials handling industries within 50 miles of the ESP site.

2.2.1.2–2.2.2.2 Regulatory Evaluation

In SSAR Section 2.2, the applicant identified the following applicable NRC guidance regarding potential hazards in the vicinity of the proposed ESP site:

- RG 1.91, Revision 1, “Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plant Sites,” issued February 1978

- RG 1.78, Revision 1, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Chemical Release,” issued December 2001

- RG 1.70

In SSAR Section 2.2, the applicant referenced the GGNS Updated Final Safety Analysis Report (UFSAR). The staff considered the following regulatory requirements in reviewing information regarding potential site hazards that could affect the safe design and siting of a nuclear power plant(s) falling within the applicant’s PPE that might be constructed at the proposed site:

- 10 CFR 52.17(a)(1)(vii), with respect to information on the location and description of any nearby industrial, military, or transportation facilities and routes

- 10 CFR 100.20(b), with respect to information on the nature and proximity of human-related hazards

- 10 CFR 100.21(e), with respect to the evaluation of potential hazards associated with nearby transportation routes and industrial and military facilities

The following RGs identify methods acceptable to the NRC staff to meet the Commission’s regulations identified above:

- RG 1.91
- RG 1.78

Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of RS-002, as well as RG 1.70, provide guidance on the information appropriate for identifying, describing, and evaluating potential manmade hazards.

2.2.1.3–2.2.2.3 Technical Evaluation

The staff evaluated the potential for manmade hazards in the vicinity of the proposed ESP site by reviewing (1) the information provided by the applicant in SSAR Section 2.2.1–2.2.2, (2) the applicant’s responses to the staff’s RAIs, (3) information obtained during a visit to the proposed ESP site and its vicinity, and (4) other publicly available reference material, including topographic maps (see DeLorme, *Louisiana Atlas and Gazetteer*, issued 2003, and *Mississippi Atlas and Gazetteer*, issued 1998), airport data (see GCR and Associates, “5010: Airport Summary and Activity Data,” which includes 2004 data from the Federal Aviation Administration

(FAA) National Flight Data Center), aerial imagery (see Topozone 2004), and geographic information system coverage files (see the Platts POWERmap GIS spatial data, issued 2004, which include map layers depicting natural gas pipelines, railroads, and electric transmission lines).

The staff reviewed the applicant's identification of potential hazards in the vicinity of the ESP site and finds that potential hazards exist from the onsite storage of hazardous and explosive materials at GGNS. The applicant identified a potential hazard in the river water intake, disruption of which could potentially affect plant operations. Section 3.5.1.6 of the SER describes the evaluation of aircraft hazards, and SER Section 2.2.3 evaluates all other manmade hazards.

2.2.1.4–2.2.2.4 Conclusions

As set forth above, the applicant provided information in the SSAR on potential site hazards, in accordance with the requirements of 10 CFR 52.17 and the guidance of RG 1.70, thereby allowing the staff to evaluate the applicant's compliance with the requirements of 10 CFR 100.20, "Factors to be Considered When Evaluating Sites," and 10 CFR 100.21, "Non-Seismic Site Criteria." The staff reviewed the nature and extent of activities involving potentially hazardous materials that are conducted at industrial, military, and transportation facilities located near the ESP site to identify any potential hazards from such activities that might pose an undue risk to the type of facility proposed under this ESP. Figure 2.2-1 of the SER illustrates the locations of such facilities in reference to the ESP site. On the basis of its evaluation of the SSAR, as well as information obtained independently, the staff concludes that the applicant has identified all potentially hazardous activities on and in the vicinity of the site.

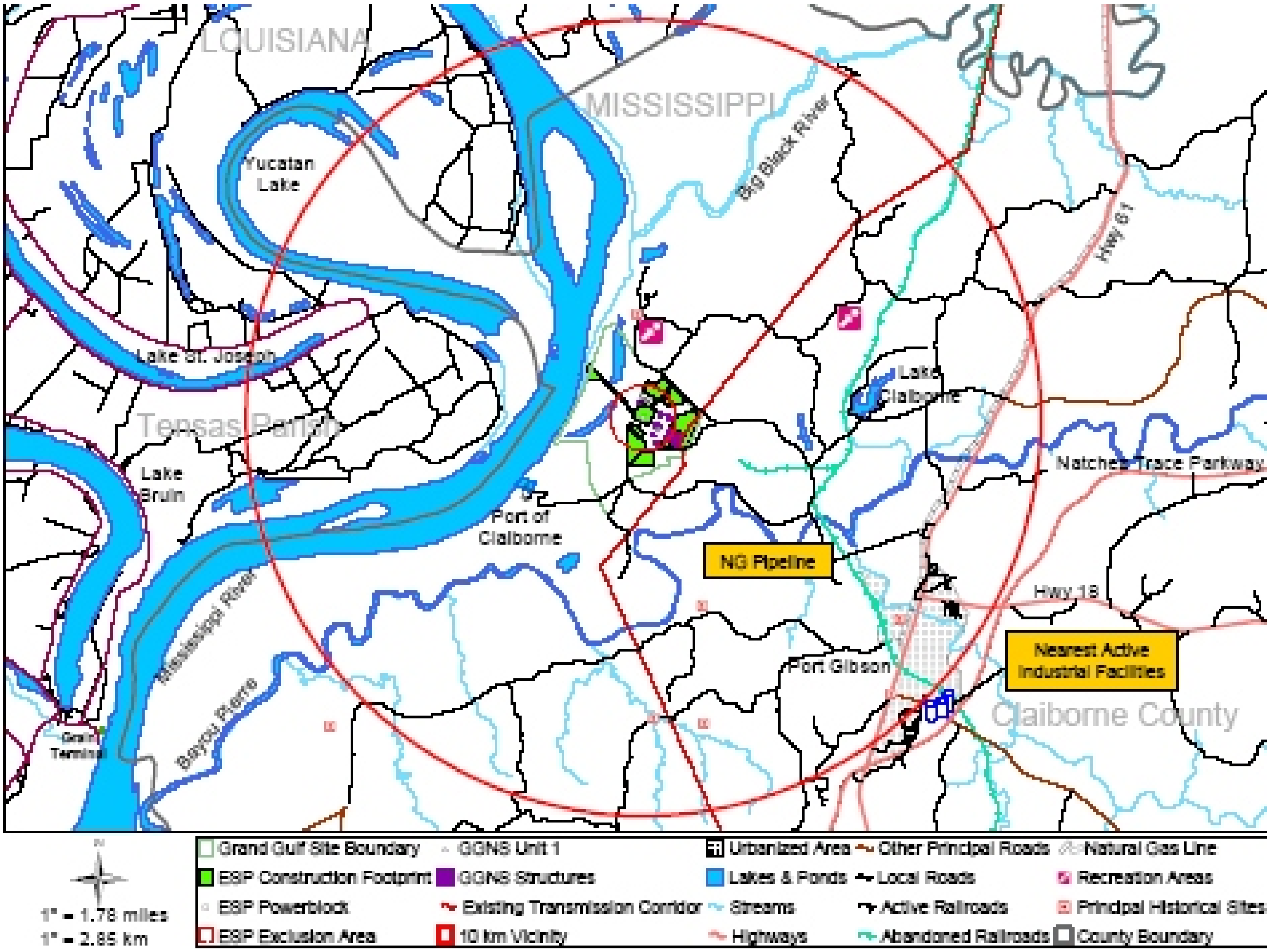


Figure 2.2-1 Industrial, military, and transportation facilities near the GGNS ESP site

2.2.3 Evaluation of Potential Accidents

In SSAR Section 2.2.3, the applicant identified potential accident situations on and in the vicinity of the ESP site. The staff reviewed this information to determine its completeness, as well as the bases upon which these potential accidents may need to be considered in the design of a nuclear power plant(s) that might be constructed on the proposed site (see SER Section 2.2.1–2.2.2).

The applicant elected to use the PPE approach for analyzing potential accidents. As such, it has not determined the specific design of the ESP facility, including control room habitability systems. Some potential accidents on or in the vicinity of the ESP site may have the ability to affect control room habitability (e.g., toxic or asphyxiating gases). The design of the actual facility that might be constructed on the proposed site must address those accidents that are to be accommodated on a design basis (as determined through a review conducted using Section 2.2.3 of RS-002). The staff will review these potential accidents at the COL stage using the guidance in Section 6.4 of NUREG-0800, Revision 3, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," issued July 1981 (also referred to as the Standard Review Plan (SRP)).

The staff reviewed the applicant's analyses of the probability of potential accidents involving hazardous materials or activities on and in the vicinity of an ESP facility that might be constructed on the proposed site to determine whether these analyses used the appropriate data and analytical models. The staff also reviewed the analyses of the consequences of accidents involving nearby industrial, military, and transportation facilities to determine if any should be identified as design-basis events (DBEs).

2.2.3.1 Technical Information in the Application

Section 2.2.3 of the SSAR presents information concerning potential accidents, including flammable vapor clouds, toxic chemicals, fires, collisions with the intake structure, and liquid spills. With one exception, the applicant found that the separation distances between the ESP site and the potential hazards identified in Section 2.2.1–2.2.2 of the SSAR are large enough that the effects of potential accidents would not affect the safety-related systems of the ESP facility. The exception is with respect to barges carrying hazardous commodities on the Mississippi River, which will be discussed later in this section as well as in Technical Evaluation, Section 2.2.3.3.

In SSAR Section 2.2.3.1.1, the applicant stated that, because of the separation distance between the closest point of State Route 61 and the ESP site (4.5 miles), under the conservative assumption of an accident involving delayed detonation of a flammable vapor cloud, the peak reflected pressure would be well below 1 pound per square inch (psi) at the ESP site.

The applicant determined that the separation distance between the 4-inch, 225-psi natural gas line and the ESP site (closest approach of 4.75 miles) is great enough that the pipeline would pose no hazard to proposed facilities at the ESP site.

The applicant also evaluated the case of onsite delivery of liquified hydrogen by truck and determined that delivery operations would be separated from the proposed ESP facility by at least 400 feet, which is less than the minimum safe distance of 1285 feet given in R.G. 1.91. However, the applicant estimated the probability of an explosive event in such a case to be 4.1×10^{-7}, which falls below the RG 1.91 threshold for considering trucked liquid hydrogen as a DBE. The applicant also evaluated the effects of onsite storage of 20,000 gallons of liquid hydrogen at the GGNS site. On the basis of analyses performed for the GGNS UFSAR, the applicant reported minimum separation distances of 737 feet for a tank explosion and 1340 feet for a gaseous cloud formation based on a pipe break or leak. The applicant indicated that the proposed ESP powerblock location and the locations of the safety-related systems are beyond these minimum distances.

Section 2.2.3.1.2 of the SSAR describes the applicant's analysis of potential accidents involving toxic chemicals. The applicant noted that no significant industrial facilities or toxic chemical storage facilities currently exist within 6 miles of the ESP site. In response to staff RAIs, the applicant analyzed toxic chemical hazards using the following guidelines in RG 1.78:

- chemicals transported on routes (including river routes) within a 5-mile radius of the site, at a frequency of 10 or more per year, and with weights outlined in RG 1.78; and

- chemicals stored within 0.3 miles of the control room in quantities greater than 100 pounds.

For the first case above, on the basis of analyses in the UFSAR, the applicant found that the large separation distance between the ESP site and the nearest highway would mitigate any highway transportation accidents involving the release of toxic chemicals. SSAR Table 2.2-4 indicates the amount of hazardous material transported past the ESP site on the Mississippi River in the year 2000. The applicant based its assessment of accidents involving river barges on barge mishap analyses presented in the UFSAR. In addition, the applicant submitted additional analyses that estimated the likelihood of a barge accident leading to an explosion and an overpressure in excess of 1 psi at the proposed site. The applicant also considered fuel fires from barge accidents, chlorine spills, and toxic chemical releases. In the case of gaseous chemical or hot plumes from fuel fires, the applicant stated that the separation distance and topographic barriers are sufficient to eliminate these types of accidents from further consideration. The applicant estimated that the probability of a significant chlorine spill in the river is 1.8×10^{-7} per year.

For the second case, SSAR Table 2.2-5 lists the hazardous materials stored at GGNS. The specific chemicals to be stored at the ESP facility are not currently known and will be evaluated at the time of the COL application. The applicant relied on the GGNS UFSAR to postulate the explosion of an underground diesel fuel storage tank at GGNS, concluding that, because of plume rise from fire conditions, the control room habitability systems would be affected only if extreme wind events accompanied the explosion. The UFSAR analysis of hazards from other stored chemicals at GGNS resulted in estimated concentrations affecting control room habitability that are within RG 1.78 limits. The applicant also found, on the basis of analyses in the GGNS UFSAR, that a hydrogen or oxygen release from the GGNS hydrogen water chemistry system would not adversely affect control room habitability.

In SSAR Section 2.2.3.1.3, The applicant stated that forest fires originating locally from accidents could produce a maximum concentration of 45 pounds of particulate matter per ton and that the toxicity of such fires falls well below the acceptable limits for the GGNS control room air intake system. In SSAR Section 2.2.3.1.4, the applicant noted that the water intake structure in the Mississippi River is positioned away from the shipping channel, and that it did not consider ship impact a DBE. In Section 2.2.3.1.5 of the SSAR, the applicant found that chemical spills in the river could force the shutdown of the water intake of the ESP facility and thus the shutdown of the ESP facility itself. Such an event would require spilling toxic chemicals that would sink below the river surface and reach the water intake. The applicant stated that it will develop appropriate procedures to ensure safe shutdown in the event that raw water makeup is unavailable.

The applicant found that some commodities being shipped by barge on the Mississippi River past the site may exceed the R.G. 1.91 criterion of 1 psi overpressure due to insufficient separation distance between the potential explosions of hazardous substances and the proposed site. However, the applicant claimed there was sufficient reduction in overpressure due to the existence of a 65-foot elevation bluff between the river and the proposed site. The applicant submitted a revised analysis of the explosion hazards associated with barge shipments of hazardous cargoes on the Mississippi River. The revision was in response to the staff’s view that there was insufficient quantitative evidence for the overpressure reduction that could be credited to the existence of a 65-foot elevation bluff between the river and the proposed site. The revised analysis was based on a best estimate assessment of hazardous cargo shipments in terms of quantities, shipping frequencies, barge accident rates, and the estimation of potential explosion overpressures of specific commodities. The latter included modeling of on-board confined explosions as well as vapor cloud formation ensuing a spill leading to ignition and an explosion. The applicant’s analysis indicates that the likelihood of a barge mishap leading to an explosion that could exceed 1 psi overpressure at the proposed site is on the order of 10^{-8} per year.

2.2.3.2 Regulatory Evaluation

In SSAR Section 2.2, The applicant identified the following applicable NRC guidance regarding potential hazards in the vicinity of the proposed ESP site:

- RG 1.91
- RG 1.78
- RG 1.70

In SSAR Section 2.2, the applicant referenced the GGNS UFSAR and RG 1.70. The staff considered the following regulatory requirements in its review of information regarding potential accidents that could affect the safe design and siting of a nuclear power plant(s) falling within the applicant’s PPE that might be constructed at the proposed site:

- 10 CFR 52.17(a)(1)(vii), with respect to information on the location and description of any nearby industrial, military, or transportation facilities and routes

- 10 CFR 100.20(b), with respect to information on the nature and proximity of human-related hazards

- 10 CFR 100.21(e), with respect to the evaluation of potential hazards associated with nearby transportation routes and industrial and military facilities

The following RGs identify methods acceptable to the NRC staff to meet the Commission's regulations identified above:

- RG 1.91
- RG 1.78

Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of RS-002, as well as RG 1.70, provide guidance on the information appropriate for identifying, describing, and evaluating potential accidents.

2.2.3.3 Technical Evaluation

The staff evaluated potential accidents in the vicinity of the proposed ESP site by reviewing (1) the information provided by the applicant in SSAR Section 2.2.3, (2) the applicant's responses to staff RAIs, (3) information obtained during a visit to the proposed ESP site and its vicinity, and (4) other publicly available reference material, including topographic maps (see DeLorme 2003 and *Mississippi Atlas and Gazetteer* 1998), airport data (see GCR and Associates), aerial imagery (Topozone 2004), and GIS coverage files (see the Platts POWER map GIS spatial data, 2004).

Section 2.2.1–2.2.2 of this SER describes potential hazards that might be identified in the future in association with a currently vacant industrial development in Claiborne County Port, just south-west of the ESP site.

The staff reviewed the applicant's analysis of the effects of potential explosions and the formation of flammable vapor clouds. Using the guidance provided in RG 1.91, the staff found that the distance of U.S. Highway 61 is sufficiently far from the potential ESP facility that no significant damage is expected with respect to safety-related SSCs that may be located on the ESP site for the worst-case truck-tank explosion accident scenario.

Table 2.2-4 of the SSAR characterizes the type of commodities typically transported on the Mississippi River by listing specific hazardous materials and quantities. The hazards posed by these materials are potential explosions, fires, or the release of airborne gases that are toxic.

The proposed ESP site would be about 1.1 miles from the nearest bank of the river. At this distance, an explosion of a 5000 ton TNT-equivalent charge (representing a bounding quantity of explosive cargo) would produce a peak positive normal reflected pressure of about 4 psi. On this basis, the hazardous cargo explosion hazard exceeds the acceptance criteria of RG 1.91. The applicant initially postulated an overpressure reduction due to the existence of a 65-foot elevation bluff between the river and the proposed site. However, there was insufficient basis for quantifying this effect. Hence, the applicant submitted additional analyses that estimated the likelihood of exceeding a 1 psi overpressure at the proposed site on the basis of actual shipment quantities and shipping frequencies.

The revised analyses considered available historical data on barge shipments on the Mississippi River in terms of type of hazardous commodities, quantities, and shipping frequencies. In estimating the likelihood of a barge mishap leading to a spill and explosion that would exceed 1 psi at the proposed site, the applicant estimated the likelihood of a major spill in the event of a barge mishap, as well as the probability of an explosion given a spill. Specifically, for each identified hazardous commodity the applicant evaluated the likelihood of a series of sequential events (i.e., barge mishap, spill, and an explosion leading to an overpressure at the proposed site in excess of 1 psi). Explosion modeling included consideration of confined explosions at the mishap site as well as vapor cloud formation and subsequent ignition. The applicant estimated the total probability of exceeding a 1 psi overpressure at the proposed site to be on the order of magnitude of 10^{-8} per year.

In estimating the likelihood of spill frequencies and explosion probabilities the applicant's analyses used some assumptions that are difficult to verify. Hence, the staff did a confirmatory analysis regarding the explosion hazard of barge shipments on the Mississippi River. The staff's confirmatory analysis is described below. The staff used information provided by the applicant, as well as data from independent sources.

With respect to barge mishaps leading to confined onboard explosions, the applicant's analyses indicate that none of the commodities have the potential of exceeding a 1 psi overpressure at the proposed site. The staff reviewed the applicant's analyses of confined explosions. The staff confirmed that the analyses contained the upper bound blast energy potentially available recommended by Regulatory Guide 1.91. The staff also confirmed that the licensee calculated distances from a confined blast to a 1 psi overpressure were less than the 1.1 miles from ESP site to the Mississippi river. Accordingly, the staff finds the analysis to be reasonable. Hence, the staff concludes that potential onboard confined explosions would not pose an undue hazard with respect to the proposed site.

The two other types of explosion hazards identified by the applicant are associated with delayed ignition of an unconfined vapor cloud in the vicinity of the proposed site and unconfined cloud explosions where ignition takes place before the cloud can drift away from the barge mishap site.

With respect to delayed ignition of unconfined vapor clouds, the applicant's analyses identify only one specific commodity, acetylene, that has the potential of exceeding 1 psi overpressure at the proposed site. This commodity is identified by the applicant as a subset of the general category identified as Acyclic Hydrocarbons (Table E-1 of Attachment 1 of the applicant's letter to USNRC - Response to Request for Additional Information Regarding the Grand Gulf Early Site Permit Final Safety Evaluation Report (ADAMS Accession No. ML060760443), dated February 22, 2006). The shipping frequency of Acyclic Hydrocarbons was 14 barges per year in 2003 and 9 barges per year in 2004. To account for possible variations in shipping frequency, the staff conservatively assumed 20 shipments of acetylene per year. An added conservatism is that acetylene is only a subset of this group of commodities (that is, not every shipment of Acyclic Hydrocarbons contains acetylene). An independent study of barge accident rates (Saricks, C., and T. Kvitek, 1994, "Longitudinal Review of State-Level Accident Statistics for Carriers of Interstate Freight, ANL-ESD/TM-68) shows barge accident rates for inland waterways and the Mississippi River to be about $3.9x10^{-6}$ accidents per mile. On this basis, the staff assumed an order-of-magnitude rate of 10^{-5} mishaps per river mile for the barge mishap rate.

With respect to the likelihood of a spill in the event of a mishap, the applicant has presented U.S. Coast Guard data (Ref. 37 in the applicant's SERI letter to USNRC - Response to Request for Additional Information Regarding the Grand Gulf Early Site Permit Final Safety Evaluation Report (ADAMS Accession No. ML060760443), dated February 22, 2006, on spill frequency of combustible materials on the Mississippi River. Page 24, Equation 1 and Figure H-1 in the applicant's analyses present a linear curve fit for the spill frequency versus spill size. Using the maximum barge capacity of 4260 tons of acetylene, the spill frequency is estimated from Equation 1 to be about 1.98×10^{-5} spills/river mile-year. Also, using the same U.S. Coast Guard data, the applicant estimates the mishap rate for barges on the Mississippi in the vicinity of the proposed site to be about 0.009 collisions/river mile-year. The staff estimated the spill rate per mishap from the ratio of these two quantities, that is

$$\frac{1.98 \times 10^{-5} \dfrac{spills}{river\ mile - year}}{0.009 \dfrac{collisions}{river\ mile - year}} = 2.20 \times 10^{-3} \frac{spills}{collision}$$

The applicant estimates the explosion probability as 0.008 explosions per spill on the basis of one reported boiling liquid expanding vapor explosion (BLEVE) on the Mississippi or Ohio Rivers. However, the applicant reduces this value by a factor of ten, yielding a value of 0.0008, on the basis that "there is no evidence that all the fuel detonated in that event." While the possibility that not all the fuel detonated may add to the conservatism in using the 0.008 rate, there is no apparent means of verifying that the factor of ten reduced value of 0.0008 is appropriate. Hence, the staff's analysis assumes the 0.008 rate is applicable. The length of river (referred to as 'at risk length') that needs to be considered is determined by the modelling of a vapor cloud plume and estimating the furthest distance from the site at which a 1 psi overpressure may be exceeded. The applicant estimated the at risk length for acetylene as 2.74 miles.

On the basis of the above, the staff estimated the annual frequency of exceeding 1 psi due to barge mishaps near the proposed site involving the release and an explosion of acetylene to be

$$P \frac{\text{explosions}}{\text{year}} = F_1 \frac{\text{haz. barges}}{\text{year}} * F_2 \frac{\text{mishaps}}{\text{haz. barge - river mile}} * F_3 \frac{\text{spills}}{\text{mishap}} * F_4 \frac{\text{explosions}}{\text{spill}} * L_{\ river\ mile}$$

$$P = (20)*(10^{-5})*(2.2E - 3)*(0.008)*(2.74) \cong 1 \times 10^{-8} \frac{explosions}{year}$$

With respect to unconfined vapor cloud explosions occurring at the barge mishap location, the applicant's analyses determined that some hazardous commodities that pass the plant have the potential for exceeding a 1 psi overpressure at the proposed site. Based upon the following description of the staff analysis, the staff calculated the probability of an unconfined vapor cloud explosion exceeding 1 psi overpressure at the proposed site. The staff used the results of this calculation to assess the applicant's calculation.

The staff reviewed the applicant's list of identified commodities and confirmed the applicant's calculated values for the distances to yield a 1 psi overpressure at the proposed site. The staff notes that the applicant has not included LNG shipments in the screening analysis on the basis that LNG detonation exceeding 1 psi overpressure at the proposed site, while possible, is not credible on the basis of low likelihood. Specifically, the applicant notes that a) it takes a substantial amount of initiating energy (significantly more, for example, than that associated with a spark) for detonation to occur, and b) transition from deflagration to detonation is unlikely due to relatively slow flame propagation velocities observed even with maximum laboratory induced flame acceleration. The staff agrees that there is no reasonable basis for postulating sources of ignition of sufficient size in the vicinity of the barge or the site. However, the relative likelihood of deflagration transition to detonation for LNG is difficult to assess. Furthermore, explosions other than true detonations may have the potential for significant overpressures. Therefore, in assessing explosion hazards, the staff also considered LNG in addition to the crude petroleum, gasoline, naphtha, acyclic hydrocarbons, benzene and toluene considered by the applicant.

The staff estimated the shipping frequency (F_1) using the maximum yearly frequency for each commodity passing the proposed site during 2003 and 2004. The staff estimated the spill frequency for each of these commodities using the applicant's correlation between spill frequency and spill size.

The staff noted that the applicant's correlation uses the midpoints of variable spill size bins and midpoint representations for each interval in establishing a linear representation of spill size and frequency. To check the results the applicant obtained using this correlation, the staff determined the spill frequency distribution by constructing a Weibull and a lognormal probability plot of the data provide in Table H-1 of the applicant's submittal. A comparison of the two approaches indicates that the applicant's and staff's approaches produce similar spill frequency estimates. In addition, the staff also checked the validity of the applicant's model relating the size of the barge and the likelihood of a spill by estimating the spill frequency for a selected spill size. Specifically, the staff calculated the frequency of a 100,000 gallon spill (300 tons at 0.72 specific gravity) using the applicant's model. The staff compared this value to the applicant's review of nine years of U.S. Coast Guard (USCG) Safety Management System data. The staff calculated value of 1.6 spills per year is conservative, with respect to the actual number of 100,000 gallon spills on the Mississippi river (zero spills) during the nine years researched. In view of the above, although the applicant's correlation is not a valid statistical model, the results are not significantly different from those obtained using a Weibull or lognormal probability distribution.

In applying the applicant's correlation, the staff used the maximum barge cargo size for each commodity passing the proposed site during 2003 and 2004. The spill rate for each commodity was divided by 0.009 collisions/river mile-year, discussed above, to determine the spill rate per collision (F_2). The staff used the barge mishap rate of 10^{-5} per year (F_3) and the conditional probability of explosion of 0.008 (F_4) discussed above. Finally, the staff determined the length along the river (L) that exposes the plant to a postulated 1 psi overpressure assuming a vapor cloud explosion at the river.

Using the equation above for the estimated annual frequency of exceeding 1 psi due to barge mishaps (P), the staff estimated the probability for each commodity. The total probability of exceeding a 1 psi overpressure, obtained by summing over all of the analyzed commodities, is about 10^{-6} per year.

The staff performed checks of the parameters used to determine this probability. First, the staff determined the sensitivity of the analysis to assumed barge size. The staff performed another calculation assuming the mass of each barge is 70% of the maximum barge size of each commodity. This calculation determined that for this smaller cargo barge, the decrease in river length (exposing the plant to a 1 psi overpressure) approximately offsets the increased likelihood of a smaller spill. Therefore, based upon this calculation, the probability is relatively insensitive to the assumed mass size of the barges.

Lastly, the likelihood of a collision or grounding on the Mississippi river in the area of the proposed site appears to be low as compared to other areas along the river. The applicant stated that the proposed site is adjacent to the river between river mile marker 406 and 407. Except for sedimentation control dikes on the west bank (down river of marker 405), there are no bridges within several miles of the proposed site. The nearest bridges are at Vicksburg and Natchez. The staff concurs with the licensee's assessment that obstructions create a higher probability of collisions. Quantitatively, this view is supported by the applicant's review of USCG incident data which indicated that there were no spills events reported for this area of the river in the last four years. Therefore, the staff agrees with the applicant that this area of the river should be exposed to fewer accidents than other areas of the river included in the above analysis.

On the basis of the above analysis, the information provided by the applicant and the staff's calculated total probability of exceeding a 1 psi overpressure of about 10^{-6} per year for all commodities considered above, the staff agrees with the applicant's conclusions that the explosion hazard due to barge traffic on the Mississippi River meets the acceptance criterion of RS-002 (Chapter 2.2.3, "Evaluation of Potential Accidents," Section II, "Acceptance Criteria").

With respect to potential fires caused by accidental releases of flammable substances on the river, the staff estimates that the incident thermal flux is sufficiently low so as not to pose a hazard to safety-related structures. Specifically, using the methodology of NUREG/CR-3330, "Vulnerability of Nuclear Power Plant Structures to Large External Fires," dated August 1983, the staff estimates that the incident thermal flux at 1.1 miles from a large gasoline vapor cloud fire would be less than 5 kilowatts per square meter (kW/m^2). At this thermal flux, the allowable wall exposure time is well in excess of 12 hours in duration. Hence, potential fires caused by accidents on the river do not pose a significant hazard to a plant on the proposed ESP site.

The staff reviewed the applicant's analysis of potential toxic chemical accidents. The applicant used the UFSAR inventory of toxic chemicals in its analysis. The staff notes that the principal commodities posing a potential hazard are shipments of anhydrous ammonia and chlorine. The applicant analyzed the potential for the release of these chemicals for GGNS and found the estimated toxicity levels at the control room to be acceptably low. However, the staff finds that, since the PPE does not specify a control room design, it cannot make a determination with respect to control room habitability in the event of a toxic chemical accident at the site or in its vicinity. Accidents involving such materials cannot be evaluated for the ESP facility at the ESP stage without a specific set of plant design parameters. Therefore, the staff will evaluate such accidents at the COL application stage. This is **COL Action Item 2.2-1**.

2.2.3.4 Conclusions

As set forth above, the applicant identified potential accidents related to the presence of hazardous materials or activities on or near the proposed ESP site that could affect a nuclear power plant(s) falling within the applicant's PPE. The staff finds that the applicant selected those potential accidents that should be considered as DBEs at the COL stage, in accordance with 10 CFR Part 100. The applicant identified and evaluated hazards from nearby facilities and the staff concludes that such facilities pose no undue risk to the type of facility proposed for the site, subject to confirmation at the COL stage regarding design-specific hazard interactions. Therefore, the staff concludes that the ESP site location is acceptable with regard to potential accidents that could affect such a facility or facilities built on the site, and that it meets the requirements of 10 CFR 52.17(a)(1)(vii), 10 CFR 100.20(b), and 10 CFR 100.21(e).

2.3 Meteorology

To ensure that a nuclear power plant or plants could be designed, constructed, and operated on an applicant's proposed ESP site in compliance with the Commission's regulations, the NRC staff evaluates regional and local climatological information, including climate extremes and severe weather occurrences that may affect the design and siting of a nuclear plant. The staff reviews information concerning the atmospheric dispersion characteristics of a nuclear power plant site to determine whether the radioactive effluents from postulated accidental releases, as well as routine operational releases, are within Commission guidelines. The staff has prepared Sections 2.3.1 through 2.3.5 of this SER in accordance with the review procedures described in RS-002, using information presented in SSAR Section 2.3, responses to staff RAIs and open items, and generally available reference materials, as described in the applicable sections of RS-002.

2.3.1 Regional Climatology

2.3.1.1 Technical Information in the Application

In Section 2.3.1 of the SSAR, the applicant presented information concerning the averages and the extremes of climatic conditions and regional meteorological phenomena that could affect the design and siting of a nuclear power plant that falls within the applicant's PPE and that might be constructed on the proposed site. Specifically, the applicant provided the following information:

- a description of the general climate of the region with respect to types of air masses, synoptic features (high- and low-pressure systems and frontal systems), general airflow patterns (wind direction and speed), temperature and humidity, precipitation (rain, snow, and sleet), and relationships between synoptic-scale atmospheric processes and local (site) meteorological conditions

- seasonal and annual frequencies of severe weather phenomena, including tornadoes, thunderstorms, lightning, hail (including probable maximum size), and high air pollution potential

- meteorological site characteristics to be used as minimum design and operating bases, including the following:

  — the maximum snow and ice load (water equivalent) on the roofs of safety-related structures

  — the ultimate heat sink (UHS) meteorological conditions resulting in the maximum evaporation and drift loss of water and minimum water cooling

  — the tornado parameters, including translational speed, rotational speed, and the maximum pressure differential with the associated time interval

  — the 100-year return period straight-line winds

  — other meteorological conditions to be used for design- and operating-basis considerations

The applicant characterized the regional climatology pertinent to the Grand Gulf ESP site using data reported by the National Weather Service (NWS) at the Vicksburg, Mississippi, and Jackson, Mississippi, first-order weather stations, as well as the Port Gibson, Mississippi, cooperative observer station. The applicant also used data recorded by the GGNS onsite meteorological tower. The applicant considered the Vicksburg and Jackson weather stations to be representative of the climate at the Grand Gulf ESP site because of topographic considerations and their proximity to the site. Since Vicksburg is the closer of the two stations and borders the Mississippi River, the applicant based the climatic summaries primarily on Vicksburg data when the period of record and observational procedures were considered adequate. Otherwise, it presented Jackson data. The applicant also obtained information on severe weather, including extreme conditions, from a variety of sources, such as publications by the National Climatic Data Center (NCDC), the Structural Engineering Institute (SEI), the American Society of Civil Engineers (ASCE), and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

The Grand Gulf ESP site is located in the southwest climatic division of Mississippi. The applicant described the climate as humid and subtropical with a short cold season and a relatively long warm season. The predominant air mass over the region during most of the year is maritime tropical with origins over the Gulf of Mexico. In the winter, occasional southward movements of continental polar air from Canada bring colder and drier air into Mississippi. However, cold spells seldom last more than 3 or 4 days.

The applicant noted that the westward extension of the Bermuda High, a subtropical, semipermanent anticyclone, dominates the region in summer. The prevailing southerly winds provide a generous supply of moisture, and this, combined with thermal instability, produces frequent afternoon and evening showers and thundershowers over the region. The convective thundershowers of the summer season are more numerous than the frontal-type thunderstorms. However, the thunderstorms associated with the occasional polar front activity in late winter and early spring are more severe, sometimes producing tornadoes.

The applicant stated that Mississippi is south of the average track of winter cyclones, but occasionally one moves over the State. In some winters, a succession of such cyclones will develop in the Gulf of Mexico or in Texas and move over or near the State. Mississippi is also occasionally in the path of tropical storms or hurricanes.

The applicant noted that, for the most part, the general synoptic conditions predominate with regard to the climactic characteristics of the site region. However, the applicant considered the Vicksburg humidity data to be more appropriate for site estimates than the Jackson data, because of Vicksburg's proximity and similar location relative to the Mississippi River. A slight tendency exists for lower level winds at the Grand Gulf ESP site to be channeled along the Mississippi River.

The applicant stated that the general airflow over the Grand Gulf ESP site region is from the southerly sectors during much of the year, although the prevailing direction may be from one of the northerly sectors during some months. The average wind speed at the Grand Gulf ESP site ranged from 3.7 miles per hour (mi/h) to 4.4 mi/h between 1996 and 2003, whereas the average wind speed at Vicksburg ranged from 7.0 mi/h to 7.6 mi/h between 1997 and 2003.

Revision 0 of the SSAR presented various dry-bulb and wet-bulb temperature statistics for Jackson, Vicksburg, and the GGNS site. These statistics included 97.75 and 99 percent maximum summer exceedance dry-bulb and wet-bulb temperatures and 97.75 and 99 percent minimum winter exceedance dry-bulb temperatures. The applicant based the percentage exceedances on the summer months of June through September (2928 total hours) and the winter months of December through February (2160 total hours). In RAI 2.3.1-5, the staff asked the applicant to provide various dry-bulb and wet-bulb temperature statistics based on annual exceedances (for example, the dry-bulb temperatures that will be exceeded no more than 2.0 and 0.4 percent of the time annually). By doing so, these data will be more consistent with the recent ASHRAE design guidelines, "2001 ASHRAE Handbook—Fundamentals," issued July 2001, for the design of heating, ventilation, air-conditioning, and dehumidification equipment.

In response to RAI 2.3.1-5, the applicant provided the requested temperature and humidity statistics, including the historic highest and lowest dry-bulb temperatures (107 °F and −5 °F, respectively) recorded at Jackson during the 108-year period 1896–2003. The applicant used these historic dry-bulb temperatures to represent 100-year return period temperatures for the Grand Gulf ESP site. The staff found a higher temperature, 110 °F, that was recorded at Vicksburg (August 31, 2000) during the 38-year period 1967–2004, and a lower temperature, −8 °F, that was recorded at St. Joseph, Louisiana (January 27, 1940), during the 72-year period 1930–2001. In Open Item 2.3-1, the staff stated that the applicant had not conservatively identified the historic highest and lowest dry-bulb temperatures recorded in the Grand Gulf ESP site region for use as the 100-year return period temperatures.

In its submittal dated June 21, 2005, the applicant responded to Open Item 2.3-1 by statistically generating 100-year return period temperatures (108 °F and −6 °F) using data recorded at Port Gibson during the 73-year period 1930–2001. The applicant proposed using the 108 °F and −6 °F values as the 100-year return period temperature site characteristics. The applicant also noted that the maximum and minimum temperatures recorded at Port Gibson during this same period were 105 °F and −6 °F, respectively. The applicant discussed this information in Section 2.3.2.1.2 of Revision 2 to the SSAR.

Table 2.3.1-1 presents the applicant's proposed ambient air temperature and humidity site characteristics.

Table 2.3.1-1 Applicant's Proposed Ambient Air Temperature and Humidity Site Characteristics

SITE CHARACTERISTIC		VALUE
Maximum Dry-Bulb Temperature	98% annual exceedance	92 °F
	99.6% annual exceedance	95 °F
	average of annual highest	98 °F
	100-year return period	108 °F
Minimum Dry-Bulb Temperature	99% annual exceedance	25 °F
	99.6% annual exceedance	21 °F
	average of annual lowest	14 °F
	100-year return period	−6 °F
Maximum Wet-Bulb Temperature	98% annual exceedance	78 °F
	99.6% annual exceedance	80 °F

Using the exceedance criteria in Table 2.3.1-1, the applicant also evaluated the GGNS site 2000–2003 dry-bulb and 2001–2003 wet-bulb temperature data and found that the site values generally match the Jackson values, except that the minimum dry-bulb temperatures reported for Jackson are several degrees cooler than the compatible minimum dry-bulb temperatures

reported for GGNS. The applicant attributed the slightly warmer GGNS minimum dry-bulb temperatures to the mitigating effects of the Mississippi River at the GGNS site.

The applicant reported that the relative humidity in the Grand Gulf ESP site region is high throughout the year, with an annual average relative humidity of approximately 75 percent recorded at Vicksburg during the period 1997–2001. The highest relative humidities occur in the early morning hours (00:00–06:00) during the summer (June–August), averaging more than 90 percent. The lowest relative humidities occur during the afternoon hours (12:00–18:00) in the autumn (September–November), averaging less than 55 percent.

The applicant reported that, while snowfall is not of much economic importance, it is not a rare event in Mississippi. During the 65 years from 1898–1957 and 1997–2001, measurable snow or sleet fell on some part of the State in all but 3 years. Along the latitude of the site (about 32° N), snow fell during approximately 30 percent of the years.

According to the applicant, 117 hurricanes affected the Middle Gulf Coast (Florida, Alabama, Mississippi, Louisiana, and Texas) during the period 1899–2000. Table 2.3.1-2 presents the storm classifications and respective frequencies of these hurricane occurrences over this period.

Table 2.3.1-2 Frequency of Hurricanes for the States of Florida, Alabama, Mississippi, Louisiana, and Texas from 1899–2000

CLASSIFICATION	NUMBER OF OCCURRENCES	MAXIMUM SUSTAINED WIND SPEED RANGE
Category 5 Hurricane	2	> 155 mi/h
Category 4 Hurricane	10	131–155 mi/h
Category 3 Hurricane	36	111–130 mi/h
Category 2 Hurricane	30	96–110 mi/h
Category 1 Hurricane	39	74–95 mi/h

Tropical storms, including hurricanes, lose strength as they move inland from the coast. Typically, the greatest concern for an inland site, such as the Grand Gulf ESP site, is possible flooding resulting from excessive rainfall. As an example, the applicant reported that the small-diameter, extremely intense hurricane Camille (August 1969) had top winds estimated at more than 170 mi/h at the coast, but, as the center passed less than 10 miles to the east of Jackson, it only generated gusts of 67 mi/h at Jackson.

The applicant reported that a total of 108 tornadoes touched down in the vicinity of Claiborne, Warren, and Hinds Counties in Mississippi and Tenasa Parish in Louisiana from 1950 to April 2002. The applicant used these data to calculate a tornado mean recurrence interval of 2860 years. The applicant also noted that a highly destructive tornado struck Vicksburg in December 1953, and a tornado struck the GGNS site while the plant was under construction in April 1978.

The applicant estimated that, on average, 66 thunderstorm-days occur per year in the site area, resulting in an estimated 33 lightning flashes to earth per square mile per year. Hail often accompanies severe thunderstorms and can be a major weather hazard, causing damage to crops and property. The applicant reported that 279 hailstorms occurred in the region (Claiborne, Warren, and Hinds Counties in Mississippi and Tenasa Parish in Louisiana) from 1955 through April 2002. Property damage occurred infrequently, with only 26 events recorded during this period.

Large-scale episodes of atmospheric stagnation are not common in the site region. The applicant noted that 36 cases of 4 days or more of atmospheric stagnation over southwest Mississippi were reported in the 35-year period from 1936–1970.

The applicant indicated that three ice storms and one heavy snowstorm were reported in the three counties and one parish around the Grand Gulf ESP site for 1993–2001. From these data, the applicant estimated that the frequency of ice storms in the Grand Gulf ESP site area is 4 storms in 8 years or 0.5 per year.

The applicant stated that the occurrence of dust, blowing dust, or blowing sand is a comparatively rare phenomenon in the Grand Gulf ESP site area. Vicksburg did not record any hours of blowing dust or blowing sand in the period 1997–2001. However, Jackson reported 33 hours of blowing dust during the period 1955–1964. Using the Jackson data, the percent frequency of occurrence of dust, blowing dust, or blowing sand is 0.04.

In Revision 0 of the SSAR, the applicant estimated a 100-year return period snowpack of 11 inches based on historic maximum regional snowfall data. Using a conservative estimate of 0.20 inches of water per inch of snowpack, the applicant estimated that the water equivalent of the 100-year return period snowpack of 11 inches is 2.2 inches of water, which equals a weight of 11.44 lbf/ft^2. In its submittal dated June 21, 2005, the applicant revised its estimated weight of the 100-year return period snowpack to 6.1 lbf/ft^2, based on SEI/ASCE 7-02, "Minimum Design Loads for Buildings and Other Structures," issued 2002, and the maximum 24-hour snowfall of 10.6 inches reported for Jackson for a recent 83-year data period. Because snow melts and/or evaporates quickly, usually within 48 hours and before additional snow is added, the applicant believes that the Jackson maximum 24-hour snowfall is indicative of the 100-year return period snowpack.

In Revision 0 of the SSAR, the applicant estimated the weight of the 48-hour probable maximum winter precipitation (PMWP) as 36.4 lbf/ft^2, based on 7.0 inches (water equivalent) of precipitation. The figure of 7.0 inches of precipitation represents a 100-year return period value derived by the applicant using a statistical extrapolation of the maximum 48-hour winter (November–March) precipitation values reported each year at Jackson during the period 1960–1975.

In Open Item 2.3-2, the staff stated that the applicant had not provided an appropriate 48-hour PMWP value that can be used to define the extreme winter precipitation roof loads. As discussed in the staff's branch position on winter precipitation loads (see memorandum from H.R. Denton to R.R. Maccary, dated March 24, 1975), the 48-hour PMWP should be developed in accordance with the guidance provided in the National Oceanic and Atmospheric Administration (NOAA) hydrometeorological reports (HMRs) (e.g., HMR 53, "Seasonal Variation of 10-Square Mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," issued April 1980). In its submittal dated June 21, 2005, the applicant responded to Open Item 2.3-2 by identifying a 48-hour PMWP value of 35 inches of rainwater based on HMR 53. However, the applicant contended that because this PMWP is in the form of rainfall, it would not remain on rooftops. Instead, the applicant proposed a 48-hour "frozen" PMWP value of 1.9 inches of frozen precipitation (equivalent to 9.9 lbf/ft^2), based on a 100-year return period frozen precipitation value that was statistically extrapolated by the applicant from four ice storms recorded in nearby counties and parishes during the 11-year period 1993–2003.

In the same June 21, 2005, submittal, the applicant proposed defining the snow load for extreme live loads to be considered for roof structural design purposes as 16 lbf/ft^2, which represents the sum of the 100-year return period snowpack (6.1 lbf/ft^2) and the 48-hour frozen PMWP (9.9 lbf/ft^2).

Table 2.3.1-3 presents the applicant's proposed snow load site characteristics.

Table 2.3.1-3 Applicant's Proposed Snow Load Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
48-Hour PMWP (Rainfall)	35 inches of rainfall	The 48-hour 10-square-mile probable maximum winter-month precipitation from HMR 53
48-Hour PMWP (Frozen)	1.9 inches of ice	The 48-hour probable maximum frozen winter precipitation
100-Year Snowpack	6.1 lbf/ft^2	Weight, per unit area, of the 100-year return period snowpack
Extreme Live Winter Precipitation Load	16 lbf/ft^2	The combination of the 48-hour probable maximum frozen winter precipitation and the 100-year snowpack (to be used in determining extreme winter precipitation loads for roofs)

According to the applicant, the wet-bulb temperature and the coincident dry-bulb temperature are the controlling parameters for the type of UHS it selected (e.g., mechanical draft cooling towers with water storage basins). The applicant calculated the worst 1-, 5-, and 30-day daily average wet-bulb temperatures and coincident dry-bulb temperatures as UHS site characteristic values.

Revision 0 of the SSAR presented UHS meteorological site characteristic values for maximum evaporation and minimum water cooling based on wet-bulb and dry-bulb temperatures recorded at Jackson during the period 1948–1975. In RAI 2.3.1-3, the staff noted that the SSAR states that Vicksburg humidity data are considered to be more appropriate for site estimates than the Jackson data because of the proximity and similar location relative of the Mississippi River. Therefore, the staff asked the applicant to use temperature and humidity data from Vicksburg to determine the site characteristics for evaluating UHS performance. In its response to this RAI, the applicant examined temperature and humidity data from Jackson (1948–1975), Vicksburg (July 1996–December 2000), and the GGNS onsite meteorological monitoring program (2001–2003) to determine bounding meteorological design conditions for the UHS in accordance with RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," issued January 1976. Table 2.3.1-4 presents these results.

In Open Item 2.3-3, the staff identified the need for an additional UHS meteorological site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility, a phenomenon which would reduce the amount of water available for used by the UHS. In its submittal dated June 21, 2005, the applicant responded to Open Item 2.3-3 by proposing a cumulative degree-day below freezing site characteristic value of 98 °F degree days (i.e., 98 accumulated freezing degree days), based on the worst case freezing spell recorded at Port Gibson for the period 1930–2001.

Table 2.3.1-4 Applicant's Proposed UHS Site Characteristics

SITE CHARACTERISTIC	VALUE
Worst 1-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	81.0 °F wet-bulb temperature with coincident 86.3 °F dry-bulb temperature
Worst 5-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	80.2 °F wet-bulb temperature with coincident 86.2 °F dry-bulb temperature
Worst 30-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	78.5 °F wet-bulb temperature with coincident 83.1 °F dry-bulb temperature
Worst Accumulated Freezing Degree Days	98 °F

Revision 0 of the SSAR presented tornado site characteristics based on the staff's interim position on the design-basis tornado for the region in which the Grand Gulf ESP site is located (see letter from L.S. Rubinstein to E.E. Kintner, dated March 25, 1988). In its submittal dated June 21, 2005, the applicant revised the tornado maximum wind speed site characteristic based on the recently published Revision 1 to NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," issued April 2005. The applicant also revised the remaining tornado site characteristics to be consistent with the staff's interim position on the design-basis tornado for a tornado with a maximum wind speed of 300 mi/h. Table 2.3.1-5 shows the applicant's proposed tornado site characteristics.

Table 2.3.1-5 Applicant's Proposed Tornado Site Characteristics

SITE CHARACTERISTIC	VALUE
Maximum Wind Speed	300 mi/h
Maximum Translational Speed	60 mi/h
Rotational Speed	240 mi/h
Radius of Maximum Rotational Speed	150 feet
Pressure Drop	2.0 lbf/in.^{2}
Rate of Pressure Drop	1.2 lbf/in.^{2}/s

The applicant reported that the highest "fastest-mile" wind speed recorded at Jackson, corrected to a standard height of 30 feet above ground level, is 64 mi/h. The applicant selected a basic fastest-mile wind speed site characteristic of 83 mi/h, which it considers to represent a "fastest mile of wind" at 30 feet above the ground with a 100-year return period. In Open Item 2.3-4, the staff asked the applicant to also identify a 3-second gust wind speed that represents a 100-year return period for the ESP site. The 3-second gust wind speed site characteristic value potentially represents a typical design parameter input for new reactor designs. In its submittal dated June 21, 2005, the applicant responded to Open Item 2.3-4 by proposing a 100-year return period 3-second gust site characteristic value of 96 mi/h. Table 2.3.1-6 shows the applicant's selected basic wind speed site characteristics.

Table 2.3.1-6 Applicant's Proposed Basic Wind Speed Site Characteristic

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Basic Wind Speed (fastest mile)	83 mi/h	Highest "fastest mile of wind" at 30 feet above the ground with a 100-year return period
Basic Wind Speed (3-s gust)	96 mi/h	100-year return period 3-second gust wind speed at 33-ft elevation

2.3.1.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant noted that the NRC regulations that apply to the evaluation of an ESP include 10 CFR 100.20 and 10 CFR 100.21. The staff notes that 10 CFR 100.20(c) and 100.21(d) are the applicable 10 CFR Part 100 regulations with respect to the consideration of the site's regional meteorological characteristics.

In SSAR Sections 1.0, 1.4, and 2.3.1 and in its response to RAI 2.3.1-3, the applicant identified the following applicable NRC guidance regarding regional climatology:

- RG 1.27, with respect to the meteorological conditions that should be considered in the design of the UHS

- RG 1.70, with respect to the type of general climate and regional meteorological data that should be presented

- RG 1.76, "Design Basis Tornado for Nuclear Power Plants," issued April 1974, with respect to the characteristics of the design-basis tornado[1]

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

Section 2.3.1 of RS-002 and Section 2.3.1 of RG 1.70 provide the following guidance on information appropriate for determining regional climatology:

- The description of the general climate of the region should be based on standard climatic summaries compiled by NOAA. Consideration of the relationships between regional synoptic-scale atmospheric processes and local (site) meteorological conditions should be based on appropriate meteorological data.

- Data on severe weather phenomena should be based on standard meteorological records from nearby representative NWS, military, or other stations recognized as standard installations that have long periods of data on record. The ability of these data

[1] In SSAR Table 1.4-1, the applicant noted that the staff developed an interim position modifying the design-basis tornado criteria presented in RG 1.76.

to represent site conditions during the expected period of reactor operation should be substantiated.

- Tornado site characteristics may be based on RG 1.76 or the staff's interim position on design-basis tornado characteristics. An ESP applicant may specify any tornado wind speed site characteristics that are appropriately justified, provided that a technical evaluation of site-specific data is conducted.

- Basic (straight-line) wind speed site characteristics should be based on appropriate standards, with suitable corrections for local conditions.

- The UHS meteorological site characteristics, as stated in RG 1.27, should be based on long-period regional records which represent site conditions. Suitable information may be found in climatological summaries for the evaluation of wind, temperature, humidity, and other meteorological data used for UHS design.

- Freezing rain estimates should be based on representative NWS station data.

- High air pollution potential information should be based on U.S. Environmental Protection Agency studies.

- All other meteorological and air quality data identified as climatic site characteristics should be documented and substantiated.

2.3.1.3 Technical Evaluation

The staff evaluated regional meteorological conditions using information reported by NWS, NCDC, the National Severe Storms Laboratory (NSSL), the Southern Regional Climate Center (SRCC), ASHRAE, SEI, and ASCE. The staff reviewed statistics for the following climatic stations located in the vicinity of the Grand Gulf ESP site:

- Port Gibson, Mississippi, located approximately 5 miles east-southeast of the ESP site
- St. Joseph, Louisiana, located approximately 11 miles west-southwest of the ESP site
- Vicksburg, Mississippi, located approximately 26 miles north-northeast of the ESP site
- Jackson, Mississippi, located approximately 61 miles east-northeast of the ESP site

The staff concurs with the applicant's description of the general climate of the region, which is consistent with the SRCC narrative, "Climate Synopsis for Mississippi," as well as the NCDC narrative, "Jackson, Mississippi, 2003 Local Climatological Data, Annual Summary with Comparative Data." The NCDC climatic data summary for Jackson shows an annual mean wind speed of 6.8 mi/h, and the annual prevailing wind direction is from the south-southeast.

The applicant based the maximum annual 98 percent and 99.6 percent exceedance dry-bulb and wet-bulb temperatures and the minimum annual 99 percent and 99.6 percent exceedance dry-bulb temperatures on Jackson data that ASHRAE published in its July 2001 handbook.[2] The applicant also evaluated the GGNS site data using these same exceedance criteria and found that the site values generally match the Jackson values, except that the Grand Gulf ESP site is slightly warmer than the Jackson data would indicate at cold temperatures. Therefore, the staff agrees with the annual exceedance temperature and humidity site characteristics presented by the applicant.

In its response to RAI 2.3.1-5, the applicant reported the historic highest and lowest dry-bulb temperatures recorded at Jackson during the 108-year period 1896–2003 as 107 °F and −5 °F, respectively, and proposed using these historic dry-bulb temperatures to represent 100-year return period temperatures for the Grand Gulf ESP site. The staff did not believe that the applicant had conservatively identified the historic extreme dry-bulb temperatures recorded in the Grand Gulf ESP site region for use as the 100-year return period temperatures. The staff found a higher temperature, 110 °F, that was recorded at Vicksburg (August 31, 2000) during the 38-year period 1967–2004 in SRCC, "Vicksburg Military Park, Mississippi Period of Record General Climate Summary—Temperature." The staff also found a lower temperature, −8 °F, that was recorded at St. Joseph (January 27, 1940) during the 72-year period 1930–2001 in NCDC, "Cooperative Summary of the Day TD 3200 POR—2001 Data CDROM, Central United States." This concern resulted in Open Item 2.3-1.

In its response to Open Item 2.3-1, the applicant statistically generated 100-year return period temperatures (108 °F and −6 °F) using data recorded at Port Gibson during the 73-year period 1930–2001 and proposed using these values as the 100-year return period temperature site characteristics. The staff believes that the Port Gibson temperature data, collected at a similar grade elevation approximately 5 miles from the Grand Gulf ESP site, are representative of the Grand Gulf ESP site. The staff performed an equivalent analysis with the same Port Gibson data set and obtained similar results. The staff also used the Port Gibson data to generate mean annual highest and lowest temperatures and obtained results similar to the applicant. Therefore, the staff agrees with the 100-year return period temperature site characteristics presented by the applicant.

During the period 1900–2000, 35 hurricanes directly hit either Mississippi or Louisiana or both States at hurricane-storm intensity with maximum sustained winds of 74 mi/h or greater. According to Jarrell, et al. (2003), 18 of these storms were classified as major hurricanes (Category 3 or higher on the Saffir/Simpson hurricane scale) with maximum sustained winds of 111 mi/h or greater. These hurricanes typically weaken as they move inland, so wind damage tends to be confined to the coastal regions while damage inland comes primarily from heavy rain and flooding. During this period, the most intense hurricane to affect the Mississippi and Louisiana coasts was Hurricane Camille in August 1969. Hurricane Camille was classified as a Category 5 hurricane on the Saffir/Simpson hurricane scale with maximum sustained winds exceeding 155 mi/h as it crossed the coastline. However, according to Simpson, et al. (1970), Hurricane Camille only generated gusts of 67 mi/h as it passed 10 miles east of Jackson.

[2] The data presented by the applicant as the maximum 98 percent and 99.6 percent temperatures are equivalent to (1) the ASHRAE 2 percent and 0.4 percent exceedance values and (2) the 2 percent and 0.4 percent exceedance values identified by the staff as regional climatic site characteristics in SER Table 2.3.1-7.

According to NSSL, “Severe Thunderstorm Climatology, Total Threat,” dated August 29, 2003, the mean number of days per year with the threat of tornadoes occurring within 25 miles of the Grand Gulf ESP site is approximately 1.0 to 1.2 days per year for any tornado, approximately 0.30 to 0.35 days per year for a significant tornado (F2 or greater; wind speeds in excess of 113 mi/h), and approximately 0.020 to 0.025 days per year for a violent tornado (F4 or greater; wind speeds in excess of 207 mi/h).

At the direction of the NRC, J.V. Ramsdell, Jr., of Pacific Northwest National Laboratory prepared a report titled, “Technical Evaluation Report on Design-Basis Tornadoes for the Grand Gulf ESP Site,” dated November 9, 2004, which derived a best-estimate annual tornado strike probability of 7.4×10^{-4}, based on tornado data from January 1950 through August 2003. This probability corresponds to a mean recurrence interval of 1350 years. Using a different methodology and period of record, the applicant calculated a less conservative tornado return period of 2860 years.

A tornado struck the GGNS site shortly after 11:00 p.m. on April 17, 1978. Two units were under construction at the time; GGNS Unit 1 was 50 percent complete and GGNS Unit 2 was 10 percent complete. The tornado initially touched down approximately 9 miles west-southwest of the GGNS site and traveled to the site where the centerline passed just to the right of the cooling tower and crossed the concrete batch plant area and the northeast corner of the switchyard. The damage path at the plant site was approximately 1500–1800 feet wide, and the highest onsite wind speeds were estimated to be in the 125–150 mi/h range (indicative of an F2 tornado). After leaving the plant site, the storm intensified into an F3 tornado for approximately 1.3 miles and continued for approximately 7 miles before dissipating. According to Fujita (1978) and McDonald (1978), the collapse of construction cranes caused major damage to the power plant facility; high winds also extensively damaged the switchyard installation.

The following discussion on thunderstorms, lightning, hail, and ice events provides a general climatic understanding of the severe weather phenomena in the site region but does not result in the generation of site characteristics for use as design- or operating-basis considerations.

The applicant estimated that 66 thunderstorm-days per year occur in the site area. This frequency is compatible with the 68 thunderstorm-days per year reported by NCDC in 2003 for Jackson. The majority of these thunderstorm days occur from May through August. The applicant estimated that approximately 33 flashes to earth per square mile per year occur around the site area. This estimate is conservative compared to the mean annual ground flash density of 23 flashes per square mile presented in NUREG/CR-3759, “Lightning Strike Density for the Contiguous United States from Thunderstorm Duration Records,” issued May 1984, for the Grand Gulf ESP site region. Considering a flash frequency of 33 flashes to earth per square mile per year and the 1.3 square mile exclusion area, the applicant estimated the expected frequency of lightning flashes within the Grand Gulf ESP site EAB as 43 flashes per year.

Hail often accompanies severe thunderstorms and can be a major weather hazard, which causes damage to crops and property. The NCDC Storm Event Database, “Storm Events for Mississippi, Query Results, Hail Event(s) Reported in Claiborne County, Mississippi Between 01/01/1950 and 09/30/2004,” reports that a total of 20 hail events with hail 0.75 inches or greater occurred in Claiborne County from January 1984 through December 2003. Ten of these events had hail 1.75 inches or greater in diameter. According to NSSL, "Severe Thunderstorm Climatology, Total Threat," the threat of hail occurring within 25 miles of the Grand Gulf ESP site is approximately 3–4 days per year for damaging hail or hail 0.75 inches in diameter or greater and 0.50–0.75 days per year for hail 2 inches or more in diameter.

The NCDC Storm Event Database, "Storm Events for Mississippi, Query Results, Snow & Ice Event(s) Reported in Claiborne County, Mississippi Between 01/01/1950 and 09/30/2004," lists two ice events for Claiborne County for the period January 1993 through December 2003. In Jones, et al. (2002), the NCDC reports a 50-year return period uniform radial ice thickness of 0.5 inches because of freezing rain, with a concurrent 3-second gust wind speed of 30 mi/h for the Grand Gulf ESP site area.

Large-scale episodes of atmospheric stagnation are not common in the site region. During the 40-year period between 1936 and 1975, high-pressure stagnation conditions, lasting for 4 days or more, occurred approximately 40 times, averaging 4.6 stagnation days per case. Korshover (1976) reports that two of these stagnation cases lasted 7 days or longer. The above discussion on atmospheric stagnation provides a general climatic understanding of the air pollution potential in the region. Section 2.3.2 of this SER discusses the ESP air quality conditions for design- and operating-basis considerations. Sections 2.3.4 and 2.3.5 of this SER present the atmospheric dispersion site characteristics used to evaluate short-term postaccident airborne releases and long-term routine airborne releases, respectively.

Both the weight of the 100-year return period snowpack and the weight of the 48-hour PMWP are specified in RG 1.70 to assess the potential snow loads on the roofs of safety-related structures. The staff's branch position on winter precipitation loads provides clarification as to the load combinations to be used in evaluating the roofs of safety-related structures. Consistent with the staff's branch position on winter precipitation loads, the winter precipitation loads to be included in the combination of normal live loads to be considered in the design of a nuclear power plant that might be constructed on a proposed ESP should be based on the weight of the 100-year snowpack or snowfall, whichever is greater, recorded at ground level. Likewise, the winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a nuclear power plant that might be constructed on a proposed ESP should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP at ground level for the month corresponding to the selected snowpack. A COL or CP applicant may choose and justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on the top of the snowpack and/or building roofs.

The applicant has identified a 100-year return period snowpack of 6.1 lbf/ft^2, which it based on the guidance in SEI/ASCE 7-02. The staff agrees with the applicant's comment that the Grand Gulf ESP site is not in a heavy snowload region, in that snow typically melts and/or evaporates within 48 hours before additional snow is added. According to SRCC, "Monthly Total Snowfall, Jackson 4 NW, Mississippi" and "Monthly Total Snowfall, Jackson WSFO Airport, Mississippi," the highest monthly total snowfall reported for Jackson during the period 1930–2000 is 10.6 inches in January 1940. According to the NCDC database "Cooperative Summary of the Day TD 3200 POR—2001 Data CDROM, Eastern United States, Puerto Rico, and Virgin Islands," issued November 2002, this 10.6 inches of snow fell on January 22 and

January 23, 1940, during which time 0.78 inches of equivalent liquid precipitation (equivalent to 4.1 lbf/ft^2) was recorded. Because the applicant performed its analysis in accordance with the appropriate guidance and the results bound the estimated weight of the maximum monthly snowfall for Jackson, the staff concludes that a 100-year return period snowpack site characteristic value of 6.1 lbf/ft^2 is acceptable.

In Open Item 2.3-2, the staff stated that the applicant had not provided an appropriate 48-hour PMWP value that can be used with the 100-year snowpack to define the extreme winter precipitation roof loads. As discussed in the staff's branch position on winter precipitation loads, the 48-hour PMWP should be developed in accordance with the guidance provided in HMR 53. The applicant responded to Open Item 2.3-2 by proposing a 48-hour PMWP value of 35 inches of water based on HMR 53. Because the applicant determined this value in accordance with HMR 53, the staff concludes that a 48-hour PMWP site characteristic value of 35 inches of water is acceptable.

In its submittal dated June 21, 2005, the applicant contended that the HMR 53 48-hour PMWP value of 35 inches is in the form of rainwater that would not remain on rooftops. Instead, the applicant proposed a 48-hour frozen PMWP value of 1.9 inches of frozen precipitation (equivalent to 9.9 lbf/ft^2) for use in defining extreme live loads for roof design purposes. The applicant's 48-hour frozen PMWP value represents a 100-year return period value statistically extrapolated from four ice storms recorded in nearby counties and parishes during the 11-year period 1993–2003. The applicant proposed defining the snow load for extreme live loads to be considered for roof structural design purposes as 16 lbf/ft^2, which represents the sum of the 100-year return period snowpack (6.1 lbf/ft^2) and the 48-hour frozen PMWP (9.9 lbf/ft^2).

The staff believes that the 11-year period of record used to derive the 48-hour frozen PMWP value of 9.9 lbf/ft^2 is too short, resulting in an unacceptably large uncertainty in the resulting value. In addition, the staff contends that the temporary roof load contributed by a heavy rain on top of an existing snowpack can be significant. Its magnitude will depend on the duration and intensity of the design rainstorm, the drainage characteristics of the snow on the roof, the geometry of the roof, and the type of drainage provided. Where adequate slope to drain does not exist, or where drains are blocked by ice, snow meltwater, and rainwater may pond in low areas on the roof. As rainwater or snow meltwater flows to such low areas, these areas tend to deflect increasingly, allowing a deeper pond to form. If the structure does not possess enough stiffness to resist this progression, failure by localizing overloading can result. This mechanism has been responsible for several roof failures under combined rain and snow loads.

Therefore, the staff contends that, until a roof design has been established, the "default" winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a nuclear power plant that might be constructed at the Grand Gulf ESP site should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP. Once the roof design has been established, a COL or CP applicant may then choose and justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on the top of the snowpack and/or building roofs based on the design of the roof and its drains.

To verify the applicant's UHS meteorological site characteristics for maximum evaporation and minimum water cooling, the staff examined 30 years (1961–1990) of hourly temperature and humidity data from Jackson using NCDC, “Solar and Meteorological Surface Observational Network (SAMSON) for Eastern U.S. CDROM,” issued September 1993. The staff calculated running 1-, 5-, and 30-day average wet-bulb temperatures from the hourly data, and it selected the periods with the highest average wet-bulb temperatures as the worst periods. The resulting maximum 1-, 5-, and 30-day average wet-bulb temperature values are similar to the values presented by the applicant.

In Open Item 2.3-3, the staff identified the need for an additional UHS meteorological site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility, a phenomenon which would reduce the amount of water available for use by the UHS. The applicant responded to Open Item 2.3-3 by proposing a cumulative degree-day below freezing site characteristic value of 98 °F degree days (i.e., 98 accumulated freezing degree days), based on daily minimum and maximum temperatures recorded at Port Gibson for the period 1930–2001. Because the average winter temperature at the Grand Gulf ESP site is well above freezing, the applicant derived this site characteristic value by evaluating the Port Gibson data for the worst case cold spell.

The staff performed a similar analysis using the 1930–2001 Port Gibson daily minimum and maximum temperature data contained in the NCDC database, “Cooperative Summary of the Day TD 3200 POR—2001 Data CDROM, Eastern United States, Puerto Rico, and Virgin Islands.” The staff calculated daily average temperatures by averaging the daily minimum and maximum temperatures and defining a cold spell as one or more consecutive days where the average daily temperature was below freezing. The worst-case cold spell was then determined by identifying the cold spell with the highest accumulated freezing degree days. The staff’s results were similar to those of the applicant.

Based on the discussion presented above, the staff concludes that the UHS meteorological site characteristics proposed by the applicant are acceptable.

The applicant chose the tornado maximum wind speed site characteristic of 300 mi/h based on the recently published Revision 1 to NUREG/CR-4461. The applicant’s remaining tornado site characteristics (e.g., pressure drop and rate of pressure drop) are consistent with staff’s interim position on design-basis tornado characteristics for a tornado with a maximum wind speed of 300 mi/h. Therefore, the staff concludes that the tornado site characteristic parameters proposed by the applicant are acceptable.

The applicant’s proposed site characteristic basic wind speed of 83 mi/h is compatible with the fastest-mile wind speed having a 1-percent annual probability of being exceeded (100-year mean recurrence interval) for the Grand Gulf ESP site area, as derived by the staff from American National Standards Institute (ANSI) A58.1-1982, “Minimum Design Loads for Buildings and Other Structures,” dated March 10, 1982. Figure 1 of ANSI A58.1-1982 shows a basic wind speed of approximately 78 mi/h for the Grand Gulf ESP site, which, by definition, has a 2-percent annual probability of being exceeded or a 50-year mean recurrence interval. According to ANSI A58.1-1982, Section A6.5.2, the ratio of the 100-year to 50-year mean recurrence interval values is typically 1.07, which means that the 50-year return period basic wind speed value of 78 mi/h corresponds to a 100-year return period basic wind speed value of 83 mi/h. Therefore, the staff concludes that a site characteristic fastest-mile basic wind speed value of 83 mi/h is acceptable.

In Open Item 2.3-4, the staff asked the applicant to identify a 3-second gust wind speed that represents a 100-year return period for the ESP site. The applicant responded to Open Item 2.3-4 by proposing a 100-year return period 3-second gust site characteristic value of 96 mi/h. The applicant determined this value in accordance with the guidance provided by SEI/ASCE 7-02. Therefore, the staff concludes that a 3-second gust wind speed site characteristic of 96 mi/h is acceptable.

The staff will include the regional climatology site characteristics listed in Table 2.3.1-7 in any ESP that it might issue for the Grand Gulf ESP site.

Table 2.3.1-7 Staff's Proposed Regional Climatology Site Characteristics

SITE CHARACTERISTIC		VALUE	DESCRIPTION
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2% annual exceedance	92 °F	The ambient dry-bulb temperature that will be exceeded 2% of the time annually
	0.4% annual exceedance	95 °F	The ambient dry-bulb temperature that will be exceeded 0.4% of the time annually
	average annual highest	98 °F	The average of the maximum temperatures recorded each year
	100-year return period	108 °F	The ambient dry-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Minimum Dry-Bulb Temperature	99% annual exceedance	25 °F	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 1% of the time annually
	99.6% annual exceedance	21 °F	The ambient dry-bulb temperature below which dry-bulb temperature will fall 0.4% of the time annually
	average annual lowest	14 °F	The average of the minimum temperatures recorded each year
	100-year return period	−6 °F	The ambient dry-bulb temperature for which a 1% annual probability of a lower dry-bulb temperature exists (100-year mean recurrence interval)
Maximum Wet-Bulb Temperature	2% annual exceedance	78 °F	The ambient wet-bulb temperature that will be exceeded 2% of the time annually
	0.4% annual exceedance	80 °F	The ambient wet-bulb temperature that will be exceeded 0.4% of the time annually
Basic Wind Speed			
Fastest-mile		83 mi/h	The fastest-mile wind speed to be used in determining wind loads, defined as the fastest-mile wind speed at 33 feet above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)

SITE CHARACTERISTIC	VALUE	DESCRIPTION
3-Second Gust	96 mi/h	The 3-second gust wind speed to be used in determining wind loads, defined as the 3-second gust wind speed at 33 feet above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Tornado		
Maximum Wind Speed	300 mi/h	Maximum wind speed resulting from passage of a tornado having a probability of occurrence of 10^{-7} per year
Translational Speed	60 mi/h	Translation component of the maximum tornado wind speed
Maximum Rotational Speed	240 mi/h	Rotation component of the maximum tornado wind speed
Radius of Maximum Rotational Speed	150 feet	Distance from the center of the tornado at which the maximum rotational wind speed occurs
Pressure Drop	2.0 $lbf/in.^2$	Decrease in ambient pressure from normal atmospheric pressure resulting from passage of the tornado
Rate of Pressure Drop	1.2 $lbf/in.^2/s$	Rate of pressure drop resulting from the passage of the tornado
Winter Precipitation		
100-Year Snowpack	6.1 lbf/ft^2	Weight of the 100-year return period snowpack (to be used in determining normal precipitation loads for roofs)
48-Hour Probable Maximum Winter Precipitation	35 inches of water	Probable maximum precipitation during the winter months (to be used in conjunction with the 100-year snowpack in determining extreme winter precipitation loads for roofs)
Ultimate Heat Sink		
Meteorological Conditions Resulting in the Minimum Water Cooling during Any 1 Day	81.0 °F wet-bulb temperature with coincident 86.3 °F dry-bulb temperature	Historic worst 1-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in the Minimum Water Cooling during Any Consecutive 5 Days	80.2 °F wet-bulb temperature with coincident 86.2 °F dry-bulb temperature	Historic worst 5-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in the Maximum Evaporation and Drift Loss during Any Consecutive 30 Days	78.5 °F wet-bulb temperature with coincident 83.1 °F dry-bulb temperature	Historic worst 30-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in Maximum Water Freezing in the UHS Water Storage Facility	98 °F degree days below freezing	Historic maximum cumulative degree days below freezing

The staff acknowledges that long-term climatic change resulting from human or natural causes may introduce changes into the most severe natural phenomena reported for the site. However, no conclusive evidence or consensus of opinion is available on the rapidity or nature of such changes. If in the future the ESP site is no longer in compliance with the terms and conditions of the ESP (e.g., if new information shows that the climate has changed and that the climatic site characteristics no longer represent extreme weather conditions), the staff may seek to modify the ESP or impose requirements on the site in accordance with the provisions of 10 CFR 52.39, "Finality of Early Site Permit Determinations," if necessary, to bring the site into compliance with Commission requirements to assure adequate protection of the public health and safety.

2.3.1.4 Conclusions

As set forth above, the applicant has presented and substantiated information relative to the regional meteorological conditions important to the safe design and siting of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site. The staff has reviewed the available information provided and, for the reasons given above, concludes that the identification and consideration of the regional and site meteorological characteristics set forth above meet the requirements of 10 CFR 100.20(c) and 10 CFR 100.21(d).

The staff finds that the applicant has considered the most severe regional weather phenomena in establishing the above site characteristics. The staff has generally accepted the methodologies used to determine the severity of the weather phenomena reflected in these site characteristics as documented in SERs for previous licensing actions. Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the site characteristics previously identified are acceptable for use as part of the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

The applicant has conformed with a technical assessment of tornado wind speed data and, in part, with the staff's interim position on design-basis tornado characteristics. Therefore, the staff concludes that the identification and consideration of tornadoes are acceptable and that the resulting tornado site characteristics are acceptable for the tornado used for the generation of missiles.

The staff reviewed the applicant's proposed site characteristics related to climatology for inclusion in an ESP for the applicant's site, should one be issued, and finds these characteristics to be acceptable. The staff has also reviewed the applicant's proposed design parameters (PPE values) for inclusion in such an ESP (SSAR Section 1.3) and finds them to be reasonable. The staff did not perform a detailed review of these parameters.

2.3.2 Local Meteorology

2.3.2.1 Technical Information in the Application

In Section 2.3.2 of the SSAR, the applicant presented local (site) meteorological information. This SSAR section also addresses the potential influence of construction and operation of a nuclear power plant or plants falling within the applicant's PPE on local meteorological conditions that might in turn adversely impact such a plant or plants or the associated facilities. Finally, the applicant provided a topographical description of the site and its environs. Specifically, the applicant provided the following information:

- a description of the local (site) meteorology in terms of airflow, temperature, atmospheric water vapor, precipitation, fog, atmospheric stability, and air quality

- an assessment of the influence on the local meteorology of construction and operation of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site and its facilities, including the effects of plant structures, terrain modification, and heat and moisture sources resulting from plant operation

- a topographical description of the site and its environs, as modified by the structures of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site

The applicant used data from the GGNS onsite meteorological monitoring system, as well as data from Vicksburg and Jackson, Mississippi, and St. Joseph, Louisiana, to characterize local meteorological conditions. The applicant considered the data from the GGNS monitoring station to be the most representative of the Grand Gulf ESP site because of the station's proximity to the site.

The applicant presented wind data from Vicksburg for the period 1997–2001. The Vicksburg wind data indicate that the predominant wind directions are from the north and south (about 14 percent of the time for each sector). The mean wind speed is 7.4 mi/h.

Revision 0 of the SSAR presents wind data from the 33-foot level on the GGNS meteorological tower for the period 1996–2001. The staff noted a lack of easterly winds for the period 1996–2000, as compared to the August 1972 through July 1974 GGNS data presented in the GGNS UFSAR and the 2001 GGNS data presented in the SSAR. The staff subsequently reviewed the GGNS onsite meteorological monitoring program during a site visit and identified that the use of a wide (4-foot by 6-foot) scaffolding tower to collect the 1996–2000 data probably contributed to this phenomenon. In early 2001, a narrower triaxial tower replaced the rectangular scaffolding tower. Consequently, in RAI 2.3.2-5, the staff asked the applicant to provide wind data summaries for the data collected with the newer, narrower tower. In its response to this RAI, the applicant provided a copy of the 1996–2003 GGNS hourly meteorological database.

The newer GGNS 2001–2003 wind data set indicates that the predominant wind directions are from the northeast (about 10 percent of the time) and southeast (about 8–9 percent of the time). The average wind speed is 4.3 mi/h. The longest single-sector wind direction persistences tend to be from the northeast sector. Seasonal variations are also evident from the data, with higher wind speeds during the winter and lower wind speeds during the summer. The prevailing wind direction is from the north during the winter, from the south during the spring, and from the northeast during the summer and autumn.

The SSAR presents dry-bulb temperature data from Vicksburg for the period 1997–2001 and from the GGNS onsite monitoring program for the period 2000–2001. The average dry-bulb temperature recorded at Vicksburg is 65.6 °F, ranging from a low monthly mean value of 47.2 °F in December to a high monthly mean value of 82.5 °F in July. The average dry-bulb temperature recorded at GGNS is 65.1 °F, ranging from a low monthly mean value of 46.2 °F in December to a high monthly mean value of 81.4 °F in July. Temperature extremes at Vicksburg range from 16 °F to 107 °F, whereas temperature extremes at GGNS range from 17.3 °F to 104.2 °F. Other observed temperature extremes include 110 °F for the Vicksburg Military Park 1967–2004 database, 107 °F and −5 °F for the Jackson 1896–2003 database, and −8 °F for the St. Joseph 1930–2001 database. The applicant statistically extrapolated 100-year return period extreme temperatures of 108 °F and −6 °F from the Port Gibson 1930–2001 database.

According to the applicant, all of Mississippi experiences high humidity during much of the year. The average relative humidity recorded at Vicksburg during the period 1997–2001 is 75 percent, with relative humidity values of 90 percent or higher occurring at any hour of the day.

The SSAR presents precipitation data recorded on site during the period 2000–2001 and at Vicksburg during the period 1997–2001. The annual average precipitation recorded on site is 44.85 inches, with monthly mean totals ranging from 8.58 inches in March to 1.65 inches in October. The annual average precipitation recorded at Vicksburg is 49.56 inches, with monthly mean totals ranging from 6.89 inches in March to 1.98 inches in August. The applicant also presented maximum short period precipitation estimates ranging from 30-minute to 10-day durations. In RAI 2.3.2-1, the staff asked the applicant to update the 30-minute and 1-hour precipitation estimates using the latest data generated by NWS, and the applicant complied with this request. The resulting 100-year recurrence interval 1-hour and 24-hour maximum precipitation estimates are 4.3 inches and 9.9 inches, respectively.

The applicant estimated the annual average snowfall in the Grand Gulf ESP site area as 1–2 inches. The applicant reported that the highest monthly amount of snowfall recorded at Jackson is 10.6 inches, which fell in a 24-hour period. The highest seasonal amount of snowfall recorded at Jackson is 11.6 inches.

The SSAR presents a precipitation wind rose for Jackson, which shows that precipitation occurs most often with winds from the southeast through south and north-northwest through northeast. A precipitation wind rose for GGNS site shows a similar pattern.

The applicant stated that Vicksburg recorded an average of 93 hours of fog per year during the period 1997–2001, with the greatest frequency of fog occurring between October and March. The applicant considered the Vicksburg fog data to be representative of the Grand Gulf ESP site because of its proximity and similar location relative to the Mississippi River. During this same period, Vicksburg reported an average of 194 hours of haze but had no reports of heavy fog, smoke, duststorms, or sandstorms.

The SSAR presents atmospheric stability data based on wind data observations from the GGNS tower and sky cover data from Vicksburg. These data show that neutral (Pasquill type “D”) conditions predominated, occurring about 23 percent of the time. Moderately stable (Pasquill type “F”) and extremely stable (Pasquill type “G”) conditions occurred about 17 percent and 19 percent of the time, respectively, most often during the summer.

The applicant presented inversion height statistics based on twice daily weather balloon data at Jackson during the period 1992–2000. These data show that inversions (defined as three weather balloon elevation readings below 3000 meters showing consecutive increases in temperature with height) occurred during approximately 60 percent of the mornings and 25 percent of the afternoons. The average morning and afternoon inversion heights are 685 meters and 1490 meters, respectively. A separate study of mixing height data from Jackson for the period 1992–2001 shows that monthly mixing heights range from an average low of 320–330 meters during August and October mornings to an average high of 1820 meters during August afternoons. Ground-based inversion statistics using Jackson hourly surface observations show that ground-based inversions occurred approximately 39 percent of the time, with the longest durations lasting 16 hours.

The SSAR also presents inversion data based on GGNS onsite delta-temperature measurements taken during the periods August 1972 through July 1974 and January 1976 through December 1976. These data show inversions occurring approximately 47 percent of the time, most frequently during August (approximately 58 percent of the time) and least frequently during January (approximately 35 percent of the time). The longest durations last 14 hours.

In RAI 2.3.2-3, the staff asked the applicant to identify the air quality characteristics of the site that it would include in the design and operating bases for a nuclear power plant or plants that might be constructed on the Grand Gulf ESP site. The applicant responded that no air quality parameters exist that require consideration for the proposed ESP facility’s design and operating bases.

The applicant stated that the only aspects of the Grand Gulf ESP site that could be categorized as a unique microclimate result from the site’s proximity to the Mississippi River. The proximity of the river increases local humidity a small amount and creates a slight tendency for lower level winds to be channeled along the river.

In RAI 2.3.2-4, the staff asked the applicant to describe potential modifications to local meteorological conditions as the result of the presence and operation of a nuclear power plant or plants falling within the PPE specified in the SSAR. The applicant responded that it does not expect new construction at the site to significantly impact the local climate. Although some ground leveling will occur, it will not change any of the significant climate-shaping topographic features. Some trees will be removed, but the trees within the construction footprint are few in number compared to the surrounding forested land. The site already contains numerous buildings, large parking areas, and traffic; the impact of more structures, facilities, and activities is not expected to be noticeable in terms of local meteorology.

In its response to RAI 2.3.2-4, the applicant also stated that operation of a new facility at the Grand Gulf ESP site could affect local climate by increasing particulate emissions to the atmosphere, producing thermal discharges to the Mississippi River, and adding heat and moisture to the atmosphere through the use of cooling towers. The increase in particulate emissions during plant operation would result from a modest increase in automobile traffic and infrequent operation of diesel generators. The applicant noted that the net increase in particulate emissions would be negligible and would not cause any noticeable climatic effects.

Likewise, in its response, the applicant stated that the amount of heat rejected to the high volumetric flow of the Mississippi River would be relatively small, causing an incidentally small impact on local meteorology. The applicant's evaluation of the surface thermal plumes resulting from the discharge of blowdown water into the Mississippi River predicts a steam fog occurrence probability of only a few percent higher than over ambient river water.

The SSAR evaluates the atmospheric impact for two different options for providing normal heat sink cooling capability to the proposed facility—(1) four natural draft cooling towers and (2) four 20-cell linear mechanical draft cooling towers. These cooling systems would create visible plumes under certain atmospheric conditions, which can cause shadowing of nearby lands, salt deposition, fogging, and icing. The predicted seasonal average plume lengths for the natural draft cooling towers range from 0.93 miles in the summer to 2.32 miles in the winter. The predicted plume lengths for the mechanical draft cooling towers are generally 40 percent less, but the plumes would be closer to the ground, resulting in increased salt deposition and the possibility of fog. The applicant's plume study shows that no fogging would occur for the natural draft cooling tower option, whereas the study predicts that the mechanical draft cooling towers would cause minimal fogging (on the order of 15 hours per year). The applicant considered ground-level icing insignificant because of the low probabilities of ground-level plumes from either type of tower and freezing conditions. Except for the limited potential for fogging, the applicant determined that the use of either cooling system option would have no significant impact on meteorological conditions outside the site boundary.

In the SSAR, the applicant noted that the proposed location for the new facility site lies about 6300 feet east of the Mississippi River at an elevation of approximately 132.5 feet above mean sea level (MSL). The applicant described the surrounding terrain as generally hilly and wooded to the south and east, with several hilltops more than 350 feet above MSL to the south. To the north and west, the terrain is generally flat and wooded, lying less than 100 feet above MSL. Numerous lakes of various sizes and isolated marshes dot the landscape. A rather abrupt (irregular) 100- to 200-foot rise in terrain occurs approximately 1 mile east of the riverbank.

2.3.2.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant stated that the NRC regulations that apply to evaluating an ESP include 10 CFR 100.20 and 10 CFR 100.21. The staff notes that 10 CFR 100.20(c) and 10 CFR 100.21(d) are the applicable 10 CFR Part 100 regulations with respect to the consideration that has been given to the regional meteorological characteristics of the site.

In SSAR Sections 1.0 and 1.4, the applicant identified the following applicable NRC guidance regarding local meteorology:

- RG 1.3, Revision 2, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," issued June 1974, with respect to acceptable methods for modeling radiological releases

- RG 1.23, "Onsite Meteorological Programs," issued February 1972, with respect to providing the criteria for an acceptable onsite meteorological measurements program

- RG 1.70, with respect to the type of local meteorological data that should be presented

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

Section 2.3.2 of RS-002 and Section 2.3.2 of RG 1.70 provide the following guidance on information appropriate for a presentation on local meteorology:

- Local meteorological data based on onsite measurements and data from nearby NWS stations or other standard installations should be presented in the format specified in Section 2.3.2 of RG 1.70. RG 1.23 provides guidance related to onsite meteorological measurements.

- A topographical description of the site and environs should be provided. Section 2.3.2.2 of RG 1.70 provides guidance on the topographical description.

- A discussion and evaluation of the influence of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site and its facilities on local meteorological and air quality conditions should be provided. Potential changes in the normal and extreme values resulting from plant construction and operation should be discussed.

2.3.2.3 Technical Evaluation

The staff evaluated local meteorological conditions using data from the GGNS onsite meteorological monitoring system, as well as climatic data reported by NWS, NCDC, and SRCC. The staff reviewed statistics for the following climatic stations located in the vicinity of the Grand Gulf ESP site:

- Port Gibson, Mississippi, located approximately 5 miles east-southeast of the ESP site
- St. Joseph, Louisiana, located approximately 11 miles west-southwest of the ESP site
- Vicksburg, Mississippi, located approximately 26 miles north-northeast of the ESP site
- Jackson, Mississippi, located approximately 61 miles east-northeast of the ESP site

As discussed in Section 2.3.2.1 of this SER, the GGNS 33-foot level wind data presented in Revision 0 of the SSAR for the period 1996–2000 lack easterly winds as compared to the August 1972 through July 1974 GGNS data presented in the GGNS UFSAR and the 2001 GGNS data given in the SSAR. In response to RAI 2.3.2-5, the applicant provided a copy of the 1996–2003 GGNS hourly meteorological database.

The staff's review of the applicant's 33-foot wind data from August 1972 through July 1974 and January 2002 through December 2003 shows that the data from these two periods are compatible. The predominant wind directions for the 1972–1974 data are from the east-northeast clockwise to south-southeast (43 percent of the time), as compared to the predominant northeast clockwise to southeast (42 percent of the time) wind directions for the 2001–2003 time period. The wind speed frequency distributions between the two time periods are similar as well, with average wind speeds of 4.4 mi/h and 4.3 mi/h for the 1972–1974 and 2001–2003 time periods, respectively.

According to NCDC, “Southeast Mississippi Divisional Normals—Temperature, Period 1971–2000,” dated June 15, 2002, the 1971–2000 normal climatic data for the southwest climatic division of Mississippi indicate an annual mean temperature of 64.6 °F, ranging from a low monthly mean value of 46.6 °F in January to a high monthly mean value of 80.8 °F in July. These climatic division mean temperature values are compatible with the mean temperature values recorded on site during the period 2000–2001 (e.g., annual mean temperature of 65.1 °F with a low monthly mean value of 46.2 °F in December and a high monthly mean value of 81.4 °F in July).

The staff presents an evaluation of the applicant’s 100-year return period extreme temperatures in Section 2.3.1.3 of this SER.

The annual mean wet-bulb temperature at Jackson is 58.6 °F and ranges from a high monthly mean value of 74.3 °F in July to a low monthly mean value of 41.5 °F in January. As reported in NCDC, “Jackson, Mississippi, 2003 Local Climatological Data, Annual Summary with Comparative Data,” the annual mean relative humidity is 75 percent.

As stated in NCDC, “Southeast Mississippi Divisional Normals—Precipitation, Period 1971–2000,” dated June 15, 2002, precipitation for the southwest Mississippi climatic division averages 61.37 inches per year, with monthly climate division normals ranging from a minimum of 3.62 inches in October to a maximum of 6.51 inches in March. The annual average precipitation recorded at Port Gibson during 2000–2001 is 54.57 inches, compared to 44.85 inches noted at the GGNS site during the same period, as reported in SRCC, “Monthly Precipitation, Port Gibson 1 NW, Mississippi.” According to NWS, “NWS Jackson, MS—St. Joseph 3N Climate,” maximum and minimum monthly amounts of precipitation observed in the area are 21.80 inches in April 1940 and 0 inches in October 1952 at St. Joseph. One of the highest 24-hour precipitation totals recorded for the site region is 9.85 inches at St. Joseph on April 4, 1940, according to NCDC, “Cooperative Summary of the Day TD 3200 POR–2001 Data CDROM, Central United States.” Precipitation wind roses provided by the applicant for Jackson and the GGNS site show that rain occurs most often with wind from the southeast through south and north-northwest through northeast.

The average seasonal snowfall at Port Gibson for the period 1929–1930 through 2003–2004 is 1.1 inches. Measurable snowfall was reported during 23 seasons out of this 75-season period, with measurable snowfall recorded during November through March. According to SRCC, “Monthly Total Snowfall, Port Gibson 1 NW, Mississippi,” the highest monthly and seasonal total snowfalls reported for Port Gibson are 9.0 inches for January 1940 and 10.0 inches for the 1967–1968 season.

The SSAR presents atmospheric stability data based on delta-temperature measurements between the 162-foot and 33-foot levels on the GGNS meteorological tower for the period 2001–2002. Neutral (Pasquill type “D”) and slightly stable (Pasquill type “E”) conditions were predominant, occurring about 35 percent and 26 percent of the time, respectively. Moderately stable (Pasquill type “F”) and extremely stable (Pasquill type “G”) conditions occurred about 10 and 11 percent of the time, respectively. The onsite data presented in the GGNS UFSAR for the period 1972–1976 show similar stability frequencies. Neutral and slightly stable conditions were predominant in the 1972–1976 data set, occurring about 29 and 22 percent of the time, respectively. Moderately stable and extremely stable conditions occurred about 10 and 14 percent of the time, respectively.

In summary, the staff reviewed the applicant's description of the local meteorology and determined that it represents the conditions at and near the site. The applicant based the wind, temperature, precipitation, and atmospheric stability data on onsite data recorded by the GGNS meteorological monitoring system. Section 2.3.3 of this SER discusses the representativeness of the GGNS onsite data. Additional meteorological summaries are based on data from nearby stations with long periods of record. The staff's review of the recorded extreme values shows that the site characteristics presented in SSAR Section 2.3.1 reflect these values.

The staff reviewed the topographic information provided in the SSAR and concluded that it can readily extract the information needed.

Because of the limited and localized nature of the expected terrain modifications associated with the development of the ESP facility, the staff finds that these terrain modifications, along with the resulting plant structures and associated improved surfaces, will not have enough of an impact on local meteorological conditions to affect plant design and operation. The use of natural draft cooling towers, mechanical draft cooling towers, or both, would create visible plumes under certain atmospheric conditions, which can cause shadowing of nearby lands, salt deposition, and fogging. Ground-level icing would be insignificant because of the low probabilities of both ground-level plumes from either type of tower and freezing conditions. The staff finds that these atmospheric impacts will not have enough of an impact on local meteorological conditions to affect plant design and operation.

The Grand Gulf ESP Environmental Report (ER) states that the air quality in the vicinity of the ESP site is generally good, reflecting the predominantly rural character of the region. The Grand Gulf ESP site region has been designated as in attainment of the national ambient air quality standards. Therefore, the staff finds that the Grand Gulf ESP site air quality conditions should not be a significant factor in the design and operating bases for the ESP facility.

2.3.2.4 Conclusions

As set forth above, the applicant has presented and substantiated information on local meteorological, air quality, and topographic characteristics of importance to the safe design and operation of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site. The staff has reviewed the available information provided and, for the reasons given, concludes that the applicant's identification and consideration of the meteorological, air quality, and topographical characteristics of the site and the surrounding area meet the requirements of 10 CFR Part 100, 10 CFR 100.20(c), and 10 CFR 100.21(d) and are sufficient to determine the acceptability of the site.

The staff also reviewed available information relative to severe local weather phenomena at the site and in the surrounding area. As set forth above, the staff concludes that the applicant has identified the most severe local weather phenomena at the site and surrounding area.

2.3.3 Onsite Meteorological Measurements Program

2.3.3.1 Technical Information in the Application

In Section 2.3.3 of the SSAR, the applicant presented information concerning its onsite meteorological measurements program, including instrumentation and measured data. Specifically, the applicant provided the following information:

- a description of meteorological instrumentation, including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, and data acquisition and reduction procedures

- meteorological data, including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions

The applicant used the existing onsite meteorological measurements program for the GGNS facility to collect data for the Grand Gulf ESP site. According to the applicant, data collection (except for the humidity data) has been compliant with the applicable requirements of RG 1.23 since the startup of the GGNS onsite monitoring system in 1972.

The GGNS meteorological monitoring program has evolved over the years. A 162-foot tower was first installed before plant construction in August 1972. The tower was located approximately 5300 feet north-northwest of the center of the GGNS Unit 1 reactor and approximately 3600 feet north of the center of the proposed Grand Gulf ESP powerblock area. The tower structure consisted of approximately 4-foot-wide by 6-foot-long scaffolding with a set of climbing stairs running up the center. The instrumentation on this tower was upgraded and a 33-foot backup tower was installed approximately 300 feet south-southwest of the primary tower in 1983 as part of the initial licensing conditions for GGNS Unit 1.

Wind speed and direction were measured at the 33-foot and 162-foot elevations. Ambient temperature and dew point were measured at the 33-foot elevation, and vertical temperature difference (delta-temperature) was measured between the 162-foot and 33-foot elevations. Precipitation was monitored at the ground level.

Because of concerns that the width of the primary tower would affect the wind speed and direction measurements, the wind sensors on the primary tower had redundant/duplicate sensors located on the opposite face of the tower. Strip chart recorders located in the instrument shed near the base of the tower recorded data; in addition, data from one set of instruments were sent to the plant data system (PDS) for data display and recording.

The primary and backup tower structures were replaced in March 2001. A 162-foot guyed, triaxial, open lattice (18-inch-wide) tower was installed at the location of the 33-foot backup tower, and a 33-foot open lattice backup tower was installed at the location of the 162-foot scaffolding tower. Instrumentation on both towers was also replaced as part of the 2001 system upgrade. The new primary tower sensors are located at the same heights as on the previous tower (i.e., at the 33-foot and 162-foot levels). However, unlike the previous primary tower, the new primary tower has only one set of wind sensors. Redundant wind instrumentation is no longer necessary since the new tower’s structure should have little to no effect on the wind measurements (because of the new tower structure's narrower face). The 33-foot dew point sensor was also replaced with a relative humidity sensor as part of the instrumentation upgrade.

The wind sensors on the new tower are mounted on 6-foot booms and are oriented towards the west. The temperature and relative humidity sensors are housed in motor-aspirated shields to insulate them from the effects of precipitation and thermal radiation.

Before 2001, the meteorological data were recorded in both digital and analog form. Digital data averages were calculated each hour from 1-second readings. The analog traces recorded on strip charts served as a backup and verification for the digital data. Beginning in 2001, the meteorological data are recorded digitally from readings taken at least once every 10 seconds. Data averages are calculated every 15 minutes and every hour. The applicant used the resulting 2002–2003 hourly digital database to perform the atmospheric dispersion analyses presented in Sections 2.3.4 and 2.3.5 of the SSAR.

The meteorological monitoring system is calibrated at least semiannually. The data recovery for the 2002–2003 period of record used to evaluate atmospheric dispersion is more than 90 percent.

In RAI 2.3.2-2, the staff asked the applicant to specify the proposed locations of the two different options under consideration for normal heat sink cooling (i.e., the four natural draft cooling towers and the four mechanical draft cooling towers) and identify their potential influence on the onsite meteorological measurement system. In its response to this RAI, the applicant stated that the closest natural draft cooling tower at its proposed location would be approximately 1400 feet from the current meteorological tower location. The applicant also stated that wake effects and potential plume interaction could affect the meteorological tower if the natural draft cooling towers were to be constructed at their proposed locations and the existing meteorological tower were to remain at its current location. The natural draft cooling tower option would be the only option with potential for wake effects.

In RAI 2.3.2-5, the staff asked the applicant to provide an hourly listing of the onsite meteorological database used to generate the SSAR Section 2.3.4 short-term diffusion estimates and the SSAR Section 2.3.5 long-term diffusion estimates. In its response to this RAI, the applicant provided a copy of the hourly database for 1996–2003.

2.3.3.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant stated that the NRC regulations that apply to evaluation of an ESP include Appendix I to 10 CFR Part 50, 10 CFR 100.20, and 10 CFR 100.21. The staff notes that 10 CFR 100.20(c), 10 CFR 100.21(c), and 10 CFR 100.21(d) are the applicable 10 CFR Part 100 regulations as they relate to meteorological data collected for use in characterizing the site's meteorological characteristics. The staff also notes that Appendix I to 10 CFR Part 50 pertains to the meteorological data used to determine compliance with the numerical guides for doses in meeting the criterion of "as low as is reasonable achievable" (ALARA).

In SSAR Sections 1.0, 1.4, and 2.3.3, the applicant identified the following applicable NRC guidance regarding onsite meteorological measurements programs:

- RG 1.23, with respect to criteria for an acceptable onsite meteorological measurements program

- RG 1.70, with respect to describing the meteorological measurements at the site and providing joint frequency distributions of wind speed and direction by atmospheric stability class

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

Both RG 1.23 and RS-002, Section 2.3.3, document the criteria for an acceptable onsite meteorological measurements program. The onsite meteorological measurements program should produce data that describe the meteorological characteristics of the site and its vicinity for the purpose of making atmospheric dispersion estimates for both postulated accidental and expected routine airborne releases of effluents, and for comparison with offsite sources to determine the appropriateness of climatological data used for design considerations.

Section 2.3.3 of RS-002 and Section 2.3.3 of RG 1.70 provide guidance on information appropriate for presentation on an onsite meteorological measurements program. As set forth in this guidance, at least one annual cycle of onsite meteorological data should be provided. These data should be presented in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class in the format described in RG 1.23. If a site has a high occurrence of low wind speeds, a finer category breakdown should be used for the lower speeds so data are not clustered in a few categories. A listing of each hour of the hourly averaged data should also be provided on electronic media in the format described in Appendix A to Section 2.3.3 of RS-002. Evidence of how well these data represent long-term conditions at the site should be discussed.

2.3.3.3 Technical Evaluation

The staff evaluated the onsite meteorological measurements program by reviewing the description presented in the SSAR and conducting a site visit. During the site visit, the staff reviewed the meteorological monitoring system location and exposure, sensor type and performance specifications, data transmission and recording, data acquisition and reduction, and instrumentation maintenance and calibration procedures. In addition, the staff reviewed hourly listings of the 2002–2003 meteorological database provided by the applicant in its response to RAI 2.3.2-5. The applicant used the 2002–2003 database to generate the SSAR Section 2.3.4 short-term diffusion estimates and the SSAR Section 2.3.5 long-term diffusion estimates.

The Grand Gulf ESP site is within the existing GGNS site, and the proposed ESP facility is intended to be in close proximity to the existing GGNS facility. The GGNS primary tower is located far enough away from existing plant structures to preclude any adverse impact on measurements. Since the 2001 system upgrade, the wind sensors are mounted on 6-foot booms to preclude tower influence on the wind measurements. The temperature and relative humidity sensors are housed in motor-aspirated shields to insulate them from the effects of precipitation and thermal radiation. The ground cover at the base of the tower consists primarily of native grasses. Trees 50 feet tall are located approximately 362 feet to the west of the primary tower, and 50-foot to 60-foot trees are located approximately 396 feet to the east and 489 feet to the south of the primary tower. RS-002, Section 2.3.3, states that wind sensors should be at least 10 obstruction heights away from any obstructions (such as trees) to avoid potential influence on wind measurements. Although these trees are located within 10 times their height from the primary tower, their influence is not considered to be significant in that they are at least 6 times their height from the tower. According to the applicant, all trees within a 900-foot radius of the primary tower are scheduled to be trimmed back in the near future.

The staff evaluated the types and heights of the meteorological variables measured and found them to be compatible with the criteria of RG 1.23. During the site visit, the staff reviewed the sensor types and performance specifications, data transmission, and recording methods, as well as the inspection, maintenance, and calibration procedures and frequencies, and found them to be consistent with the guidance in RG 1.23.

The applicant based the short-term and long-term diffusion estimates presented in Revision 0 of SSAR Sections 2.3.4 and 2.3.5 on onsite meteorological data recorded from January 1996 through December 2000. However, a review of this meteorological data set by the staff revealed that wind data collected during this period show an apparent lack of easterly winds as compared to the August 1972 through July 1974 GGNS onsite meteorological data set presented in the GGNS UFSAR.

This apparent lack of easterly winds in the 1996–2000 data set may be the result of tower “shadowing” from the wide scaffolding tower used during this period. Although redundant/duplicate wind sensors were located on the opposite face of the tower, the PDS recorded only one set of these data during this period. The data recorded by the PDS were a function of an A/B switch located in the instrument shed at the base of the tower, and its setting was probably never changed during the 1996–2000 recording period. It appears that data from both sets of wind instruments were appropriately used to compile the 1972–1974 wind data presented in the GGNS UFSAR. These earlier data probably predate the use of the PDS and were most likely compiled from the strip charts.

Therefore, since the narrower triaxial tower replaced the wide scaffolding tower in March 2001, the staff asked the applicant in RAI 2.3.2-5 to recalculate the short-term and long-term diffusion factors presented in SSAR Sections 2.3.4 and 2.3.5 using meteorological data collected by the GGNS monitoring program since the 2001 system upgrade. In its response to RAI 2.3.2-5, the applicant revised the requested atmospheric diffusion factors using GGNS site meteorological data for 2002–2003.

The staff performed a quality review of the 2002–2003 hourly meteorological database provided by the applicant using the methodology described in NUREG-0917, “Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data,” issued July 1982. The staff performed further review using computer spreadsheets. As expected, its examination of the data revealed generally stable and neutral atmospheric conditions at night and unstable and neutral conditions during the day. Wind speed, wind direction, and stability class frequency distributions for each measurement channel were reasonably similar from year to year and generally consistent with the 1972–1976 data presented in the GGNS UFSAR. A comparison between the joint frequency distribution used by the applicant as input to the PAVAN and

XOQDOQ atmospheric dispersion computer codes and a staff-generated joint frequency distribution from the hourly database provided by the applicant showed that they were similar.

For the reasons cited above, the staff considers the meteorological data collected by the GGNS monitoring program since the 2001 system upgrade to be representative of the dispersion conditions at the Grand Gulf ESP site.

In its response to RAI 2.3.2-2, the applicant stated that, should natural draft cooling towers be constructed in the proposed location and the existing meteorological tower remain in its current location, the meteorological tower could experience wake effects, potential plume interactions, and other impacts. Therefore, the issue of interaction between the existing meteorological tower and the proposed facility's cooling towers should be evaluated following the finalization of the cooling tower design and placement. This is **COL Action Item 2.3-1.**

2.3.3.4 Conclusions

As set forth above, the applicant has provided and substantiated information regarding the onsite meteorological measurements program. The staff has reviewed the available information relative to the meteorological measurements program and the data collected by the program. On the basis of this review and as set forth above, the staff concludes that the system provides data adequate to represent onsite meteorological conditions, as required by 10 CFR 100.20. The onsite data collected from 2002–2003 provide an acceptable basis for (1) making estimates of atmospheric dispersion for DBA and routine releases from a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site and (2) meeting the requirements of 10 CFR Part 100 and Appendix I to 10 CFR Part 50.

2.3.4 Short-Term Diffusion Estimates

2.3.4.1 Technical Information in the Application

In Section 2.3.4 of the SSAR, the applicant presented information on atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and LPZ. Specifically, the applicant provided the following information:

- atmospheric transport and diffusion models to calculate dispersion estimates (atmospheric dispersion factors or χ/Q values) for postulated accidental radioactive releases
- meteorological data summaries used as input to dispersion models
- specification of diffusion parameters
- probability distributions of χ/Q values
- determination of χ/Q values used for assessment of consequences of postulated radioactive atmospheric releases from design-basis and other accidents

The applicant used the computer code PAVAN (NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations," issued November 1982) to estimate χ/Q values at the EAB and LPZ for potential accidental releases of radioactive material. The PAVAN model implements the methodology outlined in RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," issued November 1982.

The PAVAN code estimates χ/Q values for various time-averaging periods ranging from 2 hours to 30 days. The meteorological input to PAVAN consists of a joint frequency distribution of wind speed, wind direction, and atmospheric stability data. The PAVAN code computes χ/Q values at the EAB and LPZ for each combination of wind speed and atmospheric stability for each of the 16 downwind direction sectors. The code then ranks χ/Q values for each sector in descending order, and it derives an associated cumulative frequency distribution based on the frequency distribution of wind speed and stabilities for that sector. The χ/Q value that is equaled or exceeded 0.5 percent of the total time is determined for each sector, and the highest 0.5 percentile χ/Q value among the 16 sectors becomes the maximum sector-dependent χ/Q value. The code also ranks χ/Q values independent of wind direction into a cumulative frequency distribution for the entire site. The PAVAN program then selects the χ/Q value that is equaled or exceeded 5 percent of the total time. The larger of the two values, the maximum sector-dependent 0.5-percent χ/Q value or the overall site 5-percent χ/Q value, is used to represent the χ/Q value for a 0–2-hour time period.

To determine χ/Q values for longer time periods, PAVAN calculates annual average χ/Q values. Logarithmic interpolation is then used between the 0–2-hour χ/Q values and the annual average χ/Q values to calculate the values for intermediate time periods (i.e., 8 hours, 16 hours, 72 hours, and 624 hours).

In RAI 2.3.4-2, the staff asked the applicant to provide a copy of the PAVAN computer code input and output files used to generate the EAB and LPZ χ/Q values presented in SSAR Section 2.3.4. The applicant complied with this request in its response to this RAI.

The applicant used the following input data and assumptions in applying the PAVAN model to the Grand Gulf ESP site:

- Revision 0 to the SSAR presents PAVAN results using a joint frequency distribution of wind speed, wind direction, and atmospheric stability data based on onsite meteorological data from January 1996 through December 2000. The wind data were obtained from the 33-foot level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 162-foot and 33-foot levels of the GGNS onsite meteorological tower. As discussed in Section 2.3.3.3 of this SER, a review of this data set by the staff revealed that wind data collected during this period show an apparent lack of easterly winds as compared to the August 1972 through July 1974 GGNS onsite meteorological data set presented in the GGNS UFSAR. In RAI 2.3.2-5, the staff asked the applicant to recalculate the short-term dispersion estimates presented in SSAR Section 2.3.4 using meteorological data collected by the GGNS monitoring program since the 2001 system upgrade. In its response to this RAI, the applicant revised the requested short-term atmospheric dispersion estimates using GGNS site meteorological data for 2002–2003.

- The applicant modeled one ground-level release point and did not take credit for building wake effects.

- SSAR Section 2.1.2 states that the EAB for the new facility consists of a circle of approximately 0.52-mile (841-meter) radial distance from the circumference of a 630-foot (192-meter) radius circle encompassing the proposed powerblock location for the new facility. Thus, the minimum distance to the EAB from any individual new reactor sited within the 630-foot circle would be 0.52 miles (841 meters). Therefore, the applicant used an EAB distance of 841 meters as input to the PAVAN computer code.

- Likewise, SSAR Section 2.1.3.4 states that the LPZ for the new facility consists of a circle of approximately 2-mile (3219-meter) radial distance from the circumference of a 630-foot (192-meter) radius circle encompassing the proposed powerblock location for the new facility. Thus, the minimum distance to the LPZ from any individual new reactor sited within the 630-foot (192-meter) circle would be 2 miles (3219 meters). Therefore, the applicant used an LPZ distance of 3219 meters as input to the PAVAN computer code.

Based on the PAVAN modeling results, the applicant proposed the short-term atmospheric dispersion site characteristics presented in Table 2.3.4-1 for inclusion in an ESP, should one be issued for the applicant's proposed Grand Gulf ESP site.

Table 2.3.4-1 Applicant's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2-H χ/Q Value @ EAB (5%)	5.95×10^{-4} s/m^3	The atmospheric dispersion factors used in the safety analysis to estimate dose consequences of accidental airborne releases
0–8-H χ/Q Value @ LPZ (5%)	8.83×10^{-5} s/m^3	
8–24-H χ/Q Value @ LPZ (5%)	6.16×10^{-5} s/m^3	
1–4-Day χ/Q Value @ LPZ (5%)	2.82×10^{-5} s/m^3	
4–30-Day χ/Q Value @ LPZ (5%)	9.15×10^{-6} s/m^3	

2.3.4.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant stated that the NRC regulations that apply to the evaluation of an ESP include 10 CFR 100.21. The staff notes that 10 CFR 100.21 is the applicable NRC regulation regarding short-term (accident release) dispersion estimates with respect to the meteorological considerations used in the evaluation to determine an acceptable exclusion area and LPZ.

In SSAR Sections 1.0, 1.4, and 2.3.4, the applicant identified the following applicable NRC guidance regarding short-term dispersion estimates:

- RG 1.23, with respect to criteria for an acceptable onsite meteorological measurements program
- RG 1.70, with respect to providing conservative estimates of atmospheric dispersion at the EAB and LPZ, based on the most representative meteorological data and impacts caused by local topography

- RG 1.145, with respect to acceptable methods for choosing χ/Q values for evaluating the consequences of potential accidents

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

In SSAR Sections 1.4 and 2.3.4, the applicant identified RG 1.145 as describing methods acceptable to the staff for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of DBA releases. Use of the PAVAN model described in NUREG/CR-2858 is acceptable.

Section 2.3.4 of RS-002 and Section 2.3.4 of RG 1.70 provide guidance on information appropriate for a presentation on short-term (accident release) dispersion estimates. According to this guidance, the application should present the following:

- conservative estimates of atmospheric transport and diffusion conditions at appropriate distances from the source for postulated accidental releases of radioactive materials to the atmosphere

- a description of the atmospheric dispersion models used to calculate χ/Q values in air resulting from accidental releases of radioactive material to the atmosphere, with models documented in detail and substantiated within the limits of the model so that the staff can evaluate their appropriateness to site characteristics, plant characteristics (to the extent known), and release characteristics

- the meteorological data used for the evaluation (as input to the dispersion models) that represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release

- an explanation of the variation of atmospheric diffusion parameters used to characterize lateral and vertical plume spread (σ_y and σ_z) as a function of distance, topography, and atmospheric conditions, as related to measured meteorological parameters, and a description of a methodology for establishing these relationships that is appropriate for estimating the consequences of accidents within the range of distances that are of interest with respect to site characteristics and established regulatory criteria

- cumulative probability distributions of χ/Q values and the probabilities of exceeding these χ/Q values, presented for appropriate distances (e.g., the EAB and LPZ) and time periods as specified in Section 2.3.4.2 of RG 1.70, as well as an adequate description of the methods used for generating these distributions

- the χ/Q values used for assessing the consequences of atmospheric radioactive releases from design-basis and other accidents

2.3.4.3 Technical Evaluation

The applicant generated its atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and LPZ using the staff-endorsed computer code PAVAN. The staff evaluated the applicability of the PAVAN model and concluded that no unique topographic features preclude the use of PAVAN for the Grand Gulf ESP site. The staff also reviewed the applicant's input to the PAVAN computer code, including the assumptions used concerning plant configuration and release characteristics, and the appropriateness of the meteorological data input. The staff found that the applicant made conservative assumptions by ignoring building wake effects and treating all releases as ground-level releases. The staff independently evaluated the resulting atmospheric dispersion estimates by running the PAVAN computer model and obtained similar results.

From this review, the staff concludes that the applicant has used an adequately conservative atmospheric dispersion model and appropriate meteorological data to calculate χ/Q values for appropriate offsite (EAB and LPZ) distances and directions from postulated release points for accidental airborne releases of radioactive materials.

In order to evaluate atmospheric dispersion characteristics with respect to radiological releases to the control room, detailed design information (e.g., vent heights, intake heights, distance and direction from release vents to the room) is necessary. Because little detailed design information is available for the nuclear power plant or plants that might be constructed on the proposed site, the COL or CP applicant should assess the dispersion of airborne radioactive materials to the control room at the COL or CP stage. This is **COL Action Item 2.3-2.**

The staff intends to include the short-term (accident release) atmospheric dispersion estimates listed in Table 2.3.4-2 as site characteristics in any ESP permit that might be issued for the site.

Table 2.3.4-2 Staff's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2-H χ/Q Value @ EAB	5.95×10^{-4} s/m^3	The 0–2-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the EAB
0–8-H χ/Q Value @ LPZ	8.83×10^{-5} s/m^3	The 0–8-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
8–24-H χ/Q Value @ LPZ	6.16×10^{-5} s/m^3	The 8–24-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
1–4-Day χ/Q Value @ LPZ	2.82×10^{-5} s/m^3	The 1–4 day-atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
4–30-Day χ/Q Value @ LPZ	9.15×10^{-6} s/m^3	The 4–30-day atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ

2.3.4.4 Conclusions

As set forth above, the applicant has made conservative assessments of post-accident atmospheric dispersion conditions using its meteorological data and appropriate dispersion models. The applicant has calculated representative atmospheric transport and diffusion conditions for the EAB and the LPZ. The staff has reviewed the applicant's proposed short-term atmospheric dispersion site characteristics for inclusion in an ESP for the applicant's site, should one be issued, and, as discussed above, finds these characteristics to be acceptable. Therefore, the staff concludes that the applicant's atmospheric dispersion estimates are appropriate for the assessment of consequences from radioactive releases for postulated (i.e., design-basis) accidents, in accordance with 10 CFR 100.21.

Based on these considerations, the staff concludes that the applicant's short-term atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR Part 100. The staff will address atmospheric dispersion estimates used to evaluate radiological doses for the control room in its review of any COL or CP application that references this information.

2.3.5 Long-Term Diffusion Estimates

2.3.5.1 Technical Information in the Application

In Section 2.3.5 of the SSAR, the applicant presented its atmospheric dispersion estimates for routine releases of effluents to the atmosphere. Specifically, the applicant provided the following information:

- the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere
- the meteorological data used as input to diffusion models
- diffusion parameters
- relative concentration (χ/Q) and relative deposition (D/Q) values used to assess the consequences of routine airborne radioactive releases
- points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations

The applicant used the NRC-sponsored computer code XOQDOQ (NUREG/CR-2919, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," issued September 1977) to estimate χ/Q and D/Q values resulting from routine releases. The XOQDOQ model implements the methodology outlined in RG 1.111, Revision 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," issued July 1977.

In RAI 2.3.5-1, the staff asked the applicant to provide a copy of the XOQDOQ computer code input and output files used to generate the χ/Q values presented in SSAR Section 2.3.5. The applicant complied with this request.

The applicant used the following input data and assumptions in applying the XOQDOQ model for the Grand Gulf ESP site:

- Revision 0 to the SSAR presents XOQDOQ results using a joint frequency distribution of wind speed, wind direction, and atmospheric stability data based on onsite meteorological data from January 1996 through December 2000. The wind data were obtained from the 33-foot level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 162-foot and 33-foot levels of the GGNS onsite meteorological tower. As discussed in Section 2.3.3.3 of this SER, a review of this data set by the staff revealed that wind data collected during this period show an apparent lack of easterly winds as compared to the August 1972 through July 1974 GGNS onsite meteorological data set presented in the GGNS UFSAR. In RAI 2.3.2-5, the staff asked the applicant to recalculate the long-term dispersion estimates presented in SSAR Section 2.3.5 using meteorological data collected by the GGNS monitoring program since the 2001 system upgrade. In its response to this RAI, the applicant revised the requested long-term atmospheric dispersion estimates using GGNS site meteorological data for 2002–2003.
- The applicant modeled one ground-level release point and took no credit for building wake effects.

In Revision 0 to the SSAR, the applicant presented annual average undepleted/no decay and depleted/no decay χ/Q values and D/Q values for the site boundary and special receptors of interest (e.g., nearest home and garden within 5 miles in each downwind sector), as determined from the locations given in the GGNS 2001 Land Use Census. In Open Item 2.3-5, the staff noted that the receptor locations listed in SSAR Table 3.2-3A include the nearest milk cow and the nearest meat cow and requested that the applicant provide the χ/Q and D/Q values for these receptor locations. The applicant provided the requested information in its response to Open Item 2.3-5.

Table 2.3.5-1 lists the long-term atmospheric dispersion estimates that the applicant derived based on the XOQDOQ modeling results.

Table 2.3.5-1 Applicant's Long-Term (Routine Release) Dispersion Estimates

TYPE OF LOCATION	X/Q VALUE (s/m^3)		D/Q VALUE ($1/m^2$)
	NO DECAY UNDEPLETED	NO DECAY DEPLETED	
Site Boundary	8.8×10^{-6} (0.85 mi WSW)	7.8×10^{-6} (0.85 mi WSW)	1.2×10^{-8} (0.58 mi N)
Nearest Home	2.2×10^{-6} (0.81 mi N)	1.9×10^{-6} (0.81 mi N)	7.0×10^{-9} (0.64 mi NNE)
Nearest Garden	2.0×10^{-6} (1.05 mi SSW)	1.7×10^{-6} (1.05 mi SSW)	5.4×10^{-9} (0.63 mi ENE)
Nearest Milk Cow	7.0×10^{-8} (10 mi SSW)	4.7×10^{-8} (10 mi SSW)	8.7×10^{-11} (10 mi SSW)

Nearest Meat Cow	1.4×10^{-7} (4 mi S)	1.1×10^{-7} (4 mi S)	4.0×10^{-10} (4 mi S)

2.3.5.2 Regulatory Evaluation

In SSAR Section 3.0, the applicant stated that the NRC regulations that apply to the evaluation of an ESP include Appendix I to 10 CFR Part 50 and 10 CFR 100.21. The staff notes that Appendix I to 10 CFR Part 50 is the applicable NRC regulation regarding the demonstration of compliance with the numerical guides for doses contained in this appendix by characterizing atmospheric transport and diffusion conditions in order to estimate the radiological consequences of routine releases of materials to the atmosphere. The staff also notes that 10 CFR 100.21 requires that site atmospheric dispersion characteristics be evaluated and dispersion parameters be established such that radiological 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 off site.

In SSAR Sections 1.0, 1.4, and 2.3.5, the applicant identified the following applicable NRC guidance regarding long-term dispersion estimates:

- RG 1.70 relates to providing realistic estimates of annual average atmospheric transport and diffusion characteristics to a distance of 50 miles from the plant, including a detailed description of the model used and a calculation of the maximum annual average χ/Q values at or beyond the site boundary for each venting location.

- RG 1.109, Revision 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," issued October 1977, presents identification criteria to be used for specific receptors of interest (applicable at the ESP stage to the extent the applicant provides receptors of interest).

- RG 1.111 describes acceptable methods for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases. Use of the XOQDOQ model described in NUREG/CR-2919 is acceptable.

The staff finds that the applicant should have also identified RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," issued May 1977, with respect to the criteria to be used to identify release points and release characteristics (applicable to the extent the applicant provides release points and release characteristics at the ESP stage).

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant and to determine if the application is in compliance with the applicable regulations.

Section 2.3.5 of RS-002 and Section 2.3.5 of RG 1.70 provide the following guidance on information appropriate for a presentation on long-term (routine release) atmospheric dispersion estimates:

- The applicant should provide a description of the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere. The models should be sufficiently documented and substantiated to allow a review of their appropriateness for site characteristics, plant characteristics (to the extent known), and release characteristics.

- The applicant should discuss the relationship between atmospheric diffusion parameters, such as vertical plume spread (σ_z), and measured meteorological parameters. The applicant should substantiate the use of these parameters in terms of the appropriateness of their use in estimating the consequences of routine releases from the site boundary to a radius of 50 miles from the plant site.

- The applicant should provide the meteorological data used as input to the dispersion models. Data used for this evaluation should represent hourly average values of wind speed, wind direction, and atmospheric stability, which are appropriate for each mode of release. The data should reflect atmospheric transport and diffusion conditions in the vicinity of the site throughout the course of a year.

- The applicant should provide the χ/Q and D/Q values used for assessing the consequences of routine radioactive gas releases, as described in Section 2.3.5.2 of RG 1.70.

- The applicant should identify points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations (if available at the ESP stage). Bounding values for these parameters may be provided at the ESP stage. In such a case, the applicant will need to confirm, at the COL or CP stage, that the parameters provided at the ESP stage bound the actual values provided at the COL or CP stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.

2.3.5.3 Technical Evaluation

The applicant generated its atmospheric diffusion estimates for routine airborne releases of radioactive effluents to the site boundary and special receptors of interest using the staff-endorsed computer code XOQDOQ. The staff evaluated the applicability of the XOQDOQ model and concluded that no unique topographic features preclude the use of the XOQDOQ model for the Grand Gulf ESP site. The staff also reviewed the applicant’s input to the XOQDOQ computer code, including the assumptions it used concerning plant configuration and release characteristics and the appropriateness of the meteorological data input. The staff found that the applicant made conservative assumptions by treating all releases as ground-level releases and ignoring building wake effects. The staff made an independent evaluation of the resulting atmospheric diffusion estimates by running the XOQDOQ computer model and obtaining similar results.

From this review, the staff concludes that the applicant used an appropriate atmospheric dispersion model and adequate meteorological data to calculate χ/Q and D/Q values at appropriate distances from postulated release points for the evaluation of routine airborne releases of radioactive material. Any COL or CP applicant referencing this information should verify that the specific release point characteristics (e.g., release height and building wake dimensions) and specific locations of receptors of interest (e.g., distance and direction to nearest home, garden, meat animal, and milk animal) used to generate the ESP long-term (routine release) atmospheric dispersion site characteristics bound the actual values provided at the COL or CP stage. This is **COL Action Item 2.3-3.**

The staff intends to include the long-term (routine release) atmospheric dispersion and deposition factors listed in Table 2.3.5-2 as site characteristics in any ESP that the NRC might issue for the Grand Gulf ESP site.

Table 2.3.5-2 Staff's Proposed Long-Term (Routine Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average Undepleted/No Decay χ/Q Value @ Site Boundary	8.8×10^{-6} s/m^3	The maximum annual average site boundary undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Site Boundary	7.8×10^{-6} s/m^3	The maximum annual average site boundary depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Site Boundary	1.2×10^{-8} 1/m^2	The maximum annual average site boundary D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Home	2.2×10^{-6} s/m^3	The maximum annual average home undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Home	1.9×10^{-6} s/m^3	The maximum annual average home depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Home	7.0×10^{-9} 1/m^2	The maximum annual average home D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Garden	2.0×10^{-6} s/m^3	The maximum annual average garden undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Garden	1.7×10^{-6} s/m^3	The maximum annual average garden depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Garden	5.4×10^{-9} 1/m^2	The maximum annual average garden D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Milk Cow	7.0×10^{-8} s/m^3	The maximum annual average milk cow undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Milk Cow	4.7×10^{-8} s/m^3	The maximum annual average milk cow depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Milk Cow	8.7×10^{-11} 1/m^2	The maximum annual average milk cow D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Meat Cow	1.4×10^{-7} s/m^3	The maximum annual average meat cow undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Meat Cow	1.1×10^{-7} s/m^3	The maximum annual average meat cow depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Meat Cow	4.0×10^{-10} 1/m^2	The maximum annual average meat cow D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

2.3.5.4 Conclusions

As set forth above, the applicant has provided meteorological data and an atmospheric dispersion model that are appropriate for the characteristics of the site and release points. The applicant has calculated representative atmospheric transport and diffusion conditions for 16 radial sectors from the site boundary to a distance of 50 miles, as well as for specific receptor locations. The staff has reviewed the long-term atmospheric dispersion estimates that the applicant proposed for inclusion as site characteristics in an ESP for its site (should one be issued) and, for the reasons set forth above, finds these estimates to be acceptable. Therefore, the staff concludes that the applicant has provided the information needed to address the requirements of 10 CFR 100.21(c)(1).

Based on these considerations, the staff concludes that the applicant's characterization of long-term atmospheric transport and diffusion conditions is appropriate for use in demonstrating compliance with the numerical guides for doses contained in Appendix I to 10 CFR Part 50.

The applicant provided bounding values for points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations. Any COL or CP applicant must confirm that the parameters provided at the ESP stage bound the actual values provided at the COL or CP stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.

2.4 <u>Hydrology</u>

The ESP site is located on the east bank of the Mississippi River near river mile 406, approximately 25 miles south of Vicksburg, Mississippi, and 6 miles northwest of Port Gibson, Mississippi. The ESP site is bounded on the east by loessial bluffs and on the west by the Mississippi River. The floodplain of the Mississippi River near the ESP site ranges in elevation from 55 feet to 75 feet above MSL. The existing GGNS Unit 1 site has a grade elevation of 132.5 feet above MSL.

The Mississippi River would supply makeup and normal service water for the ESP facility or facilities. A series of existing radial collector wells that draw water from the alluvial aquifer supply plant makeup and service water to the existing GGNS Unit 1. Based on the estimation by the applicant of the total plant and service water requirement for the ESP facility or facilities and the characteristics of the alluvial aquifer, the capacity of existing radial collector wells would not be sufficient to meet combined demands of the ESP facility or facilities and the existing

GGNS Unit 1. A new intake structure will be located on the east bank of the river and north of the barge slip used during construction of the existing GGNS Unit 1. The effluent from both the ESP facility or facilities and GGNS Unit 1 would be discharged into the Mississippi River. The UHS for the ESP facility or facilities will use a closed cooling system, possibly mechanical draft cooling towers. The ESP facility UHS will not rely on water intake from the Mississippi River.

2.4.1 Hydrologic Description

2.4.1.1 Technical Information in the Application

In Section 2.4.1.1 of the SSAR, SERI stated that the ESP site is located on the east bank of the Mississippi River near river mile 406, approximately 25 miles south of Vicksburg, Mississippi, and 6 miles northwest of Port Gibson, Mississippi. The ESP site is bounded on the east by loessial bluffs and on the west by the Mississippi River. The floodplain of the Mississippi River near the ESP site ranges in elevation from 55 feet to 75 feet above MSL. The GGNS Unit 1 nuclear unit site has a grade elevation of 132.5 feet above MSL.

The applicant stated that the powerblock of the ESP facility or facilities would be located approximately at UTM coordinates N3,542,873 meters and E684,021 meters. The plant grade for the ESP facility or facilities would be established in consideration of the requirements to provide flood protection for associated safety-related SSCs.

The applicant also stated that effluent from the ESP facility or facilities will be combined with effluent from the existing GGNS Unit 1, and then the combined effluent will be discharged into the Mississippi River. The outfall will be located downstream of the intake so as to preclude recirculation of the effluent to the embayment area and intake pipes.

Two small streams flow around the GGNS plant site into Hamilton Lake, located in the floodplain of the Mississippi River. Stream B is located south of the GGNS plant site and was rerouted during construction of the existing unit. A 15-foot culvert was placed at its outlet to safely carry local floods. The drainage area of Stream B is approximately 0.6 square miles (mi^2). Stream A is located to the north of the GGNS plant site and was not rerouted. A 12-foot culvert placed under the access road connects its drainage to the floodplain. The drainage area of Stream A is approximately 2.8 mi^2. Several lakes lie in the floodplain of the Mississippi River, but they do not influence the GGNS plant site.

According to SERI, the natural floodplain of the Mississippi River is about 60 miles wide near the GGNS plant site. The flow of the river is restricted to a width of about 2 to 4 miles by high bluffs on the east bank and manmade levees with crest elevation between 101 and 103 feet above MSL. During the dry season, the approximate river width is 0.5 to 1 mile and increases to about 4 miles during floods.

The applicant stated that the U.S. Army Corps of Engineers (USACE) has finished revetments on the east bank of the river near the GGNS site to maintain the river channel. The design project flood (DPF) elevation at the GGNS site is 102.1 feet above MSL, as given in USACE, “1994 Flood Control and Navigation Maps—Mississippi River,” issued 1994.

In RAI 2.4.1-1, the NRC staff asked SERI to provide survey coordinates, including elevations, for the bounding areas of all ESP facility safety-related structures. The staff also requested that the applicant provide the coordinates of existing aquifers in the bounding areas, particularly perched aquifers. In response to RAI 2.4.1-1, the applicant stated that the UTM grid coordinates for the center of the location of the powerblock area for a new nuclear unit are approximately N3,542,873 meters and E684,021 meters in UTM Zone 15. These UTM coordinates correspond approximately to 32° N latitude and 91°3' W longitude. SERI also stated that all safety-related structures will be contained within the proposed powerblock area (PPBA) indicated on SSAR Figure 2.1-1, included below as Figure 2.4-1.

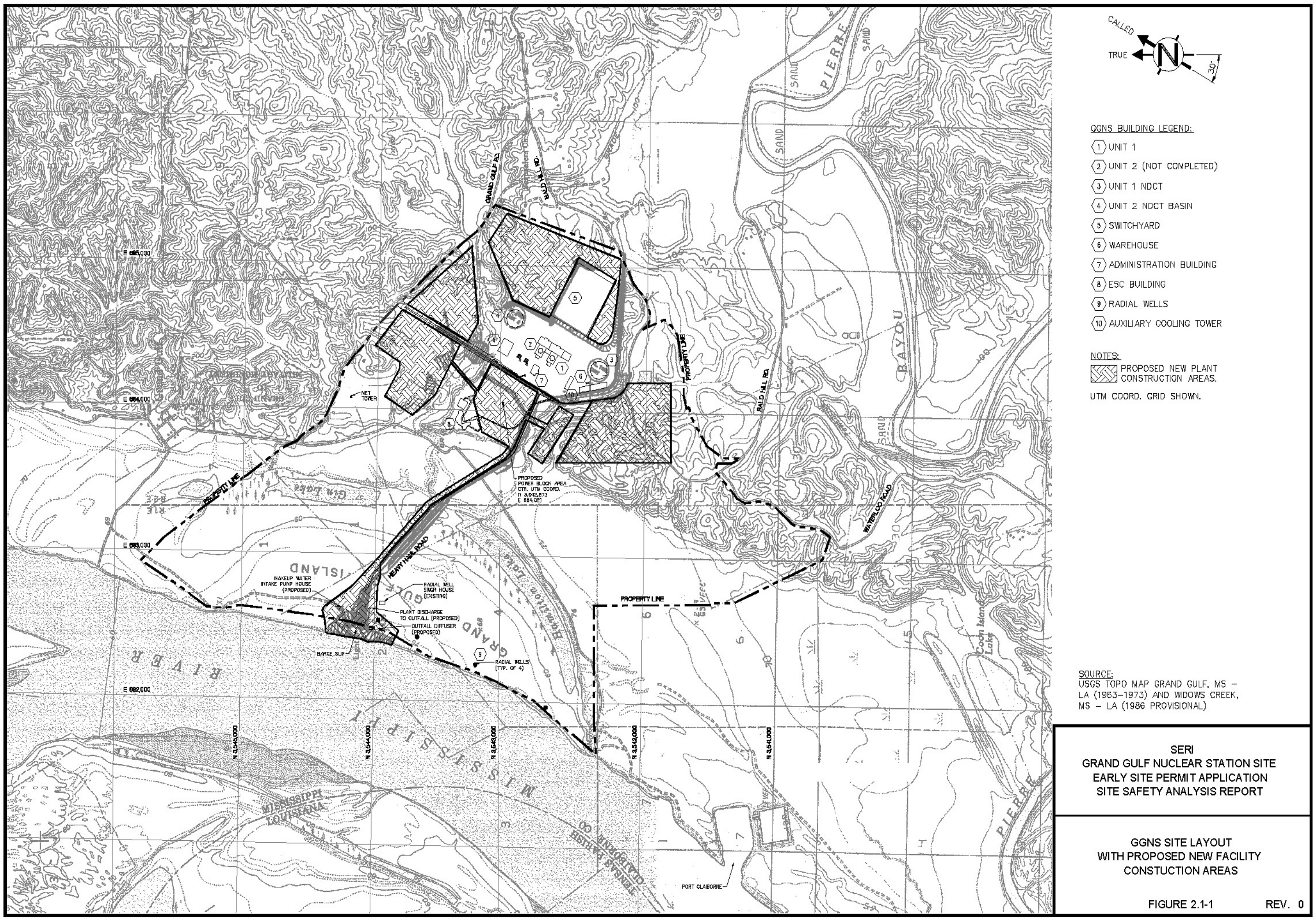


Figure 2.4-1 SSAR Figure 2.1-1 showing location and extent of PPBA

According to the applicant, SSAR Figure 2.4-37 provides a cross-section of the ESP site subsurface, including the portion that is designated as the PPBA. This figure indicates the regional ground water table for the area and the perched water table for the existing GGNS Unit 1 plant area. Section 2.4 of the GGNS Unit 1 UFSAR discusses previous site investigations, including extensive subsurface data obtained from borings. SSAR Section 2.4 summarizes these pieces of data. In addition, four borings were drilled as part of the ESP site geotechnical investigation. SSAR Section 2.5.4 describes the results of this investigation. SERI stated that the conditions encountered during the ESP geotechnical investigation were consistent with those found during the initial site investigations documented in the GGNS UFSAR. The applicant did not obtain direct ground water measurements during the ESP geotechnical investigation. Instead, it used borehole seismic compression and shear wave velocity surveys to estimate the location of the ground water table. According to the applicant, the estimated location of the ground water table ranged from 70 to 100 feet below the ground surface, which itself is located between 55 and 63 feet above MSL.

The cross-sections in SSAR Figures 2.5-75 through 2.5-77 show the ground water levels and gradients. The applicant stated that, as mentioned in SSAR Section 2.5.4.2, it is possible for a shallow perched water table to form in parts of the loess during periods of high rainfall, especially over fine-grained zones. However, the applicant stated that these perched zones are likely to dissipate rapidly after the heavy rainfall stops. Additional assessment to define the location and extent of perched aquifers would be conducted at the COL stage.

In RAI 2.4.1-2, the staff asked SERI to describe the potential use of dewatering systems in the design of a future reactor(s). In response to this RAI, the applicant stated that, during excavation of the existing GGNS Unit 1 powerblock, the use of tie-back walls effectively restricted dewatering to a localized area. The applicant anticipated that dewatering will be required for construction of a new nuclear unit on the ESP site and stated that dewatering wells will be installed to support plant construction and operation, if required. Specific well locations and well design details will be provided at the COL stage when the plant design and layout are finalized.

In RAI 2.4.1-3, the staff asked the applicant to explain how flooding from localized intense precipitation will be handled without interfering with safety-related structures of the new reactor(s). In response to this RAI, the applicant stated that the GGNS Unit 1 site has a plant grade elevation of 132.5 feet above MSL. The proposed site for a new nuclear unit is adjacent to the existing GGNS Unit 1. The design flood considerations for the site areas were based on local drainage areas shown in SSAR Figure 2.4-10. Because a specific plant design for a new nuclear unit has not yet been selected, SERI has not determined the final plant grade.

SERI reiterated that the estimated maximum floodwater elevations resulting from local intense precipitation do not exceed 133.25 feet above MSL. This is the maximum floodwater elevation from the probable maximum precipitation (PMP) at the existing GGNS Unit 1 site. The applicant considers this maximum floodwater level to be valid for the new nuclear facility on the proposed ESP site. According to the applicant, all safety-related SSCs for the new nuclear facility will be placed above the maximum flood elevation, or flood protection such as drainage provisions, grading, culverts, dams, and water-tight doors will be provided.

In RAI 2.4.1-4, the staff asked SERI to explain its estimation of the service and makeup water requirement of 85,000 gpm. In response to this RAI, the applicant stated that the normal makeup flow rate to the proposed ESP facility is approximately 50,320 gpm, and the maximum expected makeup flow rate is 85,000 gpm. SSAR Table 1.3-1 shows specific system uses of this makeup water and the estimated maximum and normal or expected amounts required. According to the applicant, the SSAR provides this value of 85,000 gpm for the proposed facility's maximum makeup water requirement primarily to demonstrate site suitability and to offer a comparison with the historical low river flow to show that adequate water will be available. As previously noted in SSAR Section 2.4.11.2, this maximum makeup water quantity is approximately 0.2 percent of the minimum historical river discharge and thus has an insignificant impact on the river's capability as a cooling water source for the ESP facility. SERI also stated that it did not use this parameter, maximum makeup water demand, in the SSAR for the analysis of safety-related features.

The applicant noted that, as discussed with NRC staff during a site visit on June 30, 2004, it did not intend for this makeup water requirement of 85,000 gpm to be a limiting parameter included as a basis for the ESP. The applicant stated that it would revise the SSAR text and Table 1.3-1 to ensure that they clearly identify the parameters and their corresponding values that were actually used in the analysis of safety-related features and treat them as bases for the SSAR.

SERI stated that it also used the river water makeup flow rate in the evaluation of environmental impacts to the site. It based the value of 85,000 gpm, developed by the PPE process, on a review of a range of plant technologies to establish the bounding makeup water requirement, as described in ESP ER Section 3.4.2.1. The applicant also referred to ESP ER Figure 2.3-29, which provides details regarding estimated plant water needs. The applicant revised the SSAR text and Table 1.3-1 to ensure that they clearly identify the parameters and their corresponding values that were actually used in the analysis of safety-related features and treat them as bases for the SSAR. The revised (Revision 2, SSAR Table 1.3-1) maximum makeup water requirement is 78,000 gpm.

2.4.1.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant's conformance to NRC regulatory guidance. The staff finds that SERI correctly identified the applicable regulatory guidance. Section 2.4.1 of RS-002 provides the review guidance used by the staff to evaluate this SSAR section.

The SSAR should address 10 CFR Part 52 and 10 CFR Part 100 as they relate to identifying and evaluating hydrologic features of the site. The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the review take into account the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s). In addition, 10 CFR 100.20(c) addresses the hydrologic characteristics of a proposed site that may affect the consequences of an escape of radioactive material from the facility. Applicants should determine factors important to hydrologic radionuclide transport, described in 10 CFR 100.20(c)(3), by using onsite measurements. The staff evaluated SSAR Section 2.4.1 in light of these requirements.

To satisfy the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the applicant's SSAR should describe the surface and subsurface hydrologic characteristics of the site and region. This description should be sufficient to assess the acceptability of the site and the potential for those characteristics to influence the design of the SSCs of a nuclear unit(s) (or a facility falling within a PPE) that might be constructed on the proposed site.

Meeting this guidance provides reasonable assurance that the hydrologic characteristics of the site and potential hydrologic phenomena will pose no undue risk to the type of facility (or facility falling within a PPE) proposed for the site. Further, it provides reasonable assurance that such a facility will pose no undue risk of radioactive contamination to surface or subsurface water from either normal operations or as the result of a reactor accident.

To meet the requirements of the hydrologic aspects of 10 CFR Part 52 and 10 CFR Part 100, SSAR Section 2.4.1 should form the basis for the hydrologic engineering analysis with respect to subsequent sections of the application for an ESP. Therefore, completeness and clarity are of paramount importance. Maps should be legible and adequate in their coverage to substantiate applicable data. Site topographic maps should be of good quality and of sufficient scale to allow independent analysis of preconstruction drainage patterns. Data on surface water users, location with respect to the site, type of use, and quantity of surface water used are necessary. Inventories of surface water users should be consistent with regional hydrologic inventories reported by applicable Federal and State agencies. The description of the hydrologic characteristics of streams, lakes, and shore regions should correspond to those of the U.S. Geological Survey (USGS), NOAA, Soil Conservation Service (SCS), USACE, or appropriate State and river basin agencies. Applicants should describe all existing or proposed reservoirs and dams (both upstream and downstream) that could influence conditions at the site. Descriptions may be obtained from reports of USGS, U.S. Bureau of Reclamation (USBR), USACE, and others. Generally, reservoir descriptions of a quality similar to those contained in pertinent datasheets of a standard USACE hydrology design memorandum are adequate. Tabulations of drainage areas, types of structures, appurtenances, ownership, seismic and spillway design criteria, elevation-storage relationships, and short- and long-term storage allocations should be provided.

2.4.1.3 Technical Evaluation

The staff conducted a site visit in accordance with the guidance provided in Section 2.4.1 of RS-002. The staff used information from the site visit, digital maps, and streamflow data from USGS to independently verify the hydrologic description provided in SSAR Section 2.4.1. SERI provided data, including maps, charts, and information from Federal, State, and regulatory bodies, describing hydrologic characteristics and water use in the vicinity of ESP site.

The staff independently verified the applicant’s description of the ESP site location using maps of the GGNS ESP site and its vicinity (Figures 2.4-2 and 2.4-3). The staff created these maps using publicly available data sources (e.g., State boundaries, city locations, and digital raster graphs (DRGs) of topographic maps). The GGNS site is located on the east bank of the Mississippi River. Cities located near GGNS include Port Gibson, about 5 miles to the southeast; Vicksburg, about 26.3 miles to the north-northeast; and Natchez, about 37.2 miles to the southwest. The staff estimated that the GGNS site is located at approximately river mile 407, based on river mile markings on the Mississippi River near the GGNS site.

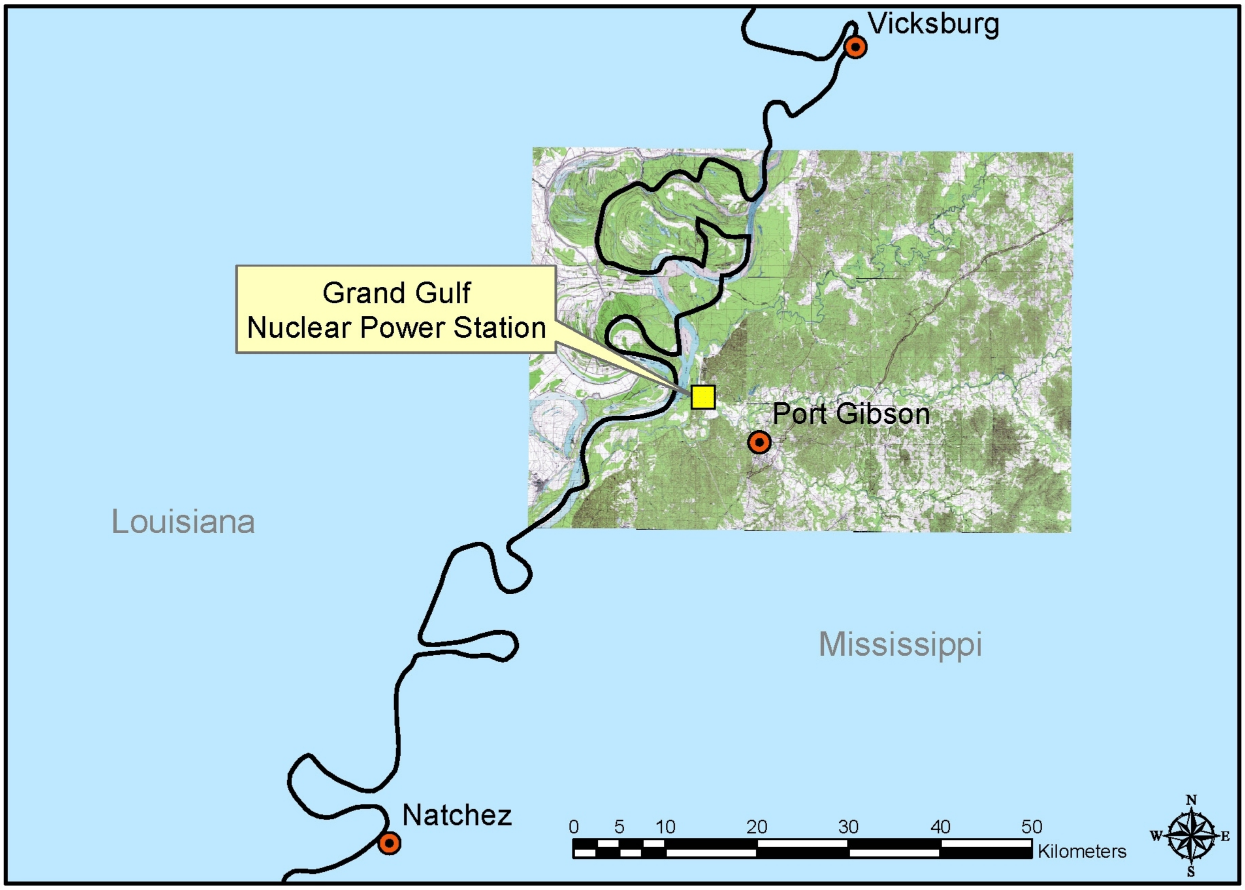


Figure 2.4-2 Location map of the GGNS site. The site is located on the east bank of the Mississippi River in Mississippi about 8 kilometers northwest of Port Gibson, Mississippi. Vicksburg, Mississippi, is about 41 kilometers north-northeast, and Natchez, Mississippi, is about 60 kilometers southwest of the GGNS site.

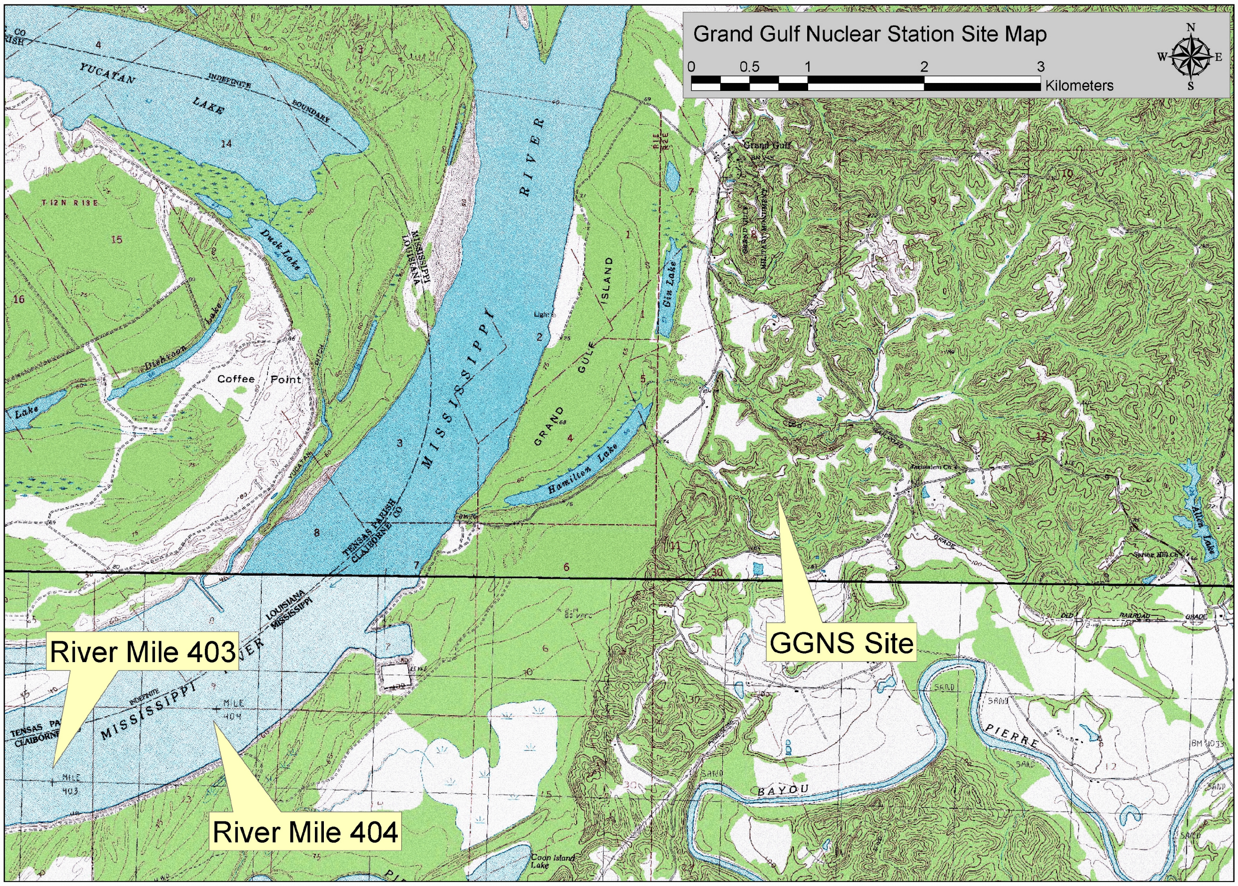


Figure 2.4-3 The GGNS site and Mississippi River miles. This map also shows Gin and Hamilton Lakes, located on the floodplain of the Mississippi River.

Sections 2.4.2 and 2.4.3 of the DSER described staff's independent estimate of the flood elevation caused by local intense precipitation on the ESP site. The NRC will require the COL applicant to design the ESP plant grade such that flooding caused by local intense precipitation will be discharged to Streams A and B without reliance on any active drainage systems that may become blocked during the local intense precipitation event. The staff intended to specify this requirement as DSER Permit Condition 2.4-1. However, DSER Permit Condition 2.4-4 in Section 2.4.2.3 of the SER also stated a similar requirement. Therefore, Section 2.4.2.3 of this SER describes the resolution of DSER Permit Conditions 2.4-1 and 2.4-4, and these DSER permit conditions are replaced by COL Action Item 2.4-5.

GGNS Unit 1 and the ESP facility or facilities will discharge their combined effluents into the Mississippi River downstream of the new ESP intake. The NRC will require the COL applicant to demonstrate that sufficient separation between the new ESP intake and the combined effluent outfall is provided so that the effluent recirculating back to the new ESP intake will not adversely affect the intake. The staff intended to specify this requirement as DSER Permit Condition 2.4-2. However, based on applicant's response to open items, the staff determined that detailed design of the ESP facility intake and outfall has not been completed at the ESP stage and will only be undertaken at the COL stage after a reactor design for the ESP facility is chosen. The staff also determined that the NRC will review the detailed design of ESP facility intake and outfall at the COL stage according to existing regulations and regulatory guidance. Therefore, the staff determined that specification of DSER Permit Condition 2.4-2 is not required. Instead, the COL or CP applicant should demonstrate that sufficient separation between the new ESP intake and the combined effluent outfall is provided so that the effluent recirculating back to the new ESP intake will not adversely affect the intake. This is **COL Action Item 2.4-1.**

The staff independently verified the applicant's description of the two small, steep streams that flow around the GGNS site. The staff manually delineated the watersheds for these two streams using USGS topographic maps (Figure 2.4-4). Stream A, located to the north of the GGNS site, drains Basin A. The staff estimated that the contributing area of Basin A at its outlet into Hamilton Lake is approximately 2.94 mi^2. Stream B, located to the south of the GGNS site, drains Basin B. The staff estimated that the contributing area of Basin B at its outlet into Hamilton Lake is approximately 0.68 mi^2.

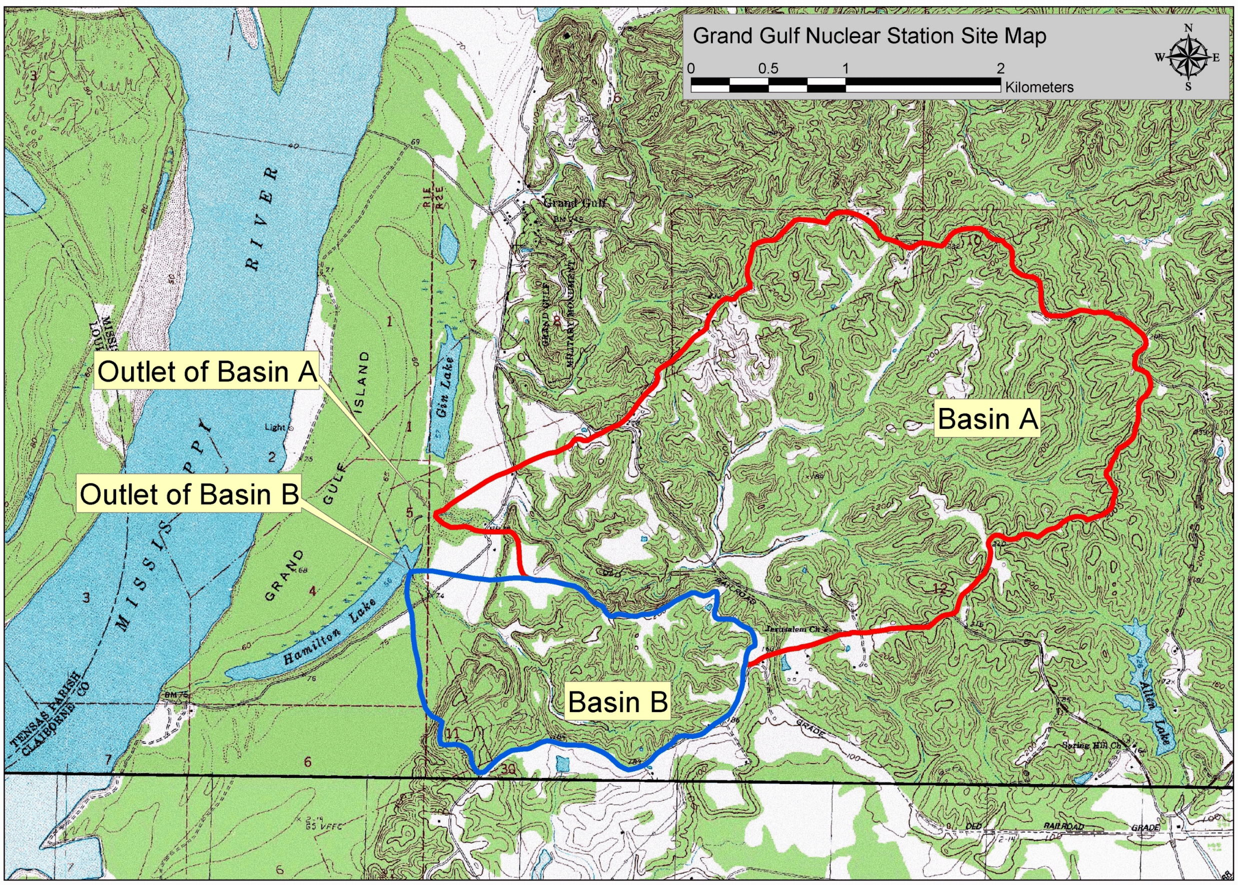


Figure 2.4-4 Small drainage basins (Basins A and B) that are drained by small, steep streams to the north and south of the GGNS site

In RAI 2.4.1-1, the staff asked SERI to provide survey coordinates, including elevations, for the bounding areas of all ESP safety-related structures. The staff also requested that the applicant provide the coordinates of existing aquifers in the bounding areas, particularly perched aquifers. In response to RAI 2.4.1-1, the applicant stated that the UTM grid coordinates for the center of the location of the powerblock area for a new facility are approximately N3,542,873 meters and E684,021 meters in UTM Zone 15. According to the applicant, these UTM coordinates correspond to approximately 32° N latitude and 91°3' W longitude. SERI also stated that all safety-related structures will be contained within the PPBA indicated on SSAR Figure 2.1-1.

The staff's review of SSAR Figures 2.1-1 and 2.1-2 revealed that, although the coordinates inscribed on these figures for the center of the proposed powerblock are the same as those mentioned in applicant's response to RAI 2.4.1-1, the coordinates do not agree accurately with the position of the center of the proposed powerblock as drawn on these figures. The staff independently created a map to more accurately locate the center of the proposed powerblock. Figure 2.4-5 shows this map.

The staff downloaded USGS DRGs and orthorectified and georeferenced aerial photographs from the Mississippi Automated Resource Information System. The staff used ArcMap™ Version 8.3 to create a map of the GGNS site, including the ESP site and its immediate vicinity. The staff used the topographic contours on the USGS DRGs to manually delineate the basins draining through local Streams A and B. The staff also used topographic contours to determine the approximate location of the bluff line that separates the GGNS site from the Mississippi River floodplain to the west. It used USGS bluelines that indicate stream channels on DRGs to locate Streams A and B, as shown on the map. Since the USGS DRGs predate GGNS construction, Stream B was located in its original configuration on the topographic maps. The staff determined the post-GGNS construction location of Stream B using the aerial photos. Aerial photos were also used to determine the location of Sedimentation Basins A and B and locations of proposed intake and discharge for the ESP facility.

The map shown in Figure 2.4-5 uses the UTM Zone 15N North American Datum (NAD) 1983 geographic projection. As shown on SSAR Figures 2.1-1 and 2.1-2, the applicant's PPBA is located north of the heavy haul road, east of the bluffs, and southeast of the ESC building. The staff created the polygon labeled "Proposed Powerblock Area" on Figure 2.4-5 closely following the location of applicant's PPBA shown on SSAR Figures 2.1-1 and 2.1-2. The staff overlaid the largest circle that could fit inside the PPBA as shown in Figure 2.4-5. The staff assumed that the center of this circle represents the location of the center of the proposed powerblock. The UTM coordinates determined by the staff for the center of the proposed powerblock are N3,543,266.06 meters and E684,017.28 meters, with reference to the UTM Zone 15N NAD 1983 geographic projection.

The staff also overlaid the applicant-stated coordinates of the center of the proposed powerblock on the map and found that these coordinates place the proposed powerblock approximately 302 feet southwest of the staff-estimated coordinates mentioned above and closer to Stream B. Because of this discrepancy between the coordinates provided by the applicant and the plotted location of the powerblock on Figures 2.1-1 and 2.1-2, the staff cannot determine the actual location of the powerblock on the ESP site. Therefore, the staff required additional information on the true coordinates of the center of the powerblock. This was Open Item 2.4-1. The staff intended to specify the coordinates of the center of the proposed powerblock as a permit condition subsequent to the satisfactory resolution of Open Item 2.4-1.

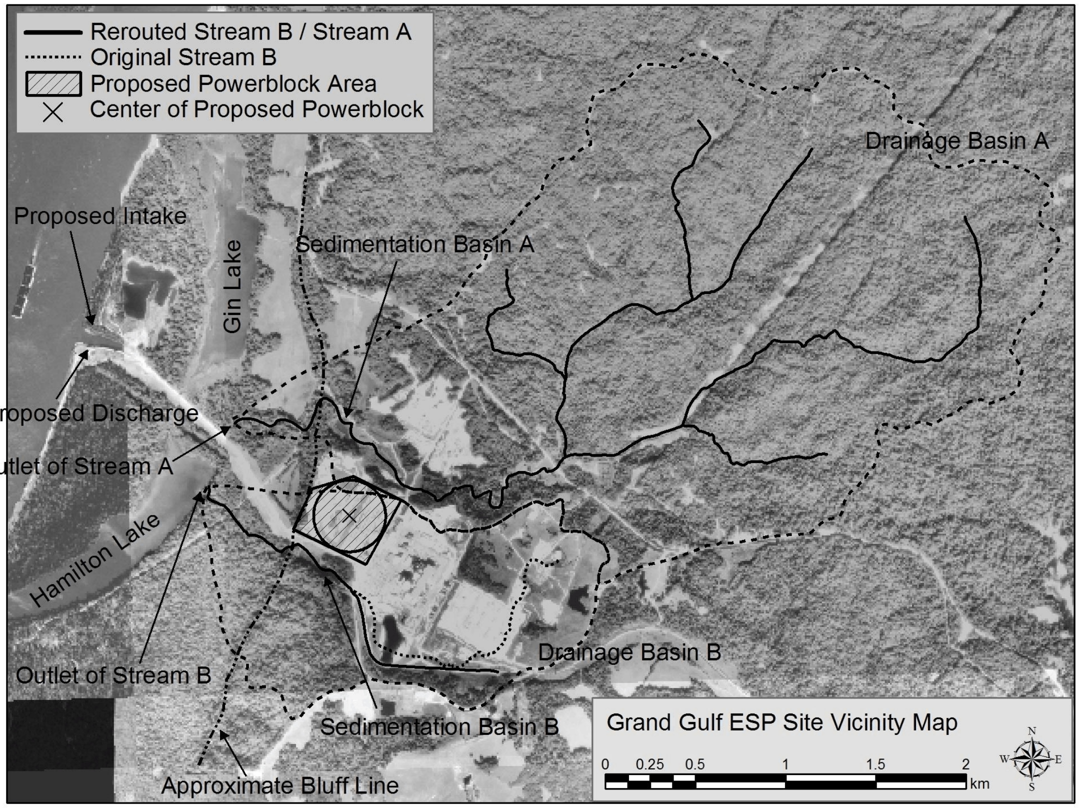


Figure 2.4-5 Grand Gulf ESP site vicinity map

In response to Open Item 2.4-1 (Response to Request for Additional Information to Resolve the Grand Gulf Early Site Permit draft Safety Evaluation Report Open Items, System Energy Resources, Inc., June 21, 2005), the applicant stated that the UTM coordinates indicated in the SSAR, ER, and Environmental Policy Institute documents were inaccurate because of an error in a spreadsheet which was used to calculate UTM coordinates corresponding to Mississippi West grid coordinates. The applicant converted the coordinates of the center of the ESP powerblock, N550,099 feet and E277,346 feet in the Mississippi West grid coordinate system, to N3,543,261 meters and E684,018 meters in the UTM Zone 18 NAD 83 projection system using USACE software Corpscon Version 6.0. The applicant revised Figures 2.1-1, 2.1-2, 2.2-4, 2.4-1, 2.4-10, and 2.4-33 of the SSAR. The applicant also revised SSAR Sections 1.2, 2.1.1.1, and 2.4.1.1; Part 1, "Administrative Information," in Section 1.1; Part 4, "Emergency Planning Information," and Figures 2-1 and 2-3; and Section 2.1.1, ER Figures 2.1-1, 2.2-1, 2.3-1, 2.3-7, 2.3-12, and 2.3-20; and ER Sections 1.1, 2.1, 2.3, and 4.5.1 to include corrected UTM coordinates.

The staff reviewed the applicant's response to Open Item 2.4-1 and concluded that the corrected UTM coordinates of the center of the proposed ESP powerblock are approximately 16.8 feet away from the coordinates estimated by the staff in its independent review. Since this separation is small compared to the overall dimensions of the ESP footprint, the staff concluded that the applicant's corrected UTM coordinates for the proposed ESP powerblock are acceptable. Based on the above review, the staff considers Open Item 2.4-1 resolved.

The applicant did not provide information on the elevation (depth) of the zone that the construction of the new facility could disturb. Excavation and fill activities will alter the local subsurface environment and its alignment with the existing hydrogeological environment. Therefore, the staff needed information on the elevation (depth) of the zone that the construction of the new nuclear facility could disturb. This was Open Item 2.4-2.

In response to Open Item 2.4-2, the applicant stated that SSAR Section 2.5 discusses various depths of foundation and excavation in relation to required foundation bearing capacity, minimum shear wave velocity at foundation mat, and depth of the same stratigraphic layer that forms the foundation of the existing GGNS unit. The applicant stated that these three criteria resulted in different embedment depths for the proposed ESP facility. The applicant noted that the foundation depth requirement based on the first two criteria may also depend on plant design and may also vary within the ESP footprint because of irregularities in elevations of contact between different geologic strata that underlie the ESP site. For these reasons, the applicant could not identify a single maximum excavation depth, and the statements made in the SSAR were an attempt to bracket the likely foundation depths based on each criterion.

The applicant stated that specific foundation design, site grading, and ground improvements can be used in some cases to decrease the required foundation depths based on the first two of the three criteria mentioned above, but not for the last. The applicant, as an example, stated that deep soil densification or grouting could be used to strengthen the soil to reduce the embedment depth required for adequate bearing capacity and may also be effective to marginally increase the shear wave velocity. However, the last criterion, the requirement to found the ESP facility structures in strata equivalent to those for the existing GGNS unit, requires a specific foundation depth that cannot be adjusted by engineering approaches.

The applicant stated that the parameters which define the range of required foundation depths are 35 to 140 feet, as reported in SSAR Section 2.5.4.6, and were developed based on a PPE worksheet. However, the PPE table (Table 1.3-1 of the SSAR) did not include the depth of the foundation.

The applicant stated that it is likely that additional excavation below the required foundation depth specified for a particular plant design will be required. The applicant also stated that soils underlying the selected plant foundation that have shear wave velocities below the design requirement will either require replacement or in situ improvements to meet seismic design criteria.

The applicant stated that the overall ground water regional gradient for the GGNS site including the ESP site points westward to the Mississippi River controlled by the prevailing river stage. The applicant stated that excavation and other construction activities related to installation of the ESP facility will alter the subsurface environment and its alignment with the existing hydrogeological environment. The applicant argued that these alterations during construction of the ESP facility are expected to be localized and temporary. The presence of the ESP facility itself will alter the subsurface environment and its alignment with the existing hydrogeological environment, but the applicant argued that these effects are also expected to be localized. The presence of the ESP facility is not expected to substantially alter the overall and controlling regional ground water table gradient or its direction. The applicant stated that any postulated liquid effluent release would be expected to eventually enter the regional ground water table beneath the GGNS site property and then move laterally towards the Mississippi River. This expectation is based on an understanding of the characteristics of the GGNS site, including site and ground water table elevations, measured gradients toward the river, and evidence of the influence of the river stage on monitored ground water levels, as summarized in SSAR Section 2.4.12.2.3.

The applicant stated that as part of standard construction measures, ground water levels will be monitored during various phases of the ESP site development and facility construction. A detailed ground water monitoring program will be developed at the COL stage.

The staff reviewed the applicant's response to Open Item 2.4-2 and concluded that because of construction activities at the ESP site, the subsurface environment will be disturbed to a depth ranging from 35 to 140 feet plus some additional excavation required to place the foundation based on three criteria—bearing capacity, minimum shear wave velocity at the foundation mat, and depth of the same stratigraphic layer that forms the foundation of the existing GGNS unit. Based on the applicant's response, the staff determined that the actual excavation depth will also depend on the foundation requirements of the chosen plant design for the ESP facility, which has not been finalized at the ESP stage. The staff had intended to use the information on the extent of ground disruption as it might affect liquid pathway and overall site drainage. At the ESP stage, the detailed design information is not available; therefore, the staff included COL Action Item 2.4-2 on ESP site dewatering related to the Open Item 2.4-3 below, and Permit Condition 2.4-1 related to preclusion of accidental release from waste treatment storage facilities in Section 2.4.13.3. Based on the above review, staff concluded that the applicant has provided sufficient information and Open Item 2.4-2 is resolved.

In response to RAI 2.4.1-2, the applicant stated that it anticipates that dewatering will be required during construction of the ESP facility, and dewatering wells may be installed to support plant operation, if required. The applicant also stated that specific locations and design details of these wells will be provided at the COL stage. The staff determined that dewatering wells, if required to support plant operation, are safety-related ESP structures. Based on the applicant's response, the staff concluded that it needed more details at the ESP stage regarding dewatering wells to determine whether ground surface subsidence could affect safety-related structures and piping. In particular, the staff needed information related to the location of dewatering wells in relation to safety-related structures and associated monitoring of the ground water table. This was Open Item 2.4-3.

In response to Open Item 2.4-3, the applicant stated that the existing site ground water levels and gradients are only expected to undergo slight modifications because of installation of the ESP facility. The applicant stated that this expectation is based upon ground water monitoring conducted for the installation of GGNS Unit 1, which showed only localized, short-term effects to ground water levels from dewatering during construction. The applicant concluded that the effect of dewatering at the ESP site will be similar and will not result in any ground water flow reversal. Dewatering is a likely necessity during construction of the ESP facility and is a possibility for ESP facility operation. The applicant also stated that any such alteration to ground water levels would be included in design considerations for safety-related structures for the ESP facility.

The applicant stated that the potential for subsidence resulting from alterations to ground water levels will be one such design consideration. Several factors that may affect the potential for subsidence, including stability of soils and other subsurface material, will be evaluated. The applicant stated that this analysis will be used to define where over-excavation may be required to reach proper soil characteristics for foundation embedment, or where other stability control measures such as the use of engineered backfill may be required. The applicant stated that any backfill around safety-related structures would have strict gradation requirements that will ensure lateral confinement and appropriate soil-structure interaction along sidewalls of buried structures to prevent any possible liquefaction or dynamic strength loss under seismic loadings. The applicant stated that backfill criteria would be developed to minimize potential settlement of shallow structures that may be placed over filled areas adjacent to the ESP facility powerblock.

The applicant stated that geotechnical analyses would determine temporary excavation stabilization requirements. For example, tie-back walls could be used to provide support to temporary foundation excavation walls and also to assist in control of ground water inflow into the excavation pit during construction. The applicant noted that during construction of GGNS Unit 1, no unstable conditions or materials were discovered and standard shoring techniques were successfully used to stabilize deep foundations in loess and alluvial soils below the ground water table.

The applicant stated that the specific location of dewatering wells in relation to safety-related structures of the ESP facility is a design feature and will be addressed at the COL stage. After the selection of location and plant design of the ESP facility, a program to monitor ground water levels will be developed, which would start preconstruction monitoring with additional exploratory borings throughout the planned excavation area and ESP facility footprint. This monitoring plan is expected to provide detailed information on ground water levels, including the location of perched water, and to assist in assessment of dewatering requirements, determination of location and design of dewatering wells, and in measuring dewatering effects.

The applicant stated that inspection and monitoring procedures will be developed for the construction phase of the ESP facility. Observation wells would be installed and monitored periodically throughout the construction of the ESP facility to measure ground water levels and to verify that ground water drawdown and radius of influence evolve as predicted. The design of dewatering wells will be modified if necessary.

Information obtained during the preconstruction and construction ground water monitoring will be used to determine the location of permanent dewatering wells, if required by the selected plant design and ground water conditions at the ESP site. The applicant stated that localized reversal of the ground water gradient may occur, but engineering and design controls will be used to minimize the need for dewatering and subsequent impact on the gradient and the area of influence.

The applicant stated that the pumping rate of 3570 gpm given in the SSAR is the maximum expected consumption of water during operation of the ESP facility, which is a short-term or temporary flow rate with an expected average usage of approximately one-third of the stated maximum. Since the maximum withdrawal rate is short-term, it is not relevant for the consideration of ground subsidence because any impact on the subsurface ground water table would also be temporary. The applicant also stated that this water supply (3570 gpm) will likely come from a variety of sources, including, but not necessarily limited to, ground water and/or surface water.

Any newly required water supply wells would be designed and located at a suitable distance from the ESP facility to prevent significant drawdown of the water table and impacts to the ground water gradient. The operational ground water monitoring program would be used to ensure that effects from any new water supply wells are within expected ranges.

The staff reviewed the applicant's response to Open Item 2.4-3 and concluded that dewatering will be necessary during construction of the ESP facility. The staff also determined that local impacts to ground water levels and the ground water gradient may occur because of the dewatering activities. Since a specific plant design for the ESP facility has not been chosen at the ESP stage, the design and location of dewatering wells, which partially depend on the foundation type of the selected plant design, are also not known. The COL applicant will design the dewatering wells and establish their locations, and the NRC will review them at the COL stage according to appropriate regulations and regulatory guidance. However, if dewatering is necessary for the operation of the ESP facility, it will be considered a safety-related facility and must be designed, operated, and maintained as such. This is **COL Action Item 2.4-2.** Based on the above review, the staff considers Open Item 2.4-3 resolved.

In response to RAI 2.4.1-3, SERI stated that it has not yet determined the final plant grade since it has not finalized a specific plant design for the ESP facility. The estimated maximum floodwater elevation caused by local intense precipitation does not exceed 133.25 feet above MSL. However, the staff's independent assessment of flooding caused by local intense precipitation could not verify the same floodwater elevation. Therefore, the staff determined that the applicant must provide more details regarding its floodwater level estimation, including the data and methods used during this analysis. This was Open Item 2.4-4.

In response to Open Item 2.4-4, the applicant stated that SSAR Revision 0 contained the current GGNS Unit 1 design basis for local flooding based on a PMP determined using HMR 33, "Seasonal Variation of the Probable Maximum Precipitation East of 105th Meridian for Areas from 10 to 100 Square Miles and Durations of 6, 12, 24, and 48 hours," issued April 1956, and USACE EM-1110-2-1411, "Standard Project Flood Determinations," issued 1965. According to the applicant, SSAR Revision 0 indicated that the GGNS Unit 1 design basis was reviewed and that the flooding level for GGNS Unit 1 was also considered valid for the ESP site flooding from local intense precipitation because the 6-hour-duration PMP from HMR 53 was within 2 percent of that derived from HMR 33.

In response to the staff's Open Item 2.4-5, SERI agreed that local intense precipitation should be estimated using the guidelines of HMR 52, "Application of Probable Maximum Precipitation Estimates—United States East of the 105th Meridian," issued August 1982, which is the current relevant guidance for this site characteristic. The applicant provided newly estimated PMP values for various durations in response to Open Item 2.4-5. It noted that PMP values for 30-minute and 1-hour durations are about 40 percent greater than those based on HMR 33 and reported previously in the SSAR.

The applicant stated that the higher local intense precipitation will have an impact on the ESP site flooding calculations because of increased runoff from Basins A and B. It still considers the method used to determine flow in Streams A and B during a PMP event valid, although the maximum flow in these streams would increase. The applicant described differences in relative positions of the existing GGNS Unit 1 site and the proposed ESP facility site to provide a qualitative evaluation of the effect of increased flow on the estimated floodwater levels at the ESP site.

SSAR Figures 2.4-13 (Sheet 1) and 2.4-18, which show site drainage characteristics, indicate that the proposed ESP site powerblock area is located west of the existing GGNS Unit 1 across the site access road. The topography from the ESP site drops off to the north to Sedimentation Basin A, located at the downstream end of Stream A, which flows west from GGNS Unit 1 through Culvert 9, and to the south to Sedimentation Basin B, located at the downstream end of Stream B, which flows west from GGNS Unit 1 through Culvert 1. Although the ESP site grade has not been established at the ESP stage, the applicant estimated that it will approximately be 132.5 feet above MSL. ESP site grading will take full advantage of its topography to provide adequate runoff to the north and south to Streams A and B, respectively.

Culverts 1 and 9, on Streams B and A, respectively, and the site access road act as restrictions to flow in these streams that drain Basins B and A, respectively. The applicant noted that downstream of the culverts and the access road, the primary restrictions to flow in the streams are sedimentation basin dams shown in SSAR Figure 2.4-13 (Sheet 1), with the top elevation of these dams at approximately 89 feet above MSL. Design-basis PMP flooding calculations for the GGNS UFSAR showed that water levels in the two streams to the west of the access road and downstream of the two culverts were significantly less than the water levels upstream. Runoff from the ESP site would drain into Streams A and B downstream of the two culverts. Therefore, the applicant argued, during a local PMP event, storm water runoff from the ESP site would discharge directly into receiving channels where significantly more discharge capacity would be available than for discharge point receiving runoff from the GGNS Unit 1 site.

Given the physical site topography and the proposed location of the ESP facility powerblock to the west of the site access road and downstream of existing Culverts 1 and 9, it is reasonable to expect that the flood water elevation in the two streams at locations adjacent to the ESP facility powerblock would be substantially less than that of the proposed ESP site grade. The applicant noted that since local PMP rainfall intensities have been revised according to the guidelines of HMR 52, GGNS Unit 1 flood calculations are no longer applicable to the ESP site. Since Streams A and B are expected to be capable of carrying PMP-event flows from the ESP site without flooding, the potential and extent of flooding from a local PMP event on the ESP site will depend on the facility design, the final grade, and the drainage system design. The applicant also stated that the final ESP site drainage systems may use several techniques, including grading slopes and providing additional drainage channels, to efficiently move runoff water. Given the topographic location of the ESP site in relation to Streams A and B, an effective drainage system can be designed at the COL stage. The COL applicant will establish the final ESP site characteristic for local intense precipitation flood water elevation and design flooding protection requirements, such as placement of safety-related equipment above the estimated PMP flood elevation, provision of water-tight doors, elevated structure access openings and floors, and provision of penetration seals.

The applicant revised SSAR Section 2.4.2 to indicate that the flooding analysis discussed is specific to the GGNS Unit 1 site area and that a local intense precipitation flooding analysis for the ESP site will be carried out at the COL stage. The applicant removed the references to a maximum GGNS Unit 1 PMP flood water elevation of 133.25 feet above MSL from the SSAR and annotated tables and figures in the SSAR that refer to the PMP flooding analysis to clearly indicate their limited applicability to the GGNS Unit 1 site.

The staff reviewed the applicant's response to Open Item 2.4-4 and concluded that the applicant provided a qualitative comparison of the topographic layout of the flooding mechanism for the ESP site with that of the GGNS Unit 1 site. The applicant stated, and the staff agrees, that the flood water elevation estimation performed for the GGNS Unit 1 site is not appropriate for the ESP site because the local intense precipitation at the ESP site is different and greater than that at the GGNS Unit 1 site and because the drainage pattern at the ESP site is expected to be much different than that at the GGNS Unit 1 site. The staff also concluded that the site grade for the ESP facility powerblock footprint has not been determined at the ESP stage. For these reasons, a comprehensive flood water elevation analysis for the ESP site cannot be carried out at this time. However, the COL applicant will have to design the site grading to provide flooding protection to safety-related structures at the ESP site based on a comprehensive flood water routing analysis for a local PMP event on the ESP site. This is **COL Action Item 2.4-3.** Based on the above review, the staff considers Open Item 2.4-4 resolved.

In response to RAI 2.4.1-4, the applicant stated, "As discussed with the NRC Staff in the site visit of June 30, 2004, it was not intended that this makeup value of 85,000 gpm be understood as a limiting parameter to be included as bases for the early site permit." However, the staff determined that this statement contradicts the concept of enveloped parameter (PPE). In response to RAI 2.4.1-4, the applicant also stated that it would revise the SSAR text and Table 1.3-1 to ensure that they clearly identify the parameters and their corresponding values that were actually used in the analysis of safety-related features and treat them as bases for the SSAR. The staff determined that the applicant has not amended PPE Section 2.4 of SSAR Table 1.3-1 as of SSAR Revision 2. According to the latest available revision of the SSAR, the staff assumed that all parameters included in PPE Section 2.4 of SSAR Table 1.3-1 are important and bounding PPE parameters. Therefore, the NRC will limit the COL applicant to a maximum service and makeup water withdrawal of 85,000 gpm (SSAR Revision 2, Section 2.4.1.1, page 2.4-2). The staff intended to specify this limit as DSER Permit Condition 2.4-3. However, based on the applicant's response to open items, the staff determined that the detailed design of the ESP facility including its makeup water requirements will not be available until the COL stage. At that time, the NRC will review the detailed facility design according to existing regulations and regulatory guidance. The staff determined, therefore, that specification of DSER Permit Condition 2.4-3 is not necessary. The COL applicant should design the ESP facility with a maximum withdrawal of 85,000 gpm from the Mississippi River to meet the makeup water requirement for the ESP facility. This is **COL Action Item 2.4-4.**

2.4.1.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to the general hydrologic characteristics of the site, including descriptions of rivers, streams, lakes, water-control structures, and users of the waters discussed. Therefore, the staff concludes that the applicant has met the requirements for general hydrologic descriptions with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c).

2.4.2 Floods

The ESP site is adjacent to the existing GGNS Unit 1 site, located on the bluffs to the east of the Mississippi River floodplain. Runoff resulting from precipitation and snow melt on major tributaries (i.e., the Ohio, Missouri, Arkansas, and Red Rivers) is primarily responsible for flooding in the Mississippi River.

Two small, steep streams, called Stream A and Stream B, flow around the GGNS site. Stream A is located to the north of the GGNS site, and Stream B is located to the south. The greatest floods in these small streams are expected to result from local intense precipitation. These streams and their drainage basins are of interest because they will carry runoff from local precipitation on the ESP site itself. Stream B was rerouted during construction of GGNS Unit 1.

2.4.2.1 Technical Information in the Application

SERI stated that runoff resulting from precipitation and snow melt on major tributaries (i.e., the Ohio, Missouri, Arkansas, and Red Rivers) is primarily responsible for flooding in the Mississippi River. The Ohio River contributes 66 to 76 percent of mean flow in the Mississippi from January to March, and the Missouri River contributes 47 to 52 percent of this flow from June to September. The applicant stated that major floods on the Ohio River occur between mid-January and mid-April, and those on the Missouri and Upper Mississippi Rivers occur between mid-April and the end of July. The Arkansas and White Rivers flood from April through June. The applicant stated that, because the timing of floods varies within the tributaries, flooding on the Lower Mississippi River extends from mid-December to July, and the magnitude, duration, and number of flood peaks during a year vary greatly.

SSAR Table 2.4-4 shows the flood discharges for the Mississippi River measured at Vicksburg, Mississippi, during the six highest historical floods. SSAR Figure 2.4-6 provides a water surface profile for the Mississippi River between river miles 360 and 480 corresponding to the 1937 flood. Based on this water surface profile, SERI estimated that the highest recorded water level near the GGNS site is 92.5 feet above MSL. The applicant stated that the 1927 flood is the highest on record, with a peak discharge equal to 2,278,000 cubic feet per second (cfs) at Vicksburg, Mississippi. Updated records show that no flood since the construction of GGNS has exceeded the discharge of the 1973 flood. The applicant also included graphs of maximum, minimum, and average water surface elevation at Vicksburg, Mississippi, based on data from 1932 to 2000, and those at Natchez, Mississippi, based on data from 1940 to 2000. The SSAR also provided the annual instantaneous peak discharge at Vicksburg, Mississippi, from 1858 to 1999.

According to the applicant, no historical data exist for the two streams (A and B) that flow around the GGNS site. Based on U.S. Weather Bureau (now NOAA) Technical Paper 16, “Maximum 24-Hour Precipitation in the United States,” issued January 1952, the maximum observed 24-hour rainfall in the region varies from about 7.9 to 21.4 inches. Based on USGS Water Supply Paper 1870-D, “Summary of Floods in the United States during 1966,” issued 1971, and USGS Water Supply Paper 2030, “Summary of Floods in the United States during 1969,” issued 1975, the applicant estimated the maximum observed streamflow values for drainage basins located in the region, ranging in area from 0.18 to 182 mi^2. These flood values range from 147 to 1581 cfs per mi^2.

The applicant considered several flooding events that safety-related structures must withstand, including (1) the Mississippi River probable maximum flood (PMF) coincident with wind-generated waves, (2) seismic failures of upstream dams coincident with the USACE DPF, (3) ice flooding, and (4) PMF events on Streams A and B. The applicant provided details on its estimation of these flooding events in SSAR Section 2.4.3. The applicant stated that the plant-grade elevation of the ESP facility or facilities will be well above the Mississippi River DPF; thus, the design flood for safety-related SSCs will be the PMF caused by local intense precipitation on the ESP site.

SERI stated that all safety-related SSCs for the ESP facility or facilities would be located above the maximum flood elevation, or that flood protection would be provided such that the requirements of 10 CFR Part 100 and General Design Criterion (GDC) 2, “Design Bases for Protection Against Natural Phenomena,” in Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50 will be met.

According to the applicant, the GGNS UFSAR evaluated the effects of local intense precipitation at the GGNS site, and its review determined that this evaluation is valid for the ESP site. The local intense precipitation at the GGNS site was based on the PMP estimated using NOAA HMR 33. The all-season PMP of 48-hour duration for a 10-mi^2 area was determined using HMR 33. However, since the original UFSAR analysis, HMR 53 has superceded HMR 33 and shows a 2-percent increase in the hourly rate of rainfall. The applicant concluded that this increase is relatively small and will not significantly affect the previous analysis. Thus, according to the applicant, the PMF analysis for GGNS Unit 1 also applies to the ESP facility or facilities.

The applicant stated that, because of the small drainage areas of Basins A and B, the duration of the PMP is too long for determination of the PMF. The applicant used the guidelines of USACE EM-1110-2-1411 to distribute the first 6-hour PMP depth within the first 6-hour time period (SSAR Table 2.4-7).

SERI estimated the peak discharges from Basins A and B in response to the 6-hour PMP event using a synthetic unit hydrograph. This approach consisted of the estimation of basin lag times based on the length and slope of the draining channel for Basins A and B using the curves given by Chow in University of Illinois Experimental Station, Bulletin 462, “Hydrologic Determination of Waterway Areas for the Design of Drainage Structures in Small Drainage Basins,” issued 1962. Hudlow (1966) and Feddes (1970) developed a set of curves for small basins varying in size from 0.5–75 mi^2 for the estimation of dimensionless hydrographs. From these studies, the applicant used dimensionless hydrographs for two basins called Basin J and Hudson Creek, which have characteristics similar to Basins A and B, to derive an average hydrograph for use in Basins A and B.

The applicant used estimated basin lag times for Basins A and B to develop a 0.5-hour unit hydrograph for Basin A and a 0.25-hour unit hydrograph for Basin B. These unit hydrographs were used along with a runoff coefficient equal to 1.0 to compute the PMF for Streams A and B.

The applicant stated that the time of concentration for a drainage basin is defined as the time required for precipitation falling at the most remote point of the drainage basin to reach the outlet of the drainage basin. The time of concentration includes overland flow time and channel flow time. The applicant estimated the overland flow time using a formula given by Chow in Bulletin 462. It estimated the channel flow time based on the average velocity of flow in the channel and the length of channel to the outlet of the drainage basin.

SERI estimated that the times of concentration for different subareas of Basins A and B range from about 24 to 48 minutes. The applicant argued that, during the PMP event, the detention of water from ponding in different subareas will result in a longer time of concentration. Therefore, the applicant decided to use an average time of concentration of 30 minutes for local site basins.

The applicant stated that the PMP rainfall intensity corresponding to a time of concentration of 30 minutes is 16.4 inches per hour (in./h), based on a probable maximum half-hour precipitation of 8.2 inches determined from HMR 33 and USACE EM-1110-2-1411. SERI estimated the peak discharges for Basins A and B using flood hydrographs determined from unit hydrographs developed previously.

The applicant's estimate of maximum floodwater elevation is 133.25 feet above MSL.

The applicant stated that snowfall at the GGNS site occurs about once a year with an average depth of 2 inches. The site is not subject to heavy snow accumulations. The maximum depth of winter PMP is smaller than that for the all-season PMP. Therefore, the applicant concluded that flooding resulting from winter PMP will not be a design issue for the ESP facility or facilities.

In RAI 2.4.2-1, the staff asked SERI to provide the road height above Culvert 9 on Stream A and the survey coordinates, including elevation, of Culvert 1 on Stream B. In response to this RAI, the applicant stated that SSAR Figure 2.4-21 shows the road height above Culvert 9, which is 125 feet above MSL. SSAR Figures 2.4-18, 2.4-20 (Sheet 2), 2.4-23, and 2.4-24 and SSAR Table 2.4-12 provide details regarding Culvert 1. The survey coordinates for the center of Culvert 1 are N548,692.44 meters and E277,342.18 meters. The inlet elevation of Culvert 1 is 107.50 feet above MSL, and the outlet elevation is 103.17 feet above MSL. The length of Culvert 1 is 230 feet, and its diameter is 180 inches.

In RAI 2.4.2-2, the staff asked the applicant to explain its use of a DPF to PMF ratio of 0.5. The SSAR estimated the PMF for the Mississippi River based upon the DPF defined by USACE. According to a reference cited in the SSAR, the ratio of DPF to PMF ranges from 0.4 to 0.6. Use of the former (DPF/PMF = 0.4) will result in a more conservative estimate of the PMF, given the DPF. In response to RAI 2.4.2-2, the applicant stated that it included the text in question in SSAR Section 2.4.3.4.1 from the GGNS Unit 1 UFSAR. The applicant noted that the UFSAR stated that the standard project flood (SPF) is generally 40 to 60 percent of the PMF. The DPF is approximately equivalent to the SPF but probably higher. The applicant considered it conservative to use a midpoint of 50 percent for the DPF to PMF ratio. This ratio results in an estimated Mississippi River PMF of 6.6 million cfs.

According to SERI, SSAR Section 2.4.3.5 indicates that a flood with a peak discharge of 6.6 million cfs in the Mississippi River near the GGNS site will overtop the levee with a maximum elevation of 103 feet above MSL, which can contain a peak discharge of about 3 million cfs, and inundate the wide alluvial floodplain west of the levee. The applicant conservatively estimated a discharge capacity of the floodplain west of the levee at a water surface elevation slightly in excess of 103 feet above MSL of about 11 million cfs using Manning's roughness coefficient of 0.1, floodplain slope of 0.2 ft/mi, and floodplain width of 60 miles. The applicant stated that, based on the total river and floodplain discharge capacity of 11 million cfs, which is much larger than the estimated PMF of 6.6 million cfs, use of a DPF to PMF ratio of 0.4 instead of 0.6 will not change the conclusions of the analysis for the ESP site.

In RAI 2.4.2-3, the staff asked SERI to explain which parts of the new facility might need flood protection during local intense precipitation since the plant grade level is above the PMF level. In response to this RAI, the applicant noted that the statement referenced by the staff in this RAI came out of SSAR Section 2.4.2.2. The applicant stated that this section of the SSAR addresses flooding in broad terms and includes consideration of both Mississippi River floods and the impact of PMP on the ESP site.

The applicant stated that, as noted in SSAR Section 2.4.3, the levee elevation of 103 feet above MSL on the west bank of the Mississippi River controls the maximum water surface elevation caused by a PMF in the river. Thus, the maximum PMF water surface elevation is about 29 feet below the proposed ESP facility grade of approximately 132.5 feet above MSL. Since the ESP site is located on the bluffs on the east side of the river, the maximum PMF water surface elevation in the Mississippi River would not affect any safety-related structures of the ESP facility or facilities. The applicant stated that this evaluation is separate from that conducted with regard to PMP.

SSAR Section 2.4.2.3 discusses the potential flooding of the ESP site from PMP. According to the applicant, the estimated maximum floodwater elevation for the ESP site in its existing configuration does not exceed 133.25 feet above MSL. The applicant anticipated that the construction of the ESP facility or facilities in the proposed powerblock locations would approximately maintain the existing plant grade elevation of 132.5 feet above MSL. The plant yard for the ESP facility would be graded such that runoff is directed away from existing and ESP facility buildings. Assuming that the final ESP site grade in relation to the location of safety-related equipment is such that flooding of the safety-related equipment during a PMP event is precluded, the applicant stated that flooding protection would not be needed. However, as noted in SSAR Sections 2.4.2.2 and 2.4.10, once the final ESP plant grade is established at the COL stage, the need for flood protection of safety-related equipment will be reevaluated.

In RAI 2.4.2-4, the staff asked SERI to provide details to support the estimation of a maximum flood elevation of 133.25 feet above MSL. In response to this RAI, the applicant stated that Section 2.4.3.5, particularly Section 2.4.3.5.3, of the GGNS Unit 1 UFSAR provided a detailed discussion of flooding caused by the local PMP on the GGNS site.

2.4.2.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant's conformance to NRC regulatory guidance. The applicant identified the applicable RGs. Section 2.4.2 of RS-002 provides the review guidance that the staff used to evaluate this SSAR section.

The acceptance criteria for this section address 10 CFR Part 52 and 10 CFR Part 100 as they relate to identifying and evaluating hydrologic features of the site. The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the review take into account the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear unit(s).

To satisfy the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the SSAR should contain a description of the surface and subsurface hydrologic characteristics of the site and region and an analysis of the PMF. This description should be sufficient to assess the acceptability of the site and the potential for those characteristics to influence the design of plant

SSCs important to safety. Meeting this guidance provides reasonable assurance that the hydrologic characteristics of the site and potential hydrologic phenomena will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the relevant limiting parameters.

To judge whether the applicant has met the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the NRC uses the following criteria:

- For SSAR Section 2.4.2.1, the staff compares the potential flood sources and flood response characteristics of the region and site identified in its review (as described in the review procedures) to those identified by the applicant. If similar, the staff accepts the applicant's conclusions. If, in the staff's opinion, significant discrepancies exist, the applicant must provide additional data, reestimate the effects on a nuclear unit(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site, or revise the applicable flood design bases, as appropriate.

- For SSAR Section 2.4.2.2, the applicant's estimate of controlling flood levels is acceptable if it is no more than 5 percent less conservative than the staff's independently determined (or verified) estimate. If the applicant's SSAR estimate is more than 5 percent less conservative, the applicant should fully document and justify its estimate of the controlling level. Alternatively, the applicant may accept the staff's estimate.

- For SSAR Section 2.4.2.3, the applicant's estimates of the local PMP and the capacity of site drainage facilities (including drainage from the roofs of buildings and site ponding) are acceptable if the estimates are no more than 5 percent less conservative than the corresponding staff assessment. Similarly, conclusions relating to the potential for any adverse effects of blockage of site drainage facilities by debris, ice, or snow should be based upon conservative assumptions of the storm and vegetation conditions likely to exist during storm periods. If a potential hazard does exist (e.g., the elevation of ponding exceeds the elevation of plant access openings), the applicant should document and justify the local PMP basis.

The staff used the appropriate sections of several documents to determine the acceptability of the applicant's data and analyses in meeting the requirements of 10 CFR Part 52 and 10 CFR Part 100. RG 1.59, Revision 2, "Design Basis Floods for Nuclear Power Plants," issued August 1977, provides guidance for estimating the design-basis flooding considering the worst single phenomenon, as well as combinations of less severe phenomena. The staff used the publications of USGS, NOAA, SCS, USACE, applicable State and river basin authorities, and other similar agencies to verify the applicant's data relating to the hydrologic characteristics and extreme events in the region.

2.4.2.3 Technical Evaluation

The staff obtained peak flow data for the Mississippi River from the USGS “Peak Streamflow for the Nation” Web site for the streamflow gauge located at Vicksburg, Mississippi (USGS Gauge No. 07289000), and used them to create the plot shown in Figure 2.4-6. The staff selected the six highest historical peak flows from the record. These observations are shown by red circles on the plot and are also labeled by their corresponding water years. Table 2.4-1 shows the streamflow values corresponding to these observations. Gauge heights corresponding to these six highest flows were not available.

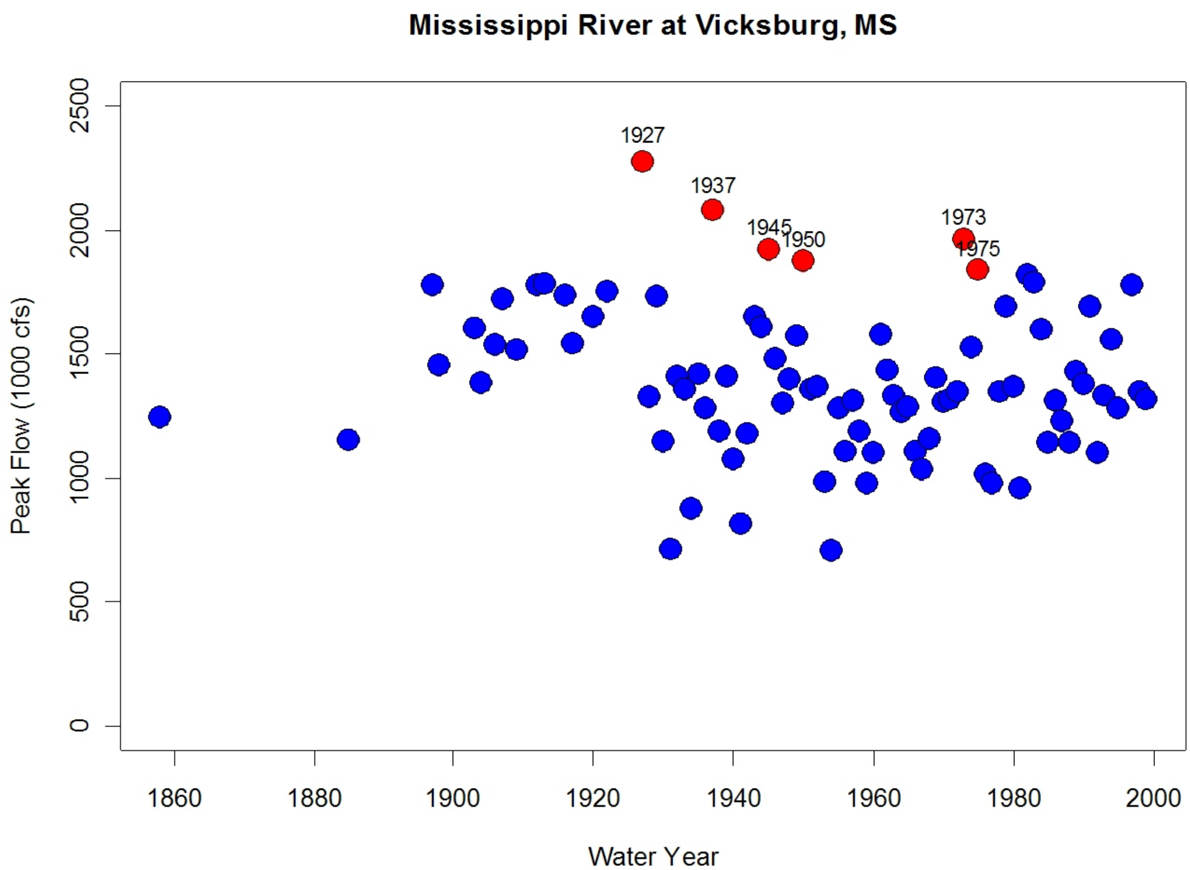


Figure 2.4-6 Peak flow in the Mississippi River observed at Vicksburg, Mississippi. The six highest peak flows are shown by red circles and are labeled by their corresponding water years.

Table 2.4-1 Peak Streamflow during Six Highest Floods at Vicksburg, Mississippi

Water Year	Peak Streamflow in cfs
1927	2278000
1937	2080000
1973	1962000
1945	1922000
1950	1876000
1975	1839000

Based on the peak flow data obtained by the staff, five of the six highest peak flows are identical to those reported by SERI in SSAR Table 2.4-4. However, the peak flow reported by the applicant, that of 1,783,000 cfs in 1913, was exceeded in 1975. The peak flow in 1975 was 1,839,000 cfs. The staff accepted the applicant's statement that no flood in the Mississippi River has exceeded the magnitude of the 1973 flood since the construction of GGNS.

The staff did not find any historical data for the two local streams, Streams A and B. The staff estimated the PMP for the drainages of Streams A and B using HMR 53 and estimated the PMF for these drainages assuming no precipitation losses and an instantaneous time of concentration. These assumptions result in more conservative PMF values. The staff analyzed the resulting flood hydrographs assuming that the culverts on Streams A and B are completely blocked to obtain flood elevations under these conservative PMF events. Section 2.4.3 of this SER provides details of this analysis.

Section 2.4.3 of this SER also provides more detail on the staff's evaluation of floods in the Mississippi River and their impact on the ESP site. The staff estimates that the highest water surface elevation in the Mississippi River as a result of the DPF, wind setup, and wave runup will not impact the ESP site since the maximum water surface elevation is significantly below the ESP site grade.

Section 2.4.4 of this SER describes the staff's evaluation of floods caused by the seismically induced failure of upstream dams. The staff concluded that any upstream dam failure and resulting flood wave would not impact the ESP site.

Section 2.4.7 of this SER describes the staff's evaluation of ice-jam-induced flooding. The staff concluded that ice jams are not likely to form sufficiently close to the GGNS site on the Mississippi River to adversely impact the operations or safety of the ESP facility or facilities.

According to HMR 52, local intense precipitation at the ESP site is equivalent to a short-duration, 1-mi^2 PMP. The staff used HMR 52 guidelines to estimate the 1-hour, 1-mi^2 PMP depth for the ESP site. Column 2 of Table 2.4-2 lists the HMR 52-recommended multiplication factors that are applied to the 1-hour, 1-mi^2 PMP depth to estimate the PMP depths for other durations. Column 3 shows the staff's estimated PMP depths corresponding to these durations.

Table 2.4-2 Local Intense Precipitation (1 mi^2 PMP) at the ESP Site

Duration	Multiplier to 1-Hour PMP Depth	PMP Depth (in.)
5 min	0.331	6.08
15 min	0.522	9.58
30 min	0.748	13.73
1 h	1	18.36
6 h	1.527	28.04

SSAR Table 2.4-7 shows the applicant's estimate of the local intense precipitation. SERI estimated a 1-hour PMP depth at the plant site of 11.6 inches (see SSAR Table 2.4-7) and a 30-minute PMP depth of 8.2 inches using HMR 33. The applicant's estimates are 37 and 40 percent less than the corresponding staff estimates, respectively. Therefore, the staff determined that the applicant's assertion that the hourly PMP values contained in the newer HMR 53 are only 2 percent higher than those recommended by HMR 33 is not valid. HMR 53 applies to 10-mi^2 areas. However, local intense precipitation should be based on a 1-mi^2 area as recommended in HMR 52. Therefore, the staff concluded that the applicant must estimate the local intense precipitation using the guidelines of HMR 52. This was Open Item 2.4-5.

In response to Open Item 2.4-5, the applicant stated that it estimated the local intense precipitation using the guidelines of HMR 52. Table 2.4-2a provides the applicant's revised PMP values for the ESP site.

Table 2.4-2a Applicant's Revised Local Intense Precipitation (1 mi^2 PMP) at the ESP Site

Duration	Area	Multiplier to 1-h, 1-mi^2 PMP	Source in HMR 52	PMP Depth (in.)	Comments
5 min	1 mi^2	0.325	Fig. 36	6.2	multiplier*1 h, 1 mi^2
15 min	1 mi^2	0.505	Fig. 37	9.7	multiplier*1 h, 1 mi^2
30 min	1 mi^2	0.735	Fig. 38	14.1	multiplier*1 h, 1 mi^2
1 h	1 mi^2	1		19.2	HMR 52, Fig. 24
1 h	10 mi^2	0.825	Fig. 28	15.8	HMR 52, Fig. 29
6 h	10 mi^2	1/0.615	Fig. 23	31.2	multiplier*1 h, 1 mi^2

The applicant revised SSAR Section 2.4.2.3 to include the above HMR 52 PMP values and annotated SSAR Table 2.4-7 to indicate its applicability to the GGNS Unit 1 analysis only.

The staff reviewed the applicant's response to Open Item 2.4-5 and concluded that it is sufficient to resolve the open item because the applicant's revised estimates closely match those of the staff and conforms to the latest HMR-52 criteria. The staff also determined that newly provided PMP values for local intense precipitation at the ESP site will be specified as site characteristics in this ESP.

In response to RAI 2.4.2-1, the applicant provided the road heights above Culverts 1 and 9 and the survey coordinates of Culvert 1. The staff determined that the applicant provided sufficient information for it to locate these culverts on the map in relation to the drainage characteristics of Basins A and B. Therefore, the applicant's response is satisfactory.

In response to RAI 2.4.2-2, SERI stated that a flood with a peak discharge of about 3 million cfs can be carried by the levees on the west bank of the river near the GGNS site. The peak PMF discharge of 6.6 million cfs estimated by the applicant will overtop the levees on the west bank. However, the applicant estimated a discharge capacity of the floodplain west of the levees of about 11 million cfs. If a DPF to PMF ratio equal to 0.4 were used for estimation of the PMF, the peak PMF discharge would be 8.25 million cfs. Therefore, the applicant concluded that, since this more conservative estimate of peak PMF discharge is still less than the discharge capacity of the floodplain west of the levee, the conclusion of the applicant's previous analysis will not change. The staff determined that the applicant satisfactorily addressed the concern regarding its use of a less conservative DPF to PMF ratio in the previous analysis presented in the SSAR. The staff also agreed that, even with the more conservative estimate of peak PMF discharge in the Mississippi River, the water surface elevation at peak PMF discharge will not be appreciably higher than 103 feet above MSL, the top surface elevation of the levee on the west bank.

In response to RAI 2.4.2-3, SERI stated that it established the maximum water surface elevation at the ESP site based on local intense precipitation at the site. The applicant's estimate of maximum water surface elevation at the ESP site is 133.25 feet above MSL. The applicant proposed to use the existing site grade of 132.5 feet above MSL as the ESP site grade. The applicant also suggested that the plant yard for the ESP facility or facilities would be graded to direct the runoff away from the ESP facility and buildings. Finally, the applicant proposed to reevaluate the need for flooding protection requirements once the ESP plant grade is established at the COL stage.

The NRC will require the COL applicant to demonstrate that the ESP plant grade is safe from the flooding effects of maximum water surface elevation during local intense precipitation without relying on any active surface drainage systems that may be blocked during this event. Section 2.4.1.3 of this SER stated a similar requirement as DSER Permit Condition 2.4-1:

> The NRC will require the COL applicant to design the ESP plant grade such that flooding caused by local intense precipitation will be discharged to Streams A and B without reliance on any active drainage systems that may become blocked during the local intense precipitation event.

The staff intended to propose that the Commission include this requirement in the ESP, should it be granted. However, based on the applicant's response to open items, the staff determined that the ESP site grade will not be designed until the COL stage when a reactor design is chosen and the locations of safety-related structures are established. The NRC will review the ESP site grade design according to existing regulations and regulatory guidance at that time. The staff determined, therefore, that specification of DSER Permit Conditions 2.4-1 and 2.4-4 is not required. The COL applicant should demonstrate that the ESP plant grade is safe from the flooding effects of maximum water surface elevation during local intense precipitation without relying on any active surface drainage systems that may be blocked during this event. This is **COL Action Item 2.4-5.**

In response to RAI 2.4.2-4, the applicant provided the reference to GGNS Unit 1 UFSAR Section 2.4.3.5. This section contained details of the PMF backwater analysis during local intense precipitation. The staff reviewed this section of the GGNS Unit 1 UFSAR and is satisfied that the applicant's response to RAI 2.4.2-4 is adequate.

2.4.2.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to floods. Therefore, the staff concludes that the applicant has met the requirements for floods with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c)(3).

2.4.3 Probable Maximum Flood on Streams and Rivers

The ESP site is located at approximately 32° N latitude and 91°3' W longitude. It is located at approximately river mile 406 on the east bank of the Mississippi River, about 25 miles south of Vicksburg, Mississippi.

Two small, steep streams flow around the ESP site, draining a combined area of less than 4 mi^2, and into Lake Hamilton, located in the floodplain of the Mississippi River. The ESP site itself partially drains to both streams.

The ESP site is subject to flooding from the Mississippi River, because of flooding in the two small streams that flow around the site, and to local flooding in response to intense precipitation.

2.4.3.1 Technical Information in the Application

According to SERI, it based the PMF for the Mississippi River on the DPF for the Lower Mississippi Basin, as estimated by USACE in Annex C, "Project Design Flood Study, 'Comprehensive Review of the Mississippi River and Tributaries Project,' " issued 1969. According to the applicant, using the DPF to estimate the PMF for the Mississippi River meets the requirements of RG 1.59 and is consistent with the GGNS UFSAR position on RG 1.59.

The USACE determined the DPF for the Mississippi River, as described in its comprehensive review cited above. Several logical storm combinations within the Mississippi River Basin were studied to compute floods on tributaries. These storm combinations were then analyzed in meteorologically feasible sequences that would result in the peak flows of individual tributaries coinciding with each other as far as practicable at key discharge locations on the Mississippi River. These hypothetical floods were used to select four storm combinations. These storms were rearranged to maximize flood flows at key locations. Based on regulation data, modified hydrographs were estimated for three groups of reservoirs—(1) existing, (2) existing and near future, and (3) existing, near future, and distant future. The modified and unregulated flows were routed down the Mississippi River to determine daily flows at St. Louis, Missouri; Cairo, Illinois; Memphis, Tennessee; Helena and Arkansas City, Arkansas; and Vicksburg and Natchez, Mississippi.

The applicant developed the DPF hydrograph for the GGNS site from the USACE DPF hydrograph for Arkansas City, Arkansas, located at approximately river mile 547. The Arkansas City DPF hydrograph was lagged by 36 hours, assuming an approximate average flood velocity of 100 miles per day, and augmented to account for inflow from the Yazoo and Big Black River tributaries. Figure 2.4-15 of the ESP application shows the resulting DPF at the GGNS site. The applicant stated that peak discharge of the unregulated DPF at the GGNS site is 3.3 million cfs.

According to Chow in "Open Channel Hydraulics," issued 1959, the SPF is generally between 40 and 60 percent of the PMF. According to the applicant, the DPF is approximately equivalent to the SPF but is probably somewhat greater. Based on these statements, SERI used a value of 0.5 for the ratio of DPF to PMF. The applicant estimated the PMF on the Mississippi River near the GGNS site by doubling the DPF previously estimated for the GGNS site. The applicant estimated a peak discharge in the Mississippi River near the GGNS site during a PMF event of 6.6 million cfs.

The applicant determined water surface elevations corresponding to the peak discharges during the PMF in the Mississippi River. For the Mississippi River near the GGNS site, it developed a rating curve using the one at Vicksburg. In developing the rating curve for the GGNS site, the applicant assumed that the two locations (GGNS site and Vicksburg) have the same discharge, since no major tributaries exist between Vicksburg and the GGNS site except the Big Black River. The Big Black River contributes less than 1 percent to the discharge in the Mississippi River at its confluence, as compared to the discharge in the Mississippi River at Vicksburg. Figure 2.4-6 in the ESP application shows this rating curve.

The applicant stated that the peak flow during the PMF in the Mississippi River will overtop the west bank levee, which has a maximum elevation of 103 feet. At a flood elevation of 103 feet, the discharge in the Mississippi River is about 3 million cfs, resulting in inundation of the floodplain on the west bank. The applicant estimated that the discharge capacity of the floodplain at a water surface elevation slightly above 103 feet, assuming a width of 60 miles, a Manning's roughness coefficient of 0.1, and a channel slope of 0.2 ft/mi, is approximately 11 million cfs. The applicant concluded that the peak discharge of 6.6 million cfs during the PMF is not expected to raise the water surface elevation much above 103 feet within the Mississippi River. This peak water surface elevation is about 29 feet below the plant grade.

The applicant estimated the PMF for Streams A and B using the local PMP. Section 2.4.2 of this SER discusses the applicant's description of the estimation of the PMP for drainages of local Streams A and B. The applicant used a unit hydrograph approach to determine peak discharge on these drainages during the PMP event, as described above in SER Section 2.4.2.1. The applicant's estimates of peak discharges during the PMF event for Basins A and B are 13,900 cfs and 4,630 cfs, respectively.

SERI estimated the water surface elevation in Stream A at the culvert assuming that the culvert would be completely blocked and the top of the access road would act as a broad-crested weir 580 feet wide, with a weir bottom surface elevation of 125 feet above MSL. The applicant carried out a backwater analysis of Stream A during the PMF event using the HEC-2 program for water surface profiles. The resulting maximum water surface elevation is 128.93 feet above MSL.

According to the applicant, Stream B was rerouted around the GGNS Unit 1 cooling tower. This rerouted channel was lined with concrete and has a bottom width of 6.67 feet. The sides were lined with concrete to a height of 5 feet above the bottom, and riprap was provided above the concrete to the plant grade. The applicant stated that the channel is hydraulically steep because of its slope of 0.4 percent in the downstream reach and 1 percent upstream of Culvert 15. The culvert is located at the downstream end of this channel, and an access road passes over it. The natural drainage area of Basin B to Culvert 1 is about 0.5 mi^2. Because of site grading, about 0.15 mi^2 of this area now drains to Basin A, and the remaining 0.35 mi^2 drains to Culvert 1.

The applicant estimated the water surface elevation in Stream B during the PMF event using a standard step backwater method. The analysis used a prorated peak discharge of 2775 cfs at Culvert 1, corresponding to a drainage area of 0.35 mi^2. The applicant conservatively assumed concurrent peak discharges at all culverts draining into the channel. The water depth in the channel exceeded the normal depth, resulting in a hydraulic jump about 1200 feet upstream of the entrance to Culvert 1. The applicant stated that the Froude number based on the upstream and downstream depth of flow is 1.1, classifying the hydraulic jump as a low-energy jump, dissipating less than 1 percent energy.

According to the applicant, the possibility of substantial blockage of Culvert 1 is highly unlikely because the channel is lined up to the 100-year flood level and riprap is provided above this level. The watershed draining to the channel upstream of Culvert 2, including the plant yard, contains no source of debris that may cause blockage. Therefore, the applicant concluded that, in the event of a 45-percent blockage of the culvert entrance area, part of the PMF discharge would be passed through the culvert, and the remaining volume could be impounded in the channel and the yard area around the GGNS Unit 1 cooling tower below an elevation of 132.8 feet above MSL.

In RAI 2.4.3-1, the staff asked SERI to explain how it bounded the wave runup estimation through the examination of the combined event criteria indicated in ANSI/American Nuclear Society (ANS)-2.8-1992, “Determining Design Basis Flooding at Power Reactor Sites,” issued 1992. The staff also asked the applicant to discuss the coincident wave estimation and its basis for using a 40-miles per hour (mph) wind speed. In response to this RAI, the applicant stated that SSAR Section 2.4.3.6 discusses wind-wave estimation in detail. The applicant stated that it performed wave height estimation in accordance with the procedures described in the USACE "Shore Protection Manual,” issued 1973. According to the applicant, this estimation used an overland windspeed of 40 mph and assumed a wind velocity over water that was 1.3 times higher than the overland wind speed. The resulting over-water wind speed is 52 mph. The applicant estimated the resulting water surface elevation caused by wind-wave activity coincident with the PMF in the Mississippi River to be 108.8 feet above MSL. Based on this estimation, the maximum water surface elevation during the PMF event in the Mississippi River is about 23.7 feet below the proposed ESP plant grade elevation of 132.5 feet above MSL.

According to the applicant, ANSI/ANS-2.8-1992 indicates that the 2-year annual extreme mile wind speed may be used as a starting point. According to Figure 1 of the ANSI/ANS standard, the wind speed for GGNS is between 40 and 50 mph. The fastest hourly averaged wind speeds at GGNS and Vicksburg are 31 and 33 mph, respectively, in 1999, based on data from 1997–2001. The wind speed value used in the original estimation of coincident wave activity is more conservative than the measured values at GGNS.

SERI argued that, even if the wind speed were increased to 65 mph, using the most conservative range from Figure 1 of ANSI/ANS-2.8-1992, the new estimate of wave height would be 6.9 feet (4.4 feet x $(65/52)^2$ = 6.9 feet). The difference in elevation between the new maximum water surface elevation and the proposed ESP site grade would still be 21.2 feet. The new estimation will not result in a significant change from the original analysis and will not pose a safety hazard to the ESP site from flooding in the Mississippi River.

In RAI 2.4.3-2, the staff asked the applicant to provide survey coordinates for points A and B on SSAR Figure 2.4-10. In response to this RAI, the applicant stated that points A and B only represent approximate locations of the discharge locations of drainage Basins A and B, respectively. The approximate UTM coordinates in NAD 83 are N3,543,936 meters and E683,868 meters for point A and N3,543,108 meters and E683,868 meters for point B.

2.4.3.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant's conformance to NRC regulatory guidance. The staff finds that SERI correctly identified the applicable regulatory guidance. Section 2.4.3 of RS-002 provides the review guidance used by the staff to evaluate this SSAR section.

The acceptance criteria for this section address 10 CFR Part 52 and 10 CFR Part 100, as they relate to identifying and evaluating the hydrologic features of the site. The regulations at 10 CFR Part 52 and 10 CFR Part 100 require that the review take into account a site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear unit(s).

To satisfy the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the SSAR should contain a description of the hydrologic characteristics of the site and region and an analysis of the PMF. This description should be sufficient to assess the acceptability of the site and the potential for those characteristics to influence the design of SSCs important to safety for a nuclear unit(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site. Meeting this guidance provides reasonable assurance that any hydrologic phenomena of severity up to and including the PMF will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters.

To judge whether the applicant has met the requirements of the hydrologic aspects of 10 CFR Part 52 and 10 CFR Part 100, the NRC uses specific criteria.

The PMF, as defined in RG 1.59, has been adopted as one of the conditions to be evaluated in establishing the applicable stream and river flooding design basis referenced in GDC 2. PMF estimates are needed for all adjacent streams or rivers and site drainage (including the consideration of PMP on the roofs of safety-related structures). The criteria for accepting the applicant's PMF-related design basis depend on one of the following three conditions:

(1) The elevation attained by the PMF (with coincident wind waves) establishes a necessary protection level to be used in the design of the facility.

(2) The elevation attained by the PMF (with coincident wind waves) is not controlling; the design-basis flood protection level is established by another flood phenomenon (e.g., the probable maximum hurricane (PMH)).

(3) The site is "dry"; that is, the site is well above the elevation attained by a PMF (with coincident wind waves).

When condition (1) is applicable, the staff will assess the flood level. The staff may perform this assessment independently from basic data, by detailed review and checking of the applicant's analyses, or by comparison with estimates made by others that have been reviewed in detail. The applicant's estimates of the PMF level and the coincident wave action are acceptable if the estimates are no more than 5 percent less conservative than the staff estimates. If the applicant's estimates of discharge are more than 5 percent less conservative than the staff's, the applicant should fully document and justify its estimates or accept the staff estimates.

When condition (2) or (3) applies, the staff analyses may be less rigorous. For condition (2), acceptance is based on the protection level estimated for another flood-producing phenomenon exceeding the staff estimate of PMF water levels. For condition (3), the site grade should be well above the staff assessment of PMF water levels. The evaluation of the adequacy of the margin (difference in flood and site elevations) is generally a matter of engineering judgment. Such judgment is based on the confidence in the flood-level estimate and the degree of conservatism in each parameter used in the estimate.

The staff used the appropriate sections of several documents to determine the acceptability of the applicant's data and analyses. RG 1.59 provides guidance for estimating the PMF design basis. Publications by NOAA and USACE may be used to estimate PMF discharge and water level conditions at the site, as well as coincident wind-generated wave activity.

2.4.3.3 Technical Evaluation

The staff evaluation consisted of an independent analysis to verify the applicant's PMF analysis.

The current HMR publications from NOAA are applicable for the estimation of the PMP that is subsequently used to develop the PMF in a given drainage basin. These reports, accessible through the NWS Hydrometeorological Design Studies Center Web site, deal with specific regions within the continental United States (Figure 2.4-7). Procedures outlined in HMR publications are recommended for drainage areas up to 20,000 mi^2. The drainage area of the Mississippi River Basin upstream of the USGS streamflow gauge at Vicksburg is 1,144,500 mi^2, approximately 57 times larger than the largest areas of applicability recommended by the HMRs. The extent of the Mississippi River Basin implies that at least four of these regions, with five different HMRs, may apply in different portions of the Mississippi River Basin (Figure 2.4-7). There are no recommendations on combining estimates from different HMRs for a PMP estimation over a large basin that straddles multiple HMR regions.

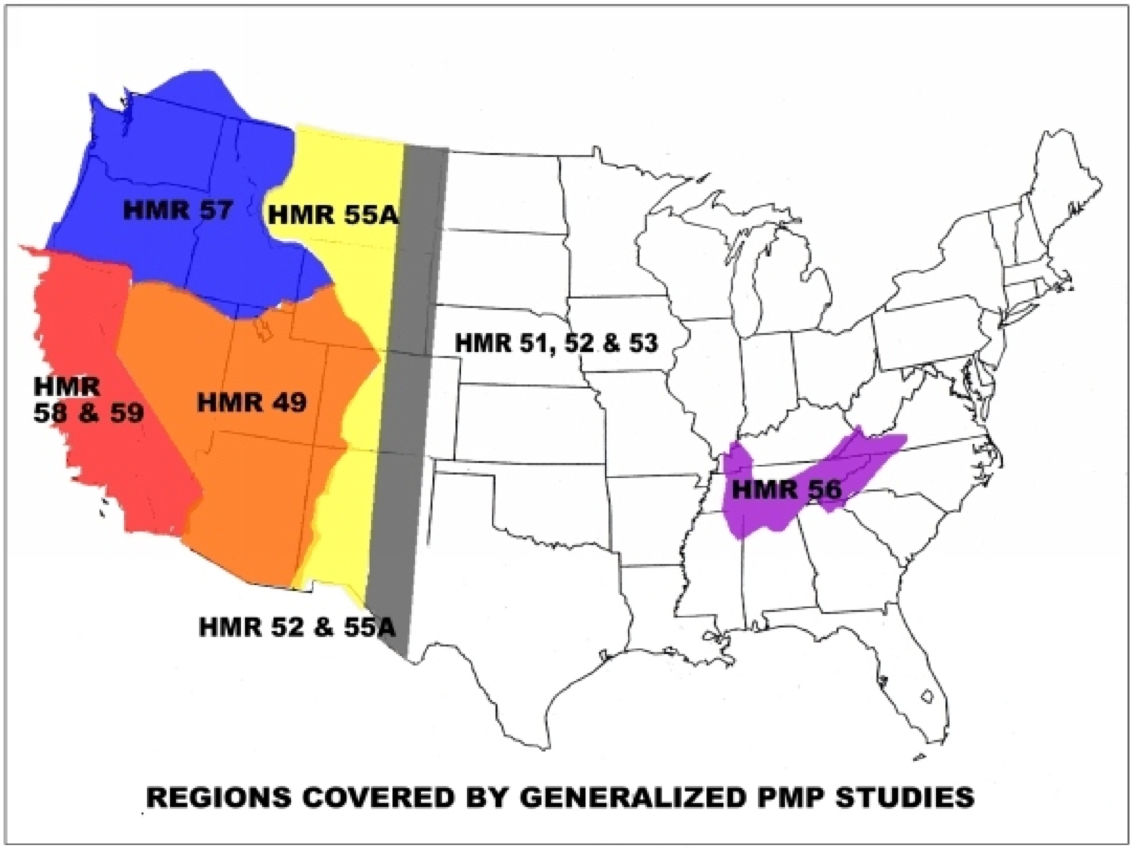


Figure 2.4-7 Regions of applicability of HMRs within the continental United States for estimation of the PMP. Figure from the Hydrometeorological Design Studies Center <http://www.nws.noaa.gov/oh/hdsc/max_precip/pmp.html>

The staff consulted USACE, Vicksburg District, for independent verification of the DPF in the Mississippi River near the GGNS site. In a letter to Mr. G. Bagchi of the NRC, dated July 9, 2004, USACE stated that major storms that occurred in the central United States were examined for their flood-producing potentialities in the Lower Mississippi River. Selected storms from this set were transposed or shifted in timing within the season in which they occurred and arranged in critical sequence on the drainage area to produce maximum flows in the lower Mississippi River. The USACE used observed hydrographs and hydrographs computed from unit graphs to determine flows from major tributaries. The resulting flows were routed to key stations along the river as unregulated or regulated by tributary reservoirs. The DPF was selected from these routed flows.

According to USACE, it used four combinations of the selected storms for detailed study on the basis of the large floods produced and the variation in season of occurrence. It selected the combination designated 58A as the DPF for the Lower Mississippi River. Combination 58A consists of the storm that occurred January 6–24, 1937, over all areas with rainfall excess increased by 10 percent, followed in 4 days by the storm of January 3–16, 1950, over all areas above Cairo, Illinois, and followed in 3 days by the storm of February 4–18, 1938, transposed 90 miles and rotated 20 degrees for all areas below Cairo, Illinois.

The USACE stated that the levee on the west bank of the Mississippi River opposite the current GGNS plant (approximate levee station 5300+00) varies in elevation from 105 feet above MSL to 102 feet above MSL. The levee is proposed to be raised 3 to 4 feet within the next 7 to 10 years at this location.

The USACE also stated that the DPF elevation at river mile 406, the location of the current GGNS plant, is 102.2 feet above MSL, based on the Refined 1973 Mississippi Rivers and Tributaries Project Flood Flowline.

In RAI 2.4.3-1, the staff asked SERI to provide additional information on the bounding of its wave runup calculations through the examination of the combined events criteria indicated in ANSI/ANS-2.8-1992. In addition, the staff asked the applicant to discuss the basis for applying a 40-mph design wind.

In its response to RAI 2.4.3-1, the applicant estimated wave heights using a more conservative value based upon a 65-mph wind. With this higher wind speed, the revised wave heights were 6.9 feet, and the margin to the proposed ESP facility grade elevation was more than 20 feet.

The staff examined wave heights generated by winds at 100 mph. This more conservative value was thought plausible because the site is located near the Gulf of Mexico, where hurricanes are known to develop. The staff estimated wave heights using wave height nomographs (see USACE EM-1110-2-1100, Revision 1, "Coastal Engineering Manual," issued July 2003). These nomographs estimate wave height based upon fetch length and wind speed. The staff used a fetch length of 22,704 feet; the resulting 1-percent wave height was 10.9 feet. When this conservative wave height value was added to the PMF water surface elevation, an adequate margin existed to determine that the ESP site will not be affected. Therefore, the staff determined that the applicant's response is satisfactory.

In response to RAI 2.4.3-2, SERI provided the coordinates of points A and B shown on SSAR Figure 2.4-10. The applicant also clarified that these coordinates are only approximate locations of the discharge points for Basins A and B, respectively. The staff determined that the applicant's response is satisfactory.

2.4.3.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to the PMF on streams and rivers. Therefore, staff concludes that the applicant has met the requirements for the PMF on streams and rivers with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c).

2.4.4 Potential Dam Failures, Seismically Induced

The ESP site is adjacent to the existing GGNS Unit 1 site, located on the bluffs to the east of the Mississippi River floodplain. Runoff resulting from precipitation and snow melt on major tributaries (i.e., the Ohio, Missouri, Arkansas, and Red Rivers) is primarily responsible for flooding in the Mississippi River.

2.4.4.1 Technical Information in the Application

SERI analyzed the effect of dam failures on the water surface elevation of the Mississippi River at the GGNS site, assuming that the Mississippi River would be carrying a flood of DPF magnitude with the water surface elevation at 96.2 feet above MSL when an upstream dam breaks. Since no dams exist on the Mississippi River upstream of the site, the applicant considered dam failure of the largest upstream dam closest to the ESPs on a tributary to the Mississippi River.

The applicant divided the Mississippi River Basin into six major drainage areas (Figure 2.4-27 of the ESP application):

(1) Upper Mississippi
(2) Missouri
(3) Tennessee-Ohio
(4) Red-Ouachita
(5) Arkansas-White
(6) Lower Mississippi

The total number of dams in the Mississippi River Basin exceeds 300; 61 of these dams have storage capacities greater than 1 million acre-feet (acre-ft). Figure 2.4-28 of the ESP application shows the seismic risk map of the United States which divides the United States into four zones of seismic risk. Zone 0 represents minimum risk, while Zone 3 represents maximum risk. The applicant took the information on dams listed in Table 2.4-15 of the SSAR from the report of the International Commission on Large Dams. The table was arranged on the basis of the major drainage areas in which the dams are located. Table 2.4-15 of the SSAR only lists dams with reservoir capacities greater than 1 million acre-ft.

According to SERI, the Upper Mississippi Basin has a total estimated storage capacity of 10.0 million acre-ft. Only three dams within the Upper Mississippi Basin have capacities greater than 1 million acre-ft. All dams in the Upper Mississippi Basin are in seismic Zone 1.

The total storage of the dams in the Missouri subbasin is estimated to be 140 million acre-ft. This subbasin includes 21 dams with a capacity of 1 million acre-ft or more. The dams in this subbasin belong to seismic Zones 1 and 2.

The Tennessee-Ohio subbasin has a total estimated storage capacity of approximately 45 million acre-ft. This subbasin includes 14 dams with reservoir capacities greater than 1 million acre-ft. Nine of these are in seismic Zone 2 and the other five are in seismic Zone 3.

The Red River subbasin joins the Mississippi River downstream from the site. Hence, consideration of the dams and storage in this subbasin was not required.

The Arkansas-White subbasin has a total estimated storage capacity of 45 million acre-ft, with 20 dams having capacities greater than 1 million acre-ft. Two of these dams are in seismic Zone 3, four in seismic Zone 2, and the rest of the dams are in seismic Zone 1.

The Lower Mississippi Basin has an extensive river-control system consisting of levees, revetments, cutoffs, and floodways extending from Cairo, Illinois, to the Gulf of Mexico. Two dams are in seismic Zone 2.

The largest dam that is nearest to the GGNS site is the Kentucky Dam on the Tennessee River, located in the Tennessee-Ohio subbasin about 450 river miles upstream, with a storage capacity of 6.13 million acre-ft. The Fort Randall Reservoir and Dam on the Missouri River, located in the Missouri subbasin, exceeds the capacity of the Kentucky Dam by 0.17 million acre-ft, but this dam is located 1300 river miles from the GGNS site, almost three times as far as the Kentucky Dam. Because of the relative proximity of the Kentucky Dam to the GGNS site, the applicant chose it as the dam to use in its hypothetical seismically induced failure analysis.

The applicant estimated that the initial discharge from the Kentucky Dam in the event of its complete failure will be about 3 million cfs. Conservatively neglecting the attenuation caused by the travel of the flood wave 450 miles down the river from the Kentucky Dam to the GGNS site, the applicant estimated a peak flow of about 5.7 million cfs at the GGNS site.

SERI estimated a PMF of 6.6 million cfs, which exceeds the peak flood caused by the effect of Kentucky Dam failure combined with a DPF at the GGNS site. Therefore, the applicant concluded that the failure of the nearest largest dam from seismic causes when the Mississippi River is carrying a flood of (regulated) DPF magnitude at the GGNS site is not a safety issue.

2.4.4.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant’s conformance to NRC regulatory guidance and cites RGs 1.29, “Seismic Design Classification”; 1.59; 1.70; and 1.102, Revision 1, “Flood Protection for Nuclear Power Plants,” issued September 1976. The staff finds that SERI correctly identified the applicable RGs. The applicable regulations are 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.23(c). Section 2.4.4 of RS-002 provides the review guidance used by the staff to evaluate this SSAR section.

The acceptance criteria for this section are based on meeting the requirements of the following regulations:

- 10 CFR Part 52 and 10 CFR Part 100, as they relate to evaluating the hydrologic features of the site

- 10 CFR 100.23, “Geologic and Seismic Siting Criteria,” as it relates to establishing the design-basis flood resulting from seismic dam failure

The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the review take into account the site’s physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear unit(s).

The regulations at 10 CFR Part 52 and 10 CFR Part 100 apply to SSAR Section 2.4.4 because it addresses the site’s physical characteristics, including hydrology, considered by the Commission when determining its acceptability to host a nuclear unit(s). To satisfy the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the SSAR should contain a description of the hydrologic characteristics of the region and an analysis of potential dam failures. The description should be sufficient to assess the acceptability of the site and the potential for those characteristics to influence the design of SSCs important to safety. Meeting this criterion provides reasonable assurance that the effects of high water levels resulting from the failure of upstream dams, as well as those of low water levels resulting from the failure of a downstream dam, will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters.

The regulation at 10 CFR 100.23 requires consideration of geologic and seismic factors in determining site suitability. Specifically, 10 CFR 100.23(c) requires an investigation of the geologic and seismic site characteristics to permit evaluation of seismic effects on the site. Such an evaluation must consider seismically induced floods, including failure of an upstream dam during an earthquake.

The regulation at 10 CFR 100.23 applies to SSAR Section 2.4.4 because it requires investigation of seismic effects on the site. Such effects include seismically induced floods or low water levels, which constitute one element in the Commission’s consideration of the suitability of proposed sites for nuclear power plants. RG 1.70 provides more detailed guidance on the investigation of seismically induced floods, including results for seismically induced dam failures and antecedent flood flows coincident with the flood peak. Meeting this guidance provides reasonable assurance that, given the geologic and seismic characteristics of the proposed site, a nuclear unit(s) of a specified type (or falling within a PPE) could be constructed and operated on the proposed site without undue risk to the health and safety of the public, with respect to those characteristics.

To judge whether the applicant has met the requirements of 10 CFR Part 52, 10 CFR Part 100, and 10 CFR 100.23 as they relate to dam failures, the NRC uses the following criteria:

- The staff will review the applicant’s analyses and independently assess the coincident river flows at the site and at the dams being analyzed. ANSI/ANS-2.8-1992 provides guidance on acceptable river flow conditions to be assumed coincident with the dam failure event. To be acceptable, the applicant’s estimates of the flood discharge resulting from the coincident events (which may include landslide-induced failures) should be no more than 5 percent less conservative than the staff estimates. If the applicant’s estimates differ by more than 5 percent, the applicant should fully document and justify its estimates or accept the staff estimates.

- The applicant should identify the location of dams and potentially likely or severe modes of failure, as well as dams or embankments built to impound water for a nuclear unit(s) that might be constructed on the proposed site. The applicant should discuss the potential for multiple, seismically induced dam failures and the domino failure of a series of dams. Approved USACE and Tennessee Valley Authority models should be used to predict the downstream water levels resulting from a dam breach. First-time use of other models will necessitate complete model description and documentation. The staff will review the model theory, available verification, and application to determine the acceptability of the model and subsequent analyses. For cases that assume something other than instantaneous failure, the conservatism of the rate of failure and shape of the breach should be well documented. The applicant should present a determination of the peak flow rate and water level at the site for the worst possible combination of dam failures, a summary analysis that substantiates the condition as the critical permutation, and a description of and the bases for all coefficients and methods used. In addition, the effects of other concurrent events on plant safety, such as blockage of the river and waterborne missiles, should be considered.

- The effects of coincident and antecedent flood flows (or low flows for downstream structures) on initial pool levels should be considered. Depending upon estimated failure modes and the elevation difference between plant grade and normal river levels, it may be acceptable to use conservative, simplified procedures to estimate flood levels at the site. For cases in which calculated flood levels employing simplified methods are at or above plant grade and use assumptions which cannot be demonstrated as conservative, it will be necessary to use unsteady flow methods to develop flood levels at the site. The methods described in RS-002 "Processing Applications for Early Site Permits," (ML040700094), are acceptable to the staff; however, other programs could be acceptable with proper documentation and justification. Applications should summarize the computations, coefficients, and methods used to establish the water level at the site for the most critical dam failures. Coincident wind-generated wave activity should be considered in a manner similar to that discussed in Section 2.4.3 of RS-002.

RG 1.59 provides guidance for estimating the design basis for flooding, considering the worst single phenomenon and a combination of less severe phenomena.

2.4.4.3 Technical Evaluation

The staff carried out a simplified bracketing estimation of the discharge needed to raise the water surface elevation near the GGNS site above the existing GGNS Unit 1 plant grade of 132.5 feet above MSL. The staff assumed a simplified cross-section for the Mississippi River near the GGNS site, as shown in Figure 2.4-8. The staff conservatively assumed that the width of the floodplain is 60 miles, even at a water surface elevation of 132.5 feet above MSL. The cross-sectional area of discharge is estimated as 11.5 million square feet (ft^2). The wetted perimeter was estimated as 317,065 feet.

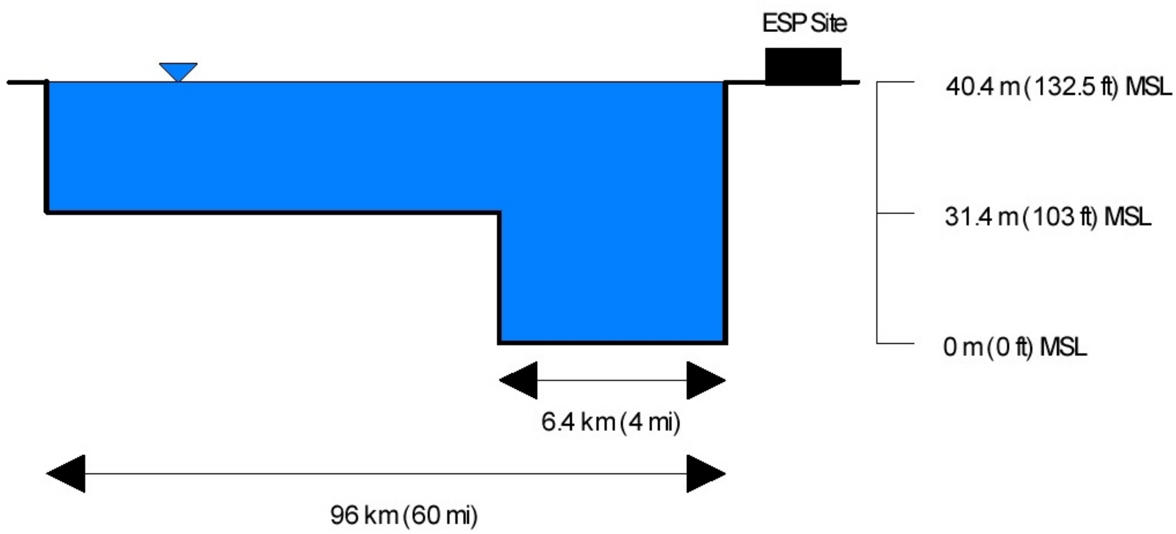


Figure 2.4-8 Simplified cross-section of the Mississippi River near the ESP site (not drawn to scale)

Based on a staff-assumed Manning's roughness coefficient of 0.025 for natural channels and a bed slope of 0.2 feet per mile (ft/mi), the staff estimated the discharge in the Mississippi River corresponding to a water surface elevation of 132.5 feet above MSL as 46.3 million cfs. This estimate is more than four times larger than the discharge capacity of the river at a water surface elevation of 103 feet above MSL, and about seven times larger than the applicant-estimated PMF. Therefore, the staff concluded that the ESP site is safe from flooding caused by a seismically induced dam failure upstream of the GGNS site.

2.4.4.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to dam failures. Therefore, the staff concludes that the applicant has met the requirements for dam failures with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c). The staff finds that the application is in partial compliance with GDC 2 with respect to the assumption of upstream dam failure caused by a seismic event.

2.4.5 Probable Maximum Surge and Seiche Flooding

The ESP site is adjacent to the existing GGNS Unit 1 site, located on the bluffs to the east of the Mississippi River floodplain at approximately river mile 406. The existing power plant site has a grade elevation of 132.5 feet above MSL.

2.4.5.1 Technical Information in the Application

SERI stated in SSAR Section 2.4.5 that the ESP site is not located in a coastal region or on a lake. Therefore, the applicant concluded that consideration of surge and seiche flooding was not warranted.

2.4.5.2 Regulatory Evaluation

Section 1.4 of the application discusses conformance to NRC regulatory guidance. The applicant identified the applicable regulations as 10 CFR 52.17(a) and 10 CFR 100.20. The staff finds that the applicant correctly identified the applicable regulatory guidance as RG 1.70. Section 2.4.5 of RS-002 provides the review guidance used by the staff to evaluate this SSAR section.

The acceptance criteria for this section are based on meeting the requirements of the following regulations:

- 10 CFR Part 52 and 10 CFR Part 100, as they relate to evaluating the hydrologic characteristics of the site

The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the review take into account the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear unit(s).

To satisfy the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the applicant's safety assessment should contain a description of the surface and subsurface hydrologic characteristics of the region and an analysis of the potential for flooding caused by surges or seiches. This description should be sufficient to assess the acceptability of the site and the potential for a surge or seiche to influence the design of SSCs important to safety for a nuclear unit(s) of a specified type that might be constructed on the proposed site. Meeting this requirement provides reasonable assurance that the most severe flooding likely to occur as a result of storm surges or seiches will not pose an undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters. Important PPE parameters for SSAR Section 2.4 include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

If it has been determined that surge and seiche flooding estimates are necessary to identify flood design bases, the NRC will consider the applicant's analysis to be complete and acceptable if it addresses the following areas and if the staff can independently and comparably evaluate them based on the applicant's submission:

- All reasonable combinations of PMH, moving squall line, or other cyclonic windstorm parameters are investigated, and the most critical combination is selected for use in estimating a water level.

- Models used in the evaluation are verified or have been previously approved by the staff.

- Detailed descriptions of bottom profiles are provided (or are readily obtainable) to enable an independent staff estimate of surge levels.

- Detailed descriptions of shoreline protection and safety-related facilities are provided to enable an independent staff estimate of wind-generated waves, runup, and potential erosion and sedimentation.

- Ambient water levels, including tides and sea level anomalies, are estimated using NOAA and USACE publications, as described below.

- Combinations of surge levels and waves that may be critical to the design of a nuclear unit(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site are considered, and adequate information is supplied to allow a determination that no adverse combinations have been omitted.

- At the COL stage, if the applicant elects RG 1.59, Position 2, the adequacy of the design basis for flood protection of all safety-related facilities identified in RG 1.29 should be shown in terms of the time necessary for the implementation of any emergency procedures. The applicant should also demonstrate that the less severe design basis selected provides for all potential flood situations that could negate the time and capability to initiate flood emergency procedures.

This section of the SSAR may also state with justification that surge and seiche flooding estimates are not necessary to identify the flood design basis (e.g., the site is not near a large body of water).

Hydrometeorological estimates and criteria for the development of PMHs for East and Gulf Coast sites, squall lines for the Great Lakes, and severe cyclonic windstorms for all lake sites by USACE, NOAA, and the staff are used for evaluating the conservatism of the applicant's estimates of severe windstorm conditions, as discussed in RG 1.59. USACE and NOAA criteria call for variation of the basic meteorological parameters within given limits to determine the most severe combination that could result. The applicant's hydrometeorological analysis should be based on the most critical combination of these parameters.

Data from publications by NOAA, USACE, and other sources (such as tide tables, tide records, and historical lake level records) are used to substantiate antecedent water levels. These antecedent water levels should be as high as the 10-percent exceedance monthly spring high tide, plus a sea-level anomaly based on (1) the maximum difference between recorded and predicted average water levels for durations of 2 weeks or longer for coastal locations or (2) the 100-year recurrence interval high water for the Great Lakes. In a similar manner, the staff independently analyzes the storm track, wind fields, effective fetch lengths, direction of approach, timing, and frictional surface and bottom effects to ensure that the applicant selected the most critical values. Models used to estimate surge hydrographs that the staff has not previously reviewed and approved are verified by reproducing historical events, with any discrepancies in the model being on the conservative (i.e., high) side.

The staff uses USACE criteria and methods, as generally summarized in RS-002, as a standard to evaluate the applicant's estimate of coincident wind-generated wave action and runup.

The staff uses USACE criteria and methods and other standard techniques to evaluate the potential for oscillation of waves at natural periodicity.

At the COL stage, the staff uses USACE criteria and methods to evaluate the adequacy of protection from flooding, including the static and dynamic effects of broken, breaking, and nonbreaking waves. RG 1.102 provides further guidance on flood protection, and RG 1.125, Revision 1, "Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants," issued October 1978, provides guidance for using physical models in assessing flood protection.

2.4.5.3 Technical Evaluation

The staff conducted its review in accordance with RS-002, Section 2.4.5, and RG 1.59.

Because the ESP site is located on a flowing river, an increase in water surface elevation on one bank of the river because of wind blowing across the water's surface would be minor and negligible during nonflood conditions. This conclusion follows because the ESP site is located at an elevation of 132.5 feet above MSL and the normal surface elevation of the Mississippi River is between 55 and 75 feet above MSL. Section 2.4.3 of this report examined wind waves on the water surface during the DPF, which were found not to impact the ESP facility or facilities because of the grade elevation of the ESP site.

Storm surge flooding is unlikely to have a measurable impact at the ESP site because of the distance (406 river miles), elevation change of the water surface (typically between 55 and 75 feet above MSL) between the site and the mouth of the Mississippi River, and the elevation of the ESP site (132.5 feet above MSL) during nonflood river conditions. During a large storm event, a surge in the Gulf of Mexico would hinder flow from exiting the Mississippi River because the difference of elevation between the two water bodies would be less, causing backwater effects. The applicant took backwater effects into account during the estimation of the DPF, discussed in Section 2.3.4 of this report, which was also the worst-case scenario for storm surge.

2.4.5.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to surge and seiche. Therefore, the staff concludes that the applicant has met the requirements for surge and seiche with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c).

2.4.6 Probable Maximum Tsunami Flooding

The ESP site is adjacent to the existing GGNS Unit 1 site, located on the bluffs to the east of the Mississippi River floodplain at approximately river mile 406. The existing GGNS Unit 1 power plant site has a grade elevation of 132.5 feet above MSL.

2.4.6.1 Technical Information in the Application

The applicant stated that the ESP site is located near river mile 406 above Head of Passes and is not in a coastal region. Therefore, SERI did not expect any effects on water level in the Mississippi River resulting from geoseismic activity to occur at the ESP site.

In RAI 2.4.6-1, the staff asked the applicant to document any seismically induced tsunami-like waves near the ESP site. The staff also requested that the applicant include in its review the ability of a tsunami-like wave to impact the ESP site. In response to this RAI, SERI stated that no historical indication exists of landslides in the GGNS area caused by seismic activity, according to the Center for Earthquake Research and Information in Memphis, Tennessee. The applicant also stated that USACE did not have any records of bluff failures or collapses in the GGNS site area.

SERI noted that according to USACE, the Mississippi coast is located in Tsunami Zone 1, with a predicted wave height of 5 feet. Conservatively assuming a coastal tsunami wave reached the GGNS site without attenuation and was coincident with the DPF on the Mississippi River, the maximum combined wave height would be 107.1 feet above MSL (102.1 feet from DPF + 5 feet from tsunami). The applicant concluded that the tsunami wave would not affect the ESP facility or facilities located at an elevation of 132.5 feet above MSL.

2.4.6.2 Regulatory Evaluation

Section 1.4 of the application discusses the applicant's conformance to NRC regulatory guidance. The staff finds that the applicant correctly identified the applicable regulations and guidance as 10 CFR 52.17(a), 10 CFR 100.20(c), and RG 1.70.

Section 2.4.6 of RS-002 provides the following review guidance used by the staff to evaluate this SSAR section. The acceptance criteria for this section are based on meeting the requirements of the following regulations:

- 10 CFR Part 52 and 10 CFR Part 100, as they relate to identifying and evaluating hydrologic features of the site
- 10 CFR 100.23, as it relates to investigating the tsunami potential at the site

The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the NRC take into account the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear unit(s). The regulations at 10 CFR Part 52 and 10 CFR Part 100 apply to RS-002, Section 2.4.6, because they address the physical characteristics, including hydrology, considered by the Commission when determining the acceptability of the proposed site. To satisfy the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the SSAR should contain a description of the hydrologic characteristics of the coastal region in which the proposed site is located and an analysis of severe seismically induced waves. The applicant's description should be sufficient to assess the site's acceptability and the potential for a tsunami to influence the design of SSCs important to safety for a nuclear unit(s) of specified type that might be constructed on the proposed site. Meeting this requirement provides reasonable assurance that the most severe flooding likely to occur as a result of a tsunami will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of parameters. Important PPE parameters for SSAR Section 2.4 include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

The regulation at 10 CFR 100.23(c) requires that the NRC consider the geologic and seismic factors when determining suitability of the site. Pursuant to 10 CFR 100.23(c), an investigation must be completed to obtain geologic and seismic data necessary for evaluating seismically induced floods and water waves. This regulation also applies to RS-002, Section 2.4.6, because it requires the investigation of distantly and locally generated waves or tsunamis that have affected or could affect a proposed site, including available evidence regarding the runup or drawdown associated with an historic tsunami in the same coastal region and local features of coastal topography that might modify runup or drawdown. RG 1.70 provides more detailed guidance on the investigation of seismically induced flooding.

Though not required at the ESP stage, the applicant for a COL must demonstrate compliance with GDC 2 as it relates to designing SSCs important to safety to withstand the effects of a tsunami.

To judge whether the applicant has met the requirements of 10 CFR Part 52, 10 CFR Part 100, and 10 CFR 100.23 with respect to tsunamis and the analysis thereof, the NRC uses the following criteria:

- If it has been determined that tsunami estimates are necessary to identify flood or low-water design bases, the NRC will consider the applicant's analysis to be complete if it addresses the following areas and if the staff can independently and comparably evaluate them based on the applicant's submission:

    — All potential distant and local tsunami generators, including volcanoes and areas of potential landslides, are investigated, and the most critical ones are selected.

    — Conservative values of seismic characteristics (source dimensions, fault orientation, and vertical displacement) for the tsunami generators selected are used in the analysis.

    — The staff previously approved or verified all models used in the analysis. RG 1.125 provides guidance in the use of physical models of wave protection structures.

- — Bathymetric data are provided (or are readily obtainable).
- — Detailed descriptions of shoreline protection and safety-related facilities are provided for wave runup and drawdown estimates. RG 1.102 provides guidance on flood protection for nuclear power plants.
- — Ambient water levels, including tides, sea level anomalies, and wind waves, are estimated using NOAA and USACE publications, as described below.
- — If the applicant adopts RG 1.59, Position 2, the design basis for tsunami protection of all safety-related facilities identified in RG 1.29 should be shown at the COL stage to be adequate in terms of the time necessary for implementation of any emergency procedures.

- The applicant's estimates of tsunami runup and drawdown levels are acceptable if the estimates are no more than 5 percent less conservative than the staff's estimates. If the applicant's estimates are more than 5 percent less conservative (based on the difference between normal water levels and the maximum runup or drawdown levels) than the staff's, the applicant should fully document and justify its estimates or accept the staff's estimates.

- This section of the SSAR will also be acceptable if it states that the criteria used to determine that tsunami flooding estimates are not necessary to identify the flood design basis (e.g., the site is not near a large body of water).

2.4.6.3 Technical Evaluation

The staff investigated two potential failure mechanisms that have the potential to cause flooding and that other sections do not cover, including hill slope failure and an inland tsunami generated by an earthquake.

The area surrounding the ESP site is relatively flat, except for the bluffs upon which the ESP facility or facilities would be constructed. Hill slopes on the bank opposite the ESP site do not have the potential to fail in such a manner that a wave could be produced of sufficient height to flood the ESP site. In addition, the integrity of the bank in the vicinity of the plant was evaluated for the construction of GGNS Unit 1. As SERI stated in SSAR Section 2.4.3.6, the new facility would be closer to the bluffs than the existing reactor containment, and the potential impact of a new facility to bank stability will be evaluated before the final design construction.

Earthquakes have the potential to create tsunami-like waves and have occurred on the Mississippi. According to Lockridge, et al. (2002), three earthquakes near New Madrid, Missouri, occurred during the winter of 1811–1812 (December 6, January 16, and February 7) that generated large tsunami-like waves. Observers of the New Madrid earthquake reported walls of water that were 15 to 20 feet high. Because these events are rare, one is unlikely to occur during the time of the PMF. Therefore, assuming a normal mean annual flood elevation of approximately 75 feet above MSL, a tsunami-like wave would have to reach a height greater than 50 feet to inundate the ESP site, which is not credible.

According to NOAA, since 1990, the 10 most destructive tsunamis in the Pacific produced maximum wave heights of 9.8 to 49.2 feet. Effects of even the largest ocean tsunamis occurring during an annual flood event (water surface elevation 75 feet above MSL) would not be of sufficient height to exceed the elevation of the ESP site (grade elevation 132.5 feet above MSL).

The staff also examined the possibility of a severe landslide, concluding that bank slopes on the opposite side of the river from the site are not of sufficient height to generate a wave that could flood the ESP site.

2.4.6.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to probable maximum tsunami flooding. Therefore, the staff concludes that the applicant has met the requirements for probable maximum tsunami flooding with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c)(3). The staff concludes that the ESP site is safe from tsunami flooding, and this application is in partial conformance with GDC 2.

2.4.7 Ice Effects

The ESP site, with coordinates of approximately 32° N latitude and 91°3' W longitude, is adjacent to the existing GGNS Unit 1 site, located on the bluffs to the east of the Mississippi River floodplain at approximately river mile 406. The existing GGNS Unit 1 power plant site has a grade elevation of 132.5 feet above MSL. Runoff resulting from precipitation and snow melt on major tributaries, including the Ohio, Missouri, Arkansas, and Red Rivers, is primarily responsible for flooding in the Mississippi River.

2.4.7.1 Technical Information in the Application

In SSAR Table 2.4-16, the applicant summarized water temperatures at the USGS gauging station on the Mississippi River at Vicksburg for the period 1973–1999. The applicant reported that the lowest temperature recorded at the USGS gauging station was 34.7 °F. In SSAR Table 2.4-16a, SERI also summarized water temperatures recorded by USACE in the Mississippi River at Vicksburg for the period 1962–1979. As shown in Table 2.4-16a, USACE reported the lowest water temperature as ranging from 30 to 40 °F in January 1970. From these two data sources, the applicant concluded that water temperatures in the Mississippi River near the GGNS site are expected to be above the freezing point most of the time.

SERI searched the USACE historical database of ice jams on the Mississippi River in September 2002. The applicant noted that this database did not list any ice jams on the Mississippi River in Mississippi or Louisiana. One ice jam was reported for the Mississippi River in Arkansas on February 1, 1940. SERI concluded that the possibility of a flood resulting from an ice jam occurring downstream of the site was remote, especially because of the continued development of river control works for navigation, irrigation, and flood control on the Mississippi River and its principal tributaries.

The applicant argued that, in the event of ice-jam-induced high flows, a rise in water level above 103 feet above MSL at the site would result in the overtopping of the levees and the diversion of water into the floodplain on the west bank of the Mississippi River. SERI stated that, since the proposed site for a new facility is located on the property's upland area and is significantly above 103 feet above MSL, ice-jam-induced high flows in the Mississippi River would not affect it.

According to the applicant, in Section 2.4.8 of the NRC SER for GGNS Unit 1 (NUREG-0831), the NRC reported the occurrence of an ice jam at Vicksburg, Mississippi, on February 3, 1940. However, the NRC concluded that the occurrence of a major ice jam on the Mississippi River was very unlikely. SERI stated that the NRC concurred that ice flooding was not a design-basis consideration for the GGNS Unit 1 site.

2.4.7.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant's conformance to NRC regulatory guidance. The staff finds that the applicant correctly identified the applicable regulatory guidance.

Section 2.4.7 of RS-002 provides the review guidance used by the staff to evaluate this SSAR section. The acceptance criteria for this section are based on meeting the requirements of 10 CFR Part 52 and 10 CFR Part 100, as they relate to identifying and evaluating the hydrologic features of the site.

The regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the NRC take into account the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability for hosting a nuclear power reactor(s). To satisfy the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the SSAR should contain a description of any icing phenomena with the potential to result in adverse effects to the intake structure or other safety-related facilities for a nuclear unit(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site. Applicants should describe ice-related characteristics historically associated with the site and region, and they should perform an analysis to determine the potential for flooding, low water, or ice damage to safety-related SSCs. The analysis should be sufficient to evaluate the site's acceptability and to assess the potential for those characteristics to influence the design of SSCs important to safety for a nuclear unit(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site. Meeting this guidance provides reasonable assurance that the effects of potentially severe icing conditions will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters.

RG 1.59 provides guidance for developing the hydrometeorologic design basis.

To judge whether the applicant has met the requirements of 10 CFR Part 52 and 10 CFR Part 100 as they relate to ice effects, the NRC uses the following criteria:

- Publications by NOAA, USGS, USACE, and other sources are used to identify the history and potential for ice formation in the region. The historical maximum depths of icing should be noted, as well as mass and velocity of any large, floating ice bodies.

The phrase, “historical low water ice affected,” or similar phrases in streamflow records (USGS and State publications) will alert the reviewer to the potential for ice effects. The following items should be considered and evaluated, if necessary:

- The regional ice and ice jam formation history should be described to enable an independent determination of the need for including ice effects in the design basis.

- If the potential for icing is severe, based on regional icing history, it should be shown that water supplies capable of meeting safety-related needs are available from under the ice formations postulated and that safety-related equipment could be protected from icing. If this cannot be shown, it should be demonstrated that alternate sources of water are available that could be protected from freezing and that the alternate source would be capable of meeting safety-related requirements in such situations.

- If floating ice is prevalent, based on regional icing history, potential impact forces on safety-related intakes should be considered. The structural design basis should include dynamic loading caused by floating ice. (This item will be addressed at the COL or CP stage.)

- If ice blockage of the river or estuary is possible, it should be demonstrated that the resulting water level in the vicinity of the site has been considered. If this water level would adversely affect the intake structure or other safety-related facilities of a nuclear unit(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site, it should be demonstrated that it would not also adversely affect an alternate safety-related water supply.

• The applicant’s estimates of potential ice flooding or low flows are acceptable if the estimates are no more than 5 percent less conservative than the staff estimates. If the applicant’s estimates are more than 5 percent less conservative than the staff’s, the applicant should fully document and justify its estimates or accept the staff estimates.

2.4.7.3 Technical Evaluation

The staff verified the water temperatures at the USGS gauging station on the Mississippi River at Vicksburg for the period 1973–1999 on June 23, 2004. The staff downloaded daily water quality data, including water temperature, from USGS. The staff found that the lowest water temperature recorded at this USGS station was 34.7 °F, which occurred on January 4, 1977; February 8, 1977; and February 3, 1978. The staff also obtained water temperature data from the USACE Mississippi River Office in Vicksburg for the period 1991–2003. The USACE measured these temperatures near the water surface. The USACE reported the lowest water temperature as 33 °F, which occurred on January 5, 2001. From these data, the staff concluded that water temperatures are expected to be above the freezing point most of the time in the Mississippi River near the GGNS site.

The staff reviewed air temperature records from the National Climate Data Center spanning January 1930 through December 2001 for the Port Gibson weather station. The average minimum daily temperature was 34.4 °F for the month of January and 37.5 °F for the month of

February. The average minimum daily temperature ranged from 33 to 39 °F in December, 32 to 37 °F in January, and 34 to 41 °F in February. The lowest daily minimum air temperature at this station was −5 °F, which occurred on January 27, 1940.

The staff reviewed concurrently available data to look at the differences between water and air temperatures during the winter months (December through March) at Vicksburg. The staff found that the water temperatures in the Mississippi River were consistently higher than the air temperatures during these months. Therefore, the staff concluded that it is highly unlikely that, even when air temperatures fall near historical lows, the water in the Mississippi River will not freeze.

On December 28, 2004, the staff searched the USACE historical database of ice jams on the Mississippi River. This database does not list any ice jams on the Mississippi River in Mississippi or Louisiana. Figure 2.4-9 shows several ice jams reported on the Mississippi River. One ice jam was reported on the Mississippi River at Helena, Arkansas, located at approximately river mile 663, on February 1, 1940. This ice jam was the closest to the GGNS site and persisted for 3 days. The database does not list any ice jams downstream of Helena, Arkansas, on the Mississippi River.

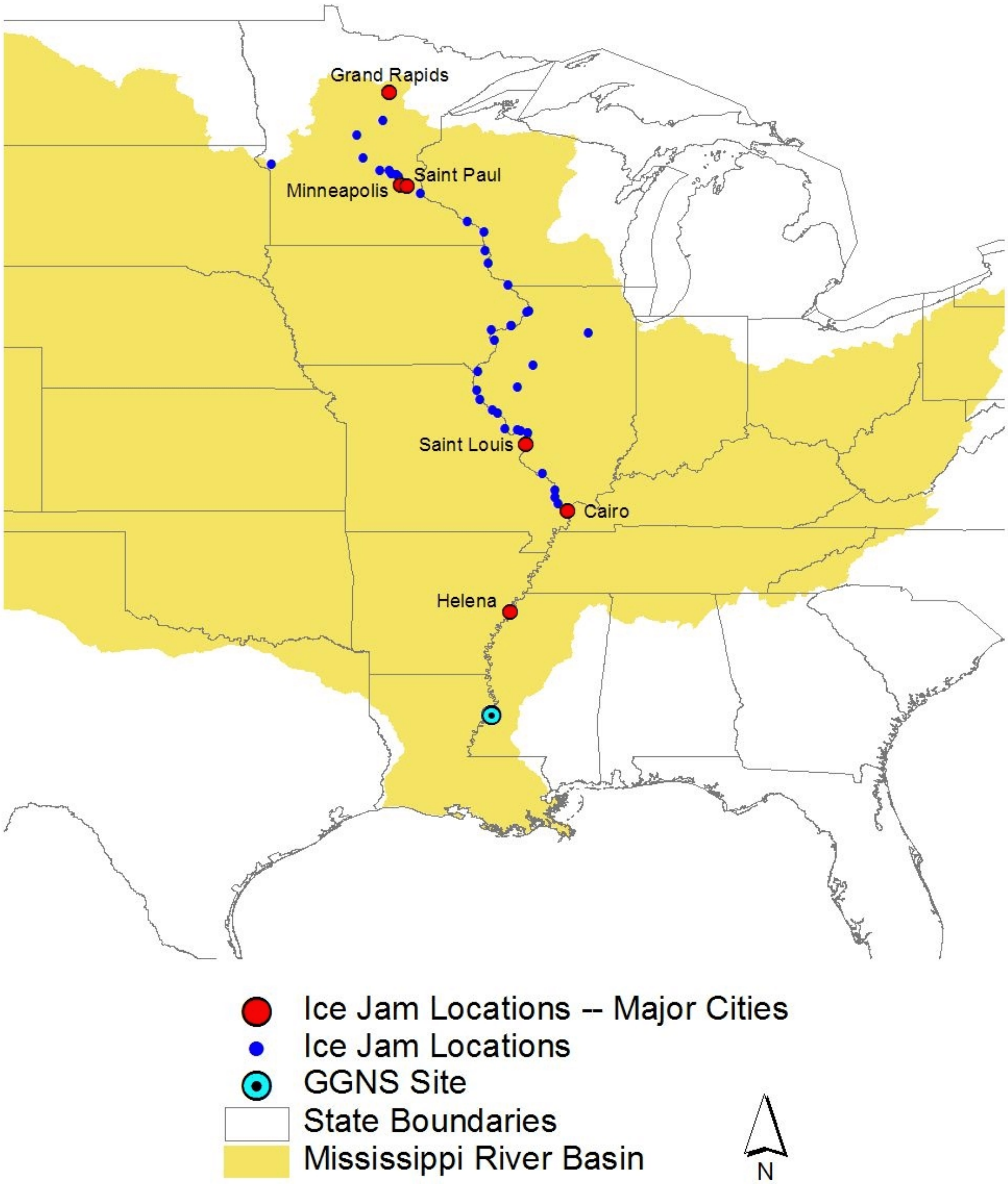


Figure 2.4-9 Locations of reported ice jams on the Mississippi River

The closest location of sustained ice jam on the Mississippi River is more than 250 river miles upstream of the GGNS site. Based on the staff review of the ice jam database, the likelihood of flooding resulting from an ice jam downstream of the GGNS site is considered remote. In addition, continued development of river control works for navigation, irrigation, and flood control on the Mississippi River and its principal tributaries would reduce the possibility of a sustained ice jam.

If an ice jam were to occur, and if ice-jam-induced high flows raise the water level to 103 feet above MSL at the GGNS site, it would result in the overtopping of the levees and diversion of water into the floodplain on the west bank of the Mississippi River. The staff determined that the ESP site, located on the upland area of the GGNS property at a plant grade of 132.5 feet above MSL, will be safe from any potential flooding resulting from ice jams.

In the event of low flow from ice blockage, safety-related facilities would not be adversely affected, as the UHS would provide a source of cooling and service water to maintain the plant in a safe mode.

Ice can produce forces on, or can create blockage of, safety-related equipment. Frazil and anchor ice can also form on components. In ER Section 3.4.1.3, SERI stated that the UHS for the ESP facility or facilities would include a dedicated water storage basin. Since the UHS for the ESP facility or facilities would have a dedicated water storage basin(s), the staff considered the effect of sustained low temperatures at the ESP site to evaluate the potential for freezing of the UHS water storage basin(s). DSER Permit Condition 2.4-5 is eliminated in Section 2.4.8.3 of this SER, which would have required that the COL applicant demonstrate that sufficient water will be available for a 30-day UHS supply, accounting for any losses resulting from ice formation in the dedicated water storage basin. However, based on the applicant’s response to open items, the staff determined that the detailed design of the ESP facility, including its UHS and dedicated water storage basin(s), will not be available until the COL stage. At that time, the NRC will review the complete design of the ESP facility UHS using existing regulations and regulatory guidance. The staff determined, therefore, that specification of DSER Permit Condition 2.4-5 is not necessary. The COL applicant should show that sufficient liquid water will be available for a 30-day ESP facility UHS supply, accounting for any losses resulting from ice formation in the dedicated water storage basin. This is COL Action Item 2.4-6 stated in Section 2.4.8.3 of this SER. In Section 2.3.1.1 of this SER, the staff discusses the resolution of the cooling parameter at the ESP site. The staff has identified a characteristic value of 98 °F degree days (i.e., 98 accumulated freezing degree days), based on daily minimum and maximum temperatures recorded at Port Gibson for the period 1930–2001.

2.4.7.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to ice effects. Therefore, the staff concludes that the applicant has met the requirements for ice effects with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c), and the application is in partial conformance with GDC 2 and 44, “Cooling Water.”

2.4.8 Cooling Water Canals and Reservoirs

The ESP site is located on the east bank of the Mississippi River near river mile 406. The applicant proposed the use of a mechanical draft cooling tower and a dedicated makeup water storage basin for the UHS for the ESP facility or facilities.

2.4.8.1 Technical Information in the Application

On page 2.4-18 of the SSAR, the applicant stated, "there are no current or proposed cooling water canals or reservoirs at the Grand Gulf Nuclear Station site." This quotation is the applicant's complete submission on this topic in SSAR Section 2.4.8. The staff gleaned the following additional information from the ER.

In ER Section 3.3, SERI stated, "the majority of raw water would be withdrawn from the Mississippi River via an intake structure on the river shoreline and other wells would be used." In the same section, the applicant also stated that raw water might be used for makeup water for a UHS cooling system.

In Section 3.3.1.3, SERI noted that it anticipated the UHS to be a closed-loop system with a water reservoir and mechanical draft cooling tower(s), and makeup water should replenish water losses because of evaporation, drift, and blowdown.

In ER Section 3.4.1.3, the applicant indicated that the UHS could be used for nonemergency operations. In this section, SERI also stated, "A closed-loop UHS for the new facility would be comprised of pumps, heat exchangers, a dedicated water basin, and cooling tower(s)."

2.4.8.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant's conformance to NRC regulatory guidance. The staff finds that the applicant correctly identified the applicable regulatory guidance.

The acceptance criteria for this section are based on meeting the requirements of 10 CFR Part 52 and 10 CFR Part 100 as they relate to identifying and evaluating the hydrologic features of the site.

Compliance with 10 CFR 52.17(a) and 10 CFR 100.20(c) requires that the NRC take into account the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear power reactor(s). To satisfy the hydrologic requirements of 10 CFR Part 52 and 10 CFR Part 100, the applicant's SSAR should describe the cooling water canals and reservoirs for a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. The analysis related to cooling water canals and reservoirs should be sufficient to evaluate the site's acceptability and to assess the potential for those characteristics to influence the design of SSCs important to safety for a nuclear power plant(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. Meeting this requirement provides reasonable assurance that the capacities of cooling water canals and reservoirs are adequate.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of parameters. Important PPE parameters for SSAR Section 2.4 include, but are not limited to, cooling needs (e.g., adverse local meteorological conditions, high ambient temperature).

Though not required at the ESP stage, the applicant for a COL must demonstrate compliance with GDC 2 as it relates to designing SSCs important to safety to withstand the effects of natural phenomena.

2.4.8.3 Technical Evaluation

The staff visually inspected the ESP site during the site safety analysis visit on June 29–30, 2004. No cooling water canals exist or are planned at the ESP site.

SERI proposed that the UHS for the ESP facility or facilities consist of a mechanical draft cooling tower(s) supplied by a dedicated water storage basin(s).

RG 1.27 specifies a UHS capable of providing sufficient cooling for 30 days to permit simultaneous safe shutdown and cooldown of all nuclear reactor units that it serves and to maintain them in a safe-shutdown condition. In addition, procedures for ensuring continued capability after 30 days should be available. In ER Section 3.4.1.3, the applicant stated that the UHS may be used for nonemergency operations, but it did not specify the frequency of such nonemergency UHS usage. The UHS storage basin could lose water because of leakage, evaporation, or ice formation.

The COL applicant must demonstrate the availability of a 30-day cooling water supply for the UHS, accounting for any losses including, but not limited to, those resulting from evaporation, seepage, icing, and a margin of safety. The staff intended to propose that the Commission include this requirement in the ESP, should it be granted. However, based on the applicant's response to open items, the staff determined that the detailed design of the ESP facility, including its UHS and dedicated water storage basin(s), will not be available until the COL stage. At that time, the NRC will review the complete design of the ESP facility UHS using existing regulations and regulatory guidance. The staff determined, therefore, that specification of DSER Permit Condition 2.4-5 is not necessary. The COL applicant should demonstrate that a 30-day cooling water supply for the ESP facility UHS will be available as liquid water in any dedicated water storage basin(s), accounting for any losses including, but not limited to, those resulting from evaporation, seepage, icing, and a margin of safety. This is **COL Action Item 2.4-6.**

The COL applicant must demonstrate that the UHS is not used frequently for nonemergency use. The staff intended to specify this requirement as DSER Permit Condition 2.4-6. However, based on the applicant's response to open items, the staff determined that the detailed design of the ESP facility, including its UHS and dedicated water storage basin(s), will not be available until the COL stage. At that time, the NRC will review the complete design of the ESP facility UHS and its performance, including the frequency of reliance of the ESP facility on its UHS, according to existing regulations and regulatory guidance. The staff determined, therefore, that specification of DSER Permit Condition 2.4-6 is not necessary. The COL applicant should demonstrate that the ESP facility UHS will not be used frequently for nonemergency operation of the ESP facility. This is **COL Action Item 2.4-7.**

2.4.8.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to cooling water canals and reservoirs. Therefore, the staff concludes that the applicant has met the requirements for cooling water canals and reservoirs with respect to Appendix A to 10 CFR Part 50, 10 CFR 52.17(a), and 10 CFR 100.20(c)(3).

2.4.9 Channel Diversions

The ESP site is located on the east bank of the Mississippi River near river mile 406, approximately 25 miles south of Vicksburg, Mississippi, and 6 miles northwest of Port Gibson, Mississippi. The ESP site is bounded on the east by loessial bluffs and on the west by the Mississippi River. The floodplain of the Mississippi River near the ESP site ranges in elevation from 55 to 75 feet above MSL. The existing GGNS Unit 1 power plant site has a grade elevation of 132.5 feet above MSL.

2.4.9.1 Technical Information in the Application

In SSAR Section 2.4.9, the applicant stated that USACE protects the banks of the Mississippi River in the Lower Mississippi region. Protection and stabilization methods include placing revetments composed of articulated concrete under water and stone riprap above the waterline. SERI stated that a revetment mattress is composed of 20 individual concrete blocks, each 4 feet long, 14 inches wide, and 3 inches thick, that are assembled into blocks 4 feet wide and 25 feet long. These blocks are fastened together to form mattresses 140 feet wide that are laid on the river bank in a pattern that resembles shingles on a roof. Usually, an entire bend is revetted from the upstream point of river current attack to the point where the channel crosses to the opposite bank.

The applicant stated that the Mississippi River has in the past experienced, and is currently undergoing, lateral shifting near the GGNS site, as indicated by the presence of oxbow lakes, sand bars, and low-lying swamps. The river divides into two branches around Middle Ground Island that rejoin at approximately river mile 408. SERI noted that USACE performed extensive work to stabilize the river, including construction of submerged dikes across the western channel to help divert flow through the eastern channel and construction of Grand Gulf revetments on the east bank from approximately river mile 400.5 to 407.9 and from river mile 408.2 to 410.0. During the 1960s and 1970s, USACE completed Grand Gulf revetments from river mile 400.5 to 405.0 and from river mile 408.5 to 409.6. The USACE left the rest of the bank between river miles 400.5 and 410.0 unprotected to undergo erosion until it attained acceptable alignment. The USACE then completed the revetment on the east bank down to river mile 410.0 during the mid-1970s and early 1980s, with a small gap at the existing GGNS barge slip.

The applicant stated that USACE does not have any plans to carry out additional revetment work near the GGNS site, except for occasional maintenance of existing structures. The USACE also evaluates the need for additional shoreline work, and SERI expects it to make improvements where appropriate.

In RAI 2.4.9-1, the NRC staff requested that the applicant provide copies of references related to geologic features or other characteristics that might preclude any likelihood of channel diversion upstream of the site. In response to RAI 2.4.9-1, SERI listed several references from the GGNS UFSAR and the GGNS ESP application.

2.4.9.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant's conformance to NRC regulatory guidance. The staff finds that the applicant correctly identified the applicable regulatory guidance.

The staff used the review guidance provided in RS-002, Section 2.4.9, to evaluate this SSAR section. The acceptance criteria for this section relate to 10 CFR Part 52 and 10 CFR Part 100, insofar as they require that the site evaluation consider hydrologic characteristics. The regulations at 10 CFR 52.17(a), 10 CFR 100.20(c), and 10 CFR 100.21(d) require that the NRC take into account the physical characteristics of the site (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear unit(s).

Channel diversion or realignment poses the potential for flooding or for an adverse effect on the supply of cooling water for a nuclear unit(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site. Therefore, it is one physical characteristic that must be evaluated pursuant to 10 CFR 100.21(d). The consideration of the 10 CFR 100.21(d) criteria in this evaluation provides reasonable assurance that the effects of flooding caused by channel diversion resulting from severe natural phenomena will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters.

To judge whether the applicant has met the requirements of 10 CFR Part 52 and 10 CFR Part 100 as they relate to channel diversion, the NRC uses the following criteria:

- A description of the applicability (potential adverse effects) of stream channel diversions is necessary.

- Historical diversions and realignments should be discussed.

- The topography and geology of the basin and its applicability to natural stream channel diversions should be addressed.

- If applicable, the safety consequences of diversion and the potential for high or low water levels caused by upstream or downstream diversion to adversely affect safety-related facilities, water supply, or the UHS should be addressed. RG 1.27 provides guidance on acceptable UHS criteria.

2.4.9.3 Technical Evaluation

During its independent review, the staff found on the Web site of the USACE, Vicksburg District, River Operations Branch (ROB) that it—

> …is responsible for channel improvement, dredging, and navigation activities on the lower Mississippi, Red, Ouachita/Black, and Pearl rivers. This work is accomplished by utilizing specialized floating plant, dustpan and cutterhead dredges, towboats, survey boats, and various other river-related equipment. The scope of work encompasses four Corps of Engineers districts, seven states, multiple watersheds, and utilizes the latest technology in river engineering and operations.

The ROB defines a revetment as a "facing (such as of stone or concrete) to sustain an embankment." Every autumn, the ROB mat sinking unit, which comprises some 400 employees, begins several months of work on the river for establishing locations that need bank stabilization. Traditionally, the unit carries out this work during the low-water months of August through November.

The staff found that USACE, Vicksburg District, provided the location of the dikes constructed on the Mississippi River, along with their elevations, in Navigation Bulletin No. 1, "Special Notice: Mississippi River," issued 2004. The USACE constructs these pile and stone dikes in reaches where it is difficult to maintain a navigable channel. The USACE expects that the dikes will reduce flow in secondary channels, thus restricting the width of reaches and helping to maintain good navigation conditions.

The staff found that USACE constructed the dikes at frequent intervals on the Mississippi River channel along the Grand Gulf revetment from approximately river mile 410 to river mile 399 (sheets 26 and 27 in Navigation Bulletin No. 1). Three groups of dikes, named Yukatan, Coffee Point, and Below Grand Gulf Dike Fields, extend from river mile 410.4 to 407.4, river mile 405.0 to 401.8, and river mile 400.3 to 399.0, respectively. The Yucatan and Coffee Point dike groups are on the western part of the channel as the river bends right, flowing past the Grand Gulf Revetment on the east bank. The Below Grand Gulf dikes group is located on the eastern part of the channel as the river bends left, flowing past the Hardscrabble Revetment on the west bank.

Based on its independent review, the staff found that SERI adequately described the issues relating to channel diversions near the ESP site. The Lower Mississippi River is heavily navigated, and USACE, Vicksburg District, is responsible for maintaining navigable conditions. As part of this responsibility, USACE actively maintains revetments and dikes that are constructed to minimize risk of channel diversions, bank erosion, and instability.

2.4.9.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to channel diversions. Therefore, the staff concludes that the applicant has met the requirements for channel diversions with respect to Appendix A to 10 CFR Part 50, 10 CFR 52.17(a), and 10 CFR 100.20(c)(3).

2.4.10 Flooding Protection Requirements

The ESP site is located at approximately 32° N latitude and 91°3' W longitude. The ESP site is located at approximately river mile 406 on the east bank of Mississippi River, about 25 miles south of Vicksburg, Mississippi. GGNS Unit 1 is located at a grade elevation of 132.5 feet above MSL.

Two small, steep streams flow around the ESP site, draining a combined area of less than 4 mi^2, and into Lake Hamilton, located in the floodplain of the Mississippi River. The ESP site drains partially to both streams.

The ESP site is subject to flooding in the Mississippi River, flooding in the two small streams that flow around the ESP site, and local flooding in response to intense precipitation.

2.4.10.1 Technical Information in the Application

In Table 2.4-14 of the SSAR, SERI estimated the design-basis flood elevation in the Mississippi River near the GGNS site as 108.8 feet above MSL. This flood elevation includes flooding caused by the PMF, wind setup, and wave runup. In SSAR Section 2.4.10, the applicant stated that, since it has not selected a specific design for the ESP plant, no final plant grade has been determined. In this section, SERI also stated that all safety-related SSCs of the ESP facility or facilities will be located at or above the site grade elevation of 133 feet above MSL or protected from flooding such that the site would meet the requirements of GDC 2 and 10 CFR Part 100.

2.4.10.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant’s conformance to NRC regulatory guidance. The staff finds that the applicant correctly identified the applicable regulatory guidance. Acceptance criteria for this section relate to 10 CFR Part 52 and 10 CFR Part 100, insofar as they require that the site evaluation consider hydrologic characteristics. Specifically, the regulations at 10 CFR 52.17(a) and 10 CFR 100.20(c) require that the NRC take into account the physical characteristics of the site (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear unit(s).

The regulation at 10 CFR 100.20(c) requires estimation of the PMF using historical data. Meeting this requirement provides reasonable assurance that the effects of flooding or a loss of flooding protection resulting from severe natural phenomena will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters.

To judge whether the applicant has met the requirements of 10 CFR Part 52 and 10 CFR Part 100 as they relate to flooding protection, the NRC uses the following criteria:

- The applicability (potential adverse effects) of a loss of flooding protection should be described.

- Historical incidents of shore erosion and flooding damage should be discussed.

- The topography and geology of the basin and its applicability to damage as a result of flooding should be addressed.

- If applicable, the safety consequences of a loss of flooding protection and the potential to adversely affect safety-related facilities, water supply, or the UHS should be addressed. RG 1.27 provides guidance on acceptable UHS criteria.

2.4.10.3 Technical Evaluation

The staff determined that the ESP site is subject to flooding in the Mississippi River as a result of PMP on the river's contributing area and coincident wind activity, flooding in the Mississippi River resulting from seismically induced upstream dam failures, flooding in the Mississippi River resulting from ice-jam-induced high flows, flooding in the local Streams A and B as a result of PMP on their respective contributing areas, and flooding on the ESP site caused by local intense precipitation.

In DSER Section 2.4.3.3, the staff determined that flooding in the Mississippi River because of a PMF and coincident wind activity will not result in inundation of the ESP site. The staff also noted in DSER Section 2.4.4.3 that seismically induced dam failures will not result in flooding of the ESP site. In DSER Section 2.4.7.3, the staff stated that ice jams on the Mississippi River are not likely to form sufficiently close to the GGNS site and that any high flows resulting from the breaking of such ice jams will not impact the safety of the ESP site.

The staff determined that local intense precipitation controls flooding in Streams A and B and on the ESP site. The applicant used HMR 33 and USACE EM-1110-2-1411 to estimate local intense precipitation at the ESP site. The applicant claimed that hourly rainfall rates derived from the more recent HMR 53 show only a 2-percent increase over the values determined using HMR 33. The staff stated that local intense precipitation obtained using the guidelines of HMR 52 shows a 37- and a 40-percent increase to 1-hour and 30-minute precipitation depths, respectively, compared to those reported by the applicant. This was Open Item 2.4-5, stated in Section 2.4.2.3 of this SER. Subsequent response from the applicant resolved Open Item 2.4-5, as documented in Section 2.4.2.3 of this SER.

As stated in Section 2.4.2.3 of this SER, the COL applicant must demonstrate that the ESP plant grade is safe from the flooding effects of maximum water surface elevation during local intense precipitation without relying on any active surface drainage systems that may be blocked during this event. This is COL Action Item 2.4-5, as stated in Section 2.4.2.3 of this SER.

2.4.10.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to flood protection requirements. Therefore, the staff concludes that the applicant has met the requirements for flood protection with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c)(3), subject to the open items. The staff finds that the application is in partial conformance with GDC 2 for flood protection.

2.4.11 Low-Water Considerations

The ESP site is adjacent to the Mississippi River floodplain, from which ground water is withdrawn for cooling the existing GGNS Unit 1, and is located approximately at river mile 406. Water withdrawn directly from the river will supply the proposed ESP facility or facilities for normal heat sink cooling. Events such as low-river stage and intake blockages from sediment or ice may potentially reduce or limit the availability of cooling water at the site. Makeup water from a dedicated basin will supply the proposed ESP facility or facilities for UHS cooling.

2.4.11.1 Technical Information in the Application

In SSAR Section 2.4.2 and SSAR Figure 2.4-4, the applicant stated that the Lower Mississippi derives its water from six major subbasins, including Upper Mississippi, Missouri, Ohio, Arkansas, White, and Red-Ouachita. SERI concluded that low-flow conditions in the Mississippi River are a function of the nature of flow in the individual subbasins. Table 2.4-1 of the SSAR shows the percentage contribution to mean streamflow in the Lower Mississippi from these individual subbasins. The applicant stated that hydrometeorologic conditions in the basin vary greatly, and although it is difficult to predict low streamflow values in the Lower Mississippi, an analysis may be made on the basis of statistical considerations. SERI noted that no dams on the Mississippi River downstream of the site could affect the low streamflow condition near the GGNS site.

The applicant studied low-water conditions near the GGNS site on the basis of streamflow records at the Vicksburg Gauging Station. Table 2.4-17 of the SSAR presents the annual minimum daily streamflow observed at Vicksburg, Mississippi, for water years 1932–1979; this table also includes corresponding river stages. The minimum streamflow observed during the period of record was 99,400 cfs on November 1, 1940. SERI concluded that the corresponding historical low-flow elevation at the site was approximately 28 feet above MSL, and the mean 30-day low flow was 108,000 cfs, also measured in 1940.

The applicant also referred to a USACE data source for low streamflow in the Mississippi River at Vicksburg. SERI stated that, according to this data source, the lowest daily streamflow for the period 1930–2000 was 93,800 cfs, recorded on August 31, 1936.

Table 2.4-19 of the SSAR provides the 1-, 7-, and 30-day low streamflow for different recurrence intervals, based on the historic streamflow data for the period 1933–1979 at the Vicksburg Gauging Station obtained from USGS. Figure 2.4-32 of the SSAR plots the recurrence interval for low flows of the Mississippi River at Vicksburg.

The applicant cited information provided by USACE to establish the low-water reference plane for river mile 406 at 37.5 feet above MSL. SERI stated that the low-water reference plane was based on the average stage from 1982–1991, representing the discharge equaled or exceeded 97 percent of the time.

The applicant proposed that an intake located on the east bank of the Mississippi River, on the north side of the existing barge slip, supply the makeup and service water for the ESP facility or facilities. The ESP facility or facilities would require a maximum makeup flow rate of approximately 85,000 gpm of water, equivalent to about 190 cfs. SERI estimated that the maximum expected withdrawal for the ESP facility or facilities would be approximately

0.2 percent of the minimum historical streamflow in the Mississippi River near the GGNS site. The applicant noted that design details of the intake would consider the minimum water surface elevation in the river to determine the location of inlet screens.

SERI stated that continued development of upstream reservoirs for such purposes as flood control, navigation, irrigation, low-flow augmentation, and hydroelectric power will alter streamflow characteristics of the Lower Mississippi River, resulting in an increase of low streamflow and a decrease in the periods of high streamflow.

The applicant noted that, in the event of an emergency shutdown of the reactor or reactors of the ESP facility, while the makeup water system was not in service, dedicated basins would provide the emergency service water for the UHS for the ESP facility or facilities. SERI indicated that the UHS dedicated basins for the ESP facility or facilities would not rely on river intake for makeup water during emergency operations. Therefore, the applicant concluded that low-water conditions would not affect the UHS for the ESP facility or facilities.

In RAI 2.4.11-1, the staff requested that the applicant describe the potential effect of ice jams upstream from the site on low-water conditions at the site. In SSAR Section 2.4.11, SERI stated that a minimum stage of 39.2 feet above MSL occurred on February 3, 1940, when ice jams reduced the river discharge. The staff asked the applicant to provide its source of the river stage data. In response to this RAI, SERI stated that ice jams upstream of the GGNS site could result in low-water conditions. The applicant noted that reduction in discharge in the Mississippi River near the GGNS site because of upstream ice jams is expected to be an infrequent occurrence. The low-water plane for the river near the GGNS site is 37.5 feet above MSL, based on the average water surface elevation in the river from 1982–1991, and represents a discharge equaled or exceeded 97 percent of the time. The applicant concluded that the proposed intake structure would not be affected by low-water conditions.

2.4.11.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant’s conformance to NRC regulatory guidance. The staff finds that the applicant correctly identified the applicable regulatory guidance.

The acceptance criteria for this section relate to the following regulations:

- 10 CFR Part 52 and 10 CFR Part 100 require that hydrologic characteristics be considered in the site evaluation.

- 10 CFR 100.23 requires that siting factors to be evaluated must include the cooling water supply.

The regulations at 10 CFR Part 52 and 10 CFR Part 100 require that the evaluation of a nuclear power plant site consider the hydrologic characteristics. To satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100, the applicant’s SSAR should describe the surface and subsurface hydrologic characteristics of the site and region. In particular, the UHS for the cooling water system may consist of water sources that could be affected by the site’s hydrologic characteristics that may reduce or limit the available supply of cooling water for safety-related SSCs, such as those resulting from river blockage or diversion, tsunami runup and drawdown, and dam failure.

Meeting the requirements of 10 CFR Part 52 and 10 CFR Part 100 provides reasonable assurance that severe hydrologic phenomena, including low-water conditions, will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters.

As required by 10 CFR 100.23, siting factors, including cooling water supply, must be evaluated for a nuclear unit. The evaluation of the emergency cooling water supply for a nuclear power plant(s) of a specified type (or falling within a PPE) that might be constructed on the proposed site should consider river blockages, diversions, or other failures that may inhibit the flow of cooling water, tsunami runup and drawdown, and dam failures.

The regulation at 10 CFR 100.23 applies to this section because the UHS for the cooling water system consists of water sources that are subject to natural events that may reduce or limit the available supply of cooling water (i.e., the heat sink). Natural events such as river blockages, diversions, or other failures that may inhibit the flow of cooling water, tsunami runup and drawdown, and dam failures should be conservatively estimated to assess the potential for these characteristics to influence the design of those SSCs important to safety for a nuclear unit(s) of a type specified by the applicant (or falling within a PPE) that might be constructed on the proposed site. The available water supply should be sufficient to meet the needs of the unit(s) to be located at the site; those needs may fall within a PPE (e.g., the stored water volume of the cooling water ponds), if an applicant uses that approach. Specifically, those needs include the maximum design essential cooling water flow, as well as the maximum design flow for normal plant needs at power and at shutdown.

The specific criteria discussed in the paragraphs below assess the applicant’s ability to meet the requirements of the hydrologic aspects of the above regulations. Acceptance is based primarily on the adequacy of the UHS to supply cooling water for normal operation, anticipated operational occurrences, safe shutdown, cooldown (first 30 days), and long-term cooling (periods in excess of 30 days) during adverse natural conditions.

<u>Low Flow in Rivers and Streams</u>

For essential water supplies, the low-flow/low-level design for the primary water supply source is based on the probable minimum low flow and low level resulting from the most severe drought that can reasonably be considered for the region. The low-flow/low-level site parameters for operation should not allow shutdowns caused by inadequate water supply to trigger the frequent use of emergency systems.

<u>Low Water Resulting from Surges, Seiches, or Tsunami</u>

For coastal sites, the applicant should postulate the appropriate PMH wind fields at the ESP stage to estimate the maximum winds blowing offshore, thus creating a probable minimum surge level. Low-water levels on inland ponds, lakes, and rivers caused by surges should be estimated based on the probable maximum winds oriented away from the plant site. The same general analysis methods discussed in Sections 2.4.3, 2.4.5, and 2.4.6 of RS-002 apply to low-water estimates resulting from the various phenomena discussed. If the site is susceptible to such phenomena, minimum water levels resulting from setdown (sometimes called runout or rundown) from hurricane surges, seiches, and tsunamis should be verified at the COL or CP stage to be higher than the intake design basis for essential water supplies.

Historical Low Water

If historical flows and levels are used to estimate design values by inference from frequency distribution plots, the data used should be presented to allow for an independent determination. The data and methods of NOAA, USGS, SCS, USBR, and USACE are acceptable.

Future Controls

This section is acceptable if water use and discharge limitations (both physical and legal), which are already in effect or under discussion by the responsible Federal, State, regional, or local authorities and which may affect the water supply for a nuclear unit(s) of a type specified by the applicant (or falling within a PPE) that might be constructed on the proposed site, have been considered and are substantiated by reference to reports of the appropriate agencies. The design basis should identify and take into account the most adverse possible effects of these controls to ensure that essential water supplies are not likely to be negatively affected in the future.

2.4.11.3 Technical Evaluation

During its independent review, the staff found that six major subbasins contribute water to the Lower Mississippi, including the Upper Mississippi, Missouri, Ohio, Arkansas, White, and Red-Ouachita. On January 4, 2005, the staff verified drainage areas of these subbasins using the USGS Web site, "National Stream Water Quality Accounting Network." Low flow conditions in the Lower Mississippi depend on streamflow conditions in these individual subbasins. On January 4, 2005, the staff used the USACE "National Inventory of Dams" database to determine that no dams exist on the Mississippi River downstream of the GGNS site, the failure of which may lead to low-flow conditions at the GGNS site.

The Vicksburg Gauging Station, located at river mile 435.7, is the closest upstream station from the GGNS site. The staff determined that no major tributaries exist (except the relatively small Bayou Pierre and Big Black River) that join with the Mississippi, and no major river withdrawals exist between Vicksburg and the GGNS site. The staff also reviewed streamflow at Natchez, located at river mile 363.3, the next streamflow station downstream from the GGNS site, confirming that the river flow at Natchez closely correlates to that at Vicksburg. Since the GGNS site is located between these two gauging stations, the staff concluded that the discharge at the GGNS site closely correlates to that at Vicksburg.

Using the USGS "National Water Information System," the staff reviewed low-water conditions based on daily streamflow records at the Vicksburg Gauging Station. Figure 2.4-10 shows the minimum daily streamflow observed at Vicksburg, Mississippi, during water years 1932–1998 as 100,000 cfs on November 1, 1939. Apparently, the applicant mistyped the date for this same streamflow as November 1, 1940, in the ESP application. According to the USACE report, "Stages and Discharges of the Mississippi River and Tributaries in the Vicksburg District, Annual Report of the District Engineers," issued 1990, a streamflow of 93,800 cfs was observed on August 31, 1936.

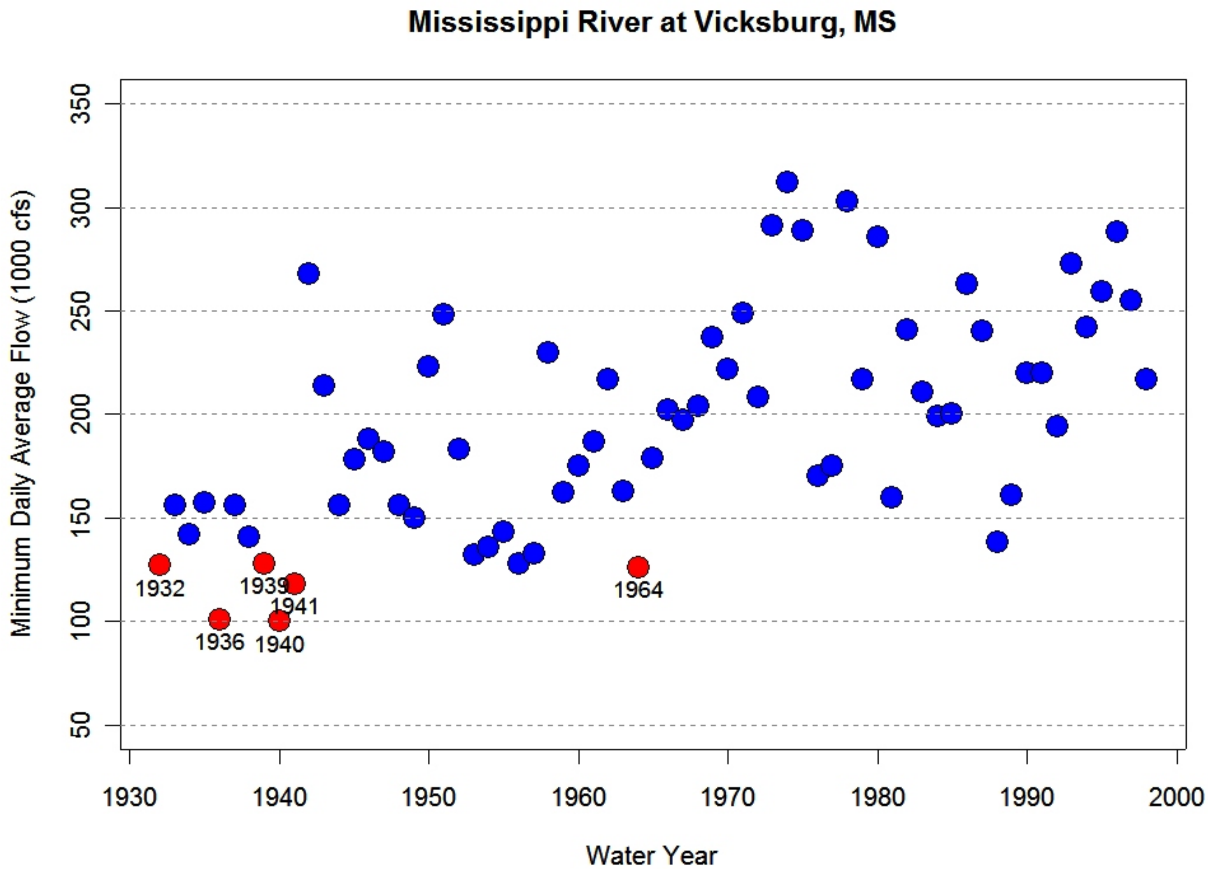


Figure 2.4-10 Minimum daily average streamflow in the USGS record for all water years 1932–1998 at Vicksburg, Mississippi. Red circles with years show six lowest historical values.

The staff obtained a copy of an email communication from SERI, in which USACE stated that the low-water reference plane for river mile 406 is 37.5 feet above MSL.

In SSAR Section 2.4.11.2, SERI stated that the historical low-flow elevation near the GGNS site is approximately 28 feet above MSL, but it did not explain how it estimated the elevation. Using the 1990 USACE report, the staff found that the historical minimum water surface elevation measured at the Vicksburg Gauging Station is 39.23 feet above MSL. The staff estimated the water surface elevation near the GGNS site using measured water surface elevations at Vicksburg and Natchez, which are the closest upstream and downstream gauges from the GGNS site, respectively. The staff used the river stage data provided by USACE to find a period in this record when the water surface elevations at the two gauging stations were fairly steady. The staff assumed that the water surface elevation from Vicksburg to Natchez decreases linearly and estimated the water surface elevation near the GGNS site. The staff-estimated water surface elevation near the GGNS site is 28.4 feet above MSL, corresponding to the historical low-water surface elevation observed at Vicksburg.

In ER Figure 5.3-2, SERI indicated that the ESP intake screens are expected to be located at an elevation of 23.5 feet above MSL, which is 4.9 feet below the staff-estimated minimum water surface elevation near the GGNS site and 14 feet below the USACE low-water reference plane.

Section 2.4.7 of this SER reviewed the USACE historical database of ice jams on the Mississippi River. In the event that ice jams would result in low water elevations in the Mississippi River near the GGNS site, the dedicated ESP UHS basins, which do not rely on the river intake for makeup cooling water, would supply makeup cooling water for emergency shutdown of the ESP reactor(s). The staff concluded that low water elevations resulting from ice jams or other causes would not adversely affect safety of the ESP facility or facilities.

In ER Section 3.4.1.3, SERI noted that the UHS for the ESP facility or facilities would include a dedicated water storage basin. As stated by COL Action Item 2.4-6 in Section 2.4.8.3 of this SER, the COL applicant must demonstrate that sufficient water will be available for a 30-day UHS supply accounting for any losses from the dedicated water storage basin.

2.4.11.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to low-water considerations. Therefore, the staff concludes that the applicant has met the requirements for low-water considerations with respect to 10 CFR 52.17(a), 10 CFR 100.20(c), GDC 2, and GDC 44.

2.4.12 Ground Water

The ESP site is located within the Mississippi Alluvial Plain Section of the Coastal Plain Physiographic Province. Aquifers at the site include the (1) Holocene alluvium in lowlands near the Mississippi River, (2) Pleistocene Upland Complex deposits beneath loess surface strata in the uplands, and (3) Miocene Catahoula Formation that underlies both the upland and lowland aquifers.

2.4.12.1 Technical Information in the Application

In SSAR Section 2.4.12, the applicant described regional and site hydrogeology and ground water conditions. SERI generally used the GGNS UFSAR to derive the information presented in the SSAR, including the subsurface site characterization performed for the two previously proposed GGNS units, as well as the ongoing monitoring for the constructed GGNS Unit 1. The applicant obtained an additional three borings as part of its pre-ESP application activities; these borings further confirmed the site hydrogeologic conceptual model presented in the UFSAR.

The following summarizes the applicant's description of the principal sources of ground water for both the region and the ESP site, composed of the Holocene Mississippi River alluvium, Pleistocene terrace deposits, and Miocene series, primarily the Catahoula Formation:

- The Mississippi River alluvium occurs in the lowland section of the ESP site to the east of the bluffs and consists of a surficial layer of clay and silt overlying lenses of sand, gravel, silt, and clay. Alluvium thickness at the ESP site ranges from 95 to 182 feet. Recharge to the alluvium occurs from infiltrating precipitation and westward ground water flow from the terrace deposits. Published values of hydraulic conductivity in the alluvium range from 200 to 400 feet/day.

- At the ESP site, the terrace deposits, which occur east of the bluffs, are overlain with 22 to 82 feet of loess. The terrace deposits, which overlay the Catahoula formation, are up to 150 feet thick. The lithology of the terrace deposits is similar to the Holocene alluvium. Recharge to the terrace deposits occurs via percolation through the overlying loess. Hydraulic conductivities for the terrace deposits range from 0.7 to 800 feet/day.

- The Miocene Catahoula Formation is continuous across the entire ESP site and consists of lenticular deposits of sand, clayey silt, and sandy-silty clay. Sand layers are predominately fine grained and range in thickness from a few inches to more than 100 feet. Recharge to the Catahoula Formation occurs from overlying alluvium and terrace deposits. Permeable zones within the Catahoula Formation are the sources of water for the majority of public and private wells in Claiborne County. Published values for five test locations in Claiborne County report hydraulic conductivity values ranging from 13 to 120 feet/day.

The applicant reported that the two routinely used wells operate near full capacity during refueling outages, and additional ground water supply wells would be required for both construction and operational needs of the ESP facility or facilities. The applicant estimated that the maximum consumption of ground water for potable, sanitary, fire protection, demineralized water, and landscape maintenance use would not exceed 3570 gpm. This operational water requirement exceeded the applicant’s estimate of water demands during construction.

The GGNS facility obtains makeup and service water from a series of Ranney wells located adjacent to the Mississippi River with laterals extending out under the Mississippi River. While these wells extract a very large volume of ground water, mostly Mississippi River water is induced to flow downward through the riverbed, and therefore the wells have a relatively localized impact on ground water elevation.

Based on population projections, the applicant estimated that the ground water withdrawal within a 2-mile radius of the plant by the year 2070 will be only 2610 gallons per day (gpd). Therefore, the ground water demand for the GGNS and the ESP facility or facilities is projected to dominate the water use in the immediate vicinity of the ESP site for many years.

Ground water at the ESP site generally moves from east to west towards the Mississippi River. Perched aquifers have been identified in the area of the proposed ESP power block. SERI provided data from peizometer measurements.

The SSAR did not provide specific coordinates (including elevation) for the bounding areas of all safety-related structures and aquifers, including perched aquifers. In RAI 2.4.1-1, the staff asked the applicant to provide these locations and elevations. The SSAR did not contain sufficient specific information of the local subsurface environment in the vicinity of the proposed ESP facility or facilities to help the staff understand all the ground water pathways. In RAI 2.4.12-1, the staff requested SERI to further describe the local subsurface environment. The applicant’s response to this RAI will help the staff in its independent estimation of ground water flowpaths and water table elevations.

2.4.12.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant's conformance to NRC regulatory guidance. The staff finds that the applicant correctly identified the applicable regulatory guidance. The acceptance criteria for this section relate to the following regulations:

- 10 CFR Part 52 and 10 CFR Part 100 require that hydrologic characteristics be considered in the site evaluation.
- 10 CFR 100.23 sets forth the criteria to determine the suitability of design bases for a nuclear unit(s) of specified type (or falling within a PPE) that might be constructed on the proposed site with respect to its seismic characteristics. This section also requires applicants to ensure the adequacy of the cooling water supply for emergency and long-term shutdown decay heat removal, taking into account information concerning the physical, including hydrological, properties of the materials underlying the site.

As specified in 10 CFR 100.20(c), the NRC must consider the site's physical characteristics (including seismology, meteorology, geology, and hydrology) when determining its acceptability to host a nuclear unit(s).

The regulation at 10 CFR 100.20(c)(3) requires that the NRC address factors important to hydrologic radionuclide transport using onsite characteristics. To satisfy the hydrologic requirements of 10 CFR Part 100, the NRC review of the applicant's SSAR should verify the description of ground water conditions at the proposed site and of the effect on those conditions of the construction and operation of a nuclear unit(s) of specified type that might be constructed on the site. Meeting this requirement provides reasonable assurance that the release of radioactive effluents from a unit(s) of specified type that might be constructed on the proposed site will not significantly affect the ground water at or near the site.

The regulation at 10 CFR 100.23 requires that the evaluation consider geologic and seismic factors when determining the suitability of the site and the acceptability of the design for each nuclear power plant. In particular, 10 CFR 100.23(d)(4) requires consideration of the physical properties of materials underlying the site when designing a system to supply cooling water for emergency and long-term shutdown decay heat removal. The regulation at 10 CFR 100.23 applies to RS-002, Section 2.4.12, because it addresses requirements for investigating vibratory ground motion, including the hydrologic conditions at and near the site. Static and dynamic engineering properties of the materials underlying the site should be determined, including the properties (e.g., density, water content, porosity, and strength) needed to determine the behavior of those materials in transmitting earthquake-induced motions to the foundations of a unit(s) of specified type (or falling within a PPE) that might be constructed on the site.

Meeting this requirement provides reasonable assurance that the effects of a safe-shutdown earthquake (SSE) will pose no undue risk to the type of facility proposed for the site.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters. Important PPE parameters for SSAR Section 2.4 include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

Though not required at the ESP stage, the applicant for a COL must demonstrate compliance with GDC 2 as it relates to designing SSCs important to safety to withstand the effects of natural phenomena.

To judge whether the applicant has met the requirements of the hydrologic aspects of 10 CFR Part 52 and 10 CFR Part 100, the NRC uses the following criteria:

- Section 2.4.12.1 of the SSAR must provide a full, documented description of regional and local ground water aquifers, sources, and sinks. In addition, the type of ground water use, wells, pump, storage facilities, and the flow needed for a nuclear unit(s) of specified type (or falling within a PPE) that might be constructed on the site should be described. If ground water is to be used as an essential source of water for safety-related equipment, the design basis for protection from natural and accident phenomena should compare with RG 1.27 guidelines. Bases and sources of data should be adequately described and referenced.

- Section 2.4.12.2 of the SSAR should provide a description of present and projected local and regional ground water use. Existing uses, including amounts, water levels, location, drawdown, and source aquifers, should be discussed and tabulated. Flow directions, gradients, velocities, water levels, and effects of potential future use on these parameters, including any possibility for reversing the direction of ground water flow, should be indicated. Any potential ground water recharge area within the influence of a nuclear unit(s) of specified type (or falling within a PPE) that might be constructed on the site, as well as the effects of construction, including dewatering, should be identified. The influence of existing and potential future wells with respect to ground water beneath the site should also be discussed. Bases and sources of data should be described and referenced. RS-002 discusses certain studies concerning ground water flow problems.

- Section 2.4.12.3 of the SSAR must discuss the need for and extent of procedures and measures, including monitoring programs, to protect present and projected ground water users. These items are site specific and will vary with each application.

To judge whether the applicant has met the requirements of 10 CFR Part 50; 10 CFR 50.55, “Conditions of Construction Permits”; 10 CFR 50.55a; GDC 2; GDC 4, “Environmental and Dynamic Effects Design Bases”; GDC 5, “Sharing of Structures, Systems, and Components”; and 10 CFR Part 100 as they relate to the COL stage, the NRC uses the following criteria:

- SSAR Section 2.4.12.4 should describe the design bases (and development thereof) for ground water-induced loadings on subsurface portions of safety-related SSCs at the COL stage. If a permanent dewatering system is employed to lower design-basis ground water levels, the bases for the design of the system and determination of the design basis for ground water levels should be provided. Information should be provided regarding the following:

— all structures, components, and features of the system

— the reliability of the system as related to available performance data for similar systems used at other locations

— the various soil parameters (such as permeability, porosity, and specific yield) used in the design of the system

— the bases for determination of ground water flow rates and areas of influence to be expected

— the bases for determination of time available to mitigate the consequences of system failure where system failure could cause design bases to be exceeded

— the effects of malfunctions or failures (such as a single failure of a critical active component or failure of circulating water system piping) on system capacity and subsequent ground water levels

— a description of the proposed ground water level monitoring program and outlet flow monitoring program

In addition, if wells are proposed for safety-related purposes, the hydrodynamic design bases (and development thereof) for protection against seismically induced pressure waves should be described and should be consistent with site characteristics.

2.4.12.3 Technical Evaluation

Based on a review of the USGS "Ground Water Atlas of the United States," the staff determined that the applicant's description of regional hydrogeologic conditions is adequate. The following summarizes the staff's independent findings:

- The GGNS and ESP sites are both located within the Mississippi Alluvial Plain Section of the Coastal Plain Physiographic Province. Several important aquifer systems are in the vicinity of the proposed site, including the Mississippi River Valley Alluvial Aquifer system, Coastal Lowlands Aquifer system, and the Mississippi Embayment Aquifer system. The proposed ESP site is south of the southern extent of the Mississippi River Valley Alluvial Aquifer system. However, the site is within the very northern extent of the Coastal Lowlands Aquifer system and is located near the center of the Mississippi Embayment Aquifer system.

- The Coastal Lowlands Aquifer System consists of a gulfward-thickening, heterogeneous, unconsolidated to poorly consolidated wedge of discontinuous beds of sand, silt, and clay that range in age from Oligocene to Holocene. The Mississippi Embayment Aquifer system is located beneath the Coastal Lowlands Aquifer system. At the ESP site, the Mississippi Embayment Aquifer system consists of several aquifers ranging in age from Late Cretaceous to Middle Eocene with a combined thickness of over 5000 feet.
- The bluffs at the ESP site delineate a change in the upper stratigraphy. The upland plain, located to the east of the bluffs, is a Pleistocene terrace rising to an elevation of about 150 feet above MSL. The surface layer of the upper plain consists of

approximately 75-foot-thick loess overlaying about 40-foot-thick coarse-grained alluvial sand and gravel deposits of the Upland Complex. The lowland, located to the west of the bluffs at an elevation of about 70 feet above MSL, consists of a layer of Holocene alluvium over 100 feet in thickness, including backswamp areas and meander belts of the Mississippi River. The Catahoula Formation underlies both the terrace deposits in the uplands and the alluvium in the lowlands. The proposed ESP plant would be located in the uplands portion of the ESP site.

The staff determined that the SSAR adequately describes onsite and offsite ground water use. The applicant proposed that ground water use will be less than 3570 gpm. The staff determined that, for a ground water well system, the applicant-stated maximum withdrawal capacity of 3570 gpm is large and may require installation of a network of several wells at the ESP site. The COL applicant must demonstrate that an adequately designed well system capable of withdrawing 3570 gpm is provided for the ESP facility or facilities. The staff intended to propose that the Commission include this requirement in the ESP, should it be granted. However, based on the applicant’s response to open items, the staff determined that the detailed design of the ESP facility, including the design of a well system to provide ground water for potable, sanitary, fire protection, demineralized water, and landscape maintenance, will not be available until the COL stage. At that time the NRC will review the complete ESP facility design, including the ground water well system, according to existing regulations and regulatory guidance. The staff determined, therefore, that it is not necessary to specify DSER Permit Condition 2.4-7. The COL applicant should demonstrate that an adequately designed ground water well system capable of withdrawing a maximum of 3570 gpm is provided for the ESP facility. This is **COL Action Item 2.4-8.**

Prior construction for the GGNS facility has changed, and future construction for the ESP facility or facilities will further alter, the subsurface environment. The current subsurface environment will be altered with the replacement of existing soils with fill and cement. These changes and any dewatering systems will alter the local ground water flow patterns and water table elevations. The staff requested in RAI 2.4.1-1 that SERI define the extent of the region (including elevation) of the ESP facility or facilities and the location of any aquifers, including perched aquifers. While the applicant submitted the coordinates of the areal extent of the facility, it did not provide any information regarding the depth of the facility, associated disturbance, or perched aquifers. This was Open Item 2.4-2, as discussed in Section 2.4.1.3 of this report. Subsequent response from the applicant resolved Open Item 2.4-2, as documented in Section 2.4.1.3 of this SER.

To understand the ground water flow paths, adequate characterization of the local subsurface environment is necessary. In RAI 2.4.12-1, the staff requested more information regarding the local subsurface environment. In response to this RAI, SERI stated that it will conduct an additional detailed assessment to define the location and extent of perched aquifers at the COL stage when the plant design and location are finalized. The COL applicant must provide the location and extent of perched aquifers, including their areal and vertical extent. The staff intended to propose that the Commission include this requirement in the ESP, should it be granted. However, based on the applicant’s response to Open Item 2.4-3, the staff determined that additional ground water characterization will be carried out by the applicant at the COL stage as part of the design of the dewatering well system. This characterization is expected to provide detailed information on ground water elevation and locations of perched water zones. At that time, in accordance with existing regulations and regulatory guidance, the NRC will review the detailed ESP facility design, including design of dewatering well system, and any potential impact perched water zones may have on construction and operation of the ESP facility. The staff determined, therefore, that specification of DSER Permit Condition 2.4-8 is not necessary. The COL applicant should provide detailed ground water information, including the location and depth of perched aquifers. This is **COL Action Item 2.4-9.**

2.4.12.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to ground water. Therefore, staff concludes that the applicant has met the requirements for ground water with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c)(3).

2.4.13 Accidental Releases of Liquid Effluents to Ground and Surface Waters

The ESP site is located within the Mississippi Alluvial Plain Section of the Coastal Plain Physiographic Province. Aquifers at the site include the (1) Holocene alluvium in lowlands near the Mississippi River, (2) Pleistocene Upland Complex deposits beneath loess surface strata in the uplands, and (3) Miocene Catahoula Formation that underlies both the upland and lowland aquifers.

2.4.13.1 Technical Information in the Application

In SSAR Section 2.4.13, SERI restated the GGNS UFSAR analysis for accidental releases of liquid effluents from GGNS to ground water and surface water. The applicant argued that, since the hydrogeologic characteristics of the site have not changed since the GGNS analysis, the findings from the evaluation of GGNS should extend to the ESP facility even though it is 1200 feet closer to the Mississippi River than GGNS Unit 1.

The applicant identified no surface water intakes within 100 miles downstream of the ESP site that use Mississippi River water as a potable water supply.

The SSAR did not provide specific coordinates (including elevation) for the bounding areas of all safety-related structures and aquifers, including perched aquifers. In RAI 2.4.1-1, the staff requested SERI to provide these locations and elevations. The applicant's response to this RAI will help the staff in its independent estimation of ground water flowpaths and water table elevations.

The SSAR did not contain sufficient specific information of the local subsurface environment in the vicinity of the proposed ESP facility or facilities for the staff to understand all the ground water pathways. In RAI 2.4.12-1, the staff requested SERI to further describe the local subsurface environment. The applicant's response to this RAI will help the staff in its independent estimation of ground water flowpaths and water table elevations.

The SSAR did not provide sufficient rationale as to the selection of strontium- (Sr-) 90 and cesium- (Cs-) 137 as radionuclides to be considered in the analysis. While these are important radionuclides in terms of human health risk, their large distribution coefficients (K_d) significantly retard their migration in the subsurface environment. In RAI 2.4.13-1, the staff requested SERI to further describe the rationale for considering Sr-90 and Cs-137 in its analysis.

2.4.13.2 Regulatory Evaluation

Section 1.4 of the SSAR discusses the applicant's conformance to NRC regulatory guidance. The staff finds that the applicant correctly identified the applicable regulatory guidance. The acceptance criteria for this section relate to the following regulations:

- 10 CFR Part 52 and 10 CFR Part 100, as they require that hydrologic characteristics of the site be evaluated with respect to the consequences of the escape of radioactive material from the facility

Compliance with 10 CFR Part 52 and 10 CFR Part 100 requires that the NRC consider the local geologic and hydrologic characteristics when determining the acceptability of a site to host a nuclear unit(s). The geologic and hydrologic characteristics of the site may have a bearing on the potential consequences of radioactive materials escaping from a nuclear unit(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. Special precautions should be planned if a reactor(s) will be located at a site where a significant quantity of radioactive effluent could accidentally flow into nearby streams or rivers or find ready access to underground water tables.

These criteria apply to RS-002, Section 2.4.13, because the reviewer evaluates site hydrologic characteristics with respect to the potential consequences of radioactive materials escaping from a nuclear unit(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. The review considers the radionuclide transport characteristics of ground water and surface water environments with respect to accidental releases to ensure that current and future users of ground water and surface water are not adversely affected by an accidental release from a nuclear unit(s) of specified type (or falling within a PPE) that might be constructed on the proposed site. RG 1.113, Revision 1, "Estimating Aquatic Dispersions of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," issued April 1977, and RG 4.4, "Reporting Procedure for Mathematical Models Selected to Predict Heated Effluent Dispersion in Natural Water Bodies," issued May 1974, provide guidance in the selection and use of surface water models for analyzing the flow field and dispersion of contaminants in surface waters.

Meeting the requirements of 10 CFR Part 52 and 10 CFR Part 100 provides reasonable assurance that accidental releases of liquid effluents to ground water and surface water, and their adverse impact on public health and safety, will be minimized.

For those cases in which a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. An ESP applicant can develop a PPE for a single type of facility or a group of candidate facilities by selecting the limiting values of relevant parameters. Important PPE parameters for SSAR Section 2.4 include, but are not limited to, precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

To judge whether the applicant has met the requirements of 10 CFR Part 52 and 10 CFR Part 100 with respect to accidental releases of liquid effluents, the NRC uses the following criteria:

- Radionuclide transport characteristics of the ground water environment with respect to existing and future users should be described. Estimates and bases for coefficients of dispersion, adsorption, ground water velocities, travel times, gradients, permeabilities, porosities, and ground water or piezometric levels between the site and existing or known future surface water and ground water users should be described and be consistent with site characteristics. Potential pathways of contamination to ground water users should also be identified. Sources of data should be described and referenced.

- Transport characteristics of the surface water environment with respect to existing and known future users should be described for conditions which reflect worst-case release mechanisms and source terms to postulate the most pessimistic contamination from accidentally released liquid effluents. Estimates of physical parameters necessary to calculate the transport of liquid effluent from the points of release to the site of existing or known future users should be described. Potential pathways of contamination to surface water users should be identified. Sources of information and data should be described and referenced. The staff will base its acceptance on its evaluation of the applicant's computational methods and the apparent completeness of the set of parameters necessary to perform the analysis.

- Mathematical models are acceptable to analyze the flow field and dispersion of contaminants in ground water and surface water, providing that the models have been verified by field data and that conservative site-specific hydrologic parameters are used. Furthermore, conservatism should guide the selection of the proper model to represent a specific physical situation. Radioactive decay and sediment adsorption may be considered, if applicable, providing that the adsorption factors are conservative and site specific. RG 1.113 guides in the selection and use of surface water models. RS-002 discusses the transport of fluids through porous media.

2.4.13.3 Technical Evaluation

Prior construction for the GGNS facility has changed, and future construction for the ESP facility or facilities will further alter, the subsurface environment. The current subsurface environment will be altered with the replacement of existing soils with fill and cement. These changes and any dewatering systems will alter the local ground water flow patterns and water table elevations. In RAI 2.4.1-1, the staff requested SERI to define the extent of the region (including elevation) of the ESP facility or facilities and the location of any aquifers, including perched aquifers. Although the applicant submitted the coordinates of the areal extent of the facility, it did not provide any information regarding the depth of the facility, associated disturbance, or perched aquifers. This was Open Item 2.4-2, as discussed in Section 2.4.1.3 of this report. Subsequent response from the applicant resolved Open Item 2.4-2, as documented in Section 2.4.1.3 of this SER.

The SSAR did not provide sufficient rationale regarding the selection of Sr-90 and Cs-137 as radionuclides to be considered in the analysis. While these are important radionuclides in terms of human health risk, their large distribution coefficients (K_d) significantly retard their migration in the subsurface environment, thereby increasing their travel time to the receiving waters and making the analysis less conservative. The staff requested SERI to further describe its rationale for considering Sr-90 and Cs-137 in its analysis. In response to RAI 2.4.13-1, the applicant stated that it would need to gather further information, and such issues will be reevaluated at the COL stage. The staff requires this information for its site suitability determination at the ESP stage. Therefore, the applicant must provide the rationale for considering Sr-90 and Cs-137 in the analysis. This was Open Item 2.4-6.

In response to Open Item 2.4-6, the applicant stated that the SSAR assessment was based on the GGNS Unit 1 UFSAR analysis in which Sr-90 and Cs-137 were the primary nuclides of interest and were identified based on transport time while considering retention and retardation from the GGNS Unit 1 site to the Mississippi River. The applicant stated that it has carried out an additional assessment to address Open Item 2.4-6. The applicant's new assessment primarily consisted of a screening analysis to identify nuclides of interest that should be considered in a more detailed accidental release analysis at the COL stage.

The applicant stated that the screening analysis proposed a hypothetical accidental release from the ESP facility's radwaste system. The applicant assumed that the ESP facility's radwaste system is located at the western edge of the proposed ESP facility footprint to minimize the distance to the river and thus making the analysis conservative. The applicant ignored all retention and retardation effects in the subsurface during the transport of an accidental release plume to the river but considered radioactive decay during the transport. The applicant identified all nuclides as nuclides of interest that could be expected to exceed 10 CFR Part 20, "Standards for Protection Against Radiation," concentration limits.

The applicant stated that the GGNS Unit 1 UFSAR analysis for accidental release had conservatively assumed that effluent would move along fracture paths in the low-permeability silt and clay Catahoula formation at the same flow rate as in the adjacent terrace deposits. The applicant stated that this assumption was conservative because travel time through the fractures would be faster than that through the surrounding Catahoula formation. The applicant also stated that the hydraulic conductivity of sand and gravel lenses in lower terrace deposits based on site-specific well test data adjacent to the proposed ESP facility footprint is approximately $3x10^5$ feet per year (ft/yr). The applicant stated that the alluvium adjacent to the terrace deposits consists primarily of silt and clay deposits underlain by basal sand and that the hydraulic conductivity of the of the terrace deposits is conservatively assumed to be approximately $5x10^3$ ft/yr, and that of the alluvium between Hamilton Lake and the Mississippi River, as determined from aquifer tests, is approximately $1.3x10^5$ ft/yr. The applicant stated that site-specific data provided in the GGNS Unit 1 UFSAR were used to determine average interstitial ground water velocity, hydraulic conductivity, hydraulic gradient, and effective porosity.

The applicant stated that accidental release at the ESP site would in general follow the same path as that used in the GGNS Unit 1 UFSAR analysis. The presence of the ESP facility may create localized perturbations in ground water flowpaths, but the overall ground water flow to the Mississippi River from the ESP site is expected to remain unchanged. The applicant stated that the exact location of the ESP radwaste facility will not be known until the COL stage, but conservatively assuming it to be located at the western edge of the proposed ESP footprint resulted in a distance approximately 1830 feet closer to the Mississippi River compared to the GGNS Unit 1 release flowpath, which was the only data that were different in applicant's new analysis for an ESP facility accidental release. The applicant estimated a travel time to the Mississippi River from the ESP radwaste facility of approximately 12.43 years, which is slightly less than that for the GGNS Unit 1 analysis, 12.5 years.

The applicant compiled an expanded list of possible radionuclides for initial screening from two sources, the AP1000 Design Control Document, Tier 2, Table 12.1-9 (Sheet 4), for the effluent holdup tank, liquid phase, and the waste holdup tank, and from the Advanced Boiling Water Reactor Standard Safety Analysis Report, Table 12.1-13a, for the low-conductivity waste collection tank. The applicant used the higher activity level from these two documents for each radionuclide to compile the composite inventory list. The applicant screened radionuclides on the composite inventory list to identify those that had residual activities in excess of their corresponding values in Column 2 of Table 2 in Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," to 10 CFR Part 20 after transport to the Mississippi River, during which retention and retardation was ignored, but radioactive decay was considered. The applicant identified Cs-134, Cs-137, Sr-90, cobalt- (Co-) 60, iron- (Fe-) 55, and nickel- (Ni-) 63 as the radionuclides of interest.

The staff reviewed the applicant's response to Open Item 2.4-6 and concluded that the applicant provided more details on its approach for determining radionuclides of interest. Based on the description of the applicant's screening analysis to identify nuclides of interest, the staff determined that the applicant's screening analysis may be inappropriate. Section 2.4.13 of RS-002 outlines the review of accidental radioactive liquid effluent releases as they may affect existing and known future uses of ground water and surface water resources. The guidance calls for the evaluation of transport capabilities and potential subsurface contamination pathways under accidental conditions to determine most adverse scenarios for contamination of ground water or of surface waters via subsurface pathways. RS-002 states that concentrations of radionuclides in the body of water under consideration should be estimated based on dispersion computations with initial concentrations determined for the most critical event. Acceptability of final estimated concentrations in the radioactive effluent at the points of interest must be within acceptable limits as prescribed by Column 2 of Table 2 in Appendix B to 10 CFR Part 20.

According to 10 CFR Part 20, which prescribes standards for protection against radiation, the total ionizing radiation dose to an individual, including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation, must not exceed the standards for protection. The effluent concentration values given in Column 2 of Table 2 of Appendix B to 10 CFR Part 20 are equivalent to the radionuclide concentrations which, if ingested continuously for a year, would produce a total effective dose equivalent of 0.05 rem (50 millirem or 50 millisieverts). The staff concluded that because of the presence of several radionuclides in the potential accidental release, an individual near a contaminated point of interest will receive a cumulative ionizing radiation dose from each radionuclide that constitutes the effluent. The staff determined that the applicant's screening procedure for selecting the radionuclides of importance to subsurface hydrological transport has been explained clearly. On the basis of this determination and the staff's proposed Permit Condition 2 which requires an applicant referencing such an ESP design any new unit's radwaste systems with features to preclude any and all accidental releases of radionuclides into any potential liquid pathway, the staff considers Open Item 2.4.6 resolved.

The regulation at 10 CFR 100.20(c)(3) contains the primary requirement for site suitability determination factors related to accidental releases to the liquid pathway. This regulation outlines factors, such as soil, sediment, and rock characteristics, adsorption and retention coefficients, ground water velocity, and distances to the nearest body of surface water, important to hydrologic radionuclide transport that must be obtained from onsite measurements. Section 2.4.13 of the SSAR does not provide these required onsite measured values. This was Open Item 2.4-7.

In response to Open Item 2.4-7, the applicant stated that four new borings were drilled at the proposed ESP site to depths between 141.5 and 238 feet to characterize subsurface geological conditions. The applicant stated SSAR Figure 2.5-69 shows the locations of these boreholes, and SSAR Tables 2.5-20 and 2.5-21 summarize the characteristics of these borings.

The applicant stated that extensive geological and geotechnical data are available from investigations completed for the existing GGNS Unit 1. The applicant stated that 275 borings were drilled within the site area to a maximum depth of 447 feet, 10 of which were located within the proposed ESP facility footprint, and some additional borings were drilled in the floodplain of the Mississippi River between the ESP site and the river. In addition to the GGNS database, three new soil borings, four new cone penetrometer tests (CPTs), two downhole geophysical surveys, and geological field observations were completed for the ESP application to evaluate subsurface conditions and to estimate input parameters to assess the dynamic response of subsurface material at the proposed ESP site. Apart from a stratum naming difference, the stratigraphy at the proposed ESP site generally agrees with that shown on the GGNS UFSAR boring logs, and material descriptions and contacts are generally consistent between the two data sets.

The applicant also stated that 60 samples of loess, Upland Complex alluvium, and Catahoula Formation bedrock from site borings were tested for basic geotechnical properties, as summarized by SSAR Tables 2.5-24 and 2.5-25, and SSAR Figures 2.5-82 and 2.5-83 summarize the results from moisture content and grain size tests, respectively.

The applicant stated that the elevation of the ground water table could not be measured directly in the borings because water was continuously injected during drilling. The applicant noted that the ground water elevation was indirectly estimated using borehole seismic velocity compression and shear (P-S) wave surveys as the elevations where there was a significant increase in compression wave velocity but no corresponding increase in shear wave velocity. The applicant estimated the ground water table elevation to range from 70 to 100 feet deep from the ground surface. The applicant stated that the regional ground water flow near the ESP site is toward the southwest direction to the Mississippi River floodplain, with a hydraulic gradient of approximately 1 foot per 100 to 125 feet of distance. The applicant also noted that it is possible for shallow perched water to form in parts of the loess during high-intensity rainfall events, but the applicant expected that these perched zones would dissipate rapidly after the rainfall ceased.

The applicant stated that SSAR Tables 2.4-34, 2.4-35, and 2.4-37 provide values for hydraulic conductivity, transmissivity, hydraulic gradient, porosity, ground water velocity, and distribution coefficients for Sr and Cs. Six of the borings and well locations listed on the above-mentioned SSAR tables, TW-1, OW29A, OW29B, OW73, P34B, and P34C, were installed within or adjacent to the proposed ESP facility footprint. The applicant argued that since the stratigraphy, as determined from ESP site assessment, generally agrees with the stratigraphy shown on the GGNS Unit 1 UFSAR boring logs and the data in the above-mentioned SSAR tables include information from wells located within the proposed ESP powerblock area, the aquifer characteristics in the above-mentioned SSAR tables are valid and applicable for the ESP site and should be considered as site characteristics for the ESP site.

The applicant included a table, shown below, of K_d values for Cs-137 and Sr-90 that were established for site-specific calculations in the GGNS Unit 1 UFSAR.

	Calculated K_d Values (ml/mg)	
	Cs-137	Sr-90
Terrace Formation	314.85	8.79
Clay-Silt Alluvium	259.29	7.24
Alluvium Aquifer	259.29	7.24

The applicant stated that in the event of accidental liquid release, the contaminants would be expected to follow the same general flowpaths as those described in the GGNS Unit 1 UFSAR. The primary difference between the GGNS Unit 1 location and the proposed ESP site is that the ESP site is closer to the Mississippi River. The west edge of the proposed ESP powerblock area is approximately 5400 feet from the Mississippi River. Based on the above summary, the applicant stated that the above-mentioned K_d values for Cs-137 and Sr-90 are directly applicable to the ESP site. As described in response to Open Item 2.4-6 above, the applicant's screening analysis selected Cs-134, Co-60, Fe-55, and Ni-63 in addition to Cs-137 and Sr-90 as nuclides of interest. The applicant also argued that since K_d is a chemical property, this site characteristic for Cs-137 and Cs-134 would be the same.

The applicant provided a table of K_d values for Cs and Sr corresponding to different soil types from those published in Table E.3 in Appendix E to RESRAD Version 6, as shown below.

	RESRAD Version 6, Appendix E, Table E.3 K_d Values (ml/gm)			
	Sand	Loam	Clay	Organic
Cs	280	4600	1900	270
Sr	15	20	110	150

The applicant concluded that K_d values corresponding to sand were most representative and appropriate for soil media at the ESP site by comparing RESRAD data with Sr-90 and Cs-137 K_d values used in the GGNS Unit 1 UFSAR analysis. The applicant then obtained K_d values for other nuclides of interest from the user's manual for RESRAD Revision 6, as listed below.

	K_d Value (ml/gm)
Co-60	60
Fe-55	220
Ni-63	400

The applicant considers these K_d values site characteristics for the additional nuclides of interest. The applicant revised SSAR Table 2.4-37 to include the above-stated K_d values as site characteristics for the proposed ESP site.

The staff reviewed the applicant's response to Open Item 2.4-7 and concluded that the applicant provided more details regarding its method for estimating site characteristics important to radionuclide migration in the subsurface at the ESP site. However, the staff determined that several subsurface hydrological properties influence the migration of the radionuclide plume in the ground water. Some of these properties include hydraulic conductivity, hydraulic gradient, and distance to the nearest surface water body that are common to all radionuclides that may constitute the radwaste inventory. Some other properties such as adsorption and retention coefficients may be unique to each radionuclide. In addition, subsurface chemical properties, such as pH, may affect different radionuclides differently (EPA 1999a, 1999b; EPA 2004). Appendix E to the RESRAD Version 6 user manual also states the following:

> Distribution coefficients depend strongly on soil type, the pH and Eh of the soil, and the presence of other ions (see Tables E.3 through E.7). Thus, considerable uncertainty can be introduced by using default values for the distribution coefficients. This uncertainty is a critical matter, particularly in cases in which the water-dependent pathways are the dominant contributors to the total dose/source concentration ratios. Default values for the distribution coefficients are provided only for the purpose of obtaining preliminary estimates; site-specific values should be used for deriving soil guidelines whenever possible.

The radwaste itself may contain certain complexing agents that are frequently used in decontamination processes to remove buildup of radionuclides from cooling systems, such as one or more chelating agents including ethylenedinitrilo tetraacetic acid, picolinic acid, oxalic acid, and citric acid. The presence of these complexing agents can enhance the mobility of some radionuclides, especially transition metals (Davis et al., 2000; Serne et al., 2002). For this reason, EPA (1999b) cautions that its lookup tables do not apply to environments containing organic chelates.

The staff concluded that because of incomplete knowledge of subsurface hydrological and chemical properties and the likely composition of the radwaste effluent itself, significant uncertainty exists in the characterization of radionuclide migration in the subsurface at the ESP site at the time of ESP review. The staff determined that after the reactor design is selected and additional details related to radwaste tank design and its location within the proposed site are known, appropriate subsurface hydrological characterization can be completed. Therefore, at the time of a COL or CP application, more reliable estimation of radionuclide migration to surface waters via subsurface pathways can be made. The staff determined that the COL applicant should be required to perform an updated conservative screening of radionuclides from the radwaste inventory of the chosen reactor design accounting for ESP site soil chemistry, presence of any chelating agents, and any other factor that may affect radionuclide mobility in the subsurface. Based on the above review, and proposed permit condition 2. as discussed below, the staff considers Open Item 2.4-7 resolved.

As reflected, in its ESP application, the applicant has not made a decision as to what specific reactor design might ultimately be built at the ESP site. Therefore, important details are not available for the staff to fully consider the effect of an accidental release of liquid effluents in ground and surface waters, including the exact location of radwaste storage facilities, the location and elevation of likely points of release, and detailed characterization of liquid pathways above and below ground from the point of release to the accessible environment. Although the staff conceptually used siting factors such as soil, sediment, and rock characteristics, adsorption and retention coefficients, ground water velocity, and distances to the nearest surface body of water in its site suitability determination, it determined that this issue could be resolved if there were no releases of radionuclides to the ground water. Accordingly, the staff proposes to include a condition in any ESP that might be issued for the Grand Gulf site requiring that an applicant referencing such an ESP design include features in any new unit's radwaste systems to preclude any and all accidental releases of radionuclides into any potential liquid pathway. This is **Permit Condition 2.**

2.4.13.4 Conclusions

As set forth above, the applicant has provided sufficient information pertaining to liquid pathways. Therefore, the staff concludes that the applicant has met the requirements for liquid pathways with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c)(3).

2.4.14 Site Characteristics Related to Hydrology

Based on its review of SSAR Section 2.4, the staff has determined that the following site characteristics should be included in any ESP that might be issued for the proposed site.

Table 2.4.14-1 Staff's Proposed Site Characteristics Related to Hydrology

SITE CHARACTERISTIC	VALUE
Proposed Facility Boundaries	SSAR Figure 2.1-1 shows the areal extent of proposed facility boundaries. This figure is reproduced below as Figure 2.4.14-1. The bounding coordinates of the ESP site are a site characteristic. During construction, the ESP site could be disturbed up to a depth ranging from 35 to 140 feet plus some additional excavation.
Site Grade	132.5 feet above MSL
Highest Ground Water Elevation	70 feet below grade; 62.5 feet above MSL; perched water may be present between the site grade at 132.5 feet above MSL and the water table at 62.5 feet above MSL.
Flood Elevation	Flood water elevation at the ESP site caused by local intense precipitation will be established by the COL applicant using local intense precipitation values established in Section 2.4.2.3 of this SER. Local intense precipitation itself is a site characteristic, listed below.
Local Intense Precipitation	19.2 in./h, of which 6.2 in. falls during the first 5 minutes.
Frazil and Anchor Ice	The ESP site does not have the potential for the formation of frazil and anchor ice.
Maximum Cumulative Degree Days Below Freezing	98 °F
Distance to the Closest Surface Water	Stream B is the closest surface water feature, approximately 1017 feet away from center of the powerblock.
Location of Aquifers Used by Large Population for Domestic, Municipal, Industrial, or Irrigation Water Supplies	The nearest public water supply wells are located 2760 feet from the ESP powerblock.

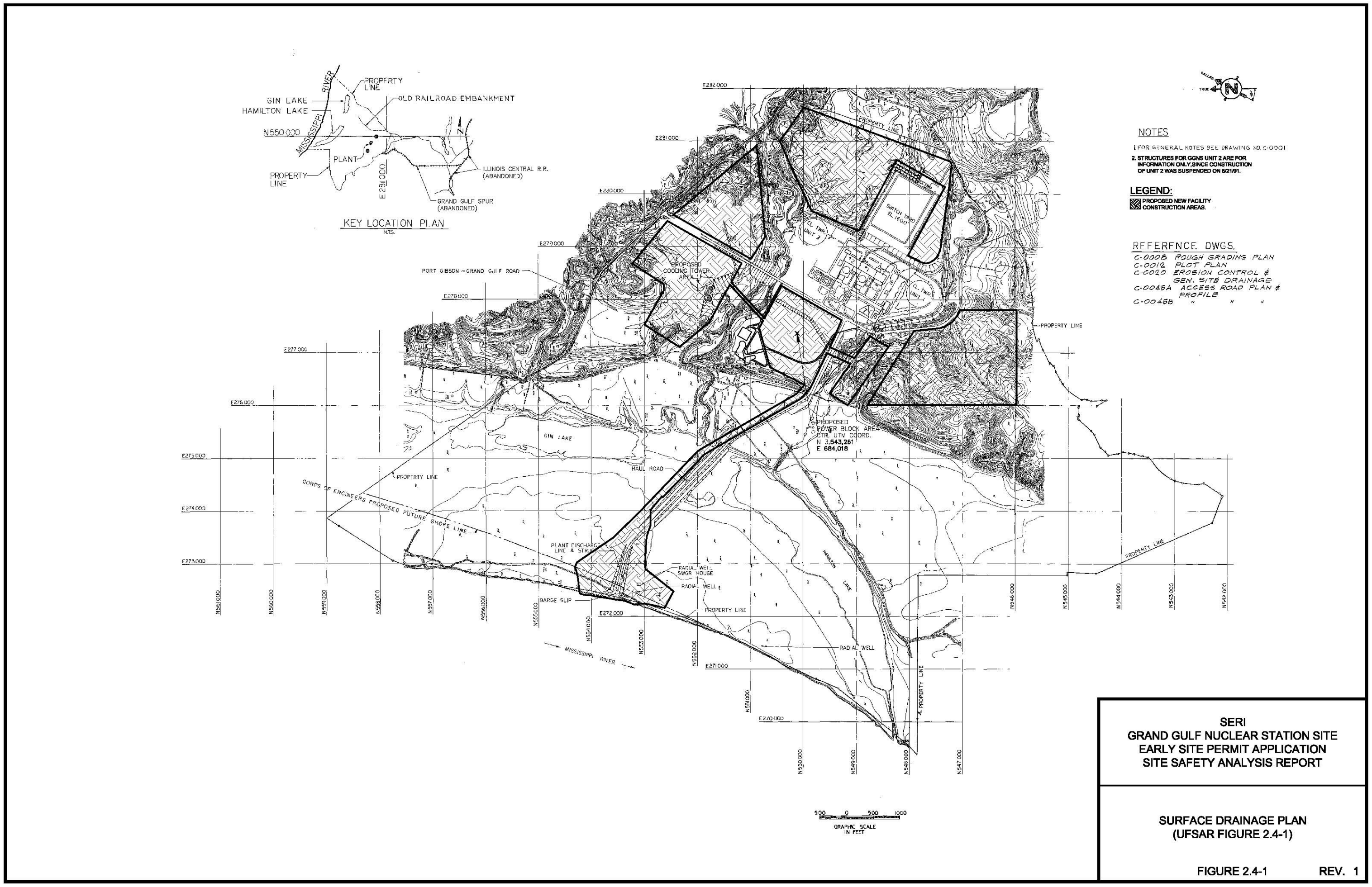


Figure 2.4.14-1 Areal extent of proposed facility boundaries

2.5 Geology, Seismology, and Geotechnical Engineering

In Section 2.5, "Geology, Seismology, and Geotechnical Engineering," of the SSAR, SERI provided a detailed description of the geological, seismological, and geotechnical engineering properties of the ESP site. In this SER, Section 2.5.1, "Basic Data," describes basic geological and seismological data, especially the data published since 1986 for the area within a 200-mile radius of the ESP site, and presents updated seismic sources. Section 2.5.2, "Vibratory Ground Motion," evaluates the vibratory ground motion for the ESP site and analyzes the safe-shutdown earthquake (SSE) ground motion. Section 2.5.3, "Surface Faulting," describes the potential for surface faulting at or near the surface of the ESP site. Section 2.5.4, "Stability of Subsurface Materials and Foundations," presents the results of site geotechnical investigations and discusses the stability of subsurface materials and foundations. Section 2.5.5, "Stability of Slopes," defers the analyses for slope stability at the site and dam performance, respectively, to the COL stage. Finally, Section 2.5.6, "Embankments and Dams," briefly states that no embankments exist within the site location (1 kilometer), and no impoundment structures exist within the site area (8 kilometers), which could affect the safety of the proposed new facility.

The applicant also stated in SSAR Section 2.5 of the ESP application that the UFSAR for GGNS formed the basis for its characterization of the site geology, seismology, and geotechnical engineering. As such, the material in Section 2.5 of the SSAR focuses on any newly published information since the publication of the GGNS UFSAR in the 1970s. In addition, the technical information presented in Section 2.5 of the ESP application is based largely on the applicant's surface and subsurface geological, seismological, geophysical, and geotechnical investigations that were performed in progressively greater detail as the location of the investigations neared the site. The applicant defined the following zones of investigation in terms of their distances from the ESP site, following the recommendation of RG 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," issued March 1997:

- site region—within 320 kilometers (200 miles)
- site vicinity—within 40 kilometers (25 miles)
- site area—within 8 kilometers (5 miles)
- site location—within 1 kilometer (0.6 miles)

The applicant adopted the Electric Power Research Institute (EPRI) report, "Seismic Hazard Methodology for the Central and Eastern United States," issued July 1986, to model regional seismic sources. Therefore, SSAR Section 2.5 focuses on those data developed since the publication of the 1986 EPRI report. RG 1.165 allows the applicant to use the seismic source interpretations developed by Savy, et al., at Lawrence Livermore National Laboratory (LLNL) in the "Eastern Seismic Hazard Characterization Update," issued 1993, or the EPRI document as inputs for a site-specific analysis.

2.5.1 Regional and Site Geology

Section 2.5.1 of the SSAR describes the regional and site geology for the ESP site. Sections 2.5.1.1 and 2.5.1.2 describe the general geologic, seismologic, and tectonic setting of the site region and site area, respectively.

2.5.1.1 Technical Information in the Application

2.5.1.1.1 Regional Geology

Section 2.5.1.1 of the ESP application describes the (1) regional physiography, (2) regional geological provinces, (3) regional geologic history, (4) regional stratigraphy, (5) regional tectonic settings, and (6) regional seismicity of the site region.

Regional Physiography. SSAR Section 2.5.1.1.1 describes the regional physiography. The ESP site is located within the Gulf Coastal Plain physiographic province. The following subprovinces make up this physiographic province, as shown in Figure 2.5.1-1:

- Loess Hills subprovince
- Mississippi Alluvial Valley subprovince
- Eastern Hills subprovince
- Western Hills subprovince
- Southern Hills subprovince
- Prairie Coastwise Terrace subprovince
- Chenier Plain subprovince
- Delta Plain subprovince

The proposed site is located within the Mississippi Alluvial Valley subprovince. This subprovince includes several interdistributary lowlands, basins, and ridges; elevations within the subprovince range from 50–250 feet. The topographic highs along the Mississippi River are remnants of older alluvial deposits that were mostly eroded and removed from the valley. The Mississippi Alluvial Valley is relatively flat with a gentle southward gradient and is characterized by fluvial geomorphic features typical of a braided stream and meandering river system.

Regional Geological Provinces. SSAR Section 2.5.1.1.2 describes the regional geological provinces. The Gulf Coast Plain physiographic province is divided into two primary geologic provinces, the Mississippi embayment and the Gulf Coast Basin. The site region is located within the Gulf Coast Basin, which includes the southern portion of the Mississippi embayment (see Figure 2.5.1-2).

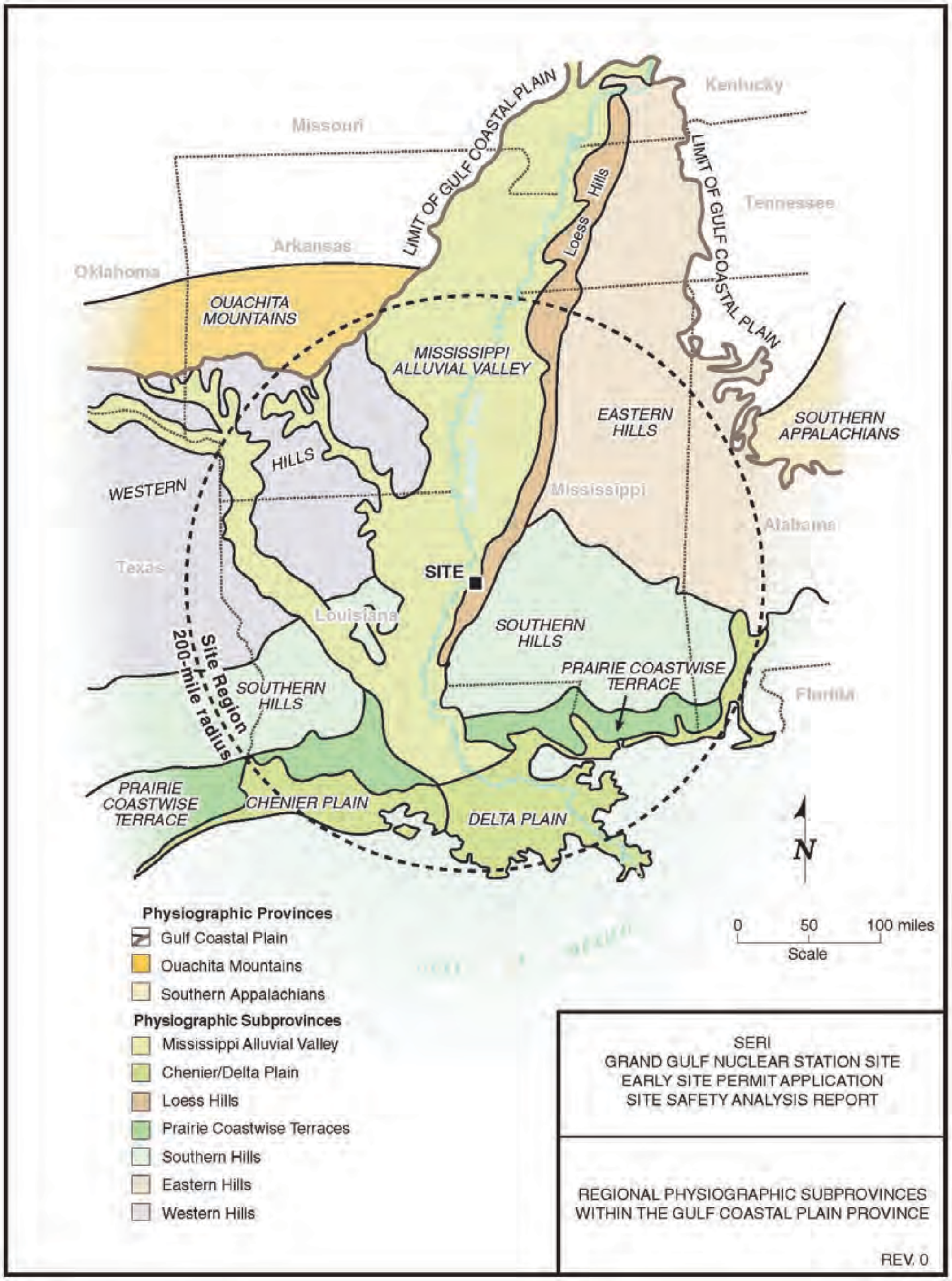


Figure 2.5.1-1 Physiographic subprovinces within the Gulf Coastal Plain province

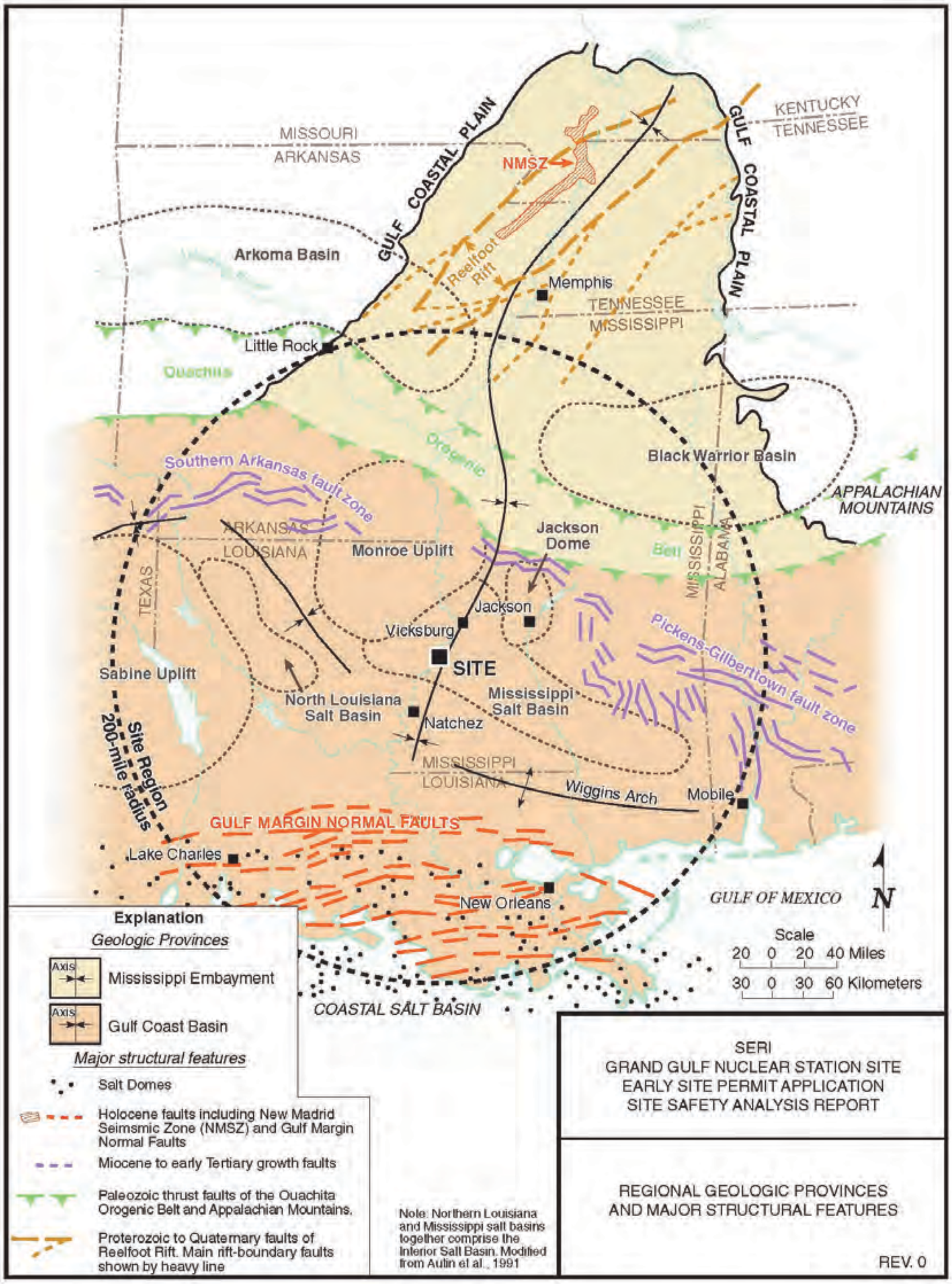


Figure 2.5.1-2 Geological provinces and major structural features

The Gulf Coast Basin extends from the Gulf of Mexico to the buried Ouachita Orogenic Belt. The basin formed during initial rifting of the Gulf of Mexico in the Triassic Period (248–209 million years before present (Ma)). The basement rocks within the Gulf Coast Basin are transitional between continental and oceanic materials, depending on the distance from the Gulf of Mexico. The Mississippi embayment lies between the Ouachita Mountains in southern Arkansas and the Appalachian Mountains in west-central Alabama, which cover the northern margin of the Gulf Coastal Plain. The Mississippi embayment formed during the late Cretaceous Period (144–66 Ma) as a result of crustal downwarping associated with the extension of the Reelfoot Rift. The embayment is structurally a south-southwest dipping syncline, underlain by Paleozoic strata and igneous and metamorphic basement rocks. This syncline extends to the Gulf Coast Basin and forms a structural downwarp that affects the depth to the basement and the thickness of the overlaying sedimentary column. The limbs of the syncline in the Gulf Coast Basin typically dip less than 1 degree towards the syncline axis. The largest historical earthquakes in the central and eastern United States (CEUS), the 1811–1812 New Madrid earthquakes, occurred inside the Mississippi embayment.

Regional Geologic History. SSAR Section 2.5.1.1.3 describes the regional geologic history of the ESP site. The applicant stated that the site region is located in the south-central margin of the North American craton. The crystalline basement of the North American craton in the central United States is wholly Precambrian in age (more than 570 Ma), with the possible exception of transitional basement rocks underlying the Gulf Coast Basin. There are eight major cratonic units, formed by orogenies ranging from Archean (3800 Ma) to middle Proterozoic (750 Ma). Overall, the North American craton enlarged gradually to the south and east because of lateral accretion during successively younger Precambrian orogenies. The similarity in the ages of the rift systems within the North American craton indicated that the Reelfoot Rift initiated as a failed arm of a triple junction (an intersection of three oceanic ridges) during an episode of late Precambrian continental fragmentation.

During the early Mesozoic Era, known as the Triassic Period (248–209 Ma), the Reelfoot Rift was reactivated, resulting in additional extension and intrusion. The Gulf of Mexico began forming during the Triassic Period from extensional rifting of the supercontinent Pangea and divergent motion of the North American and Afro-South American plates. The slow deposition of sediments on top of the Paleozoic (570–245 Ma) sedimentary rocks formed the Gulf Coastal Plain, to the north of the Gulf of Mexico. By the mid-Jurassic Period (180 Ma), the Gulf Coast region became a restricted seaway with evaporitic conditions that accumulated more than 9900 feet of salt deposits. The Mississippi embayment experienced deposition-erosion episodes during the Cretaceous Period (66–144 Ma). At the end of the Cretaceous Period, volcanic activity and igneous intrusions formed the volcanogenic structural highs, isolating the northern part of the embayment from the Gulf Costal Basin to the south.

During the Cenozoic Era (66 Ma–present), the Gulf Coastal Plain expanded southward by as much as 250 miles as the Mississippi River transported massive volumes of sediments to the Gulf Coast Basin during the Pleistocene Epoch (1.8–0.11 Ma). The rising sea level submerged the late Pleistocene continental shelf and reached its present position approximately 3000–4000 years ago, defining the current configuration of the Gulf Coast margin.

Regional Stratigraphy. SSAR Section 2.5.1.1.4 describes the stratigraphy from the youngest to the oldest for the ESP site region. The applicant described the rocks and sediments in the site region in great detail, including their distribution, components, and environment. The geological map shown in Figure 2.5.1-3 outlines the stratigraphic exposures in the site region.

Cenozoic Era (66 Ma–present)

The Cenozoic Era consists of Quaternary (1.8 Ma–present) and Tertiary Periods (66–1.8 Ma). Deposits from these two periods, especially the Quaternary, form the current surface configuration around the ESP site.

Quaternary deposits within the site region occur along the Mississippi Alluvial Valley and its tributaries, the Southern Hills subprovince of the Gulf Coastal Plain, and the Loess Hills subprovince. Holocene (0.11 Ma–present) deposits include alluvium and loess that occur within the Mississippi River Valley and its tributary valleys, and deltaic and beach facies within the Chenier Plain and Delta Plain. Holocene alluvial and deltaic deposits thicken from a few tens of feet in the northern portion of the site region to greater than 600 feet in the southern portion of the site region. In the site vicinity, the Holocene deposits in the Mississippi Alluvial Valley range from 0–400 feet thick. Holocene sediments in the two main tributary valleys within the site vicinity, Bayou Pierre and Big Black River, range in thickness from 70–100 feet. Pleistocene deposits in the site region consist of mainly loess and terrace deposits. Pleistocene loess occurs along the eastern edge of the Mississippi Alluvial Valley in a belt 10–30 miles wide. The maximum thickness of the loess is 75 feet. Erosion along the eastern side of the Mississippi floodplain forms a prominent erosional escarpment in the loess. Loess deposits unconformably overlie the Pleistocene to Pliocene alluvial deposits and Tertiary deposits in the site vicinity and site area. Pleistocene terrace deposits occur along most of the Mississippi Alluvial Valley and extend across the site region. The thickness of the terrace deposits also varies significantly, depending on the location. The applicant stated that the stratigraphic continuity and absence of vertical deformation of the terraces demonstrate the tectonic stability of the Gulf Coastal Plain through the Pliocene and Pleistocene Epochs.

Tertiary deposits are more than 6000 feet thick in the site vicinity. These deposits thicken from north to south across the region with a maximum thickness of more than 50,000 feet in the Gulf of Mexico. The Tertiary deposits consist of terrigenous sediment eroded from the interior of North America and marine sediment deposited during marine transgressions and regressions. Among the different series of sedimentary deposits in the Tertiary Period, the Miocene Catahoula formation is one of the most extensive deposits in the site vicinity. The applicant stated that this formation underlies the site area and is the load-bearing layer for the existing GGNS and the potential new facility.

Mesozoic Era (245–66 Ma)

Most of the Mesozoic deposits in the site region are located underneath the surface, with the exception of some locally exposed Cretaceous marine and terrestrial sediments that accumulated in response to active rifting and marine transgressions and regressions. Deposits of the Cretaceous system are distributed in the eastern and northern portions of the site region. The Cretaceous system has a maximum combined thickness of more than 5000 feet beneath the site and mainly includes chalk, clay, sand, limestone, and marl. Jurassic system deposits in the site region include anhydrite, sandstone, conglomerate, limestone, shale, and sandstone.

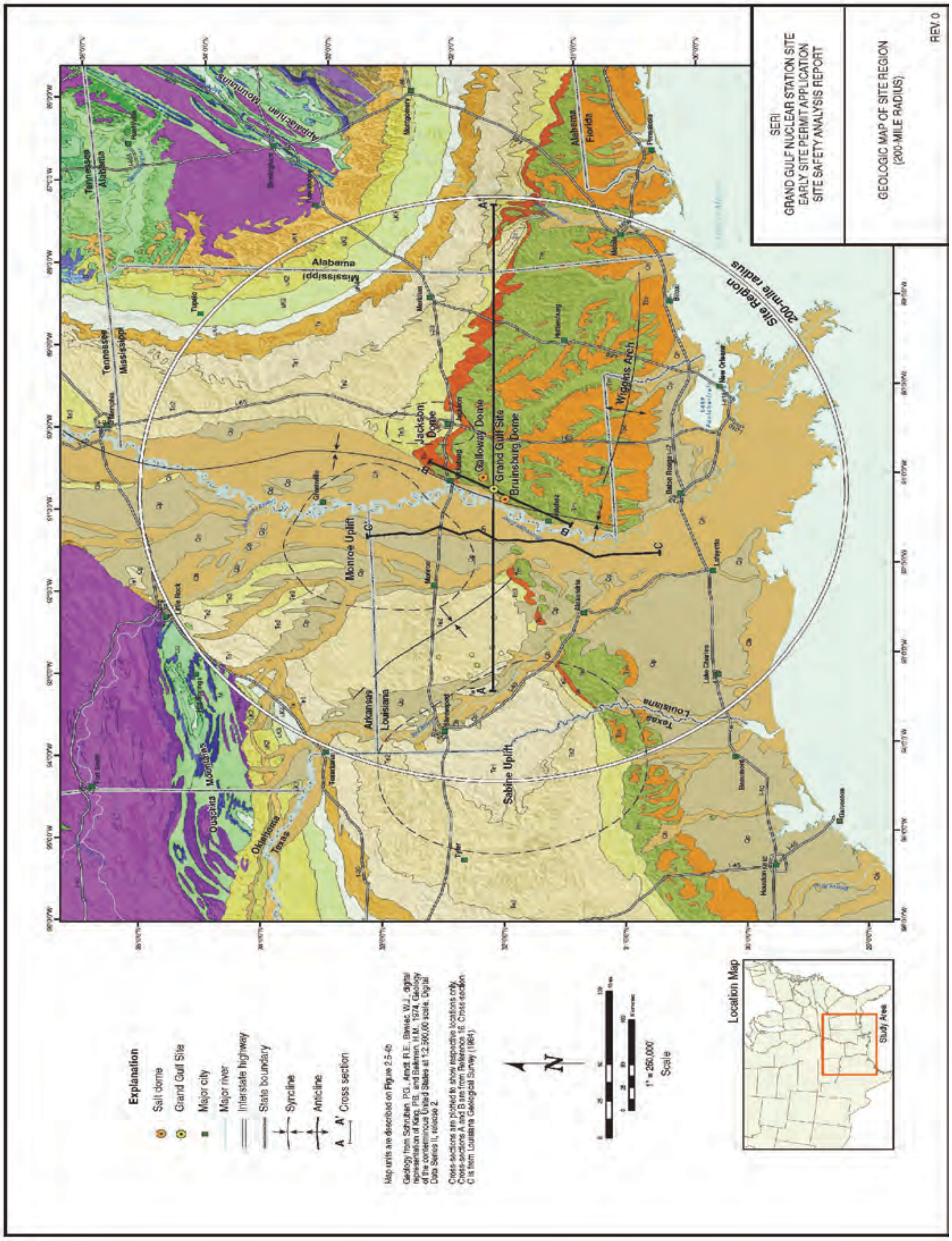


Figure 2.5.1-3 Geological map of the site region

Explanation

- Qh, Holocene; includes loess, alluvial, deltaic, beach, backswamp, and Mississippi River meander belt deposits.
- Qp, Pleistocene; includes loess, terrace, Praire Complex, Intermediate Complex, Upland Complex (Lafayette and Citronelle gravels), and Deweyville Terrace deposits.
- Tpc, Pliocene; Upland Complex (Lafayette and Citronelle gravels).
- Tm, Miocene; includes Catahoula, Pascagoula, Hattiesburg, and Flemming Formations.
- To, Oligocene; includes Forest Hill formation and Vicksburg Group (Bucatunna, Byram Marl, Glendon Limestone, and Mint Springs formations).
- Te3, Eocene; Jackson Group (Yazoo Clay and Moody's Branch formations).
- Te2, Eocene; Claiborne Group (undifferentiated).
- Te1, Eocene; Wilcox Group.
- Tx, Paleocene; Midway Group (Porters Creek Clay and Clayton formation).
- Uk4, Upper Cretaceous; Navarro Group, Arkadelphia Marl, and Nacatoch Sand.
- Uk3, Upper Cretaceous; Taylor Group, and Selma Group
- Uk2, Upper Cretaceous; Austin and Eagle Ford Groups, Tuscaloosa Formation, and Eutaw Formation.
- Uk1, Upper Cretaceous; undifferentiated.
- Ki, Cretaceous; intrusive rocks.
- PP1a, Pennsylvanian; undifferentiated.
- M, Mississippian; undifferentiated.
- DS, Devonian and Silurian; undifferentiated.

SERI
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

GEOLOGIC MAP UNIT DESCRIPTIONS
FOR GEOLOGIC MAP OF SITE REGION

REV. 0

Figure 2.5.1-3 (cont.) Geological map of the site region

Thick evaporite deposits such as salt also exist in the Interior Salt Basin and Coastal Salt Basin and caused widespread diapirism and associated folding and faulting. Cumulatively, the Jurassic deposits in the southern portion of the site region have a thickness of nearly 10,000 feet. The only identified Triassic deposits in the subsurface of the site region consist of shales, mudstones, and siltstones, as well as fine-grained sandstone.

Paleozoic Era (245–570 Ma)

Paleozoic rocks are exposed in the northwestern portion of the site region. Deposits of the Paleozoic Era beneath the site consist of 7 major stratigraphic series and 19 individual formations. The maximum combined thickness of Paleozoic deposits is in excess of 5600 feet in the site region and unknown in other regions. The depth to these deposits beneath the site vicinity is greater than 13,000 feet. Deposits of the Mississippian (362–322 Ma) and Pennsylvanian (322–290 Ma) Periods consist of interbedded shale, fine-grained sandstone, and minor limestone. Deposits of the Ordovician (510–439 Ma) Period consist of dolomite interbedded with thin layers of limestone, shale, and sandstone.

Precambrian (more than 570 Ma)

Based on deep oil and gas exploration wells in the site vicinity, the depth to Precambrian basement rocks is 6–8 miles. The applicant stated that thick, younger sedimentary layers in the Gulf Coast Basin have obstructed the collection of rock samples from the Precambrian basement.

Regional Tectonic Setting. SSAR Section 2.5.1.1.5 describes the regional tectonic setting of the ESP site. The applicant summarized the general tectonic framework and presented the orientation of tectonic stresses in the site region. The applicant also described individual seismic source zones, not only those identified by the 1986 EPRI seismic hazard model, but also new seismic source zones recognized after the 1986 EPRI study. The south-central United States, where the ESP site is located, is a passive continental margin with no nearby plate motion between the Gulf of Mexico and the oceanic plate and the North America continental plate. As such, the region has low earthquake activity and low stress and is typical of a stable continental region. The horizontal compressive tectonic stress in the CEUS orients primarily northeast-southwest, caused by ridge push associated with the mid-Atlantic oceanic ridge. In contrast to the midcontinent compression stress, the southward-oriented extension along the Gulf Coast reflects crustal loading and deformation within the Mississippi River deltaic complex in the Gulf of Mexico. This extension may be distinct from the regional east-northeastward-directed compressive stress in the underlying basement rock. The primary tectonic elements of the region are ancient rift systems, such as the Reelfoot Rift, or former collision zones, such as the Ouachita Orogenic Belt (see Figure 2.5.1-4). Younger tectonic activity appears to be entirely related to reactivation of the rift structures or collision zones. As such, a majority of the seismic events with body-wave magnitude (m_b) greater than 4.5 are concentrated inside the Reelfoot Rift and the Ouachita Orogenic Belt.

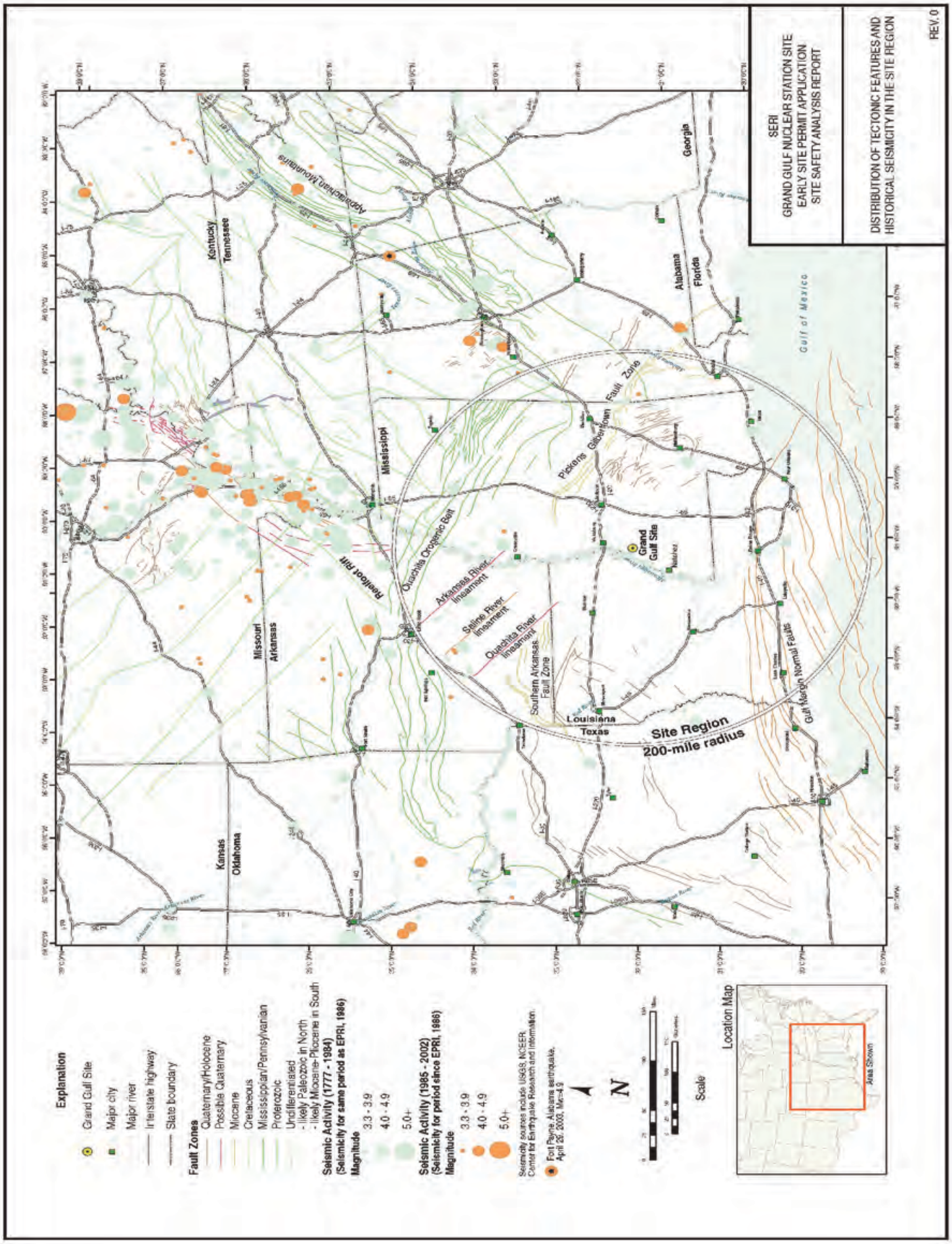


Figure 2.5.1-4 Tectonic features and seismicity in the site region

SSAR Sections 2.5.1.1.5.2 to 2.5.1.1.5.10 discuss each of the following seismic source zones surrounding the ESP site:

- Appalachian Mountains
- Ouachita Orogenic Belt
- Arkoma and Black Warrior Basins
- Reelfoot Rift
- New Madrid Seismic Zone (NMSZ)
- Gulf Coast Basin
- Pickens-Gilberttown and Southern Arkansas Fault Zones
- Saline River Source Zone (SRSZ)
- nontectonic structural features

Among these seismic sources, the SRSZ is a new addition to the original 1986 EPRI seismic hazard study, and the applicant's characterization of the NMSZ includes updated source parameters. Rather than characterizing the seismic potential of each specific geologic fault, the applicant used the areal seismic sources developed by the EPRI study, which are based on current seismicity. Descriptions of each of these seismic source zones follow, and Table 2.5.1-1 provides specific magnitude and historical earthquake parameters.

Table 2.5.1-1 Parameters for Seismic Source Zones in the Site Region

Tectonic Zones	Historical Earthquake (1777–1986)	Earthquake (1986–2002) m_b < 3.9	EPRI Maximum Earthquake Magnitude (Mw)
Appalachian Mountains	9	1	5.4–7.2
Ouachita Orogenic Belt	18	3	5.1–7.5
Arkoma and Black Warrior Basins	2	0	5.1–7.5
Reelfoot Rift	-	-	5.0–7.5
New Madrid Seismic Zone	-	-	7.1–7.9
Gulf Coast Basin	-	-	4.2–7.5
Pickens-Gilberttown and Southern Arkansas Fault Zones	6	1	4.2–7.5
Saline River Source Zone	9	3	6.0–7.0

Appalachian Mountains

The Appalachian Mountains extend from Newfoundland, Canada, to central Alabama. The Appalachian Mountains consist of a southwest-trending complex of folded, thrust, and metamorphosed terrains that developed over a period of approximately 800 million years. The mountains are approximately 2000 miles long and 400 miles wide. Structures of the Appalachian Mountains extend into the northeastern subsurface of the site region. The distance between the southern end of the Appalachian Mountains and the site is about 150 miles. Many Paleozoic thrust faults of regional extent exist within the Appalachian Mountains, but none of these faults have geological evidence of Quaternary activity. No distinct faults are identified as individual seismic sources within the Appalachian Mountains in the site region. Within the site region, only nine earthquakes with m_b 3.3–3.9 have occurred from

1777–1986. One earthquake with m_b less than 3.9 occurred within the subsurface extent of the Appalachian Mountains beneath the site region during the period from 1986–2002. Another earthquake of moment magnitude (Mw) 4.9 occurred in April 2003 within the Appalachian Mountains, outside the site region. The event occurred at a depth of 3 miles with a strike-slip mechanism and did not trigger any monitoring instrument at GGNS. Table 2.5.1-1 summarizes the historical seismic activity and relevant modeling parameters of the Appalachian Mountains.

Ouachita Orogenic Belt

The Ouachita Orogenic Belt is the eroded core of a mountain belt that formed as a result of an episode of continental collision and formation of the Pangea supercontinent during the Paleozoic Era. The Ouachita Orogenic Belt consists of complexly folded, thrust-faulted, and metamorphosed rocks, including accreted oceanic crust of Proterozoic age. The belt is approximately 1260 miles long and 50 miles wide, and 80 percent of its length is buried underneath Mesozoic and Tertiary sediments of the Gulf Coast Basin. Inside the site region, the southeastern Ouachita Orogenic Belt lies underneath the subsurface of northern Mississippi and southwestern Alabama. The closest distance between the southeastern end of the belt and the site is about 80 miles. The belt defines the northern edge of the Gulf Coast Basin, the southern margin of the Mississippi embayment, and the southern edge of the North American craton. The Ouachita Orogenic Belt was tectonically active until the late Paleozoic Era. The orogenic belt is in contact with a major decollement, along which marine sedimentary rocks from other plates thrust northward over the North American cratonic rocks. None of the large regional Paleozoic thrust faults inside the Ouachita Orogenic Belt display geological evidence of Quaternary activity, except some potential Quaternary active faults located in the southern part of the belt. Table 2.5.1-1 summarizes the historical seismic activity and relevant modeling parameters of the Ouachita Orogenic Belt.

Arkoma and Black Warrior Basins

The Arkoma and Black Warrior basins are located near the northern margin of the site region. Both basins contain sedimentary rocks associated with the Ouachita Orogenic Belt. The closest distance between the Arkoma and Black Warrior Basins and the site is about 260 kilometers. The major thrusting deformation for the basins ceased in the late Paleozoic to the early Mesozoic time period. The applicant did not identify any active tectonic features within the Arkoma and Black Warrior Basins, based on its review of previous research results. However, a swarm of small earthquakes with magnitudes less than 4.5 occurred in central Arkansas within the Arkoma Basin, just outside of the site region. Research results cited by the applicant indicate that this Enola earthquake swarm correlated spatially with a 1.6-mile-long, west-northwest-trending fault segment, relating to a basement listric fault. Favorable orientation between the basement listric fault and the current compressive stress may have caused the earthquake swarm. However, the applicant stated that large earthquakes will probably not occur in the area because two groups of faults intersect each other within the area (Schweig, E.S., R.B. Van Arsdale, and R.K. Burroughs, "Subsurface Structure in the Vicinity of an Intraplate Earthquake Swarm," 1991). Table 2.5.1-1 summarizes the historical seismic activity and relevant modeling parameters of the Arkoma and Black Warrior Basins.

Reelfoot Rift

The Reelfoot Rift represents a northeast-trending fault system that originated in Precambrian or early Cambrian time during the extension of the North American continent. The rift extends from southern Illinois at the northern end of the Mississippi embayment to east-central Arkansas and northern Mississippi. The Reelfoot Rift is approximately 45 miles wide and 180 miles long with as much as 25,000 feet of structural relief. The closest distance of the faults within the Reelfoot Rift and the site is approximately 175 miles. Magnetic anomalies that were caused by intrusive rocks define the boundaries of the rift. The rift contains a number of active tectonic features, including its own two margins, the Commerce Geophysical Lineament and the NMSZ, the primary seismic active area near the site region. The rift experienced numerous uplifts, subsidence, magma intrusions, and sedimentations. The seismic activity within the Reelfoot Rift is diffuse. Table 2.5.1-1 summarizes the historical seismic activity and EPRI modeling parameters for the Reelfoot Rift.

New Madrid Seismic Zone

The NMSZ extends from southeastern Missouri to northeastern Arkansas and northwestern Tennessee. The NMSZ is located within the Reelfoot Rift, and it experienced post-Eocene to Quaternary faulting and historical seismicity. The closest approach of the faults within the NMSZ to the site is approximately 260 miles. Although the NMSZ is outside the site region, it contributes significantly to the seismic hazard of the site. Rather than characterize the seismic potential of the known faults within the NMSZ, EPRI defines the NMSZ as an aerial source zone that is approximately 124 miles long and 25 miles wide. The NMSZ consists of three major fault segments—a southern, northeast-trending dextral slip fault, referred to as the Cottonwood Grove fault and Blytheville Arch; a middle, northwest-trending reverse fault, referred to as the Reelfoot fault; and a northern, northeast-trending dextral strike-slip fault, referred to as the East Prairie fault. Three large earthquakes occurred in 1811 and 1812 on each of these three faults. The estimated magnitudes of these earthquakes range from Mw 7.1–8.4, based on regional reports of damage intensity and the distribution of liquefaction features. The 1986 EPRI model defines magnitude ranges from Mw 7.3–8.7. The applicant stated that dates of paleoliquefaction and cross-cutting geological features suggest that the recurrence interval of a 1811–1812-type earthquake is 200–800 years, with a preferred estimate of 500 years. This recurrence estimate is significantly shorter than the 5000 years determined in the 1986 EPRI study. Table 2.5.1-1 summarizes the historical seismic activity and EPRI modeling parameters for the NMSZ.

Gulf Coast Basin

The Gulf Coast Basin is a north-south-trending syncline, approximately 280–400 miles wide, extending from eastern Texas to western Alabama and Florida and from southern Arkansas to the Gulf Coast. Bounded in the north by the Ouachita Orogenic Belt and in the east by the Appalachian Mountains, the Gulf Coast Basin defines a deep depression that contains more than 50,000 feet of Mesozoic and Cenozoic sediments. The ESP site is located inside the Gulf Coast Basin. Since post-Jurassic continental rifting and formation of the Gulf of Mexico, sedimentation is the dominant process for the basin. The amount of sediments transported to the Gulf Coast Basin exceeded the volume that could be accommodated through basin subsidence and infilling; therefore, the sedimentary complex migrated southward over 250 miles. Development of a series of growth faults, defining the margins of unstable shelves, marked each depocenter shifting. Current growth faults are located along the Cretaceous shelf edge in the vicinity of the modern Gulf Coast, 90 miles south of the ESP site. Table 2.5.1-1 summarizes the historical seismic activity and EPRI modeling parameters for the Gulf Coast Basin.

Pickens-Gilberttown and Southern Arkansas Fault Zones

The Pickens-Gilberttown and Southern Arkansas Fault Zones are a system of faults extending from southwestern Alabama though west-central Mississippi to southern Arkansas and eastern Texas. The Pickens-Gilberttown and Southern Arkansas Fault Zones consist of a series of grabens developed in Paleozoic to middle Tertiary deposits on the southward side of the Ouachita Orogenic Belt. The fault zones are more than 500 miles long and 25 miles wide. The closest approach of faults within the Pickens-Gilberttown and Southern Arkansas Fault Zones to the site is approximately 70 miles. The fault zones offset Miocene sediments by as much as 200 feet and pre-Miocene deposits by as much as 1000 feet. However, the applicant stated that the Pliocene and younger deposits are intact, which indicates that the fault zone has not been active since the Miocene Epoch. The Pickens-Gilberttown and Southern Arkansas Fault Zones formed through gravitational collapse caused by the uneven loads in the Tertiary Gulf Coast Plain, analogues to the currently active gulf margin normal faults. Very little seismicity exists along the Pickens-Gilberttown and Southern Arkansas Fault Zones. Table 2.5.1-1 summarizes the historical seismic activity and EPRI modeling parameters for the fault zones.

Saline River Source Zone

The SRSZ is located in southeastern Arkansas and northwestern Mississippi, with a minor extension into northern Louisiana. The SRSZ lies inside the Ouachita Orogenic Belt and structurally overlies the southwestward subsurface extension of the Proterozoic Reelfoot Rift. The closest approach of faults within the SRSZ to the site is approximately 175 miles. The applicant stated that Cox (Cox, R.T., "Investigation of Seismically-Induced Liquefaction in the Southern Mississippi Embayment," National Earthquake Hazards Reduction Program, Final Technical Report No. 01HQGR0052, U.S. Geological Survey, Reston, Virginia, 2002) identifies the SRSZ based on combined, although nonconclusive, evidence from geomorphology, geology, and paleoseismology. Geomorphic evidence includes asymmetry of drainage basins and the relative locations of terraces probably caused by the southwestward migration of the Ouachita, Saline, and Arkansas Rivers. Trenching and road-cut exposures show possible post-Eocene and Quaternary faulting. The vertical slip rates estimated from the incision of streams into terraces range from 0.05–1.7 millimeters per year (mm/yr). Paleoliquefaction evidence includes sand dikes found at three sites in Ashley County and Kelso in Desha County. The applicant established an earthquake chronology for the area based on liquefaction events identified through stratigraphic and cross-cutting relationships, as well as datable materials found in those sites. A four-event scenario resulted in a return period of 1725 years, and a five-event scenario resulted in a return period of 388 years for the seismic zone. The difference between minimum and maximum dated events produces an upbound recurrence interval of 3500 years. The estimated slip rates for the SRSZ range from 0.05–1.7 mm/yr based on estimates of incision rates, and range from 0.008–0.03 mm/yr based on measured fault displacement.

According to the applicant, if local events induced the liquefaction distribution, the estimated maximum magnitude for the SRSZ ranges from 5.5–6.0 based on the area of liquefaction distribution. However, if the New Madrid seismic events caused the liquefaction, the SRSZ will lack supporting grounds because the evidence from geology and geomorphology is not conclusive and may alternatively be explained by activity along the Reelfoot Rift or even nontectonic processes. Table 2.5.1-1 summarizes the historical seismic activity and EPRI modeling parameters for the SRSZ.

The applicant cited the data extensively from Cox in describing the SRSZ. In RAI 2.5.1-3, the NRC staff asked the applicant to explain the degree to which the latest findings of Cox and others (Cox, R.T., Larsen, D., Forman, S.L., Woods, J., Morat, J., and Galluzzi, J., "Preliminary Assessment of Sand Blows in the Southern Mississippi Embayment," Bulletin of the Seismological Society of America, 2004) are consistent with the applicant's characterization of the SRSZ. In response, the applicant stated that it established the earthquake chronology and recurrence based on the observed stratigraphic relationships reported in Cox and associated radiocarbon dates provided by Cox and finally published by Cox and others (Cox, et al., 2004). The applicant also described that it used two standard deviations, instead of the single standard deviation employed by Cox, to account for the full range of uncertainty. Further, according to the applicant, Cox did not present in his publications a detailed event history that can be used to assess the recurrence intervals. The staff also asked the applicant in RAI 2.5.1-3 to explain whether the large sizes of the sand blows and their positioning at or close to the edge of their liquefaction distribution are consistent with the moderate magnitudes estimates. In its response, the applicant stated that the lack of geotechnical data at the SRSZ does not allow for a complete analysis to estimate the magnitudes for the paleoearthquakes, but the area of the liquefaction distributions are consistent with the moderate earthquake estimated for the source zone.

The staff also asked the applicant in RAI 2.5.1-3 to explain the source of SSAR Table 2.5-5 and provide the reasoning for the values listed in Tables 2.5-5 and 2.5-6. The staff specifically asked the applicant to provide a link between the events listed in SSAR Section 2.5.1.1.5.9.3 and Table 2.5-5. In its response, the applicant stated that the chronologic liquefaction events provided in Table 2.5-5 are based on the summary of all the identified events dated by carbon-14 and other dependable methods. Among them, one to three possible events occurred at the Portland site, two to four events took place at the Montrose site, and three events happened at the Kelso site. The applicant explained that it estimated the average recurrence intervals based on the possible number of liquefaction events and the minimum and maximum allowable time in which these events could occur. The interpretation assumes that all of the liquefaction features could have occurred as a result of four or five local events in the SRSZ. The applicant revised SSAR Section 2.5.1 as the result of this RAI and added four new figures to further illustrate the process to establish an earthquake chronology for the area. Finally, the staff asked the applicant to explain the availability of the paleoliquefaction dates from the Morgan and Golden trenches with respect to the finishing date of the SSAR and the impact of the new paleoliquefaction dates on the conclusions in the SSAR. In response, the applicant stated that it reviewed new data from the Golden and Morgan sites after they became available. It found that the precision of age dates for the Golden and Morgan sites is not sufficient to date specific liquefaction events, although the interpreted paleoliquefaction events are consistent with the mid-Holocene events identified at the Montrose and Kelso sites.

In RAI 2.5.1-4, the staff asked the applicant to explain the impact of the remote source scenario that attributes liquefaction found in the Saline River area near the NMSZ to the magnitude determination of the NMSZ. In its response, the applicant stated that, based on an empirical relationship (Ambraseys, N.N., "Engineering Seismology: Earthquake Engineering and Structural Dynamics," Elsevier Science, 1988) between liquefaction distribution and magnitude, the southern Blytheville Arch segment, with an estimated magnitude range of Mw 7.3–8.1, could produce liquefaction 112–218 miles away from the closest approach of the fault. In addition, the estimated distances should be viewed as minimum estimates because the Ambrasey's relationship (Ambraseys, 1988) is based on a worldwide dataset that includes a majority of plate boundary events with high attenuation rates, while the CEUS is characterized by much lower attenuation rates. Therefore, the Ambrasey's relationship can account for the liquefaction found in southeastern Arkansas.

Nontectonic Structural Features

Nontectonic structural features in the site region and neighboring area include volcanic domes, salt domes, and growth faults. These nontectonic features deformed the sediments at some locations inside the Gulf Coast Basin, where the ESP site is located. The seismic source modeling process for the ESP site did not include any of these nontectonic features.

Volcanic domes are the main nontectonic features in or near the site region. The two most prominent volcanic domes located in the site region are the Jackson Dome and Monroe Uplift. The Jackson Dome is a circular volcanic plug with a 16-mile diameter, located at the southern margin of the Mississippi embayment near the city of Jackson. The center of the dome is about 62 miles away from the site. The dome became active in the early Cretaceous Period, continued to rise through post-Oligocene time, and has a total structural relief of about 10,000 feet. Radiometric dating shows a possible long-term quiescence in its active history. Seismic line interpretation reveals several faults associated with the dome (Dockery, D.T., III, and Marble, J.C., "Seismic Stratigraphy of the Jackton Dome," Mississippi Geology, 1998). The Monroe Uplift is a volcanic dome that straddles southern Arkansas, northern Louisiana, and west-central Mississippi. The center of the uplift is about 75 miles away from the site, and the uplift is characterized by the arching of strata above a deep-seated igneous intrusion. The Monroe Uplift became active in the Jurassic Period and experienced continued movement into post-Miocene time. The uplift has no surface expression.

Salt domes are located in the Interior Salt Basin and the Coastal Salt Basin within the Gulf Coastal Plain. The source of the salt is the Middle Jurassic Louann Salt in the Interior Salt Basin and the Coastal Salt Basin. Salt migration structures are concentrated in a zone approximately 156 miles wide extending from southwestern Alabama to eastern Texas. The migration of salt produced anticlines, diapiric folds, and piercement domes. The source depth for the Louann Salt in this area is approximately 15,000 feet and becomes progressively deeper to the south. The closest salt dome, the Bruinsburg Dome, is approximately 6.5 miles from the ESP site. Salt domes within the Interior Salt Basin have not been active since the Oligocene Epoch. Salt domes in the Coastal Salt Basin formed in the Miocene Epoch have been active through the Quaternary Period and deform the ground surface.

Gulf margin normal faults, which are located in the southern margin of the Gulf Coast Basin, include the Tepetate-Baton Rouge, Denham Springs-Scotlandville, and Lake Hatch faults, as well as many unnamed faults. These normal faults generally trend east-west, and the closest fault is approximately 90 miles from the ESP site. The Louann Salt forms a sliding layer on which the overlying sedimentary section has mobilized, forming a series of Tertiary and Quaternary growth faults. These faults associated with Louann Salt generally dip between 50 and 70 degrees at the surface and less than 50 degrees at depth. The current gulf margin normal faults are located along the subsurface Cretaceous shelf edge and experience high rates of aseismic slip.

Regional Seismicity. The applicant stated that historic seismicity in the region is mostly concentrated in the Reelfoot Rift and the NMSZ, which are underlain by crystalline rocks of the North American craton. Small-magnitude earthquakes also occur along the general trend of the Ouachita Orogenic Belt and Appalachian Mountains. The historic seismic rate is very low inside the site region. Since 1777, records indicate 1 earthquake of approximately m_b 3.3–3.9 within 90 miles and 39 earthquakes of m_b greater than 3.3 within 200 miles of the site. No earthquakes were ever recorded in the site vicinity during the same period.

In Sections 2.5.1 and 2.5.2 of the SSAR, the applicant described its use of an earthquake catalog with a magnitude cutoff of m_b 3.3. In RAI 2.5.1-1, the staff asked the applicant to explain whether this magnitude cutoff of m_b 3.3 resulted in excluding seismicity along the Gulf Coast of Louisiana and a 1927 earthquake of m_b 3.0 west of Jackson, Mississippi. In addition, the staff asked the applicant to explain the absence of an earthquake of m_b 3.4 in Jackson, Mississippi. As a result of the RAI, the applicant revised the regional seismic catalog with a lower cutoff magnitude of m_b 1.0 and modified the appropriate text and replaced the relevant tables and figures in the SSAR.

In RAI 2.5.1-2, the staff asked the applicant to provide scientific evidence for its statement, “This low rate of activity has characterized the seismicity of the Gulf Plain for over 150 years, and most likely throughout the Quaternary.” In its response, the applicant stated the following:

> The statement was intended to highlight the fact that rates of both earthquake occurrence and tectonic deformation in the site region are extremely low. The Gulf Coast Plain has been characterized by extremely low rates of tectonic deformation with post-Cretaceous deposits on the limbs of the Gulf Coast Syncline dipping less that 0.5 degrees. Based on the low rates of tectonic deformation that have occurred over a period of tens of millions of years and the low rates of seismic activity over the last 150 years, we infer that these rates were most likely also characteristic of Quaternary period.

2.5.1.1.2 Site Geology

Section 2.5.1.2 of the ESP application describes the geologic information of both the site area (8 kilometers) and the site location (1 kilometer) 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.

Site Physiography and Geomorphology. SSAR Section 2.5.1.2.1 describes the site physiography and geomorphology of the site area, including the site location. According to the applicant, the ESP site is approximately 1.1 miles east of the Mississippi River and adjacent to the Mississippi River floodplain. The boundary between the Mississippi Alluvial Valley and Loess Hills physiographic subprovinces, marked by a 65–80-foot-high, north-trending erosional escarpment at the edge of the Mississippi River floodplain, strides the site location. Steep-walled stream valleys, flat-topped ridgelines, and dendritic (tree-patterned) drainage systems are the main topographic features of the Loess Hills subprovince. Large river terraces occur along the river floodplains and valley bottoms. Floodplain, cut-banks, point bars, and oxbow lakes characterize the surface of the Mississippi River Valley, and the topography of the valley is relatively flat. The applicant further stated that the radius of the site location does not extend to the active channel of the Mississippi River. The proposed facility location is bounded on the east by existing internal plant roads and parking lots, on the west by the erosional escarpment at the edge of the Mississippi River floodplain, and on the north and south by two ravines that drain the location.

Site Geologic History. SSAR Section 2.5.1.2.2 describes the geologic history of the site area, including the site location. According to the applicant, the geologic formations underlying the site area and site location include both marine and terrestrial sediments that reflect distinct changes in depositional environments, climatic conditions, and glacial-eustatic cycles over the past 36 million years. Deposits of at least Oligocene age (37–24 Ma) and younger dip very gently southward and are laterally continuous across the site region. The applicant concluded that these deposits are relatively intact and thus document a long-term tectonic stability.

The Oligocene deposits in the site area, represented by the Glendon Limestone and Byram Marl Formations of the Vicksburg Group, reflect a shallow marine seas environment. The Glendon Limestone occurs at a depth of approximately 300 feet beneath the site. The Byram Marl Formations were overlain by the late Oligocene Bucatunna Clay Formation, indicating a transition to a deep-water or estuarine environment. These Oligocene sedimentary deposits are in contact unconformably with the Miocene (24–5 Ma) Catahoula formation, which consists mainly of silty to sandy clay, clayey silts, and sands. The Catahoula formation represents a marginal shoreline depositing environment. Because coarse sands and gravels of the Pliocene and Pleistocene Epochs unconformably overlie the top of the Catahoula formation, the applicant determined that the marginal shoreline environment migrated into an alluvial environment during the Pliocene (5–1.8 Ma) and Pleistocene (1.8–0.11 Ma) Epochs. Wisconsin-age glacial cycles that supplied a large volume of sediments to the Mississippi Alluvial Valley led to the deposition of sediments of the late Pleistocene terraces, Upland Complex. During the late Pleistocene Epoch, the main deposits in the area were loess deposits, which consist mainly of fine-grained sediments transported by wind. The average thickness of the loess in the site location is approximately 65 feet. Tributary streams to the Mississippi River eroded the loess deposits during the Holocene Epoch. Meanwhile, the Mississippi River floodplain in the western part of the site area and site location also accumulated alluvial sediments. Deposition of alluvial deposits during peak glacial outwash may have changed local base levels of erosion, blocking stream outlets and leading to the ponding or deposition of silt and alluvium tributary valleys. The applicant further stated that the subsequent drop in the river level during the current interglacial period may have caused the incision and formation of the terrace remnants along Bayou Pierre and the Big Black River.

Site Geologic Conditions. SSAR Section 2.5.1.2.3 describes geologic conditions of the site area, including the site location. The applicant stated that the Quaternary (including both Holocene and Pleistocene) deposits in the site area and site location include gravels, sands, silts, clays, and loess formed by fluvial processes along the river system and eolian processes along the eastern margin of the Mississippi Alluvial Valley. Specifically, the Holocene fluvial deposits are located on the floodplain of the Mississippi River, the alluvium and terrace deposits are located in tributary valleys, and the colluvium is located along hill slopes in the Loess Hills. The thickness of the Holocene deposits in the site area ranges from 22–182 feet. Terrace and loess deposits are two types of Pleistocene deposits in the site area and site location. Terrace deposits occur in the site area along the Loess Hill bluff, Bayou Pierre, and small tributary streams. The terraces occur at three elevation levels—140, 160, and 180 feet, respectively. The location of the prospective reactor lies on an inferred late-Pleistocene terrace surface at an elevation of approximately 150 feet. Beneath the terrace deposits lie the loess deposits with a thickness of up to 75 feet. Three Pleistocene-age loess sheets occur between Vicksburg and Natchez in the site vicinity. The loess deposits are up to 100-feet thick and consist of yellowish-brown, medium-stiff, sandy to clayey silt with a weak block structure. The loess deposit lies on top of the coarse-grained alluvial sand and gravel deposits of the Upland Complex.

Including the Upland Complex, all the Tertiary deposits do not reach to the surface in the site area. The youngest Tertiary deposits, the Upland Complex, consist of two alluvial layers beneath the proposed site. The upper alluvial deposit is located at an elevation of 68–71 feet with a thickness of about 46–85 feet and consists of light-gray to brownish-yellow sand and silty sand. The silty sand consists of fine- to medium-grained, well-sorted quartz grains with silt and is massive, dense, and friable. The lower alluvial deposit is located between elevations of 24–14 feet and ranges from 11–89 feet in thickness across the proposed site, which consists of stratified, thinly bedded sands, silty clays, and gravels. Immediately beneath the Upland Complex lies the Miocene Catahoula formation, a combination of hard to very hard silty to sandy clay, clayey silt, and sand. The formation occurs at depths of 125–175 feet in the site area. The Catahoula formation would serve as the load-bearing stratum for the nuclear plant structures at the ESP site. Beneath the Catahoula formation lies the Vicksburg Group, the upper part of the Oligocene deposits. The Vicksburg Group mainly consists of clay, marl, limestone, and calcareous clays.

Site Structures. SSAR Section 2.5.1.2.4 describes the structure of the site area, including the site location. The applicant focused on active faults and other structures in the site area but found no indication of tectonic deformation since the Oligocene period.

Faults and Unconformities

The applicant stated that field mapping found no faults within the 8-kilometer radius of the site area. The lateral continuity of subsurface stratigraphy demonstrates the tectonic stability of the site area and site vicinity from at least the Oligocene time, about 37 Ma to present. The top of the Glendon Limestone Formation of the Vicksburg Group shows no morphology indicative of tectonic deformation. The top of the Catahoula formation and the top of the Upland Complex also show no morphology indicative of tectonic deformation. No new information available since the licensee's original investigations for GGNS suggests the presence of faulting within the site area. Most contacts among the subsurface deposits in the site area and site location are erosional unconformities, except for the conformable contact between the Oligocene Glendon Limestone and the Byram Marl Formation of the Vicksburg Group.

Other Structures

The site is located along the northern margin of the Mississippi Salt Basin. However, no salt domes occur in the site area or site location. The nearest salt dome is the Bruinsburg Dome located 6.5 miles southwest of the site. The depth to the salt of the Bruinsburg Dome is 2200 feet. The Bruinsburg Dome has unwarped the Glendon Limestone strata in the site vicinity but does not affect the Miocene Catahoula formation.

Conditions Caused by Human Activity

According to the applicant, no mining or underground mineral extraction activities are near the site and no petroleum producing area is within 10 miles of the site. Ground water extraction is nominal in the area; no zones of observed ground water level depression are present within 5 miles of the site. The applicant also noted that it did not expect significant future mineral and underground water extraction activity in the area.

2.5.1.2 Regulatory Evaluation

SSAR Section 2.5.1 reviews and summarizes the geological and seismological characteristics of the ESP site progressively from a regional scale to the local site. According to the applicant, its assessment addresses the requirements in 10 CFR Part 52. The applicant also stated that it performed the analyses in accordance with the requirements for development of the SSE ground motions provided in Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50 and conformed to the criteria set forth in 10 CFR 100.23. The applicant also performed its analyses following the guidelines in RG 1.165; RG 1.132, Revision 1, "Site Investigations for Foundations of Nuclear Power Plants," issued March 1979; and RG 1.138, "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants," dated April 30, 1978. To satisfy the requirement in 10 CFR 100.23, the applicant described the geological and seismological characteristics of the ESP site to allow an adequate evaluation of the proposed site, to provide sufficient information to support the SSE estimates, and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. The staff notes that GDC 2 applies to this portion of the review of an ESP application only with regard to consideration of the most severe natural phenomena reported for the site (in this case earthquake), including margin.

In reviewing the SSAR, the staff considered the regulations at 10 CFR 52.17(a)(1)(vi) and 10 CFR 100.23(c), which require that the applicant for an ESP describe the seismic and geologic characteristics of the proposed site. In particular, 10 CFR 100.23(c) requires that an ESP applicant investigate the geological, seismological, and engineering characteristics of the proposed site and its environs with sufficient scope and detail to support evaluations to estimate the SSE and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the site. Section 2.5.1 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," issued 1997, RG 1.165, and Section 2.5 of RG 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants–LWR Edition," November 1978, provide specific guidance concerning the evaluation of information characterizing the geology and seismology of a proposed site.

2.5.1.3 Technical Evaluation

This section of the SER provides the staff's evaluation of the geological and seismological information submitted by the applicant in SSAR Section 2.5.1. The technical information presented in Section 2.5.1 of the application resulted from the applicant's surface and subsurface geological and seismological investigations performed in progressively greater detail as these investigations approached the site. Through its review, the staff determined whether the applicant complied with the applicable regulations and conducted its investigations with an appropriate level of thoroughness, as required by 10 CFR 100.23. SSAR Section 2.5.1

contains the geologic and seismic information gathered by the applicant in support of the vibratory ground motion analysis and site SSE spectrum provided in SSAR Section 2.5.2. According to RG 1.165, applicants may develop the vibratory design ground motion for a new nuclear power plant using either the EPRI or LLNL seismic source models for the CEUS. However, RG 1.165 recommends that applicants update the geological, seismological, and geophysical database and evaluate any new data to determine whether revisions to the EPRI or LLNL seismic source models are necessary. As a result, the staff focused its review on geologic and seismic data published since the late 1980s that could indicate a need for changes to the EPRI or LLNL seismic source models.

To thoroughly evaluate the geological and seismological information presented by the applicant, the staff obtained the assistance of USGS. In addition, the staff and its USGS advisors visited the ESP site and surrounding area to evaluate and confirm the interpretations, assumptions, and conclusions presented by the applicant concerning potential geologic and seismic hazards. The staff's review focused on the applicant's characterization of the regional and local geologic structure and seismic potential.

2.5.1.3.1 Regional Geology

The staff focused its review of SSAR Section 2.5.1.1 on the applicant's description of the regional geologic and tectonic setting of the ESP site, with an emphasis on the neotectonics, seismology, paleoseismology, physiography, geomorphology, stratigraphy, and geologic history within a distance of 200 miles from the site.

In SSAR Section 2.5.1.1.1, the applicant described each of the physiographic provinces within the site region, with an emphasis on the Gulf Coast Plain where the ESP site is located. In SSAR Section 2.5.1.1.2, the applicant described the Mississippi embayment and Gulf Coast Basin, two macroscopic geologic features of the ESP site region. In SSAR Section 2.5.1.1.3, the applicant summarized the tectonic evolution starting from the Precambrian Era for major geologic features, focusing more on recent geologic activities. In SSAR Section 2.5.1.1.4, the applicant described the regional stratigraphy of the site region with emphasis on the younger stratigraphy and the major rock units underlying the site. These four SSAR sections describe well-documented geologic information, and the staff concludes that they contain an accurate and thorough description of the regional geology as required by 10 CFR 52.17 and 10 CFR 100.23.

In SSAR Section 2.5.1.1.5, the applicant described the tectonic features included in the EPRI seismic source model from the late 1980s, focusing on the NMSZ and the SRSZ. This model was either updated or included as a new addition to the original EPRI seismic source model. The applicant compared the parameters used in the original EPRI model and parameters obtained from the latest studies and correlated these tectonic features with seismic activities in the region. The applicant summarized the latest geological and seismological studies for the NMSZ, especially the paleoseismological studies that provide the new geometry and estimates on earthquake magnitudes and recurrence intervals for the seismic zone. The applicant described in detail the uncovered geologic, geomorphologic, and paleoseismologic evidence and existing interpretations of the evidence for the SRSZ. In responding to RAI 2.5.1-3, the applicant stated that it used data from Cox and others (Cox, et al., 2004), but expanded from one to two standard deviations to account for the full range of uncertainty in the dates of the paleoliquefaction events. Based on these dates, the applicant established the multiscenario earthquake chronology for the SRSZ. Although the evidence of the SRSZ is not conclusive and the interpretations of the paleoliquefaction events are subjective and ambiguous, the addition of this particular seismic source to the ESP seismic hazard calculation only enhances the conservative estimate of ground motions for the ESP site. With this consideration, the staff concurs with the applicant's conclusions about the characterization of the SRSZ. In responding to RAI 2.5.1-4, the applicant explained that existing magnitude estimates of the NMSZ can account for the liquefaction found in southeastern Arkansas, based on the Ambrasey's relationship (Ambrasey, 1988) between liquefaction distribution and magnitude. The staff concurs with the applicant's conclusion that the liquefaction found in southeastern Arkansas can be accounted for by the existing magnitude estimates of the NMSZ. In reviewing SSAR Section 2.5.1.1.5 and the applicant's responses to the RAIs, the staff concludes that the applicant accurately characterized the tectonic features and their correlations with the regional seismicity, as required by 10 CFR 52.17 and 10 CFR 100.23.

In SSAR Section 2.5.1.1.6, the applicant described the regional seismicity. The applicant concluded that limited earthquake occurrence since 1777 characterizes the ESP site region as a low seismic-activity region, and most earthquake activities are concentrated along the reactivated older tectonic features, such as the Reelfoot Rift zone. Moreover, no faults are mapped within a 90-mile radius, centered at the ESP site. In responding to RAI 2.5.1-1, the applicant explained that it used m_b 3.3 as the magnitude cutoff for the regional earthquake catalog because it is the same cutoff employed in the earthquake catalog in the original EPRI model. As a result of this RAI, the applicant presented a new seismic catalog with a magnitude cutoff of m_b 1.0. Section 2.5.1.1.6 of the SSAR summarizes the applicant's revisions resulting from this RAI. The applicant also responded to RAI 2.5.1-2 by explaining that the observation of no tectonic deformation in the post-Cretaceous deposits in the site area, as well as 150 years of low seismic activity, led it to infer that the low rates were mostly characteristic of the entire Quaternary Period. The applicant indicated that the statement is qualitative in nature and does not affect the assessment of seismic hazard at the ESP site. In reviewing the applicant's response, the staff concludes that this RAI is resolved. Based on its review of SSAR 2.5.1.1.6, in addition to the applicant's responses to the RAIs cited above, the staff concludes that SSAR Section 2.5.1.1.6 provides an accurate and thorough description of the regional seismicity, as required by 10 CFR 52.17 and 10 CFR 100.23.

2.5.1.3.2 Site Geology

The applicant presented surface and subsurface geologic information covering both the site area and site location in SSAR Section 2.5.1.2. In SSAR Section 2.5.1.2.1, the applicant described in detail the spatial relationship between the ESP site and the relevant physiographic provinces inside the site area. In SSAR Section 2.5.1.2.2, the applicant described the site area's geologic evolution since the late Tertiary Period (Oligocene Epoch). The applicant concluded that the geologic formations underlying the area indicate a long history of tectonic stability and the absence of tectonic deformation. Based on its review, the staff concludes that the applicant provided a thorough and accurate description of the surface features and characteristics for the ESP site in support of the ESP application in these two sections.

In SSAR Section 2.5.1.2.3, the applicant described major stratigraphic units since the Oligocene Epoch based on previous and present subsurface investigations. In particular, the applicant characterized the load-bearing stratum for the existing nuclear facility and the prospective facility. In SSAR Section 2.5.1.2.4, the applicant described the geological structures and other structures in the site area based on the analysis of the surface and subsurface layer continuity. The staff concludes, based on its review, that the applicant's SSAR provides an accurate and thorough description of the site area stratigraphy, with emphasis on the younger layers of rock and soils. The staff also concludes that the applicant's description of the geological structures is complete and accurate. Based on RG 1.132, excavation made during construction provides opportunities for obtaining additional geologic and geotechnical data. Therefore, it is necessary to perform geologic mapping of future excavation for safety-related structures, evaluate any unforseen geologic features that are encountered, and notify the NRC no later than 30 days before any excavations for safety-related structures are open for NRC's examination and evaluation. This is **Permit Condition 3.**

In SSAR Section 2.5.1.2.5, the applicant described possible supporting materials for the proposed nuclear facility foundation. After reviewing, the staff concludes that this very brief section only addressed the possible depths and foundation layers for the potential reactor and the applicant's detailed description about subsurface materials is in SSAR Section 2.5.4.

Finally, the applicant discussed potential hazard conditions caused by human activities, such as ground water depression and ground surface stability related to mining activities at the site. Based on its review, the staff agrees with the applicant's assessments and concludes that no potential exists for hazard conditions, such as subsidence or collapse, caused by human activity that could compromise the safety of the site.

In summary, the staff concludes that the contents presented in these six sections regarding the site geology meet the requirements in 10 CFR 52.17 and 10 CFR 100.23.

2.5.1.4 Conclusions

As set forth above, the staff has reviewed the geological and seismological information submitted by the applicant in SSAR Section 2.5.1. On the basis of its review and as described above, the staff finds that the applicant provided a thorough characterization of the geological and seismological characteristics of the site, as required by 10 CFR 100.23. These results provide an adequate review for all the tectonic sources or seismogenic sources that have the potential for seismic impact to the ESP site, either inside the site region or outside of it, but still nearby. In addition, the staff concludes, as described above, that the applicant has identified and appropriately characterized all the seismic sources significant for determining the SSE for the ESP site, in accordance with RG 1.165 and Section 2.5.1 of NUREG-0800, and therefore satisfied, in this respect, the requirements of 10 CFR 100.23(c) and GDC 2. Based on the applicant's geological, geophysical, and geotechnical investigations of the site vicinity and site area, the staff concludes that the applicant has properly characterized the site lithology, stratigraphy, geological history, structural geology, and the characteristics of subsurface soils and rocks. Based on its review of the material presented in SSAR Section 2.5.1, the staff also concludes that the effects of human activity (e.g., ground water withdrawal or mining activity) have no potential to compromise the safety of the site. Therefore, the staff concludes that the proposed ESP site is acceptable from a geological and seismological standpoint and meets the requirements of 10 CFR 100.23.

2.5.2 Vibratory Ground Motion

SSAR Section 2.5.1 describes the regional and local geology and structural background and outlines the major seismotectonic sources and materials in the site region. Based on the background knowledge of the area, SSAR Section 2.5.2 describes the applicant's determination of the ground motions at the ESP site resulting from possible earthquakes inside or even outside the site region. SSAR Section 2.5.2.1 describes the characteristics of seismic sources used in the ESP site seismic hazard calculation. Section 2.5.2.2 presents the procedure for the probabilistic seismic hazard analysis (PSHA) and its results. Sections 2.5.2.3 and 2.5.2.4 of the SSAR describe site characteristics in seismic wave transmission and site responses at the ESP site. Finally, SSAR Sections 2.5.2.5 and 2.5.2.6 summarize the development of the SSE and operating-basis earthquake (OBE) ground motion for the ESP site.

The applicant stated that the information provided in SSAR Section 2.5.2 complies with the procedure recommended in RG 1.165. The four-step procedure includes (1) reviewing the EPRI and LLNL seismic source model and ground motion model, (2) updating these models with new information, (3) performing a new PSHA based on previous updates, and (4) developing the SSE using those updated results with consideration of the site characteristics. In particular, the applicant stated that it adopted the 1986 EPRI-Seismicity Owners Group (SOG) methodology including the seismic source model developed by six earth science teams (ESTs). Based on its review of the latest research, the applicant also added the new SRSZ and the characteristic earthquake model for the NMSZ over the original EPRI seismic source model. In addition, the applicant computed seismic ground motion using the EPRI-SOG new ground motion model (EPRI 1008910, "EUS Ground Motion Project-Model Development and Results," issued August 2003) for the CEUS. Finally, the applicant conducted a site-specific site response analysis to develop the SSE at the ESP site.

2.5.2.1 Technical Information in the Application

2.5.2.1.1 Seismic Source Characterization

SSAR Section 2.5.2.1 describes the characteristics of all seismic sources in the ESP site region. In Section 2.5.2.1.1, the applicant 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 when the model was developed. The applicant addressed two new seismic sources and their associated parameters resulting from the recent studies described in SSAR Sections 2.5.2.1.2 and 2.5.2.1.3, respectively.

<u>Summary of EPRI Seismic Source Model</u>. SSAR Section 2.5.2.1.1 summarizes the original 1986 EPRI-SOG source model and parameters. The applicant stated that six independent ESTs are involved in characterizing CEUS seismic sources in the EPRI project. These ESTs evaluated geological, geophysical, and seismological data to model the occurrence of future earthquakes and evaluate earthquake hazards at nuclear power plant sites in the CEUS. The six ESTs involved in the EPRI project included (1) the Bechtel Group, (2) Dames and Moore, (3) Law Engineering, (4) Roundout Associates, (5) Weston Geophysical Corporation, and (6) Woodward-Clyde Consultants. In 1989, EPRI implemented the results of the seismic source characterizations with modification and simplification from each of the ESTs in a PSHA for nuclear power plant sites in the CEUS. The applicant stated that the parameters used in the 1989 PSHA calculations are the primary source for the seismic parameters used in this ESP calculation. SSAR Tables 2.5-8a through 2.5-8f summarize the seismic source information developed by each of the ESTs for seismic sources in the site region, and SSAR Figures 2.5-39 through 2.5-44 show the geometry of these seismic sources. This source information includes 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 analyses. SSAR Section 2.5.2 does not present earthquake recurrence values for each of the seismic sources because they were computed for each 1-degree latitude and longitude cell that intersects any portion of a seismic source.

In RAI 2.5.2-6, the staff asked the applicant to provide a justification for not updating the EPRI 1986 seismic source characterizations to give more weight to larger magnitude earthquakes for the seismic source surrounding the site, following the 1994 Johnston studies (Johnston, A.C., et al., TR-102261-VI, "The Earthquakes of Stable Continental Regions," 1994). In its response, the applicant stated that the evaluation process of seismic sources by the ESTs is equivalent to a Level 4 analysis recommended by the Senior Seismic Hazard Advisory Committee (1997). The applicant did not find any changes in maximum magnitude, seismicity distribution, or rate of occurrence in reviewing earthquake activity after 1986. In addition, the applicant stated that in the site vicinity, no known Mesozoic and younger tectonic structures exist that may be reactivated, and the site region is underlain by relatively undeformed Cretaceous and younger strata over 10,000 feet thick. The applicant further explained that Johnston's preliminary research results were available to the ESTs and that the individual teams even adopted Johnston's estimate for the maximum magnitude for the Gulf Coastal region. The applicant believed that the uncertainty bounds of the EPRI seismic model encompass the maximum magnitude proposed by the studies of Johnston et al. Based on the information presented, the applicant concluded that Johnston's final results on the background seismic source for the ESP site do not provide new information that would significantly change the maximum magnitude estimates, probability of occurrence, recurrence models, and source geometry of the corresponding source inside the EPRI 1986 seismic source model.

<u>Characterization of the New Madrid Seismic Zone</u>. SSAR Section 2.5.2.1.2 describes the latest seismic and paleoseismic studies and the new parameters of the characteristic model of the NMSZ. The applicant stated that it overlapped the characteristic NMSZ seismic model on the EPRI original aerial source model in the PSHA for the ESP site. A three-fault configuration (the Blytheville Arch fault (New Madrid South), the Reelfoot fault, and the East Prairie fault (New Madrid North)) represents the characteristic NMSZ model. The applicant modeled the NMSZ earthquakes using a point-source model, assuming that the earthquakes occur on the southernmost end of each fault because of the large source-to-site distance. The applicant also noted that dissent exists among different researchers on maximum magnitudes and other parameters for each fault of the NMSZ. The ESP seismic source model adopted results from different researchers by assigning magnitudes and corresponding weights to each fault. The maximum magnitudes and the corresponding weights are Mw 7.3 (0.4), 7.7 (0.5), and 8.1 (0.1) for the Blytheville Arch fault; Mw 7.4 (0.4), 7.6 (0.3), and 8.0 (0.1) for the Reelfoot fault; and Mw 7.0 (0.4), 7.4 (0.5), and 7.8 (0.1) for the East Prairie fault. The applicant modeled three faults rupturing in a cluster of events within a short period of time because the composite nature of sand blows uncovered in the field investigations suggests that the NMSZ earthquakes occurred as an event sequence. Based on combined paleoseismic and paleoliquefaction investigations conducted in the area, the applicant assigned recurrence time and probability for these event clusters of 200 years (0.1), 500 years (0.6), and 800 years (0.3).

One group of the contributors to the above magnitude estimates, Bakun, W.H. and M.G. Hopper, "Magnitudes and Locations of the 1811-1812 New Madrid Missouri, and the 1886 Charleston, South Carolina Earthquake," 2004, revised their magnitude estimates shortly after they submitted their first paper. In RAI 2.5.2-5, the staff asked the applicant to explain and quantify the impact on hazard (annual probability of exceedance (APE) of 10^{-5}) caused by the revised magnitude estimates in Bakun and Hopper's latest publication. In its response, the applicant compared the magnitude estimates before and after the magnitude revision for the three faults of the NMSZ. Before the revision, Bakun and Hopper assigned the maximum magnitudes Mw 7.2, 7.1, and 7.4, respectively, to the New Madrid South, New Madrid North, and Reelfoot Rift. After the revision, the authors had two alternative magnitude models. In Model 1, the magnitudes for the New Madrid South, New Madrid North, and Reelfoot Rift are Mw 7.1 (6.8–7.9), 7.2 (6.8–7.8), and 7.4 (7.0–8.1), and in Model 2, the magnitudes for the New Madrid South, New Madrid North, and Reelfoot Rift are 7.6 (7.2–7.9), 7.5 (7.1–7.8), and 7.8 (7.4–8.1). The authors preferred Model 2. In response to this RAI, the applicant cited the research results from the work of the Exelon Generation Company (EGC) on the Clinton ESP site. After EGC interviewed Drs. Susan Hough, Bill Bakun, and Arch Johnston to obtain the latest information on the magnitude estimate, EGC revised the maximum magnitude assessment for faults within the NMSZ. This revised maximum magnitude estimate for the New Madrid South fault, the closest fault to the Grand Gulf ESP site, is Mw 7.53, compared to the weighted maximum magnitude of Mw 7.58 from this SSAR for the Grand Gulf ESP. The applicant concluded that the magnitude distribution and weighting provided in the SSAR captured the range of uncertainty recognized by the professional community. The EGC also performed a sensitivity analysis using various magnitude estimates on seismic hazard for the Clinton ESP site in Illinois, and the results of median and mean rock hazard for 1 hertz (Hz) hazard curves showed only a 3–4 percent increase because of the revised maximum magnitude estimates. Because the Clinton ESP site is located closer to the NMSZ than to the Grand Gulf ESP site, the applicant concluded that the impact of the magnitude revision to the Grand Gulf ESP site is insignificant. In addition, the applicant noted that this ESP application conservatively used only attenuation relationships for the midcontinent to estimate ground motion, although the ESP site is located inside the extended Mississippi embayment. Ground motions generally attenuate more rapidly within embayment than in midcontinent.

SSAR Section 2.5.2.1.2.4 discusses applying a moment-rate constraint on the large earthquakes (Mw greater than 7) of the NMSZ based on geodetic data. In RAI 2.5.2-2, the staff asked the applicant to justify the application of a moment-rate constraint on the modeling of those large earthquakes, in view of large uncertainties of the physical mechanism behind these earthquakes. The staff also asked the applicant to describe the impact for allowing ruptures into the lower crust, where shear wave velocities, and hence shear modulus, are higher than the shallow crustal values of California. Finally, the staff asked the applicant to explain and justify the assumption and reasoning leading to an estimated rupture area of 1300 square kilometers (km^2) for a rupture of the Reelfoot fault. In its response, the applicant stated that the moment-rate analysis in the SSAR was intended to provide the information regarding the relationship between maximum earthquake magnitudes and earthquake recurrences in the NMSZ and that the information was not used directly to assign or calculate weights for maximum earthquake magnitudes or recurrence intervals in the earthquake hazard analysis. The applicant recognized the uncertainty associated with estimates of the crustal rigidity (shear modulus) and down-dip geometry of the faults inside the NMSZ and that its analysis only intends to provide one model relating to earthquake magnitude and recurrence. However, the applicant stated that the parameters used in the analysis were derived through review of current published and unpublished literature, not from the moment-rate analysis. As a result of this RAI, the applicant deleted Section 2.5.2.1.2.4 from the SSAR.

Saline River Source Zone Characterization. SSAR Section 2.5.2.1.3 details the source parameters for the SRSZ. The applicant described the SRSZ parameters in the order in which they appear in the logic tree of the model (see SSAR Figure 2.5-46)—(1) probability of existence, (2) source geometry, (3) characteristic earthquake magnitude, (4) earthquake recurrence, and (5) characteristic earthquake recurrence model. The applicant stated that the supporting evidence for the SRSZ includes coincidence of liquefaction, sparse seismicity, late Tertiary and possibly Pleistocene fault rupture, and geomorphic asymmetry of drainage basins. However, all these lines of evidence are not conclusive because nontectonic processes could cause an asymmetrical river basin, the background or distant earthquakes could also trigger liquefaction, and active faults are limited in number and in size. Based on this, the applicant assigned a 50-percent probability to the existence of the SRSZ. The applicant defined the SRSZ as an area source encompassing all the geomorphic, liquefaction, seismicity, and geologic evidence that suggests the existence of a localized seismic zone. The northwestern boundary of the SRSZ is defined based on the northern boundary fault of the Reelfoot Rift. The southeastern boundary is defined as the southward projection of the recently identified Reelfoot Rift-related marginal faults. The southwestern boundary is the southern-rifted margin of the North American craton, and the northern occurrence of basin asymmetry along the Arkansas River defines the northeastern boundary. The estimated magnitudes and corresponding weights for the source zone are 6.0 (0.3), 6.5 (0.6), and 7.0 (0.1) based on the extent of the liquefaction features and the observed surface faults. The applicant applied both characteristic and exponential earthquake recurrence models to the SRSZ, but assigned lower weight to exponential (0.1) and higher weight to characteristic recurrence (0.9). For the characteristic recurrence model, the applicant assigned a weight of 0.6 to the recurrence period drawn from paleoliquefaction data and a weight of 0.4 to the recurrence period drawn from fault slip rates. Finally, the applicant stated that the recurrence periods and weights assigned for the characteristic earthquake model varied from 399 (0.2) to 1725 (0.4) to 3500 (0.4) years for each magnitude variable based on paleoliquefaction data. Based on fault slip rate, however, the recurrence periods and weights were 10,000 (0.1), 2,000 (0.3), and 1,000 (0.6) years for magnitude Mw 6.0; 30,000 (0.1), 6,000 (0.3) and 3,000 (0.6) years for magnitude Mw 6.5; and 125,000 (0.1), 25,000 (0.3), and 125,000 (0.6) years for magnitude Mw 7.0.

In RAI 2.5.2-7, the staff asked the applicant to provide the reasoning behind assigning a higher weight (0.6) to the slip rate of 0.05 mm/yr, instead of 0.1 mm/yr for the SRSZ, and choosing the incision rate of 0.05 mm/yr over the other incision rates for the slip-rate estimation. In its response, the applicant stated that the SSAR wrongly reported the rate and weight pair; the correct weights are 0.1, 0.3, and 0.6 for the slip rates of 0.01, 0.05, and 0.1 mm/yr, respectively. The applicant will correct this error in the revised SSAR. The minimum slip rate of 0.01 mm/yr for the earthquake occurrence model is an approximation of 0.008 to 0.03 mm/yr obtained from paleoseismic studies and was assigned a low weight of 0.1. The applicant estimated a middle value of 0.05 mm/yr based on the combination of 0.03 mm/yr, derived from paleoseismic data, and a lower bound (LB) rate of 0.05 mm/yr derived from an incision rate of the 800–1300 ka intermediate Complex terrace. The applicant estimated the upper slip rate of 0.1 mm/yr based on the upper bound (UB) rate of 0.09 mm/yr from incision of the 800–1300 ka intermediate

Complex terrace and the LB rate of 0.3 mm/yr from incision of the 70–120 ka Prairie Complex. The high incision rates in the recurrence model are excluded because these rates, 0.8–1.7 mm/yr and 0.5 mm/yr, are not consistent with other lines of evidence used to approximate the fault slip rates. A number of factors may cause these high rates, such as hydrologic regime changes and mapping uncertainty.

<u>Effect of Updating the Earthquake Catalog on the EPRI-SOG Seismicity Parameters</u>. In SSAR Section 2.5.2.1.4, the applicant noted that, after it updated the EPRI-SOG catalog to include

events from 1985–2002, it found that the updated catalog (1) does not have any event greater than m_b 3.0 which occurred within about 110 miles of the ESP site, (2) does not show any earthquakes within the site region that can be correlated with known geologic structures, (3) does not show a pattern of seismicity that would require significant revision of the EPRI seismic source model, and (4) does not show any increase in the estimated rate of earthquake occurrences. After comparing the frequency of the earthquake occurrence of the original EPRI catalog with the updated catalog, the applicant concluded that it is not necessary to modify the original EPRI seismic parameters because the new catalog shows a slightly lower occurrence frequency. However, the applicant explained that it did not evaluate the seismicity for the NMSZ because it had already established a characteristic earthquake model for the NMSZ. In RAI 2.5.2-4, the staff asked the applicant to elaborate on the magnitude-frequency curve in SSAR Figure 2.5-47 regarding the exceeding magnitude values and the b value (a value used to describe the magnitude distribution) used in the curve. In its response, the applicant stated that the point on the magnitude-frequency curve corresponds to the frequency of exceedance of the magnitude value used to enter the curve, and the b value used to generate the magnitude-frequency curve is 0.91.

2.5.2.1.2 Site Probabilistic Seismic Hazard Analysis

Section 2.5.2.2 of the SSAR describes the procedure of PSHA for the ESP site in (1) source characterization, (2) magnitude conversion, (3) ground motion attenuation models, (4) LB magnitude, and (5) PSHA calculation.

Seismic Source Characterization. SSAR Section 2.5.2.2.1 describes the three seismic sources used in the PSHA for the ESP site. The applicant stated that the PSHA was performed using the EPRI seismic sources listed in SSAR Tables 2.5-8a through 2.5-8f and the new SRSZ and the updated NMSZ. The applicant further stated that it potentially double-counted seismic hazards by overlapping the new SRSZ and the characteristic NMSZ sources over the EPRI original seismic source model to provide a conservative estimate of the seismic hazards for the ESP site.

Magnitude Conversion. In SSAR Section 2.5.2.2.2, the applicant noted that it converted the m_b into Mw to apply the new EPRI attenuation relationships. The applicant used three m_b to Mw conversion relationships—Atkinson and Boore ("Ground Motion Relations for Eastern North America," 1995), EPRI (TR-102293, "Guidelines for Determining Design-Basis Ground Motions," 1993), and Johnston (A.C. Johnston, "Seismic Moment Assessment of Earthquakes in Stable Continental Regions-III. New Madrid 1811-1812, Charleston 1886 and Lisbon 1755," 1996)—with equal weights. In RAI 2.5.2-3, the staff asked the applicant to detail the steps and equations employed in the m_b to Mw conversion and identify where the conversion is performed in the hazard calculation. In its response, the applicant stated that it took the following four steps in converting m_b to Mw in its PSHA computation:

(1) Seismicity parameters for each seismic source are defined in either m_b or Mw. The input parameters for each m_b—Mw relationship also include the probability weight.

(2) As part of the magnitude integration, the applicant determined the occurrence frequency of earthquakes in a magnitude interval using original m_b or Mw input for a seismic source.

(3) The applicant will convert each m_b input into Mw before computing ground motions. The conversion will be made for the central m_b value in a magnitude interval.

(4) The applicant estimated ground motions for a given Mw and distance pair.

These procedures are repeated for each m_b input.

Ground Motion Attenuation Models. SSAR Section 2.5.2.2.3 describes ground motion models used in estimating rock motions at the ESP site. The applicant used the EPRI 2003 ground motion attenuation models. The EPRI 2003 ground motion models provide not only the estimate of the rock motions but also the alternative estimates of the median and aleatory uncertainty in ground motion for the midcontinent and the Gulf region of the CEUS. The applicant stated that the alternative models of the median and aleatory uncertainty, as well as their probability weights, represent the epistemic uncertainty in ground motions. The EPRI 2003 ground motion model is defined for different seismic source types, including general area sources, fault sources, and sources with large earthquakes (Mw greater than 7.0). Furthermore, fault sources can also be divided into rift or nonrift regions. Using the NMSZ as an example, the applicant stated that the midcontinent, rifted ground motion attenuation relationships should be applicable to the NMSZ. There are 12 estimates of the median ground motion, 4 estimates of aleatory uncertainty, and a total of 48 ground motion model estimates. For a general area source model, a total of 36 ground motion estimates exist.

Lower Bound Magnitude. SSAR Section 2.5.2.2.4 describes the LB magnitude used in the PSHA calculation for the ESP site. The applicant stated that it used Mw 5.0 as the LB magnitude to calculate earthquake hazards at the ESP site. This LB magnitude is consistent with the original EPRI 1986 source model.

Probabilistic Seismic Hazard Analysis Calculations. SSAR Section 2.5.2.2.5 describes the PSHA procedures and PSHA results for the ESP site. The applicant stated that it used the upgraded EPRI EQHAZARD software to calculate the seismic hazards for the ESP site. In SSAR Table 2.5-15, the applicant calculated seismic hazard results at different frequencies (0.5 to 25 Hz and peak ground acceleration (pga)) and presented the median 10^{-5} uniform hazard response spectrum (UHRS) for rock conditions at the ESP site. The applicant deaggregated the median hazards for low frequency (1–2.5 Hz) and high frequency (5–10 Hz), following the procedures of the RG 1.165, and presented the results in Figures 2.5.2-1 and 2.5.2-2. The applicant concluded that the results of deaggregation show that the majority of the contribution for both low- and high-frequency hazards is from the characteristic events associated with the NMSZ. The applicant also stated that to reduce the computing time it simplified the procedures of the PSHA by decreasing the number of branches inside the logic tree. The applicant evaluated the sensitivity of the seismic hazards resulting from the simplification and determined that the sensitivity is insignificant, which is demonstrated by the ESP median seismic hazard for spectral accelerations (Sa) of both 1 and 10 Hz in SSAR Figures 2.5-55 and 2.5-56.

In RAI 2.5.2-8, the staff asked the applicant to explain why the mean hazard curves for the frequencies 0.5, 1, 2.5, 5, 10, and 25 Hz are shown above or approximately coinciding with the 0.85 fractile curves for higher Sa (SSAR Figures 2.5-48 through Figure 2.5-54). In its responses, the applicant stated that the results of a PSHA in which the epistemic uncertainty is modeled produce a probability distribution on the estimate of the annual frequency of exceedance of ground motions. The applicant further stated that experience indicates that this

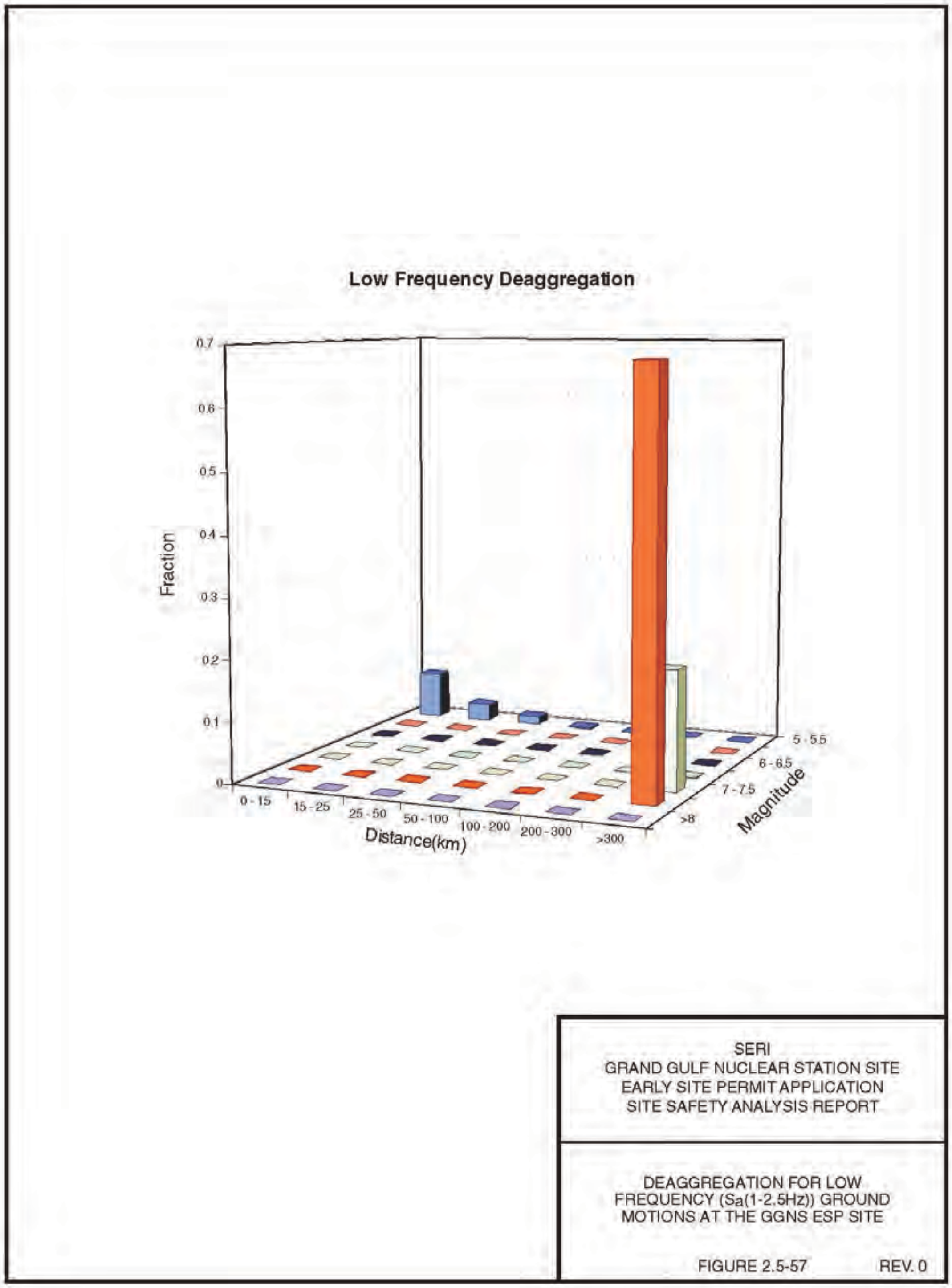


Figure 2.5.2-1 (SSAR 2.5-57) Deaggregation for low-frequency (Sa 1–2.5 Hz) ground motions at the GGNS ESP site

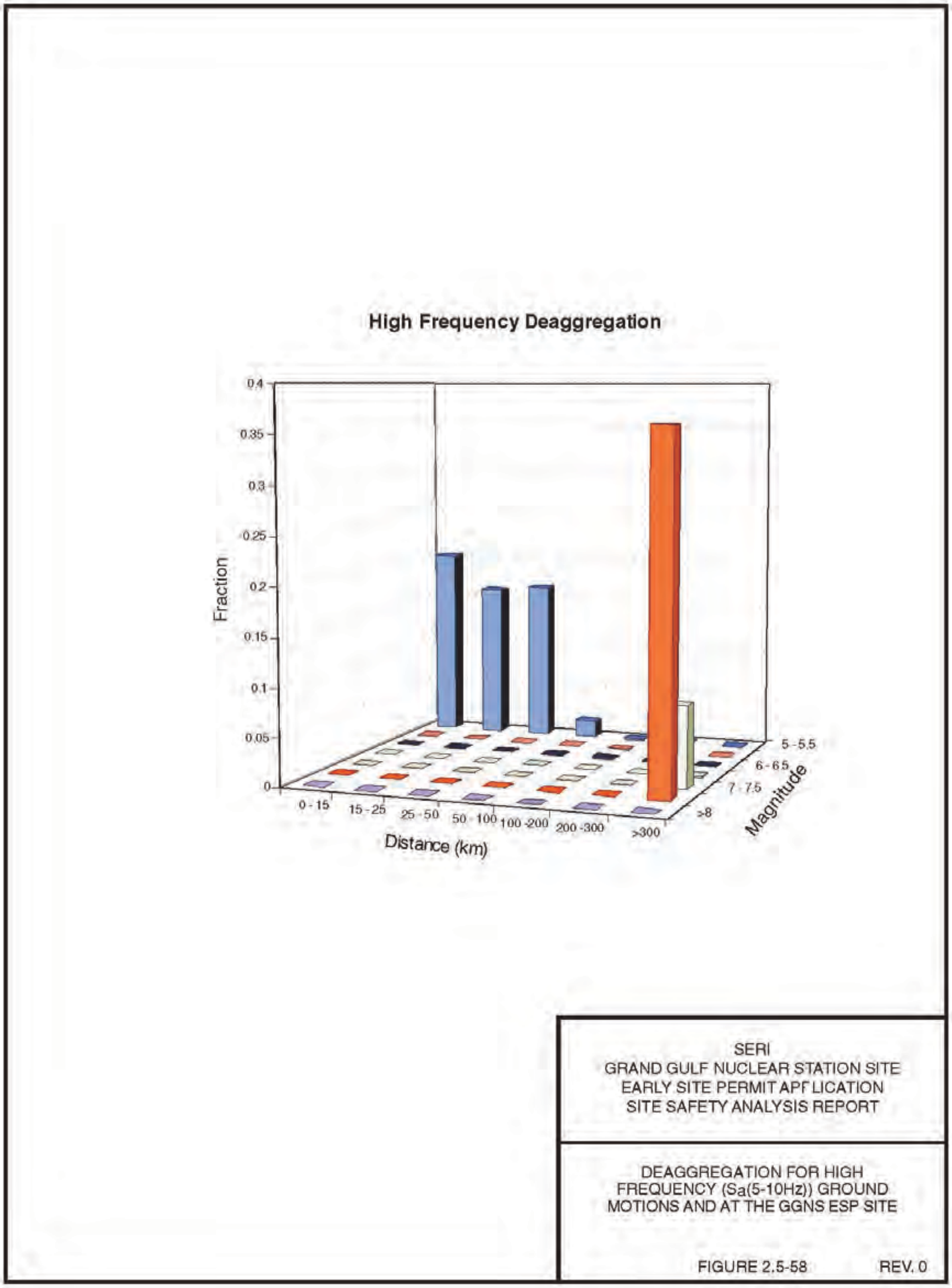


Figure 2.5.2-2 (SSAR 2.5-58) Deaggregation for high-frequency (Sa 5–10 Hz) ground motions at the GGNS ESP site

distribution is not symmetric (i.e., not Gaussian) and is typically skewed and approximately lognormal in shape. As a consequence, the mean of this distribution is skewed (higher) with respect to the median and the degree of skewness is a function of epistemic uncertainty. As the epistemic uncertainty increases, the tendency is for the mean to correspond to higher fractile estimates of the frequency of exceedance.

In RAI 2.5.2-9, the staff asked the applicant to explain why the SRSZ, with a magnitude as large as 6.0–7.0 and a distance at 81–206 miles, makes no contribution to the deaggregation results. In its response, the applicant stated the following:

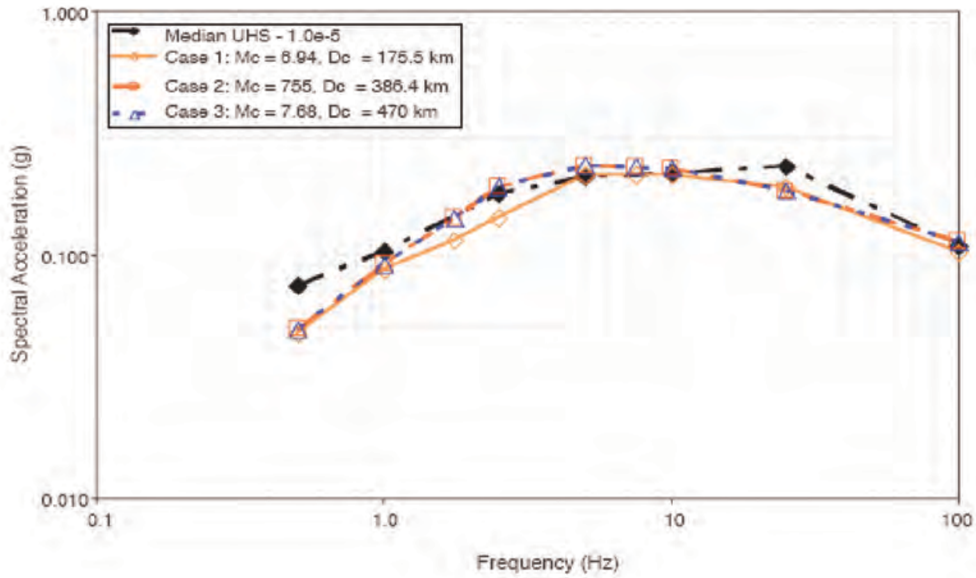
> The purpose of the magnitude-distance deaggregation is to provide a measure of the relative contribution of events (of different magnitude-distance pairs) to the total hazard. The deaggregation graphs in the SSAR show the relative contribution of earthquakes to the 10^{-5} median. The fact that events associated with the Saline River source (and all sources in this distance range) do not contribute to the 10^{-5} median hazard for the Grand Gulf site is primarily due to the fact that the overall rate of earthquake occurrences (Mw > 5) at these distances is extremely low. Further, the rate of occurrence of earthquakes of magnitude 6.0–7.0 is thus much lower. The result is that the estimated ground motion hazard at the Grand Gulf site is extremely low and, in a relative sense, makes little or no contribution to the 10^{-5} median hazard.

<u>Controlling Earthquakes</u>. SSAR Section 2.5.2.2.5.2 describes the controlling earthquakes for the ESP site. The applicant stated that it calculated the controlling earthquakes for low frequency (M=7.55 at 396.4 kilometers) and high frequency (M=6.94 at 175.5 kilometers) following the procedures of RG 1.165. The applicant also calculated the controlling earthquake for low frequency (1–2.5 Hz), but with distances greater than 100 kilometers (Mw 7.68 at 470 kilometers), because the contribution of large, distant events (greater than 100 kilometers) to low-frequency ground motions was greater than 5 percent. Using the EPRI 2003 ground motion model, the applicant determined the shape of the median response spectrum for each controlling earthquake. Figure 2.5.2-3 compares the controlling earthquake spectra and the UHRS. The applicant concluded that the response spectra from the low- and high-frequency-controlling earthquakes are a good approximation of the UHRS for frequencies greater than 1 Hz in terms of both shape and amplitude.

In RAI 2.5.2-10, the staff asked the applicant explain why the magnitude-distance bin, including the controlling earthquake, does not contribute to the high-frequency deaggregation. In its response, the applicant stated that the controlling earthquake for a given frequency range is the mean magnitude and mean distance of the deaggregation distribution. If deaggregation is multimodal or bimodal as in the Grand Gulf case, the resulting mean may not correspond to the magnitude values that are actually defined in the distribution.

2.5.2.1.3 Seismic Wave Transmission Characteristic of the Site

In SSAR Section 2.5.2.3, the applicant described the process to accommodate the surface soil effect on the incoming seismic waves at the ESP site. The applicant also briefly described the site-specific shallow soil profile and a generic deep shear wave profile extending to hard rocks referenced by the EPRI 2003 ground motion attenuation relationships.



SERI
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

COMPARISON OF THE GGNS 10^{-5} MEDIAN UNIFORM HAZARD RESPONSE SPECTRUM AND THE MEDIAN RESPONSE SPECTRA ASSOCIATED WITH THE CONTROLLING EARTHQUAKES

FIGURE 2.5-59 REV. 1

Figure 2.5.2-3 (SSAR Figure 2.5-59) Medium response spectra (10^{-5}) UHRS and controlling earthquakes

As stated in the section, the applicant calculated the ESP site ground motion using the EPRI 2003 ground motion attenuation relationships for CEUS hard rocks. The reference rocks for the EPRI 2003 attenuation relationships are defined as hard rocks with a shear wave velocity of 2.83 kilometers per second (km/s). Rocks with this kind of shear wave velocity only exist at depths exceeding 10,000 feet underneath the ESP site. However, as the applicant stated, the UHRS, and consequently the SSE, define 0.5 Hz as the lowest frequency (EPRI 1993 and PRI

EPRI 2003 ground motion models only extend to 2 seconds) and maximum amplification at 0.5 Hz for a typical deep firm soil profile at a depth of 1000 feet because the soil column to this depth already accommodates the amplification of the interesting frequencies. To be conservative, the applicant also stated that it used a local profile as deep as 3300 feet to calculate the soil amplifications. This local profile consists of a generic profile from about 225 feet to 3600 feet developed from the ground-shaking studies in the Mississippi embayment by the Mid America Earthquake Center (Professor Glenn Rix, personal communication, 2002) and a shallow profile from the surface to a depth of 225 feet based on three suspension log surveys. This shallow profile consists of 75 feet of loess, 85 feet of young alluvium, and 40 feet of old alluvium, as well as 25 feet of Catahoula formation, from the top to the bottom. The generic profile is relatively smooth, with shear wave velocities ranging from 250 meters per second (m/s) to 1000 m/s (see Figure 2.5.2-4).

The applicant also determined nonlinear dynamic material properties G/Gmax and hysteretic damping curves based on the laboratory testing of undisturbed samples taken during the survey. The applicant concluded that the laboratory dynamic test results were similar to the EPRI G/Gmax and hysteretic damping curves for cohesionless soils, which led to the adoption of the EPRI curves.

2.5.2.1.4 Site Response Analysis

In SSAR Section 2.5.2.4, the applicant described the methods it used to calculate the ESP site response and, in particular, the process to accommodate the variability in the shear wave velocity profile. The applicant used Approach 2A (use of two controlling earthquakes, both high and low frequencies, to derive soil spectra) recommended in NUREG/CR-6728 ("Technical Basis for Revision of Regulatory Guidance on Design Ground Motions; Hazard- and Risk-Consistent Motions Spectra Guidelines," 2001) to analyze the site response. The applicant used a controlling earthquake spectra of 1–2 and 5–10 Hz scaled to UHRS as control motions. It applied transfer functions, soil surface to hard rock outcropping, to each controlling earthquake in order to maintain the hazard level of the rock outcrop UHRS while incorporating variability in site-specific dynamic material properties. In order to fully count the uncertainty in the base shear wave velocity profile, the applicant incorporated 60 randomized profiles for each control motion for both shear wave velocity and layer thickness, and the randomization procedure itself came from a variance analysis of over 500 measured profiles. To accommodate variability in modulus reduction and hysteretic damping curves, these curves are also randomized around the base values. The applicant concluded that the resulting mean transfer function for each of two control motions reflects the best estimate (BE) effect of the soil/soft rock column. An upper and lower transaction of two standard deviations is used to prevent physically impossible modulus reduction or damping models. The mean transfer function, for each of two control motions (1–2 Hz and 5–10 Hz), accommodates site-specific variability in dynamic properties and depth to basement material. SSAR Figure 2.5-64 shows two transfer functions, with their envelope for the top of the loess, which correspond to 1–2 Hz and 5–10 Hz control motions. SSAR Figure 2.5-65, which is used to accommodate the effect of

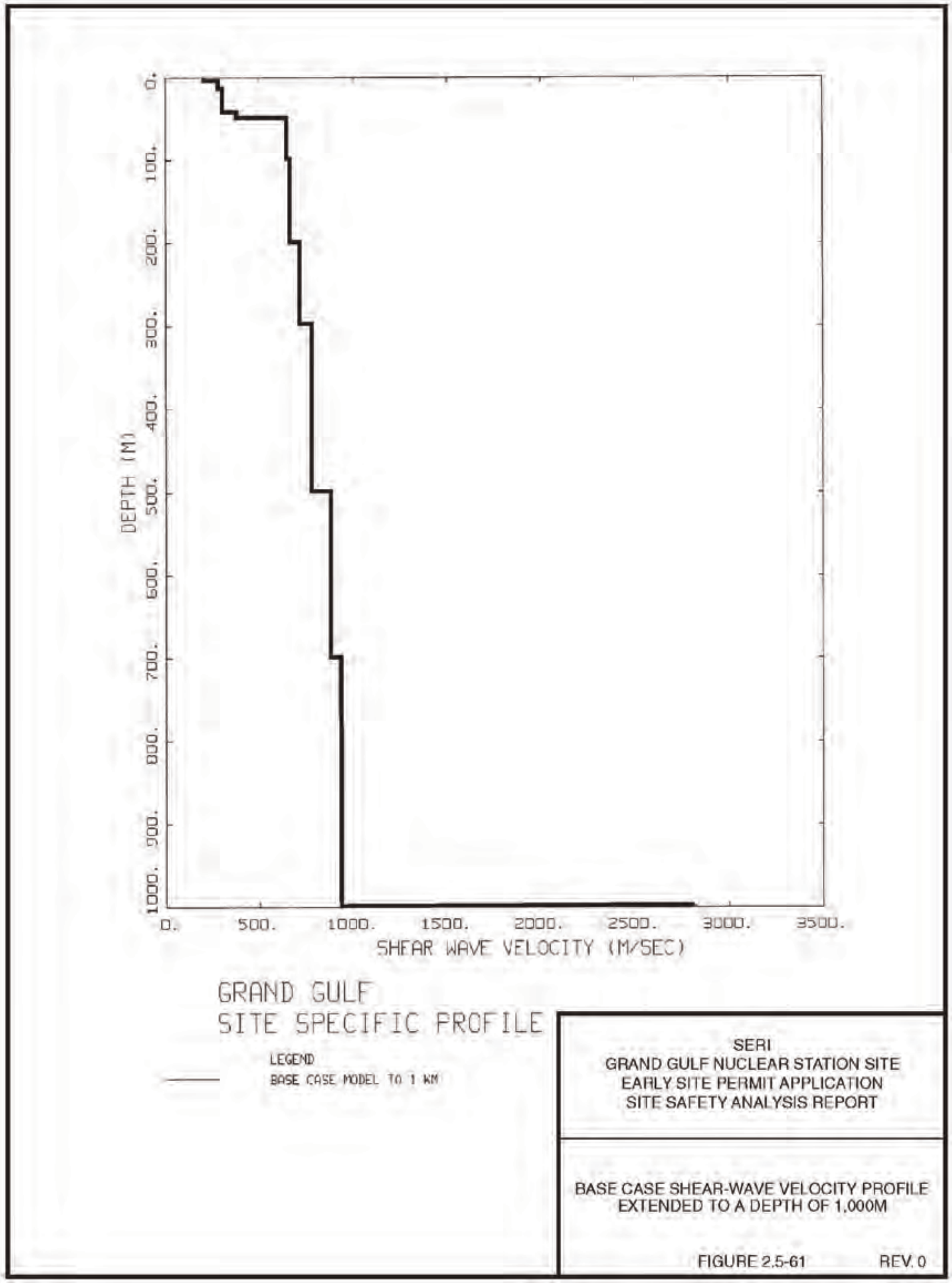


Figure 2.5.2-4 (SSAR Figure 2.5-61) Base shear wave velocity profile extended to a depth of 3300 feet

removing the surface loess (to the depth of 50 feet), shows the transfer functions for the top of surface with a shear wave velocity of 304 m/s.

In RAI 2.5.2-11, the staff asked the applicant to explain the basis for using Approach 2A instead of 2B (use of three earthquakes, including another central magnitude earthquake obtained from deaggregration to derive soil spectra) to derive soil spectra to generate the soil UHRS. The applicant responded that it considers the 2A approach to be appropriate because of the narrow magnitude range in earthquakes contributing to the UHRS at low and high frequencies. The magnitude difference is only 0.7 units, which makes the 2B approach unwarranted.

2.5.2.1.5 Safe-Shutdown Earthquake and Operating-Basis Earthquake

In SSAR Sections 2.5.2.5 and 2.5.2.6, the applicant described the procedures and relevant parameters to finally calculate the SSE ground motion and OBE.

The applicant stated that it enveloped the mean transfer functions for both the top of loess and the top of 1000 ft/s material and applied the envelope to the rock UHRS results in horizontal soil motions that are consistent with the median 10^{-5} APE hard rock UHRS. The applicant presented the calculated soil motions, together with the hard rock UHRS, in SSAR Figure 2.5-66. The applicant stated that the design horizontal motions are taken as the envelope of the two expected soil motions, as shown in Figure 2.5.2-5 below.

The applicant also stated that it used the vertical-to-horizontal (V/H) ratio in RG 1.60, Revision 1, "Design Response Spectra for Seismic Design of Nuclear Power Plants," December 1973, to estimate the vertical ground motions. The V/H ratio that is 2/3 at low frequency (0.1–0.3 Hz), increasing with the frequency to 1 near 8 Hz, is considered conservative. The vertical motions are shown in SSAR Figure 2.5-68.

The staff asked the applicant in RAI 2.5.2-12 to explain the basis for using the V/H ratio generated from the RG 1.60 design spectra and to compare the result to more recent recommendations for V/H ratio available in the literature. The applicant explained that V/H ratios are dependent on site conditions (rock versus soil), earthquake magnitude, and epicentral distance. The empirical V/H ratios for deep soils increase with magnitude and decreasing epicentral distance within 31 miles. At about 31 miles, the empirical ratio of deep soils at magnitude 7.5 has a maximum of about 1 near 15 Hz, decreasing to about 0.5 at 2 Hz and below. At distances greater than 31 miles, the V/H ratios decrease somewhat at high frequency with increasing distance and remain relatively constant (at about 0.5 Hz) at low frequency. For source distances beyond 31 miles, the RG 1.60 V/H ratio is considered to be a conservative estimate of site-specific vertical motion.

The applicant stated that the OBE ground motion spectrum is assumed to be one-third of the SSE spectrum, according to Appendix S to 10 CFR Part 50.

2.5.2.2 Regulatory Evaluation

SSAR Section 2.5.2 presents the applicant's determination of ground motion at the ESP site that could result from possible earthquakes that might occur in the site region and beyond. According to the SSAR, the applicant's assessment addresses the requirements in 10 CFR

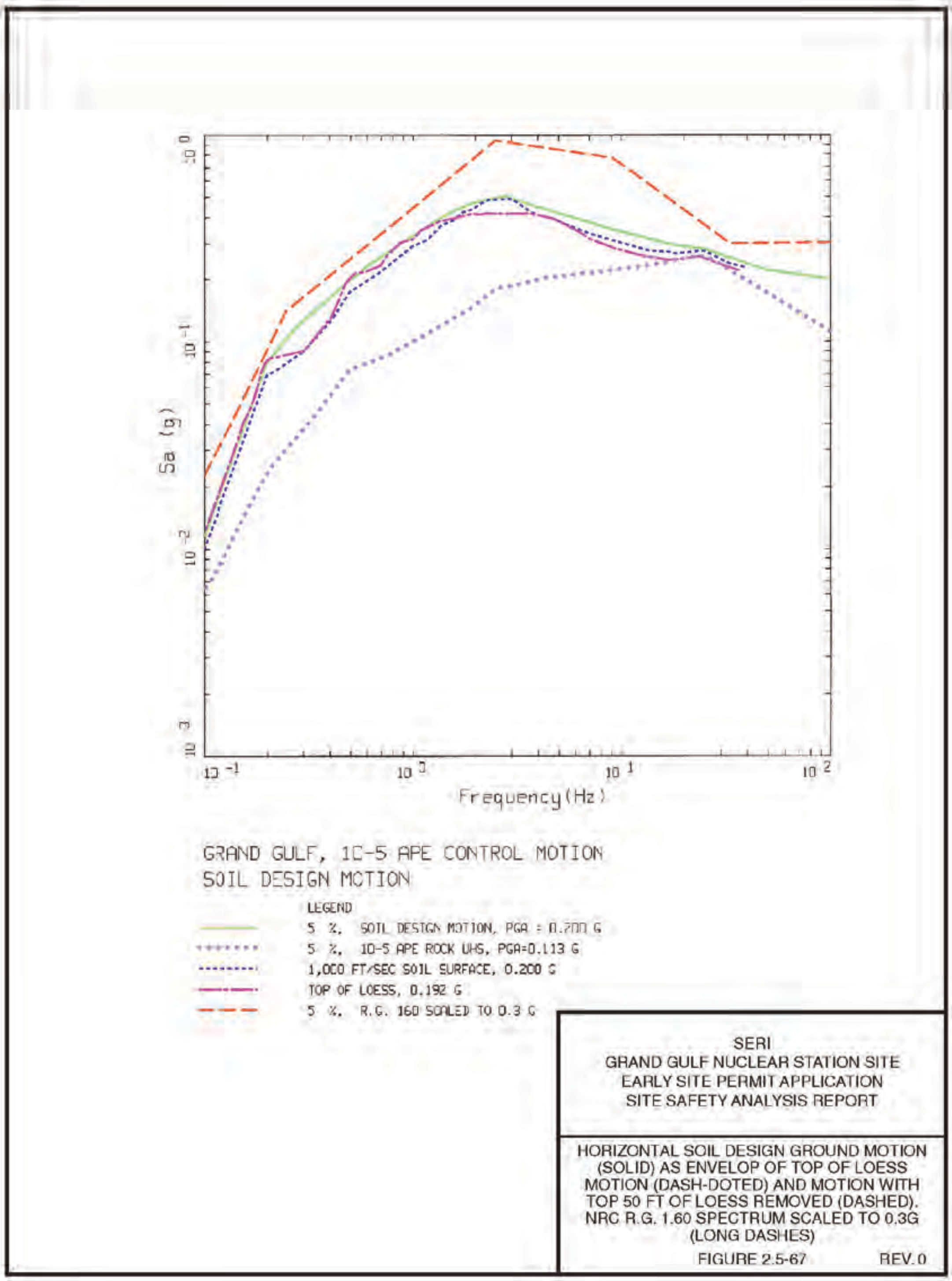


Figure 2.5.2-5 (SSAR Figure 2.5-67) Horizontal soil design ground motion and ground motions with loess and without loess. RG 1.60 spectrum also included (scaled to 0.3 g)

50.34, “Contents of Applications; Technical Information,” Appendix S to 10 CFR Part 50, and 10 CFR 100.23. The applicant further stated that it developed this information in accordance with the guidance presented in Section 2.5.2 of Revision 3 of NUREG-0800 and RGs 1.70 and 1.165. The staff notes that the application of Appendix S to 10 CFR Part 50 in an ESP review, as referenced in 10 CFR 100.23(d)(1), is limited to defining the minimum SSE for design.

In its review, the staff considered the regulatory requirements of 10 CFR 52.17(a)(1)(vi) and 10 CFR 100.23(c) and (d), which require that the applicant for an ESP describe the seismic and geologic characteristics of the proposed site. In particular, 10 CFR 100.23(c) requires that an ESP applicant investigate the geological, seismological, and engineering characteristics of the proposed site and its environs with sufficient scope and detail to support estimates of the SSE and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. In addition, 10 CFR 100.23(d) states that the SSE for a site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface. 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.

2.5.2.3 Technical Evaluation

This section of the SER provides the staff’s evaluation of the seismological, geological, and geotechnical investigations that the applicant conducted to determine the SSE for the ESP site. The technical information presented in SSAR Section 2.5.2 resulted from the applicant’s surface and subsurface geological, seismological, and geotechnical investigations performed in progressively greater detail as these investigations moved closer to the ESP site. The SSE is derived from a detailed evaluation of earthquake potential, taking into account regional and local geology, Quaternary tectonics, seismicity, and specific geotechnical characteristics of the site’s subsurface materials.

SSAR Section 2.5.2 characterizes the ground motions at the ESP site which could result from earthquakes that might occur in the site region and beyond to determine the site SSE. The SSE represents the design earthquake ground motion at the site and the vibratory ground motion for which SSCs of a certain nuclear power plant must be designed to remain functional. According to RG 1.165, an applicant may develop the vibratory design ground motion for a prospective nuclear power plant using either the EPRI or LLNL PSHA for the CEUS. Following the recommendation of RG 1.165, the applicant adopted the EPRI PSHA in the ESP application. However, RG 1.165 also recommends that applicants perform geological, seismological, and geophysical investigations and evaluate any relevant research to determine whether revisions to the EPRI or LLNL PSHA databases are necessary. As a result, the staff focused its review on geologic and seismic data published since the late 1980s that could indicate a need for changes to the EPRI or LLNL PSHAs relative to the ESP site.

2.5.2.3.1 Seismic Source Characterization

The staff focused its review of SSAR Section 2.5.2.1 on the applicant’s description of the source model updates since the 1986 EPRI studies, with an emphasis on the seismic parameters of the characteristic NMSZ model and the new SRSZ. The applicant summarized seismic source parameters used in the EPRI 1986 source model and concluded that the source model adequately captures the source information and uncertainty associated with new data and knowledge developed since the mid-1980s. The applicant stated that other than the characteristic NMSZ model and new SRSZ model, no new information would suggest significant modification to the EPRI seismic source model. After analyzing the EPRI earthquake catalog, the applicant also concluded that the new earthquake catalog actually provides a lower earthquake frequency than the one based on the original EPRI 1986 earthquake catalog.

In RAI 2.5.2-6, the staff asked the applicant to provide its reasoning for not updating the EPRI EST seismic source characterizations, following the 1994 Johnston studies, to give more weight to larger magnitude earthquakes for the seismic source surrounding the site. In its response, the applicant stated that the final results of Johnston 1994 on the seismic background source of the ESP site do not significantly change the source parameters of the 1989 EPRI-SOG seismic source model. The staff reviewed the applicant’s response to the RAI and found that it does not adequately address the recent change and the impact of this change on the original EPRI seismic source model in terms of the regional seismic background source for the ESP site. In the original EPRI seismic source model, each team had outlined and assigned both magnitudes and associated weights to the Gulf Coast region surrounding the ESP site. The staff calculated the weighted maximum magnitude for the Gulf Coast region, using EPRI source model parameters provided by the SSAR text and tables, and obtained an effective maximum magnitude of Mw 5.0 for the Grand Gulf background source for all the ESTs, giving equal weight to each of the six ESTs. The Grand Gulf Basin, with its transitional basement structure and relatively undisturbed sedimentary rocks, is relatively stable. Nevertheless, its immediate neighboring structural unit, the Ouachita Orogenic Belt, is also considered as inactive in terms of tectonic activity because, “although many large Paleozoic thrust faults of regional extent are mapped through the Ouachita Orogenic Belt, none display geological evidence of Quaternary activity.” However, the latest paleoseismic research on the SRSZ has proved that even within this relatively nonactive tectonic unit, it is still possible to uncover a new seismic source. Based on the combined evidence of geomorphic, paleoliquefaction and Quaternary faulting of the SRSZ, as well as the closeness of the SRSZ to the ESP site, the applicant has incorporated the SRSZ into the ESP seismic hazard calculation, although the lines of evidence are not conclusive. The applicant assigned maximum magnitudes and weights of Mw 6.0 (0.3), 6.5 (0.6), and 7.0 (0.1) and a return period varying between 390 and 125,000 years to the SRSZ, depending on the source of determination and magnitude distribution. The weighted maximum magnitude for the Ouachita Orogenic Belt, using the parameters provided by the SSAR, is Mw 5.4, which is also much less than the weighted maximum magnitude of the SRSZ. The discovery of the SRSZ has proven that the original estimates of the EPRI 1986 project are relatively low for the Ouachita Orogenic Belt. Although the SRSZ is not located inside the Gulf Coast Basin, the Gulf Coast Basin also has a faulted passive margin beneath the site, and the ESP site is in the midst of the Gulf Coast plain. SSAR Figure 2.5-16b shows that the crust beneath the site region has been thinned by Mesozoic extension and the upper crust thins mainly by extensional faulting. The thinning is probably caused by the extensional passive-margin faulting. Global observations imply that at least some extensional passive-margins remain able to cause relatively large earthquakes. The staff considers that all these have demonstrated the need to update the background source parameters for the ESP site. The staff concluded that the applicant’s response did not adequately address this update to the original EPRI-SOG background seismic source for the ESP site.

In responding to above issue addressed in Open Item 2.5-1, the applicant stated in its submittal dated December 10, 2004 (Entergy, Response to Request for Additional Information Letter No. 5), that initial results of the Johnston 1994 EPRI studies were available to the ESTs in a report titled “Methods for Assessing Maximum Earthquakes in the Central and Eastern United States,” by Coppersmith et al. (1987). The observation that the largest stable continental region (SCR) earthquakes appear to be associated with the Mesozoic and younger crust was known to the ESTs. Several ESTs explicitly referred to the preliminary worldwide database in their estimate of maximum magnitude for seismic sources in the CEUS. The ESTs used a variety of approaches and philosophies to estimate maximum magnitude and incorporated large uncertainties in their estimates. The applicant also indicated that the tectonic stability is another reason for not assigning high weights to larger magnitude. Up to 10,000 feet of unfaulted Cretaceous and younger sediments document the absence of capable tectonic structures in the site vicinity. In addition, the applicant stated that the SRSZ is a unique seismic source for the following reasons:

- The SRSZ is located in an area underlain by continental crust and a Paleozoic fold and thrust belt.
- It overlies the southern projection of the Reelfoot Rift.
- It contains geomorphic lineaments suggestive of long-term tectonic deformation.
- It contains localized Tertiary faults and folds associated with a pattern of increased microseismicity.
- It contains mid-Holocene-age liquefaction features.

The applicant emphasized that these unique geologic, geomorphic, and seismologic features were not observed elsewhere in the Gulf Coast Basin and are not present in the vicinity of the ESP site. The applicant also indicated that all the background seismic sources in the EPRI model that contributed significantly to the hazard at the Grand Gulf ESP site were revised to have a minimum magnitude of 5.0 or greater.

After reviewing the applicant’s response to the open item, the staff concurs with the applicant that the background source for the GGPN has been updated because ESTs had the access to the preliminary version of the Johnston 1994 studies and considered their view on the potential maximum magnitude of the Mesozoic or younger extended crust zone. Since the ESTs were facilitated in a system similar to the one recommended by the Senior Seismic Hazard Advisory Committee (SSHAC, 1997) in NUREG/CR-6372, "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts,” issued November 1997, different teams chose to characterize their own seismic sources with different maximum magnitudes based on expert opinions. The applicant did not assign higher weights to the larger magnitudes because of the absence of capable tectonic features in the site vicinity, including the lower seismic activity and nearly 10,000 feet of undisturbed Cretaceous and younger sediments. The staff also concurs with the applicant that the SRSZ is unique in its tectonic background and different from that of the ESP site. Based on the applicant’s response, the staff concludes that this open item is resolved.

In RAI 2.5.2-5, the staff also asked the applicant to explain and quantify the impact caused by the revised magnitude estimates in Bakun and Hopper's latest publication. In its response, the applicant cited results from a sensitivity analysis using updated magnitude estimates on seismic hazard at the Clinton ESP site in Illinois performed by EGC. The applicant stated that, based on the fact that the results of median and mean rock hazard for 1-Hz hazard curves increased only 3–4 percent as a result of the magnitude changes to the Clinton ESP site and because the Clinton ESP site is closer to the NMSZ than the Grand Gulf ESP site, the impact of the magnitude revision to the ESP site is insignificant. The staff concurs with the applicant in concluding that the impact caused by revising the maximum magnitude of the NMSZ earthquakes is insignificant because the sensitivity test for the Clinton ESP site showed only a 3–4 percent increase in seismic hazard level.

Based on its review of SSAR Section 2.5.2.1 and the applicant's responses to the RAIs and open items, the staff finds that the applicant has adequately characterized the overall seismic sources at the ESP site. The staff also concludes that the applicant's descriptions of the NMSZ and the SRSZ are accurate and sufficient in addressing the need for calculating the SSE for the ESP site. In addition, the staff concurs with the applicant's decision to use the original EPRI seismicity parameters based on its comparison of the updated seismic catalog with the original EPRI catalog.

2.5.2.3.2 ESP Probabilistic Seismic Hazard Analysis

To evaluate the applicant's PSHA procedures and results, the staff reviewed the information presented in SSAR Section 2.5.2.2. The staff focused its review on the ground motion model and magnitude conversion relationships used in the PSHA process and subsequent results.

In describing ground motion attenuation models, the applicant stated that it used attenuation models developed by an EPRI-sponsored project in 2003. This is an SSHAC Level 3 analysis, sponsored by EPRI, to update ground motion attenuation studies in the CEUS using the latest strong motion data. The EPRI 2003 attenuation models used various attenuation relationships and their clusters to estimate ground motions for rock sites, including not only the medians, but also the aleatory uncertainties. In addition, the EPRI 2003 ground motion models classified the attenuations based on earthquake sources, paths, and event sizes. NUREG/CR-6372 (SSHAC, 1997) provides the guidelines for performing this analysis. Because the 2003 attenuation model was used extensively in each ESP application, the staff studied the attenuation model and addressed its concerns in the Open Item 2.5-2.

The first issue in the Open Item 2.5-2 is related to the weighting scheme of the EPRI 2003 ground motion. The EPRI ground motion study used 13 different ground motion attenuation relationships, grouped into four clusters. For cluster 1, EPRI gave the highest weight (0.90) to the three attenuation relationships reported by Silva, W.J., N. Gregor, and R. Darragh, "Development of Regional Hard Rock Attenuation Relations for Central and Eastern North American, Pacific Engineering and Analysis," 2002. However, the applicant did not provide plots or tables of the residuals as a function of attenuation relation, magnitude, distance, and frequency. Similarly, for clusters 2 and 3, the ground motion experts applied higher weights to different attenuation relationships within each cluster. The staff concludes that the applicant needs to provide the rationale for these weights. In addition, the EPRI ground motion model assigned different weights to each of the four clusters. The weights were given after the expert panel members, convened for the EPRI ground motion study, subjectively evaluated how well the alternative ground motion models relied on seismological principles. Because the evaluation criteria were not provided, the staff was unable to evaluate the weights applied to the four clusters.

In responding to the above issue, the applicant provided the staff with tables of statistics that compare each of the ground motion relationships and the CEUS earthquake database. The applicant also provided plots of residuals for each of the cluster 1 ground motion models and plots comparing the final overall cluster 1 model to the actual CEUS earthquake data. The applicant stated that the mean and variance were computed by assigning weights to the models within a cluster. These weights were determined on the basis of a model's consistency (mean deviation from the data) with available strong motion data. The staff examined the plots and tables of model residuals provided by the applicant for the cluster 1 ground motion models. The staff verified that, for the ground motion frequencies (1, 5, and 10 Hz), the three Silva et al. ground motion models do provide the smallest mean residual values (i.e., best fit to the earthquake strong motion data) compared to the other cluster 1 models. As a result, EPRI gave weights of 0.192, 0.148, and 0.560 to these three ground motion models. Since the EPRI 2003 expert panel members gave the three Silva et al. attenuation relationships the highest overall weight (0.9) in the cluster, a subsequent concern is that since all three Silva et al. attenuation relationships have the same wave propagation travel path terms and parameters, this limited path variability could have biased the overall cluster 1 ground motion model. To resolve the staff's concern, the applicant responded as follows:

> The ground motion models in Cluster 1 considered a range of alternative stress drop models and alternative Q and path models. Collectively, these models represent alternative single-corner [shape] source spectrum models for the CEUS. In aggregate, these models provide a measure of the epistemic [modeling] uncertainty in the median ground motion based on the single-corner source spectrum models (e.g., intra-cluster variability).

In responding to the staff's concern regarding the criteria to assign weights to four clusters, the applicant provided the following explanation in its submittal dated June 21, 2005 (Entergy, CNRO-2005-0000-DRAFT):

> The final step in the evaluation of the median ground motion models was the assessment of relative weights for the four clusters. Each cluster represents an alternative approach for modeling earthquake ground motions in the CEUS. By assigning a weight to each cluster a final distribution and estimate of the epistemic uncertainty on the median ground motion was determined. To develop the relative weights for each cluster the following were considered:
>
> - consistency of the cluster median (mean log ground motion) with CEUS strong motion data,
> - the strength of the seismological principles used by the models in a cluster, and
> - the degree to which modeling of epistemic uncertainty was considered in developing individual ground motion relationships.

The second issue in the Open Item 2.5-2 is related to the Q value. The Silva et al. cluster 1 relationships use an expression for the seismic attenuation parameter, Q, which is frequency dependent. This frequency-dependent Q value was derived from an inversion of the data from the 1988 Saguenay earthquake. This inversion solves for Q, as well as the local site attenuation parameter kappa and the stress drop, which is the difference between the initial stress before the earthquake and the final stress. The staff was unable to determine how the recordings from a single earthquake can provide well-resolved values of both crustal Q and site kappa. The Q value of 317 at 1 Hz is much lower than values found in other studies of eastern

North American earthquakes. In addition, other studies have found less frequency dependence of Q in the east than in the west, which is contrary to the findings of Silva et al.

In responding to this staff's concern, which is related to the Silva et al. cluster 1 attenuation relationships, the applicant stated the following:

> The model functional form, basis for parameter selection, and the results developed in Silva et al. (2002) and its predecessor, Silva et al., ["Characteristics of Vertical Strong Ground Motions for Applications to Engineering Design,] (1997), are the responsibility of the lead author. Of particular relevance is the interdependence between model parameters, how the parameters were determined, model sensitivity to its parameters, and reasonable ranges in parameter values, based on expert judgement and expert interpretation of the scientific literature. It is unclear if a summary justification for the results of the Silva et al. (1997 and 2002) studies would resolve the items identified that seem, ultimately, to represent differences in expert judgement.
>
> Differences in expert judgement are often difficult to reconcile. For this very reason, the SSHAC process was developed and accepted for use by the NRC. The EPRI 2003 ground motion model was developed by implementing a SSHAC Level 3 assessment process during which the EPRI Expert Panel identified the Silva et al. Relationships as ones that should be included in the assessment and evaluated. The EPRI Expert Panel considered specific parameterizations of individual ground motion relationships in determining whether or not a relationship should be included in the SSHAC Level 3 assessment process. All ground motion relationships identified as viable by the Expert Panel were evaluated using the same criteria following the SSHAC Level 3 process.
>
> The SSHAC process does not guarantee that every scientist will agree with the assessments. It is rather intended to assure that the assessed results reflect the preponderance of current scientific views, which is the underpinning of safety decisionmaking.

After reviewing the applicant's responses to the concerns raised in Open Item 2.5-2, the staff concludes that the applicant has adequately explained why it assigned different weights to various attenuation relationships inside a ground motion cluster, and to four ground motion clusters, and also explained that the selection of Silva et al. Cluster 1 attenuation relationships that uses a frequency dependent Q value was determined by the expert panel established based on SSHAC Level 3 process. The staff concludes that the applicant has adequately resolved each of the staff's concerns with regard to applying the EPRI 2004 ground motion models to the ESP site. Therefore, this open item is resolved.

SSAR Section 2.5.2.2.2 and the applicant's response to RAI 2.5.2-3 describe in detail the procedure to implement the magnitude conversion from body-wave magnitude to moment magnitude within the hazard computing procedures. The staff finds the response sufficient in explaining the steps and procedures, as well as the magnitude conversion relationships (including parameters) used in the PSHA. The staff concludes that the applicant's procedures and relationships used in converting body-wave magnitude to moment magnitude are appropriate.

The applicant described the PSHA results in SSAR Section 2.5.2.2.2, including the rock UHRS and the deriving controlling earthquakes for both low and high frequencies. In response to RAI 2.5.2-8, the applicant explained the asymmetry of the mean hazard curves relative to the median hazard curves for high Sa. The staff concurs with the applicant's conclusions that the degree of skewness is a function of epistemic uncertainty and that the increased uncertainty at the ESP site is caused by a number of factors, including uncertainties associated with earthquake magnitude conversions and the new EPRI 2003 ground motion model.

In RAI 2.5.2-9, the staff asked the applicant to explain why the magnitude and distance bins corresponding to the SRSZ make no contribution to the deaggregation result, although the SRSZ maximum earthquake magnitude is as large as 6.0–7.0 and at a distance of 81–206 miles from the ESP site. The applicant stated that the overall rate of earthquake occurrence (Mw greater than 5) at these distances for the SRSZ was too low to contribute to the 10^{-5} median hazard. However, the staff notes that in SSAR Section 2.5.2.1.3 and in its response to RAI 2.5.1-3, the applicant stated that the activity of the SRSZ has a probability of 0.5 for its existence. This probability of existence implies that the SRSZ has a 50 percent chance to produce an earthquake with a magnitude between 6.0–7.0. The applicant also assigned three different return periods (388, 1725, and 3505 years) to the characteristic SRSZ earthquake model based on paleoliquefaction data. As such, a SRSZ earthquake with a 3,505-year return period should repeat about 30 times during the 100,000-year time span that is associated with a 10^{-5} probability of exceedance. Therefore, the staff was not certain why the magnitude and distance bins corresponding to the SRSZ do not contribute to the hazard at the 10^{-5} probability level.

In responding to the staff's concerns addressed above, the applicant further provided more details on its method for adding the SRSZ to the original EPRI-SOG seismic source model. The applicant stated that it did not modify the geometry and recurrence parameters of the original EPRI-SOG model determined by the six EST teams, to accommodate the SRSZ. Instead, the applicant retained the original EPRI-SOG model and simply added the SRSZ to the original source. The applicant stated that the addition of the SRSZ double-counts the seismicity in the geographic region defined by the SRSZ. However, the applicant emphasized that the SRSZ has only a 0.5 probability of activity (defined as probability of existence in the SSAR), because of the nonconclusive seismic evidence associated with the SRSZ. This 0.5 probability of activity for the SRSZ resulted in a logic tree source model with half of the branches consistent with the original EPRI-SOG seismic source model and the other half consistent with the original model plus the SRSZ. Since the SRSZ is about 130 to 329 kilometers from the ESP site, events that contribute to the site seismic hazard are those with magnitudes greater than 6.0. Based on the updated EPRI-SOG seismic characterization model that includes the SRSZ, there is only a 0.35 probability of earthquakes larger than 6.0 (0.5, probability of the existence, times 0.7, probability for earthquakes larger than 6.0). The applicant stated that as a result of this low probability (0.35), more than 0.5 of the weight in the logic tree is associated with events that do not have a maximum magnitude greater than 6 at the distance associated with the SRSZ. The applicant also concluded that since the earthquake that would contribute to the hazard at these distances does not occur, the median hazard in the distance bins is zero.

After reviewing the applicant's response, the staff concluded that it does not adequately address the absence of the SRSZ's contribution to the deaggregated seismic hazard at the ESP site. The absence of the hazard contribution from the SRSZ is probably due to the applicant's computational procedure for this particular seismic zone, which has a 0.5 probability of activity. To confirm this conclusion, the staff performed an independent evaluation using seismic sources similar to those used by the EPRI-SOG for the ESP site. For its evaluation, the staff also used a source weighting scheme similar to that used by EPRI -SOG and added a new source similar to the SRSZ. The staff then calculated and deaggregated its seismic hazard using two methods. The first method, which is the method adopted by the applicant model, resulted in no contribution from the SRSZ to the deaggregated seismic hazard result. The second method resulted in the appearance of a contribution from the SRSZ to the site hazard. The second method differs from the first one in that, instead of using those magnitude and distance bins associated with a 0.5 probability of non-activity in the deaggregation, they were omitted from the calculation. Implementing the second approach, the combined contribution from all relevant magnitude (M 6-6.5, M 6.5-7 and M >7.0) and associated distance bins are about 10 percent relative seismic hazard contribution for 5 and 10 Hz and 5 percent for 1 and 2.5 Hz, respectively. The staff's evaluation suggests that the SRSZ missing hazard contribution is from the applicant's computational procedure because more than half of the hazard values in the corresponding magnitude and distance bins for the corresponding non-activity logical tree branches are zeros. The staff asked the applicant to reevaluate the seismic hazard contribution from the SRSZ based on the staff's findings since the result could potentially affect the determination of the controlling earthquakes, and thus the determination of the SSE.

In response to the staff's evaluation, the applicant performed a sensitivity test to evaluate the impact of the missing SRSZ contribution to the controlling earthquakes. When increasing the hazard contribution from the SRSZ, the applicant balanced the total hazard by decreasing the hazard contribution from other sources, including the NMSZ, which ensured the NRC staff that the absence of the SRSZ contribution only caused by the applicant's deaggregation process. The applicant stated that the results from the sensitivity test indicate there is a very small change to the 5 and 10 Hz controlling earthquakes (see Table 2.5.2 -1) and associated median rock response spectrum. The calculated differences in response spectrum values ranges from +0.06 to -0.23 percent of the comparable Grand Gulf response spectra. The applicant concluded that even if the staff's approach were used to deaggregate the controlling earthquake, which shows that the SRSZ may contribute up to 5 to 10 percent of the median hazard, the contribution would not result in a significant change to the median rock ground motion at the Grand Gulf site. Based on the results of the applicant's sensitivity test and also the fact that the SRSZ is relatively far from the ESP site (130 to 329 km), the staff concurs with the applicant on its conclusion with regard to the specific situation of the ESP site. Therefore, this open item is resolved.

Table 2.5.2-1 Effect to controlling earthquakes when adding hazard contributions from the SRSZ

Frequency (Hz) of Controlling Earthquake	Magnitude and Distance (Assuming 5% contribution	Magnitude and Distance (Assuming 10% contribution	Original Controlling Earthquake Magnitude and Distance
5- 10 Hz	6.93	6.92	6.94
	174.46	173.44	175.5

The applicant's response to RAI 2.5.2-10 adequately explained why the high-frequency deaggregation graph shows no contribution from the magnitude-distance bin that contains the controlling earthquake.

Based on its review of SSAR Section 2.5.2.2 and the applicant's responses to the RAIs as discussed above, the staff concludes that the applicant's description of the PSHA parameters and procedures for the ESP site is reasonably accurate and adequate. The staff concurs with the applicant on its conservative approaches in overlapping the new characteristic NMSZ onto the original EPRI source model, as described in this section, and in using only attenuation relationships for the midcontinent to estimate ground motion, although the ESP site is located in the extended Mississippi embayment.

2.5.2.3.3 Seismic Wave Transmission Characteristics of the Site

The staff's review focused on the applicant's description of the generic shear wave profile and parameters associated with the profile in SSAR Section 2.5.2.3. In RAIs 2.5.4-4 and 2.5.4-6, the staff asked the applicant to explain the appropriateness of using the generic shear wave profile at the ESP site, including the associated parameters. Section 2.5.4 of this SER discusses the applicant's response to RAI 2.5.4-4. Based on its review of the contents of SSAR Section 2.5.2.3.3, the staff concludes that, other than the issues related to RAI 2.5.4-4, the applicant used an acceptable approach to characterize the site shear wave properties to the appropriate depth required by the reference rock used in the EPRI ground motion attenuation relationships in order to obtain the site-specific seismic wave responses. Therefore, the staff finds that the applicant's description of the site-specific seismic wave transmission characteristics is adequate and acceptable.

2.5.2.3.4 Site Response Analysis

The staff's review of this section of the SSAR focused on the applicant's description of the methodology used in deriving the site responses. The staff asked the applicant in RAI 2.5.2-11 to explain the basis for using Approach 2A instead of 2B to generate soil response spectra. The staff considers the applicant's response to be appropriate and sufficient, and, because of the narrow range in the magnitudes of the controlling earthquakes, it is appropriate to use Approach 2A. Based on its review of this section, the staff concludes that the applicant's description of the site responses and the approach used in deriving the site response are reasonably accurate and adequate.

2.5.2.3.5 Safe-Shutdown Earthquake and Operating-Basis Earthquake

Following its review of this and all the preceding sections of the SSAR, as well as the response to RAI 2.5.2-12, the staff considers the SSE developed for the ESP site to be consistent with Appendix S to 10 CFR Part 50, which defines the SSE as the "vibratory ground motion for which certain structures, systems and components must be designed to remain functional." The staff concludes that the applicant's approach, other than for those issues noted above, to calculating the SSE for the ESP site is also consistent with the requirements of 10 CFR 100.23(c) and (d) and RG 1.165. Therefore, the applicant's description of the SSE and the subsequent OBE is accurate and adequate.

2.5.2.4 Conclusions

As set forth above, the staff reviewed the seismological information submitted by the applicant in SSAR Section 2.5.2. On the basis of its review of SSAR Section 2.5.2 and the applicant's responses to the RAIs and open items, the staff finds that the applicant has provided a thorough characterization of the seismic sources surrounding the site, as required by 10 CFR 100.23. In addition, the staff finds that the applicant has adequately addressed the uncertainties inherent in the characterization of these seismic sources through a PSHA, and that this PSHA follows the guidance provided in RG 1.165. The staff concludes that the controlling earthquakes and associated ground motion derived from the applicant's PSHA are generally consistent with the seismogenic region surrounding the ESP site. In addition, the staff finds that the applicant's SSE was determined in accordance with RG 1.165 and Section 2.5.2 of NUREG-0800. The staff concludes that the proposed ESP site is acceptable from a geological and seismological standpoint and meets the requirements of 10 CFR 100.23.

2.5.3 Surface Faulting

SSAR Section 2.5.3 describes the potential for tectonic fault rupture at the ESP site. The applicant concluded that since no capable tectonic sources that can generate both vibratory ground motion and tectonic surface deformation exist within a 5-mile radius of the ESP site, the site has no potential for tectonic fault rupture. SSAR Section 2.5.3.1 describes the applicant's geological, seismological, and geophysical investigations. SSAR Section 2.5.3.2 describes previous site investigations for the surface faults. SSAR Section 2.5.3.3 describes the geologic evidence, or absence of evidence, for surface deformation. SSAR Section 2.5.3.4 describes the correlation of earthquake epicenters with capable tectonic sources in the vicinity of the ESP site. SSAR Section 2.5.3.5 provides the characterizations of capable tectonic sources. Finally, SSAR Sections 2.5.3.6 through 2.5.3.7 describe zones of Quaternary deformation requiring detailed fault investigation and the potential for tectonic or nontectonic deformation at the site.

2.5.3.1 Technical Information in the Application

2.5.3.1.1 Surface Faulting Investigations

Geological, Seismological, and Geophysical Investigations. According to SSAR Section 2.5.3.1, the applicant performed the following investigations to assess the potential for surface faulting at and within a 5-mile radius of the ESP site:

- compilation and review of existing data
- interpretation of aerial photography
- discussions with current researchers in the area
- review of seismicity
- field reconnaissance

The applicant stated that a wealth of information is available for the site regarding the surface faulting studies. The information comes from three primary sources:

(1) previous research for the existing GGNS

(2) published and unpublished geologic maps from USGS, the State of Mississippi, and the University of Memphis

(3) seismicity data compiled from published journal articles and evaluated as part of this study

The applicant performed aerial and field reconnaissance investigations within a 5-mile radius of the ESP site. In particular, the applicant prepared an updated map of surficial deposits and geomorphology for the site location. The applicant also stated that it used the new map in combination with other preexisting maps to verify the absence of subsurface faulting or other forms of tectonic and nontectonic deformation by showing the surface of buried stratigraphic layers.

<u>Previous Site Investigations</u>. As noted by the applicant in SSAR Section 1.0, the existing GGNS site is very close to the ESP site, which is only 1200 feet west and 1000 feet north of the center of the GGNS containment. The applicant stated that the UFSAR summarizes the previous site investigations performed for the ESP site. The previous investigations illustrate the buried stratigraphic layers across the site using extensive subsurface data. These buried stratigraphic layers at the site include the Oligocene Glendon Limestone, Miocene Catahoula formation, and Pliocene and Pleistocene Upland Complex. The applicant concluded that, although these surfaces are eroded, they are not deformed by faulting, folding, or tilting across the site area. In addition, these undeformed surfaces document the absence of salt diapirs, collapse structures, volcanic intrusions, and other nontectonic deformations.

The applicant reevaluated Quaternary faulting studies by two renown geologists, Fisk and Krinitzsky (U.S. Army Corps of Engineers (USACE) Technical Memorandum No. 3-311, "Geological Investigation of Faulting in the Lower Mississippi Valley," issued 1950). Fisk postulated that a densely populated rectilinear fracture exists in the Mississippi Alluvial Valley. Krinitzsky mapped several hundred inferred faults in the same area based on physiographic evidence. He investigated several sites with closely spaced borings to verify the presence of faults in Tertiary deposits. However, the applicant pointed out that these geologists' views on active faults were affected by the then prevailing belief that a worldwide grid of fault patterns caused by planetary-scale influences dominates the earth's crust. Furthermore, the applicant stated that detailed Quaternary mapping and numerous site-specific engineering geologic investigations disproved the existence of the Quaternary faults and fault zones across the site area that were proposed by Fisk and Krinitzsky. Two examples demonstrate this disapproval for some of the Quaternary faults. First, Fisk suggested that two possible fault zones may intersect about 3 miles north of the site near the mouth of the Big Black River. A cross-section constructed using borings indicates that the difference in the elevations of contacts, evidence for the faults, is attributable to the regional dip of stratigraphic units rather than a fault offset along the Big Black River. Fisk also proposed a lineament coincident with the Bayou Pierre. However, the continuation of stratigraphy across the site documented by the borings drilled both north and south of the bayou demonstrates the absence of the fault represented by the lineament. All of the previous investigations have disproved the existence of Fisk's fault zones and show no fault within 5 miles of the site.

New information developed since the original GGNS site investigation further confirms that no active faults exist within the 5-mile radius defined by the site area (USACE, "Geomorphology and Quaternary Geological History of the Lower Mississippi Valley," issued 1994).

Geologic Evidence or Absence of Evidence for Surface Deformation. SSAR Section 2.5.3.3 describes the detailed information regarding the existence of the Quaternary faults and their distance from the ESP site. The applicant reemphasized that no evidence exists of Quaternary fault offset in the site area. The applicant summarized that the closest Holocene active faults to the site are the growth faults, which are about 90 miles from the site. The closest Quaternary faults are the faults identified in the SRSZ, which are also about 90 miles from the site. The closest nontectonic sources, the Bruinsburg salt dome and the Gallaway salt dome, are within approximately 8.5 miles of the site.

Correlation of Earthquake with Capable Tectonic Sources. SSAR Section 2.5.3.4 states that no reported earthquake epicenters have been associated with faults within a 5-mile radius of the ESP site (site area). The closest earthquake of Mw 3.0 or larger is located 90 miles west of the site.

Characterization of Capable Tectonic Sources. SSAR Section 2.5.3.5 states that no capable tectonic sources exist within 5 miles of the ESP site. Subsurface borings completed for the existing GGNS document the absence of faulting in the site area, which is underlain by approximately 500 feet of Oligocene and younger deposits. These deposits decrease in elevation from north to south, are laterally continuous, and have a constant gradient across the site area. These deposits form part of a limb of a broad syncline structure, which has its axis following the current position of the Mississippi Alluvial Valley. The limbs of the syncline dip less than 1 degree toward the axis. This syncline is not a seismogenic feature, but it is caused by a slow isostatic adjustment of the crust to the continuous sediment loading.

Quaternary faults exist in the site region but all appear to lie at least 90 miles away from the site. The SRSZ is one of only two locations inside the site region where nonconclusive Quaternary faulting evidence has been found. The other location is the Gulf Coast area, where the growth faults are found. Tertiary faults of the Pickens-Gilberttown and Southern Arkansas fault zones are approximately 100 miles northeast of the site. The applicant repeated that no faults are mapped closer than 90 miles to the site.

Erosion occurred along several surfaces with gentle slopes, including the Oligocene Glendon Formation (30 Ma) and the Catahoula formation. No morphology for these surfaces or the younger surface of the Upland Complex has any indication of tectonic deformation.

The applicant also stated that the investigations by USACE ("Geological Investigation of Faulting in the Lower Mississippi Valley," 1950) also support the conclusions that the Quaternary deposits in the site area are not faulted and previous mapped faults are not present. The USACE developed its geologic cross-section based on a series of borings along the Mississippi River.

Potential for Tectonic or Nontectonic Deformation at the Site. SSAR Section 2.5.3.7 states that the ESP site has a negligible potential for tectonic deformation. The applicant stated that, since the original studies in the early 1970s, no new information has been reported to suggest the existence of any Quaternary surface faults or capable tectonic sources within the site area. In addition, the site shows no evidence of nontectonic deformation, such as glacially induced faulting, collapse structures, growth faults, salt migrations, or volcanic intrusions.

2.5.3.2 Regulatory Evaluation

SSAR Section 2.5.3 describes the applicant's evaluation of the potential for surface deformation that could affect the site. The applicant presented the information in SSAR Section 2.5.3 in accordance with the requirements of GDC 2, Appendix S to 10 CFR Part 50, and 10 CFR 100.23. The applicant also developed the geological, seismological, and geophysical information used to evaluate the potential for surface deformation in accordance with the guidance presented in Section 2.5.3 of NUREG-0800, Revision 3, and RGs 1.70, 1.132, 1.165, and 4.7. The staff notes that the application of Appendix S in an ESP review, as referenced in 10 CFR 100.23(d), is limited to defining the minimum SSE for design.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 100.23(d)(2), which state that an applicant for an ESP must determine the potential for surface tectonic and nontectonic deformations. Section 2.5.3 of NUREG-0800 and RG 1.165 provide specific guidance concerning the evaluation of information characterizing the potential for surface deformation, including the geological, seismological, and geophysical data that the applicant must provide to establish the potential for surface deformation.

2.5.3.3 Technical Evaluation

This section of the SER provides the staff's evaluation of the seismological, geological, and geophysical investigations carried out by the applicant to address the potential for surface deformation that could affect the site. The technical information presented in SSAR Section 2.5.3 resulted from the applicant's surface and subsurface investigations performed in progressively greater detail as they moved closer to the ESP site. Through its review, the staff determined whether the applicant complied with the applicable regulations and whether the applicant conducted its investigations with an appropriate level of thoroughness.

In order to thoroughly evaluate the surface faulting investigations performed by the applicant, the staff sought the assistance of USGS. The staff and its USGS advisors visited the ESP site and met with the applicant to assist in confirming the interpretations, assumptions, and conclusions presented by the applicant concerning potential surface deformation. Specific areas of review include the geological, seismological, and geophysical investigations (SSAR Section 2.5.3.1), previous investigations (Section 2.5.3.2), geological evidence or absence of evidence of surface deformation (Section 2.5.3.3), correlation of an earthquake with capable tectonic sources (SSAR Section 2.5.3.4), characterization of capable tectonic sources (SSAR Section 2.5.3.5), zones of Quaternary deformation requiring detailed fault investigation (SSAR Section 2.5.3.6), and the potential for surface tectonic deformation at the site (SSAR Section 2.5.3.7).

2.5.3.3.1 Surface Faulting Investigations

The staff focused its review of SSAR Sections 2.5.3.1 through 2.5.3.7 on the adequacy of the applicant's investigations to ascertain the potential for surface deformation that could affect the site. The staff reviewed the applicant's summary of previous site investigations recorded in the UFSAR and the recent investigations. The staff concludes that the applicant adequately investigated the potential for surface deformation in the site area. The staff and its USGS consultants also visited the site area and did not observe any evidence for Quaternary tectonic activity near the site. Therefore, the staff concludes that the applicant has adequately investigated the potential for surface deformation as required by 10 CFR 100.23.

Based on its site visit and its review of SSAR Section 2.5.3, as set forth above, the staff concurs with the applicant's conclusion that no evidence of Quaternary folding or faulting can be associated with these local faults.

2.5.3.4 Conclusions

In its review of the geological and seismological aspects of the ESP site, the staff considered the pertinent information gathered by the applicant during the regional and site-specific geological, seismological, and geophysical investigations. As a result of this review, described above, the staff concludes that the applicant performed its investigations in accordance with 10 CFR 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 concludes that the site is suitable from the perspective of tectonic surface deformation and meets the requirements of 10 CFR 100.23. In addition, the staff finds that the applicant appropriately considered the most severe surface deformation historically reported for the site and surrounding area, with sufficient margin for uncertainties, and satisfies GDC 2 in that respect.

2.5.4 Stability of Subsurface Materials and Foundations

SSAR Section 2.5.4 describes the characteristics of the subsurface materials and foundations at the ESP site. Section 2.5.4.1 of the SSAR describes the geotechnical characteristics of the site and the investigative programs conducted to support this characterization. SSAR Section 2.5.4.2 describes the site ground water conditions. Sections 2.5.4.3 and 2.5.4.4 of the SSAR summarize the soil response to dynamic loading and the evaluation of liquefaction potential at the ESP site. SSAR Section 2.5.4.5 describes the static stability conditions at the site, including an evaluation of bearing capacity and settlement. Finally, SSAR Section 2.5.4.6 briefly describes the geotechnical design criteria. Throughout this section, the applicant referred to Engineering Report ER-02, "Geologic, Geotechnical and Geophysical Field Exploration and Laboratory Testing," for details of the site's geotechnical characteristics.

2.5.4.1 Technical Information in the Application

2.5.4.1.1 Detailed Site Investigation Program

SSAR Section 2.5.4.1 describes the static and dynamic engineering properties of the subsurface materials (between the surface and a depth of 200 feet) at the ESP site. This section also presents the laboratory testing program used to obtain the engineering characteristics of the subsurface materials.

<u>Description of Subsurface Materials</u>. The applicant stated, in SSAR Sections 2.5.4.1.1 and 2.5.4.1.2, that it derived the properties of the subsurface materials and the range of their thicknesses from four new borings made at the ESP site, together with a number of borings previously obtained as part of the original field exploration program conducted for the existing GGNS. Among the four new borings, two (B-2 and B-2a) are located at essentially the same (plan) location. The applicant did not take samples of the soil overburden at similar depth ranges in these two adjacent borings. Therefore, the applicant effectively made only three new borings as part of the ESP program. In addition, the applicant took four cone penetrometer tests (CPTs) to supplement the ESP site investigation. SSAR Section 2.5.1.2 cites the GGNS UFSAR, which states that the GGNS licensee drilled a total of 275 borings when constructing the existing GGNS. Those borings reach a maximum depth of about 450 feet below grade. The applicant included information from the previous investigation that is relevant to this ESP evaluation process.

The proposed ESP site is relatively flat with an elevation of 135 feet. The site is located immediately adjacent to the existing nuclear power plant on the bluff just to the east of the Mississippi River, with an area about 0.12 km^2 (30 acres). The applicant pressed the CPTs to a depth of about 100 feet and drove the borings to a depth of 180–240 feet. The combination of these recent data with previously available boring and sample data provides information on site stratigraphy to a depth of about 240 feet. The applicant stated that the remaining part of the site profile needed to determine seismic site response characteristics comes from other generic information available for the broad region around the site.

The applicant divided the shallow part of the subsurface materials into five zones, described as follows, from the surface downward:

(1) Localized fill—At various locations across the site, the GGNS licensee placed fill to relatively shallow depths to stabilize existing swales while constructing the existing GGNS. These relatively localized fills are no more than 20 feet thick and are unimportant to seismic site response analysis and to the foundation of the SSCs.

(2) Loess—Loess with a thickness of 55–85 feet forms the surface layer across the site. It is generally composed of relatively uniform inorganic silts of low to moderate plasticity (or an ML material according to the Unified Soil Classification System (USCS), with some silty clay intervals. The loess shows layering defined by difference in clay contents, color, shell content, and consistency. The engineering properties for different

loess layers do not show significant variation. Regionally and locally, the loess shows some minor cementation and soil structures that allow it to stand vertically in cuts and river banks. The CPT soundings show that the loess exhibits layering with a thickness from 6 inches to 40 feet. Standard penetration test (SPT) sample blow counts indicate that the loess is medium-stiff to stiff and has undrained shear strengths from 750 to 1500 psf. Measured shear wave velocities for the loess vary from 590 fps to 1450 fps.

(3) Upland Alluvium—Immediately below the loess is a zone of alluvium termed the Upland Alluvium, which consists of an interbedded sand and silty sand material with a USCS classification varying from SP (poorly graded sands or gravels with little or no fines) to SM (silty sands with little or no plasticity). Discontinuous layering ranges between 6 inches and 3 feet. Sand grains are subrounded to subangular, fine to medium grained, and consist of quartz with lesser feldspar and mafic lithologies. The Upland Alluvium is typically well sorted with low fines content and low plasticity. Some of this material may also contain plastic fines (an SC classification according to the USCS) interspersed in this zone. The Upland Alluvium is typically a medium-dense to dense formation that the CPT soundings penetrated to some extent. The thickness of the Upland Alluvium varies across the site from as little as 20 feet to as much as 100 feet. Undrained shear strength (ranging from 4000 psf to 8000 psf) of the Upland Alluvium is somewhat higher than that of the loess, and its shear wave velocities vary from 740 fps to as much as 1750 fps.

(4) Old Alluvium—The Old Alluvium consists of interbedded clayey sands, sandy clay, silty sand, and gravelly sand. The Old Alluvium is poorly to well sorted and typically exhibits much poorer grading than the overlying Upland Alluvium. The Old Alluvium also exhibits layering with a thickness between 3 inches and 4 feet. Gravel-size clasts include a large percentage of soft clay and claystone rip-up clasts. Finer grained layers of the Old Alluvium exhibit low to moderately high plasticity, and the Old Alluvium contacts with the overlying Upland Alluvium unconformably. It is generally more difficult to drill into the Old Alluvium than either the loess or the Upland Alluvium using standard boring equipment. The SPT blow counts in available samples indicate the Old Alluvium to be dense to very dense. The few profiles presented in the SSAR indicate that the layer extends to a depth of approximately 200 feet. The applicant also noted that measured shear wave velocities of the Old Alluvium vary from as little as 530 fps to as much as 3360 fps. Cross-sections across the site show that the Old Alluvium appears as lenses between the overlying Upland Alluvium and underlaying Catahoula formation.

(5) Catahoula formation—The Catahoula formation consists of gravelly sands, hard clays, and claystone. The claystone is highly plastic, indicating some fracturing characteristics encountered in samples or recovered core, and possesses some slaking characteristics when soaked in water for several minutes. Based on SPT blow count correlations, the Catahoula formation (blow counts = 82) is defined as hard to very hard and is classified as a soft rock-like material. Its shear wave velocities vary from 1500 to 2830 fps. The applicant did not state the anticipated bottom depth of the Catahoula formation because it was only encountered in one of the deepest borings, which penetrated to a depth of 240 feet.

In RAI 2.5.4-2, the staff asked the applicant to describe the characteristics of the fill material and controls, if any, placed on the fill at the time of its placement. In its response, the applicant noted that before the construction of the GGNS, a system of steep-walled drainage swales crossed portions of the ESP site. The licensee filled these swales during site grading to form the present upper (Elevation 155 feet) and lower (Elevation 134 feet) pads that are encompassed by the ESP site and PPBA. The applicant discussed these localized fills in the SSAR but did not show the extent of the filled swales. Therefore, the applicant will modify SSAR Figure 2.5-69 to more accurately depict the extent of the swale fills. The modified figure will also show that the bottom of the swale is located about 30 to 50 feet below the present grades. The applicant also stated that the UFSAR for the existing GGNS site discusses the engineered structural fill placed at the powerblock of the existing plant but does not discuss the engineering controls used for fill placement at the ESP site. The SPT blow counts in the fill from an ESP boring located in the center of one of the fill areas range from 5 to 7. These blow counts are less than the underlying native loess (blow counts from 11 to 13) but are within the range of loess soils in other borings. The composition of the fill in this boring shows that it is similar in texture to the native loess soils. The applicant concluded that the fill appears to have been derived from the excavation of loess cut from areas of the GGNS site. As stated in its response, the applicant did not observe any evidence of settlement of the pavements or the filled ground surface during the ESP field work, suggesting that the fill is not unusually compressible or prone to settlement under its own weight or light pavement and vehicular loading. The applicant planned to place the foundations for the ESP reactor and safety-related facilities well below the maximum depth of these fills; therefore, the fill will not affect these facilities. The applicant also noted that the excavation to develop a uniform plant grade elevation in the ESP area would remove much of the fill underlying the upper pad area. However, a 10- to 30-foot-thick section of fill may remain under the eastern parts of the yard area. In addition, the applicant will take additional borings during the COL phase to evaluate the character of the fill and to determine if it will require additional excavations and replacements to minimize settlements of appurtenant nonsafety facility foundations and pavements.

To perform a probabilistic site response calculation, the base case is the best estimate (BE) velocity profile must be provided, together with the ±1 sigma shear wave velocity values (UB and LB values) over the entire soil profile. The staff asked the applicant in RAI 2.5.4-5 to provide the values of the BE, UB, and LB velocities selected for each primary component of the profile and the bases for its selection in either SSAR Section 2.5.4 or 2.5.2. In its response, the applicant stated that Figure 2.5.4-18 (SSAR Figure 2.5.4-60) shows the BE profile, which is based on a visual average of the three compression and shear (P-S) suspension log surveys obtained from the ESP site borings. The applicant’s response to RAI 2.5.4-8 discusses the development of this BE profile. The applicant further noted that it did not develop the UB and LB profiles; instead, it used a profile randomization scheme to incorporate expected variability across the site. This approach is intended to maintain the 10^{-5} APE hazard level of the rock outcrop UHRS by developing statistically significant estimates of the mean amplification factors for the site.

The applicant stated that, of all the ESP borings, only one (Boring 2A) reached the depth of the Catahoula formation; however, even in this boring, no continuous core was taken inside the formation. The applicant noted that the UFSAR descriptions have improperly categorized the Old Alluvium of the Upland Complex as the Catahoula formation. With only one boring available and no significant samples taken in this formation, the staff asked the applicant in RAI 2.5.4-1 to provide the basis for categorizing the Catahoula formation as bedrock as opposed to dense sands and gravels and the subsequent impact of this decision on the ESP site evaluation. In its response, the applicant compared the classifications from the UFSAR borings to those from the ESP investigation and correlated borings obtained during the two periods. The applicant noted that the nomenclature for the site geologic units used in the ESP differs from the convention used in the UFSAR. The stratigraphic nomenclature adopted for the UFSAR evaluations relies heavily on an older regional geologic study (USACE, "Geological Investigation of the Alluvial Valley of the Lower Mississippi River", 1944). To be consistent with the more recent regional geologic studies, the applicant updated and modified the soil nomenclature for the ESP site in the SSAR. These recent geologic studies provide a better understanding of the depositional history of Pliocene and Pleistocene sediments, as well as refined stratigraphic descriptions and correlations. The applicant correlated the UFSAR-defined Catahoula formation with the ESP-defined Upland Complex Old Alluvium. The applicant stated that the Old Alluvium differs from the underlying Catahoula formation by lesser degrees of lithification and coarser, less-sorted texture. Moreover, the Old Alluvium's contact with the overlying Upland Alluvium is an irregular erosion surface, and two of the borings show a yellowish-brown, slightly oxidized zone between the two. This oxidized zone helped the applicant establish the correlation between the ESP investigation and the description inside the UFSAR. The applicant also noted that the top of the Upland Complex Old Alluvium is in general about 30 to 80 feet higher in elevation at the GGNS site than underneath the ESP site. Therefore, foundations at the ESP site will require deeper excavations extending into the Upland Complex Old Alluvium to reach conditions that are similar to those of the existing plant. The existing plant foundations do not extend to the ESP-defined Catahoula formation, which consists of gray-green, hard clay to claystone that exhibits a slight degree of induration and somewhat brittle rock-like behavior. The descriptions for the ESP-defined Catahoula formation are similar to the indurated and/or partly cemented clays and silts (with some cemented sand lenses) that are described in the deeper parts of the UFSAR borings (i.e., below the bearing level of the plant foundation). The applicant believed that these materials are a better correlation to the regional descriptions of the Catahoula formation than the overlying, less-indurated sediments that are classified as Upland Complex Old Alluvium. On the basis discussed above, the applicant concluded that the change in nomenclature from that used in the UFSAR to that used in the ESP SSAR does not have any significant impact on the site evaluations because the properties for the equivalent cross-correlated units are essentially the same.

In SSAR Section 2.5.4.1.2, the applicant provided soil profiles developed for the ESP site, as shown in Figures 2.5.4-1 and 2.5.4-2. The maximum depth of these borings investigated during this program extends to about 240 feet. In RAI 2.5.4-3, the staff asked the applicant to provide the number and maximum depth of the borings that were used to characterize the ESP site area.

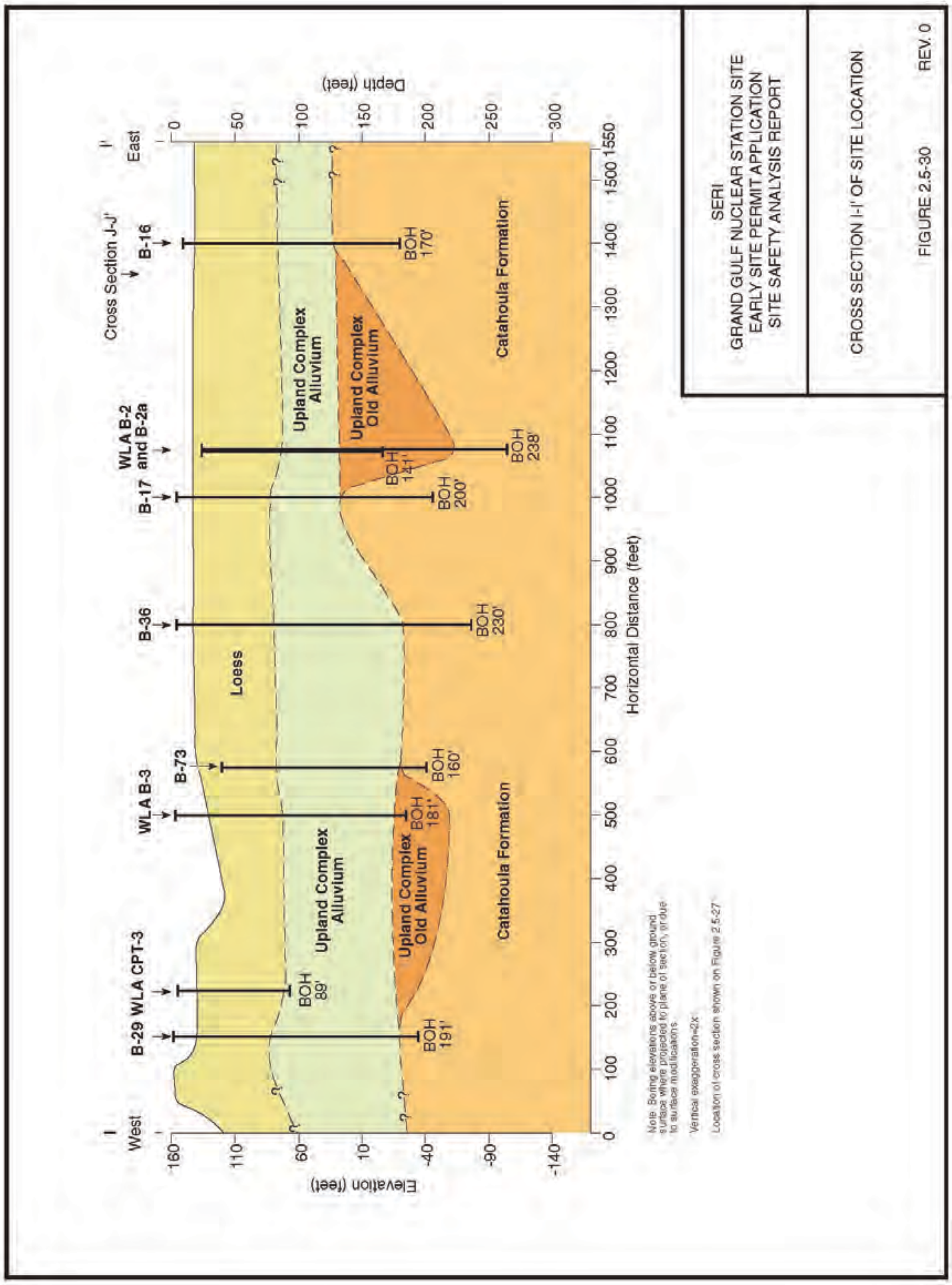


Figure 2.5.4-1 (SSAR Figure 2.5-30)
Cross Section I-I of Site Location

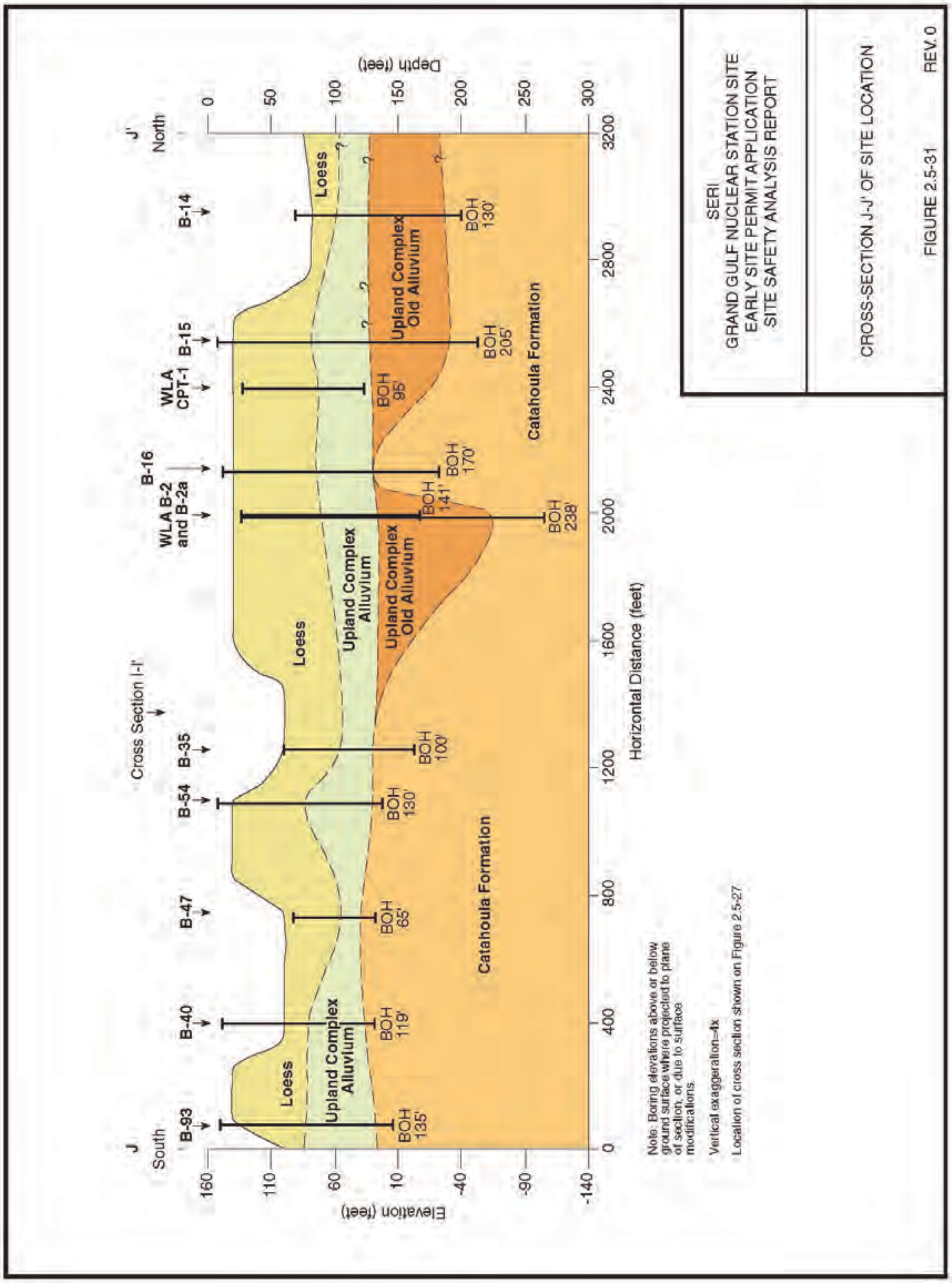


Figure 2.5.4-2 (SSAR Figure 2.5-31)
Cross Section J-J of Site Location

Presuming that these borings are also relatively shallow and that the site profile used in SSAR Section 2.5.2.3 extends thousands of feet deep into the hard rocks referred to in the EPRI-SOG ground motion attenuation relationships, the staff also asked the applicant to present additional information that allows for the characterization of the ESP site materials from a corresponding depth. In its response, the applicant explained that it characterized the ESP site by two individual borings, one composite boring, and four CPT soundings for the ESP site investigation program. The applicant distributed these borings and CPT soundings throughout the ESP site. The revised map (Figure 2.5.4-3) shows a circular PPBA that supersedes the previous polygonal proposed site location perimeter and indicates the approximate locations of the available UFSAR borings within the ESP area. The depths of the new ESP borings range between 142 and 238 feet below the ground surface while the depths of the CPT soundings range between 79 and 95 feet below the ground surface. The applicant augmented the ESP explorations with data from 20 previous borings performed for the UFSAR that fall within or adjacent to the ESP PPBA. The UFSAR borings extend to depths of between 81 and 300 feet below the ground surface. The combined coverage of the ESP and UFSAR borings provides sampling across the entire PPBA at 200- to 600-foot spacing and down to a depth of 300 feet. One of the ESP borings and about four to six of the UFSAR borings extend into the dense clay to claystone that the applicant defined as the Miocene Catahoula formation. Two of these borings include interval core sampling of the Catahoula formation. Revised SSAR Figure 2.5-69 integrates the ESP and the UFSAR explorations and indicates a good control to a depth of about 250 feet below the ground surface.

The applicant stated that it developed the ESP site investigation program to obtain sufficient information to characterize the site's subsurface conditions because soil variability may influence the earthquake ground motion response analysis. The ESP site explorations, augmented by borehole data from the UFSAR, capture the three-dimensional geometry of the strata and variations in soil properties. The applicant also stated that the generally consistent horizontal stratigraphy of the site provides a high level of confidence regarding the characterization of the geologic and geotechnical conditions appropriate for the ESP study. The applicant will further verify the site stratigraphy by additional borings taken during the COL phase. After it reviewed the data from a series of cross-hole seismic surveys performed for the UFSAR in four borings at the existing power plant area, the applicant obtained the cross-hole wave velocities to a depth of 300 feet and recorded wave velocities at 10-foot intervals to develop a site velocity profile. However, the applicant stated that the cross-hole survey used explosives, a poorly controlled source, set off in a fifth borehole, as well as old approaches and equipment that cannot be reliably correlated to the ESP site borehole seismic P-S surveys. Therefore, the applicant only used the UFSAR cross-hole velocity profiles as a general comparison to the ESP site-specific data, and the comparison did not provide information useful to extrapolate the ESP profiles to greater depth. The applicant extended the velocity profile below a depth of 300 feet using a generic deep profile developed from regional studies of the Mississippi embayment. The applicant also noted that these regional studies include extensive velocity measurements near the Memphis area and its surrounding regions, as well as the development of regional soil columns for the Mississippi lowlands and uplands. The generic profile accounts for the depth to the Paleozoic crystalline basement for long-period responses. The applicant's response to RAI 2.5.4-4 discusses this extrapolation in detail.

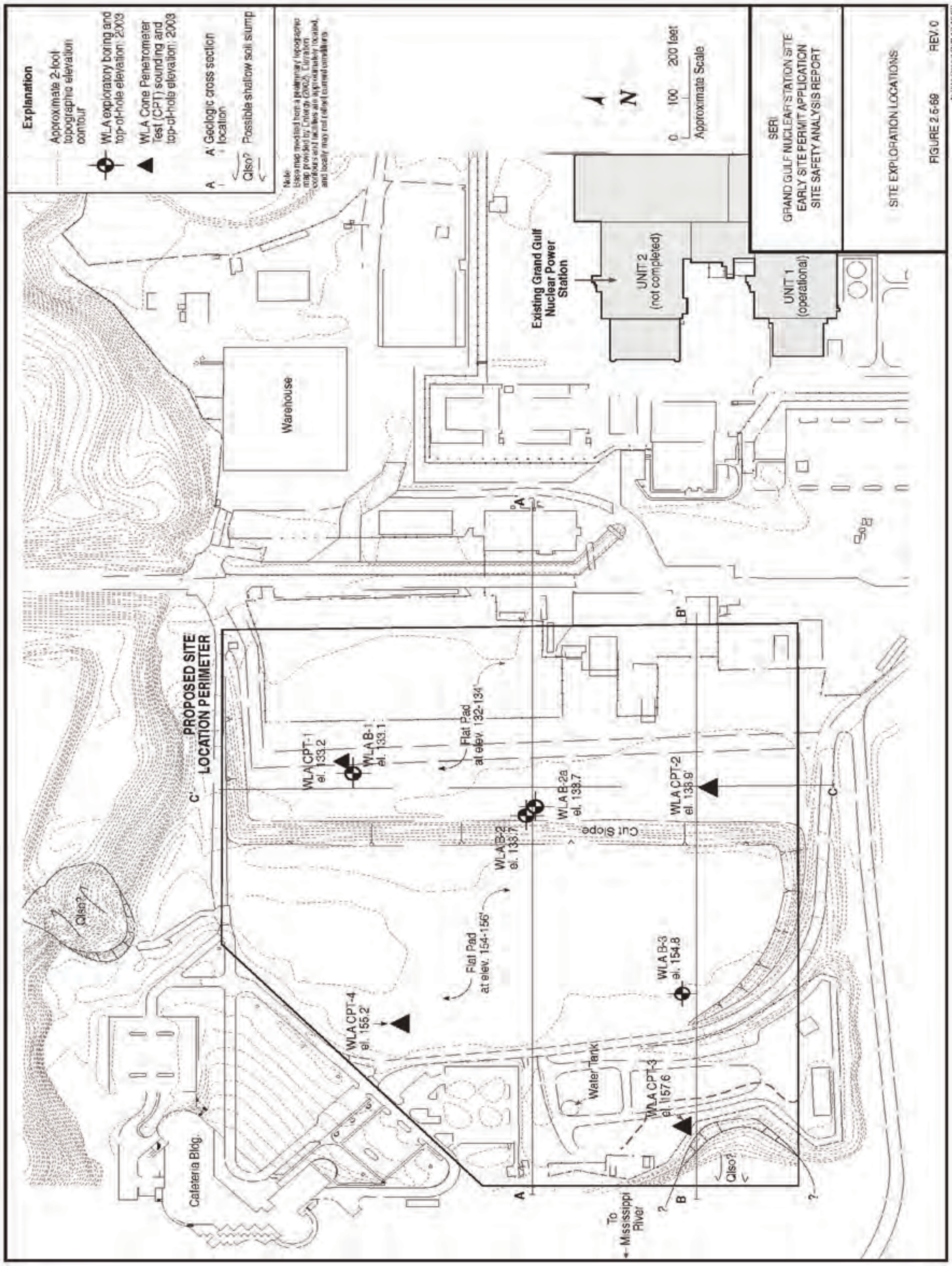


Figure 2.5.4-3 (Revision 2 of SSAR Figure 2.5-69)
Site Exploration Locations

Geophysical Properties. As stated in SSAR Sections 2.5.4.1.3 and 2.5.4.1.4, the applicant performed suspension logging using an OYO logging system that measures both compression (P) and horizontal shear (S) wave velocities in the three borings drilled in the ESP site area. Figure 2.5.4-4 presents the results of the logger measurements. The results indicate relatively slowly increasing S-wave velocities over the depths investigated in the boreholes. At a depth of about 200 feet below the ground surface, the S-wave velocity is about 2000 fps and the corresponding P-wave velocity is about 6000 to 7000 fps. The P-wave velocity increases slowly with depth, except in the vicinity of the ground water table where it increases relatively rapidly as the degree of saturation increases. No other significant difference in profile velocity occurs at any anticipated interface between the layers described above. Based on previous information obtained from the UFSAR for the existing GGNS, the applicant noted that the velocities obtained from cross-hole logging are in the same value range.

Cone Penetrometer Testing. As stated in SSAR Section 2.5.4.1.5, the applicant pressed four CPT soundings across the site to depths between 79 and 95.3 feet through the loess and into the Upland Alluvium. Resistance is relatively consistent (and relatively low) through the loess and increases significantly into the Upland Alluvium. Correlation of strength and grain-size properties using standard correlations indicates that the CPT results are generally consistent with sample SPT blow counts. Gradations are generally consistent with those found from inspection of the samples. The CPT data indicate that the loess and Upland Alluvium are somewhat overconsolidated.

Static Laboratory Testing. SSAR Section 2.5.4.1.6 summarizes the laboratory data obtained from 60 samples of site soils obtained from the ESP investigation. The majority of static tests conducted were for standard index properties, such as moisture content, dry density, Atterberg Limits, and grain-size distribution (sieve shaking and hydrometer). The applicant conducted six consolidated-undrained triaxial test series (consisting of from one to three consolidation pressures in each test series) to obtain static strength parameters. Tables 2.5-24 and 2.5-25 of the SSAR summarize those results.

The results indicate that the loess has an average dry density of 1522.18 kilograms per cubic meter (kg/m^3) (94.8 pcf) with an average moisture content of 22 percent. The Upland Alluvium has an average dry density of 1666.39 kg/m^3 (106 pcf) with an average moisture content of 68 percent. The Old Alluvium has an average density of 1522.18 kg/m^3 (94.7 pcf) with a moisture content of 23 percent. This density of the Old Alluvium is unusually low and is similar to that of the loess. Only one sample of the Catahoula formation was available for testing, and no density or strength information was obtained from this sample. The applicant noted that theresults obtained from these laboratory tests are similar to those indicated in the UFSAR for the loess.

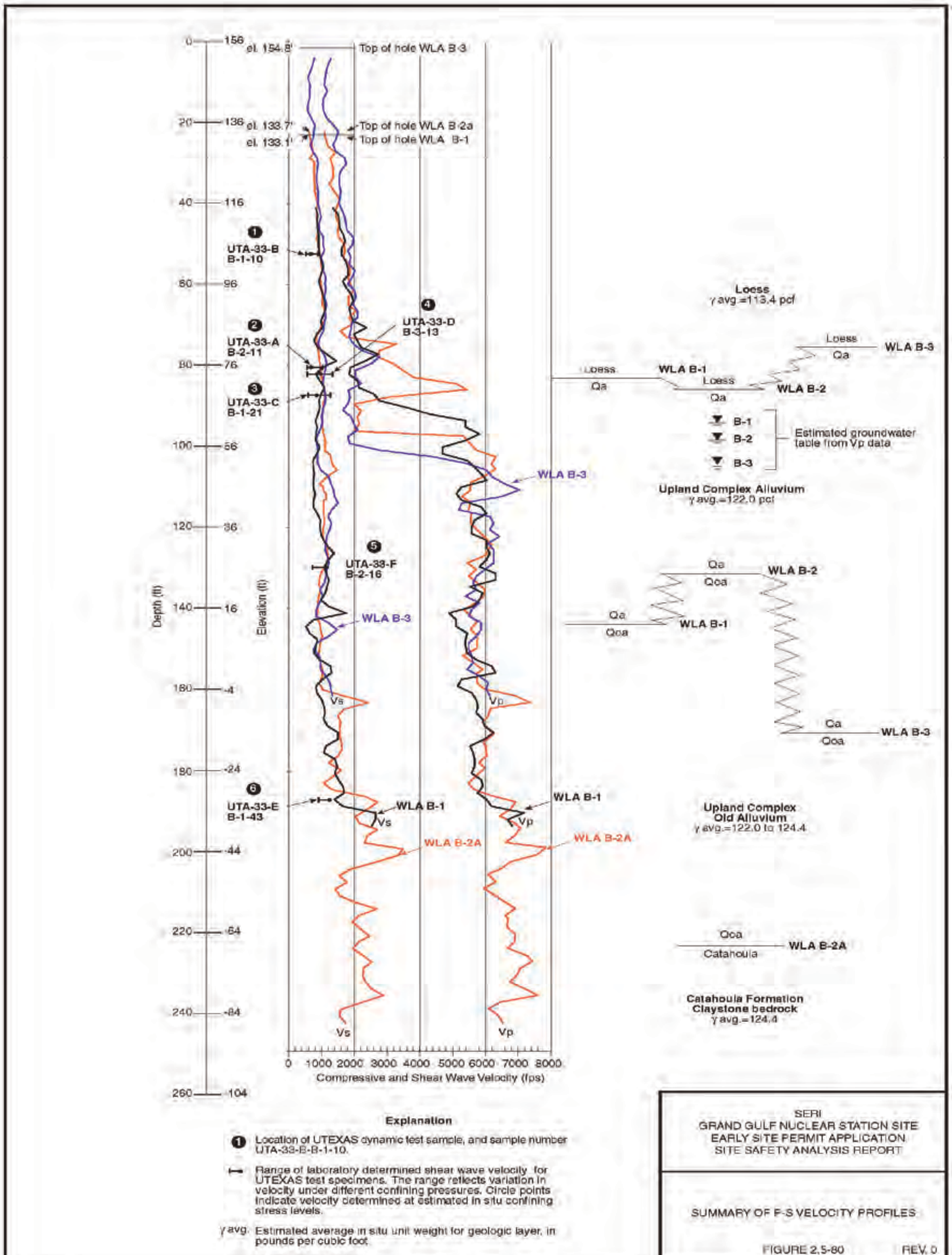


Figure 2.5.4-4 (Figure 2.5-80 of the SSAR)
Summary of P-S Velocity Profiles

Dynamic Laboratory Testing. As described in SSAR Section 2.5.4.1.7, the applicant performed laboratory tests on six samples to obtain the dynamic material properties needed to perform the site response evaluations used in developing design spectra. In addition to the standard index testing normally performed on soil samples, the applicant obtained the dynamic properties from resonant column (RC) and torsional shear (TS) testing. Of the six samples tested, two each are from the loess, the Upland Alluvium, and the Old Alluvium, respectively. As indicated in Section 11.0 of ER-02, these zones represent the effective depth over which undisturbed samples can be pushed using ordinary thin-walled Shelby tube samplers. The test results obtained were the low-strain values of shear wave velocity and hysteretic damping ratio together with shear modulus reduction and hysteretic damping curves as functions of peak effective shear strain developed in the material. Low-strain values of the parameters are typically defined at a peak effective shear strain of 10^{-4} percent. Modulus reduction and damping data are typically desired over a shear strain range of 10^{-4} to 1 percent effective strain, depending on the level of strain anticipated in the site soil column for the given level of seismic shaking resulting from the design ground motion.

SSAR Table 2.5-26 outlines the results of the testing program. A comparison of the low-strain shear wave velocities measured in the laboratory with the values measured during the field geophysical program indicates a ratio of laboratory to field velocities varying from as low as 0.58 to as high as 1.00. Five of the six samples show a ratio of laboratory to field velocities significantly below unity. As described in Section 11.0 of ER-02, the fact that the ratio is less than unity is typically ascribed to the disturbance of the soil sample caused by the sampling process and the disturbance induced during the testing program.

In the laboratory, the applicant confined the samples at a specified value of confining pressure defined by the stress ratio parameter k_0. For a given value of overburden vertical effective stress (defined typically by the total weight of material above the sample depth minus the effects of ground water), the parameter k_0 represents the ratio of the corresponding value of lateral effective stress to the value of vertical effective stress. This ratio is generally unknown in situ but is anticipated to range from a value of 0.5 to 1.0, depending upon the conditions at the site, method of deposition, and soil type, among other factors. The applicant used a value of 0.5 for the loess samples and a value of 1.0 for the Upland Old Alluvium samples. After the completion of the initial testing program, the applicant tested the samples at confining pressures of 4 times the estimated in situ mean effective pressures. The applicant stated that the stress ratio parameter k_0 used for the loess samples was most likely too low and the value of unity was probably more appropriate.

The applicant compared the strain-dependent shear modulus reduction and damping curves generated from the test program with the family of curves recommended in EPRI TR-102293, "Guidelines for Determining Design Basis Ground Motions," issued November 1993 (EPRI-TR) and concluded that the test results are reasonably consistent with the curves recommended in the EPRI report. However, the applicant observed that the test results are more linear than the EPRI curves at the comparable depth of embedment (or confining pressure) for the sample. The applicant also noted that a possible reason for this is that the EPRI curves are reasonably appropriate for relatively young and normally consolidated Holocene soils, while the ESP site soils are generally older and somewhat overconsolidated. The applicant then evaluated the test results to generate appropriate functions and used these test results for the site soils modeled in the site response analyses.

In SSAR Section 2.5.4.1.7 and ER-02, the applicant stated that the site response calculations used the EPRI-TR depth-dependent curves as the shear modulus reduction and hysteretic damping models. The staff considers these to be generally appropriate for normally consolidated cohesionless sands. As described in ER-02 Sections 11.0 and 12.0, these curves may not be appropriate for the near-surface layers of the soil profile for which laboratory data are available; further, they may not be appropriate for any gravelly layer in the profile that tends to behave significantly more nonlinear than those indicated by the EPRI-TR dataset. In RAI 2.5.4-6, the staff asked the applicant to provide its basis for selecting the EPRI-TR curves as opposed to other models that may be more appropriate based on site-specific information described in the geotechnical report. In its response, the applicant noted that the statement that the shear modulus reduction and hysteretic damping curves used in the site response calculations are the EPRI-TR depth-dependent curves is correct but not complete. The SSAR description does not specify which of the EPRI curves are to be used for the various units in the site response analyses. SSAR Section 2.5.2.3 includes specifications for assigning the EPRI curves to the three principal units involved in the site response analyses (loess, Upland Alluvium, and Old Alluvium). The applicant did not use the EPRI curves corresponding to the depth ranges for these three soil units; rather, it used EPRI curves that represent greater depths of normally consolidated soils to represent the aged and overconsolidated soils at the ESP site. For example, the applicant used the EPRI-TR curves for depths of 120 to 250 feet to represent the loess, the EPRI-TR curves for depths of 250 to 500 feet to represent the Upland Alluvium, and the EPRI-TR curves for depths of 500 to 1000 feet to represent the Old Alluvium and the underlying materials to a depth of 500 feet. Below a depth of 500 feet, the applicant assumed that the profile exhibits essentially linear material properties.

The applicant also stated in its response that SSAR Section 2.5.4.1.7 presents the results of the dynamic laboratory tests plotted on the families of EPRI modulus reduction and damping curves for loess, Upland Alluvium, and Old Alluvium. However, because it did not indicate which of the EPRI curves should be selected for the site response analyses, the applicant will revise these SSAR figures to indicate the recommended curves used in the site response analyses. The applicant also stated that SSAR Section 2.5.4.1.7 discusses the rationale for adopting the EPRI curves. Specifically, the shape of the curves defined by the site-specific laboratory tests is similar to the shape of the EPRI curves. The comparison of the laboratory and EPRI-TR curves indicates that the raw laboratory data show less modulus reduction and lower damping values than the EPRI curves for the same depths. The applicant also explained that this is likely because EPRI developed these curves for normally consolidated Holocene silty and clayey sands, whereas the soils at the ESP site are both older and overconsolidated. In addition, the applicant noted that the laboratory test results must be adjusted for the effects of stress relief sample disturbance. As indicated in SSAR Table 2.5-26, the ratio of the shear wave velocities measured in the laboratory versus the field is generally less than unity. The ratio of the shear wave velocities measured in the laboratory for specimens consolidated to 4 times the estimated in situ stress versus the field-measured velocities are on the order of unity. This suggests that the additional sample consolidation produces results that better match the in situ field conditions of these soils.

In addition, the applicant stated in its response that RAI 2.5.4-6 correctly points out that the EPRI depth-dependent curves may not be appropriate for gravels. The EPRI report includes generic curves for pure gravels that are relatively more nonlinear than the family of depth-dependent curves that apply to soils that range from gravelly sands to low plasticity silty or clayey sands. However, at the ESP site, the gravel layers consist of some gravel-size particles in a sandier matrix. Such gravelly materials are generally less than 5-feet thick and appear to be discontinuous. Therefore, the applicant noted that the use of the EPRI-TR gravel curves would not be appropriate for the ESP site conditions.

In SSAR Section 2.5.4.1.7, together with ER-02 Section 11.0 and Appendix G to ER-02, the applicant presented a detailed summary of the laboratory dynamic test results and provided a comparison of the shear modulus reduction and hysteretic damping curves generated from the laboratory testing with the EPRI-TR recommendations used in the site response calculations.

As indicated in SSAR Section 2.5.2.3, the applicant used the EPRI-TR model for all layers of the soil profile. The staff identified the following issues in RAI 2.5.4-7 as a result of its review of the EPRI-TR:

- The shear modulus data presented in Appendix G for samples taken from a shallow depth are reasonably comparable to the EPRI recommendations for depths of 500 to 1000 feet. The hysteretic damping ratios from the laboratory tests are also much lower than those indicated in the EPRI-TR recommendations for comparable sample depths. Therefore, the laboratory data indicate properties that are much more linear and possess lower damping than those represented by the EPRI-TR recommendations for similar sample depths.

- The boring logs reported in Appendix C to ER-02 indicate that some soil layers have significant gravel content. These materials may normally be expected to have properties that are much more nonlinear than indicated by the EPRI-TR recommendations.

- Section 11.0 of ER-02 suggests that the laboratory results for specimens UTEXAS 1, 2, and 6 should be corrected to account for the effects of sample disturbance and/or underestimation of effective confining stress.

In RAI 2.5.4-7, the staff asked the applicant to provide its rationale for not incorporating these effects in the site response calculations and to evaluate the potential impact of these modifications on the computed surface UHRS. In its response, the applicant referred to its response to RAI 2.5.4-6 and stated that the analysis and selection of the appropriate EPRI-TR curves for shear modulus reduction and hysteretic damping fully account for the effects of possible disturbance to the test specimens resulting from stress release during sampling, as well as possible movements during testing. The applicant considered the effects of sample relaxation by examining the results from testing soils at both the estimated in situ confining stress and 4 times the estimated in situ confining stress. The applicant plotted these two data sets together on the EPRI-TR base curves as shown in Figures 2.5.4-5 through 2.5.4-12, which replicate SSAR Figures 2.5.4-87 to 2.5.4-94. The two data sets were weighted to select the most representative EPRI-TR curve.

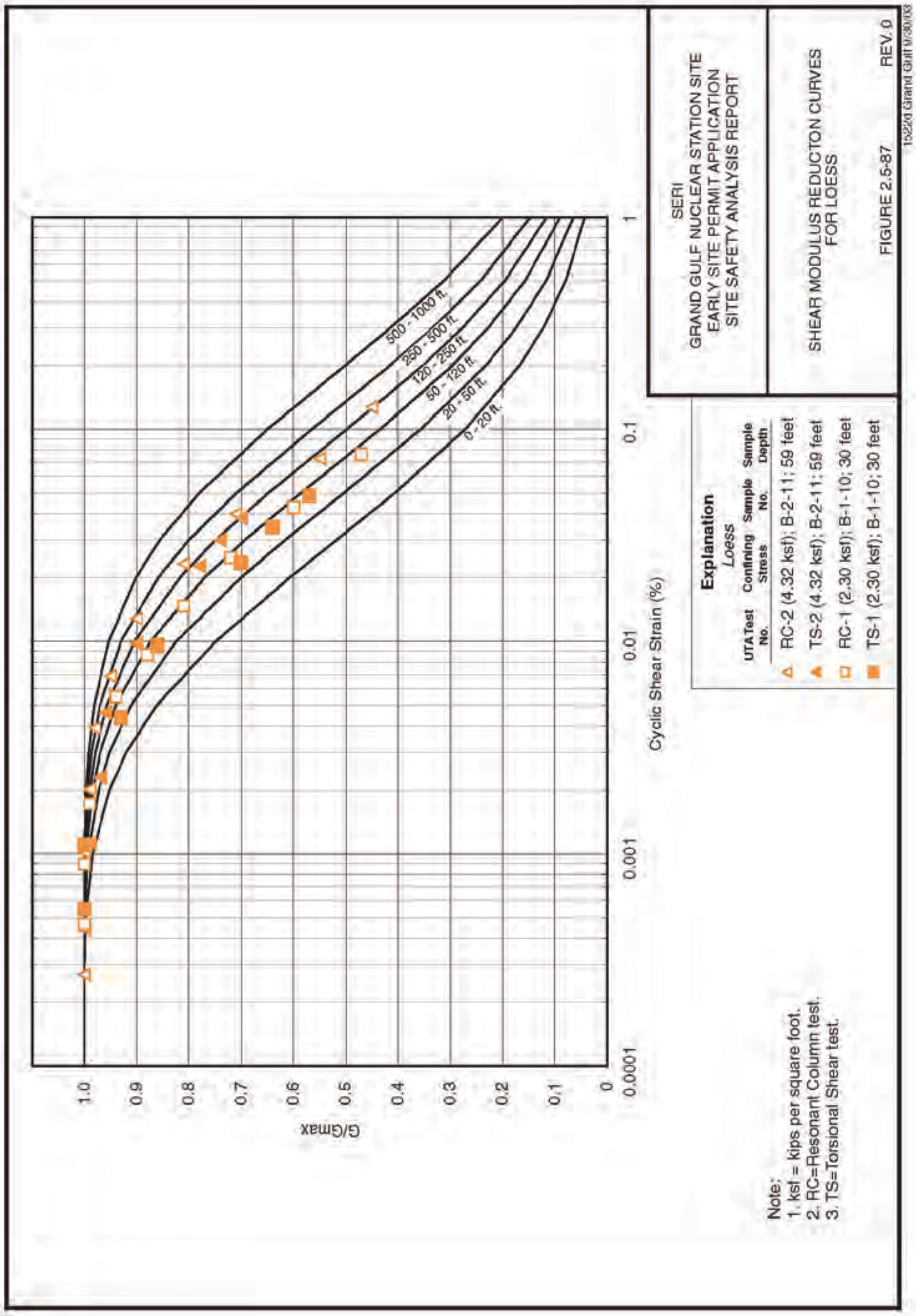


Figure 2.5.4-5 (Updated final version of SSAR Figure 2.5-87)
Shear Modulus Reduction Curves For Loess

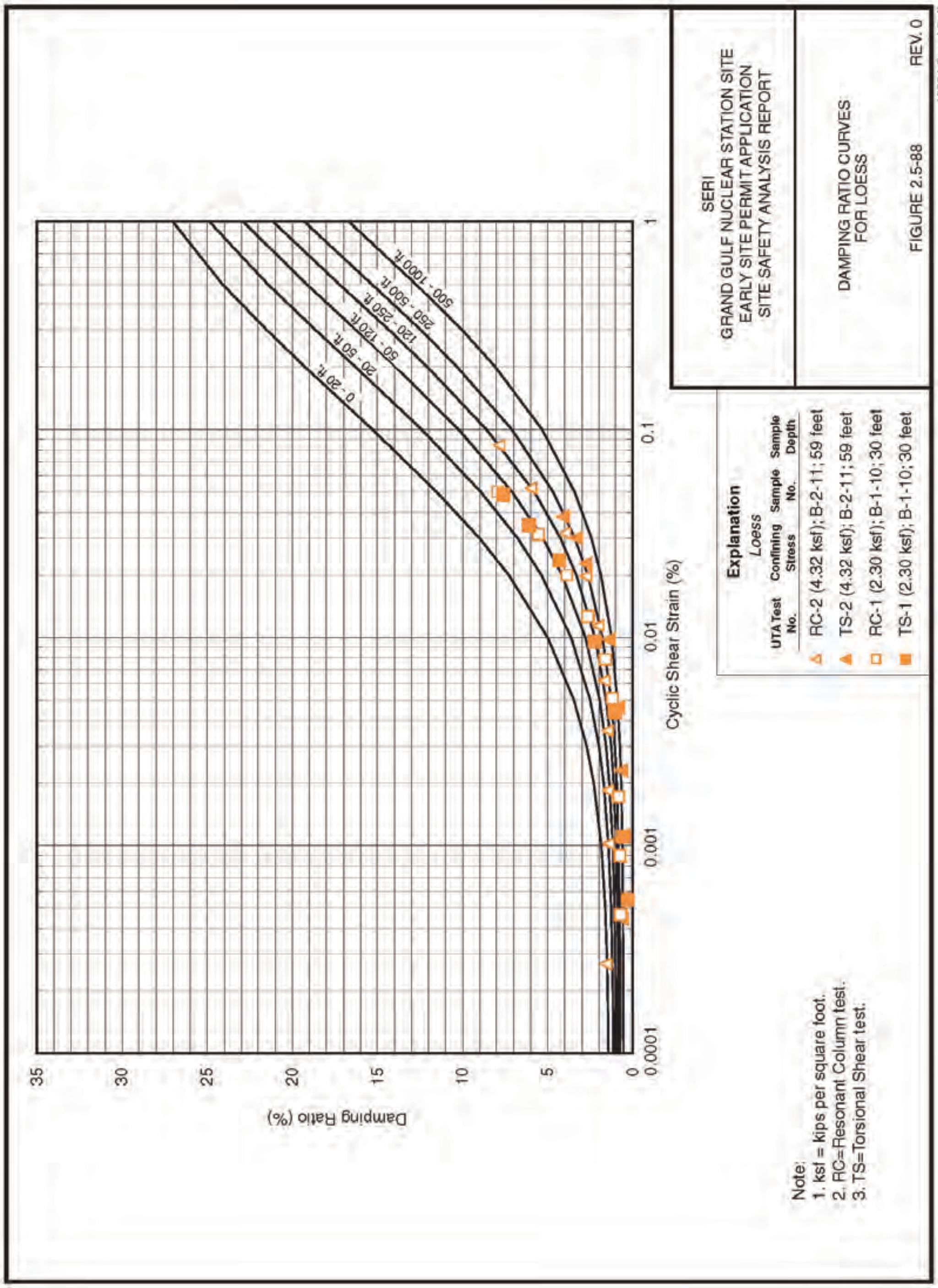


Figure 2.5.4-6 (Updated final version of SSAR Figure 2.5.4-88)
Damping Ratio Curves for Loess

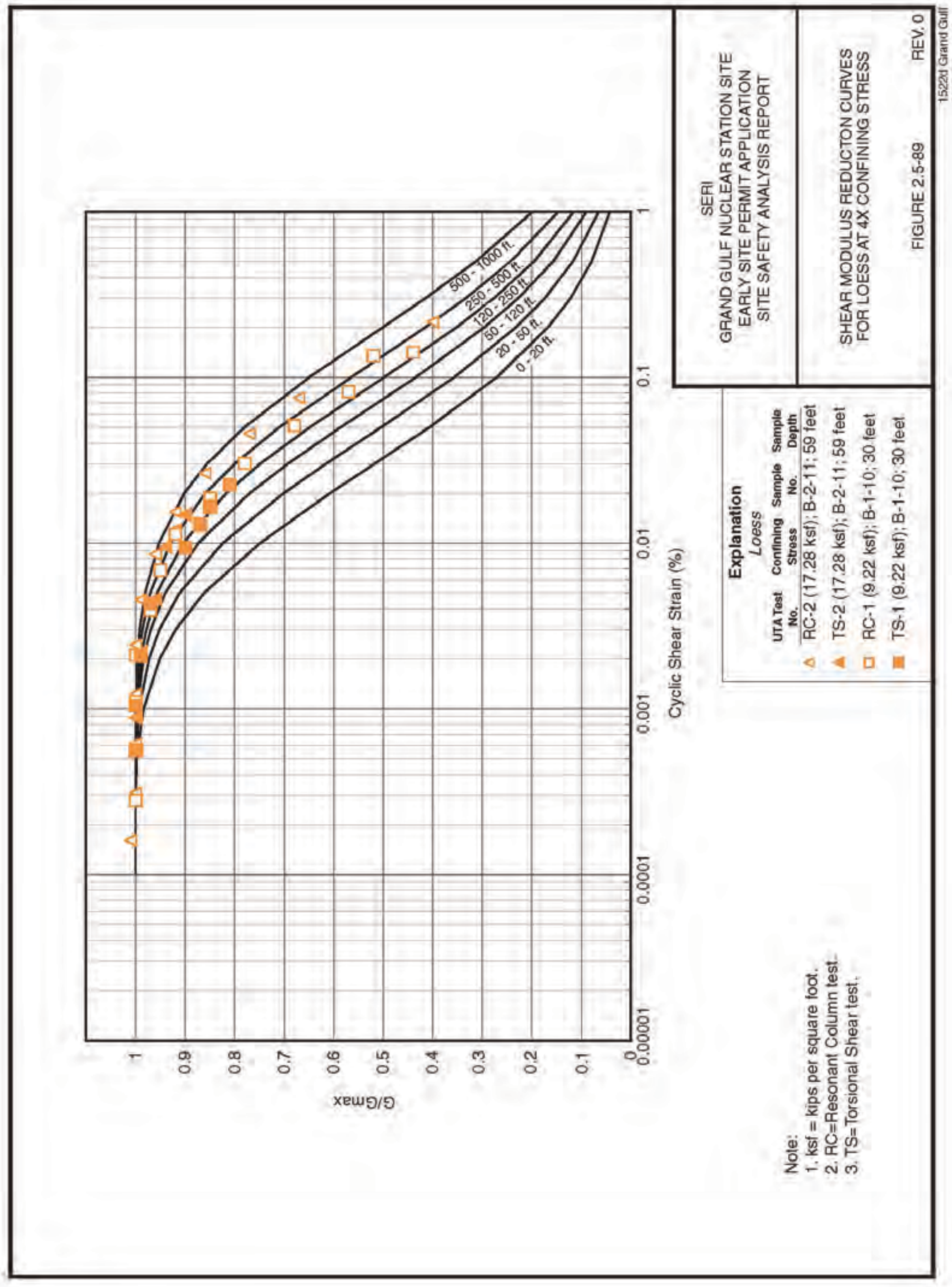


Figure 2.5.4-7 (Updated final version of SSAR Figure 2.5.4-89)
Shear Modulus Reduction Curves for Loess at 4X Confining Stress

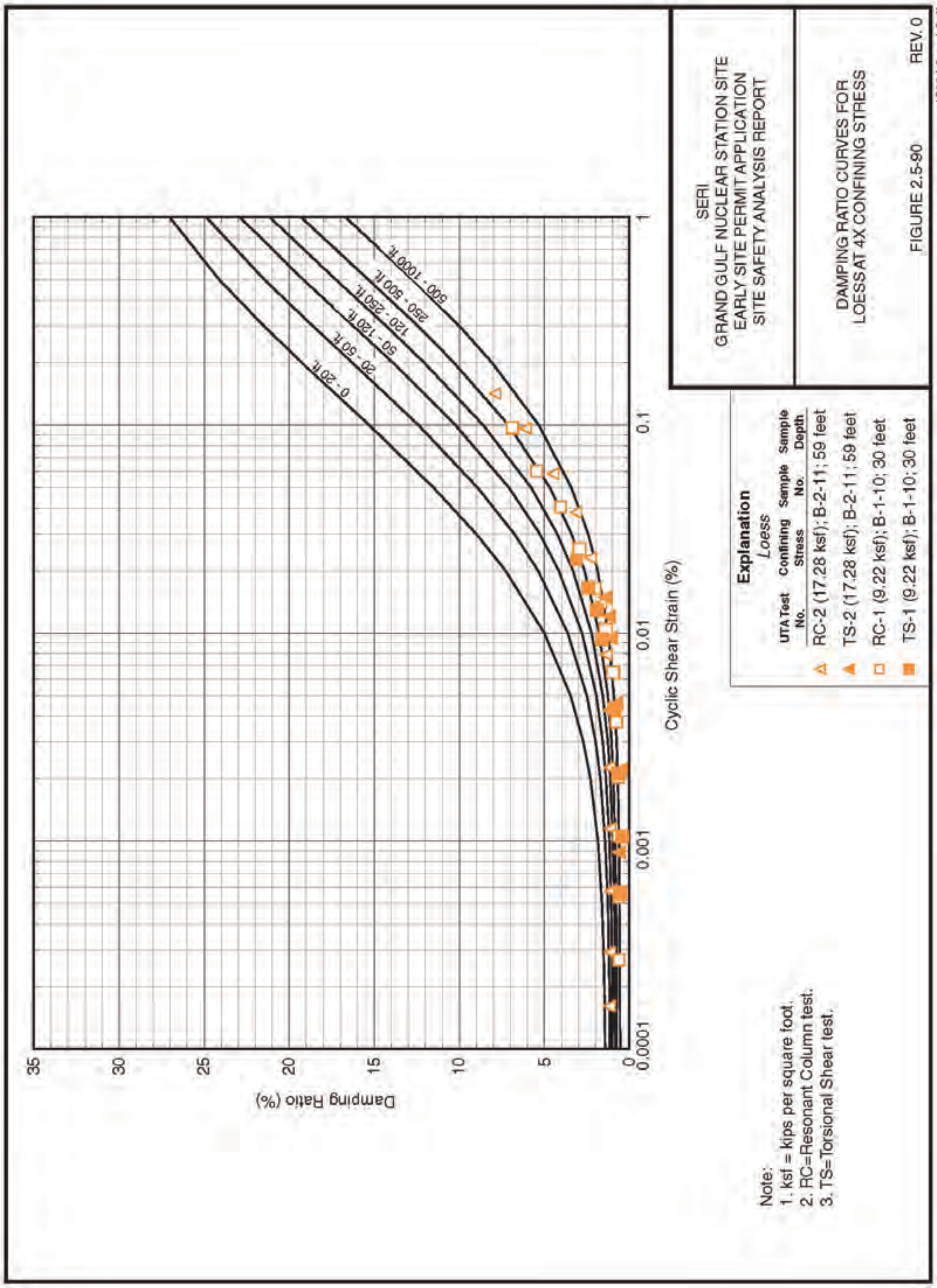


Figure 2.5.4-8 (Updated final version of SSAR Figure 2.5.4-90)
Damping Ratio Curves for Loess at 4X Confining Stress

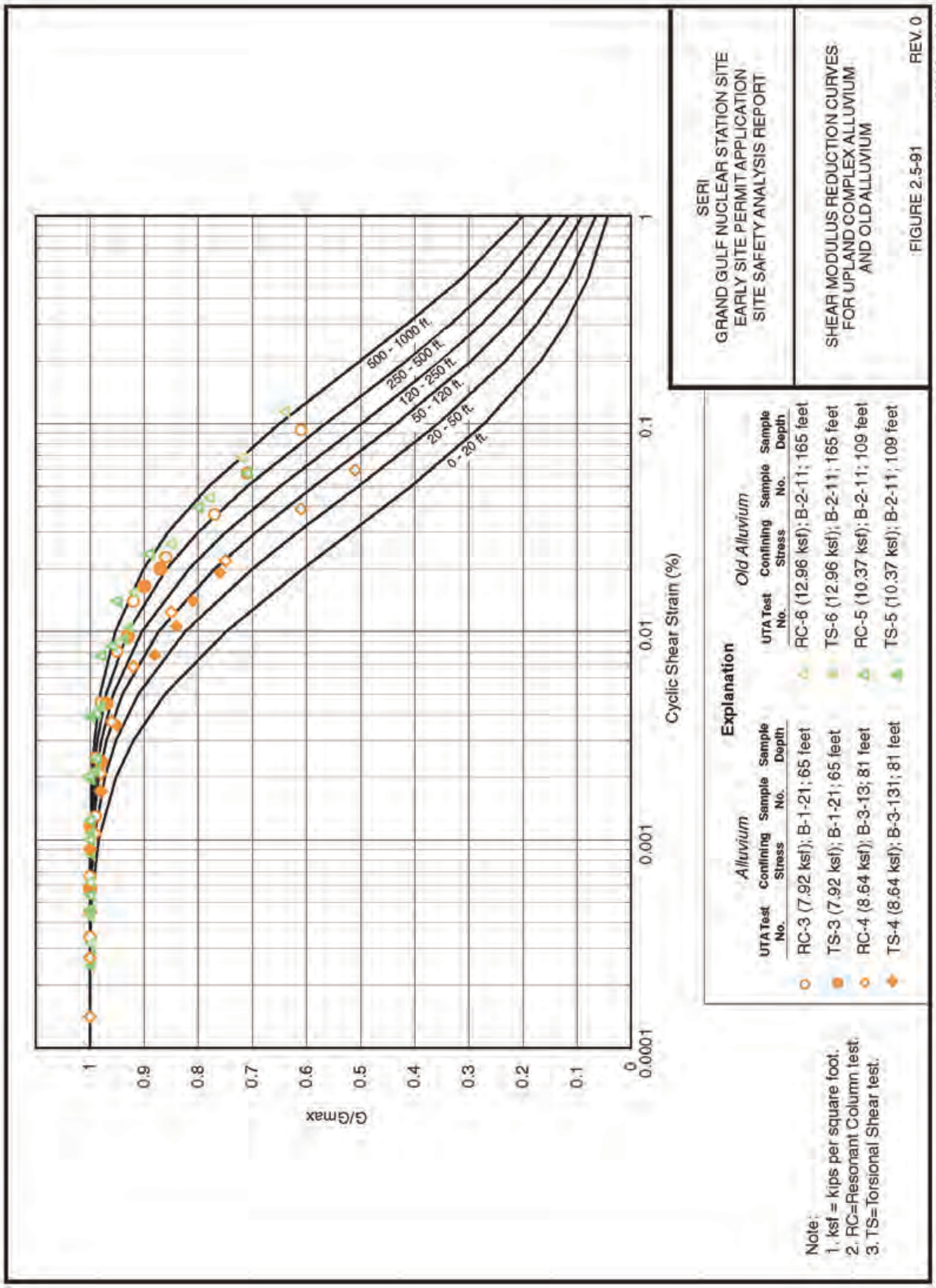


Figure 2.5.4-9 (Updated final version of SSAR Figure 2.5.4-91)
Shear Modulus Reduction Curves for Upland Complex Alluvium and Old Alluvium

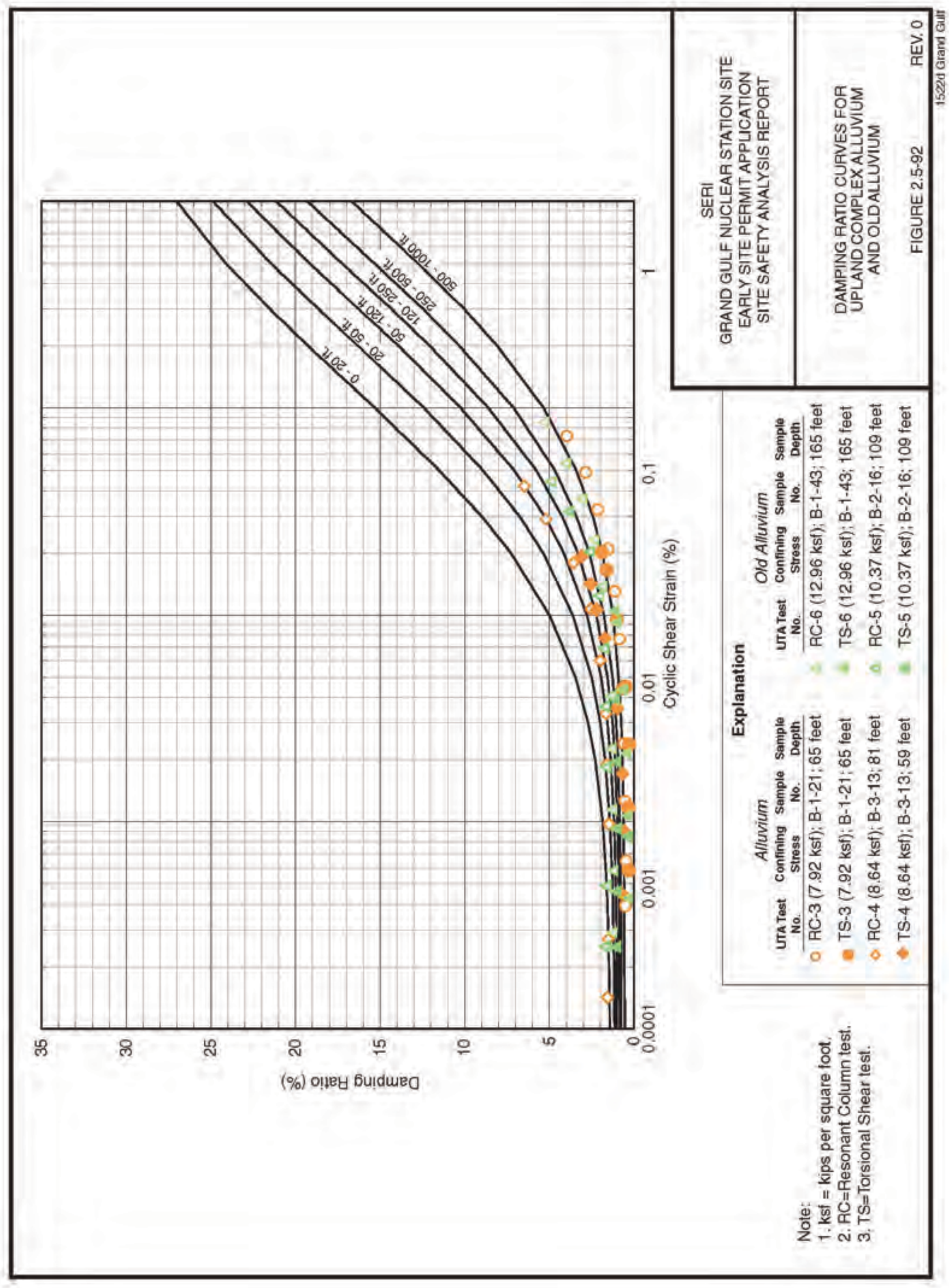


**Figure 2.5.4-10 (Updated final version of SSAR Figure 2.5.4-92)
Damping Ratio Curves for Upland Complex Alluvium
and Old Alluvium**

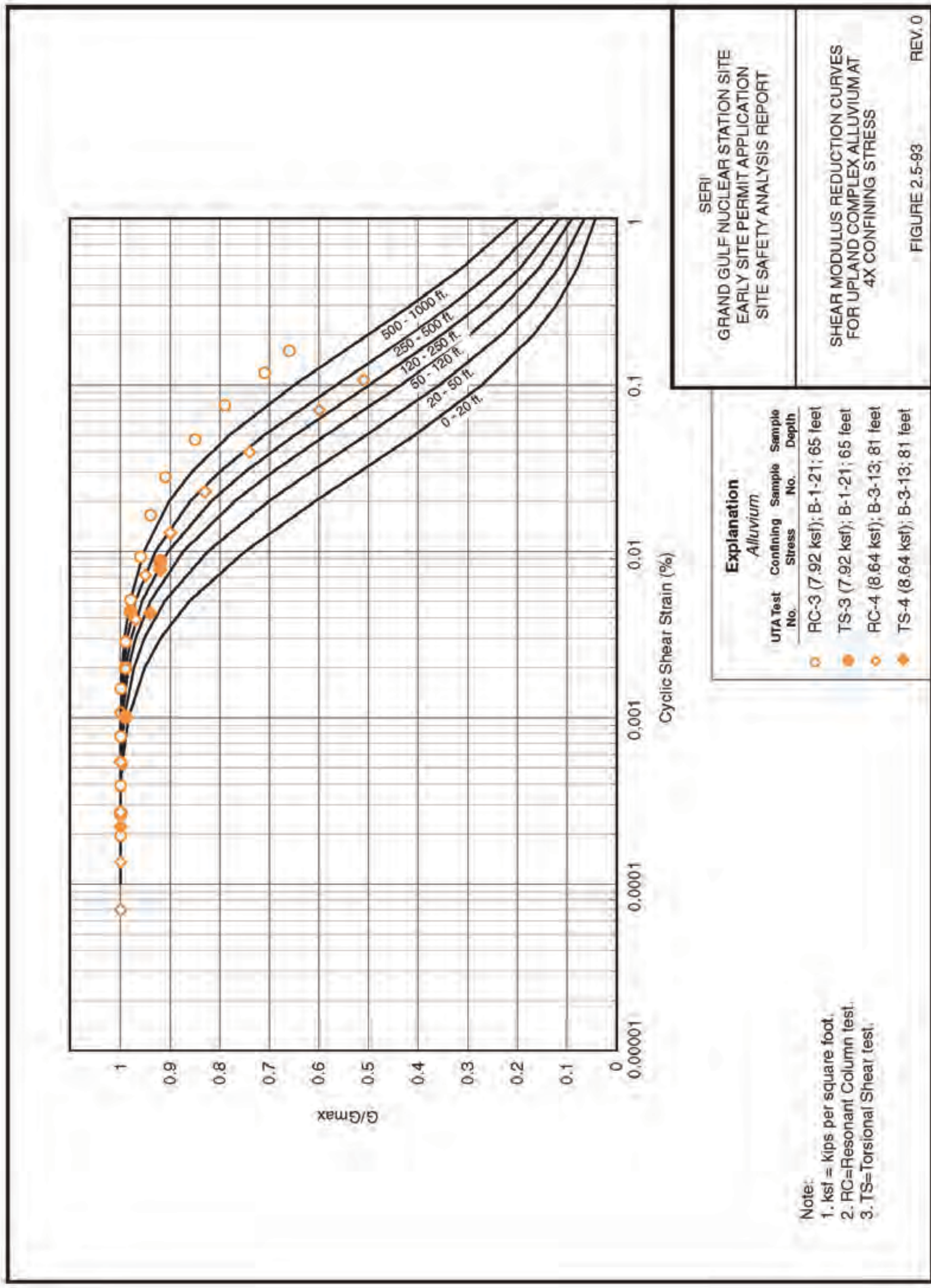


Figure 2.5.4-11 (Updated final version of SSAR Figure 2.5.4-93) Shear Modulus Reduction Curves for Upland Complex Alluvium at 4X Confining Stress

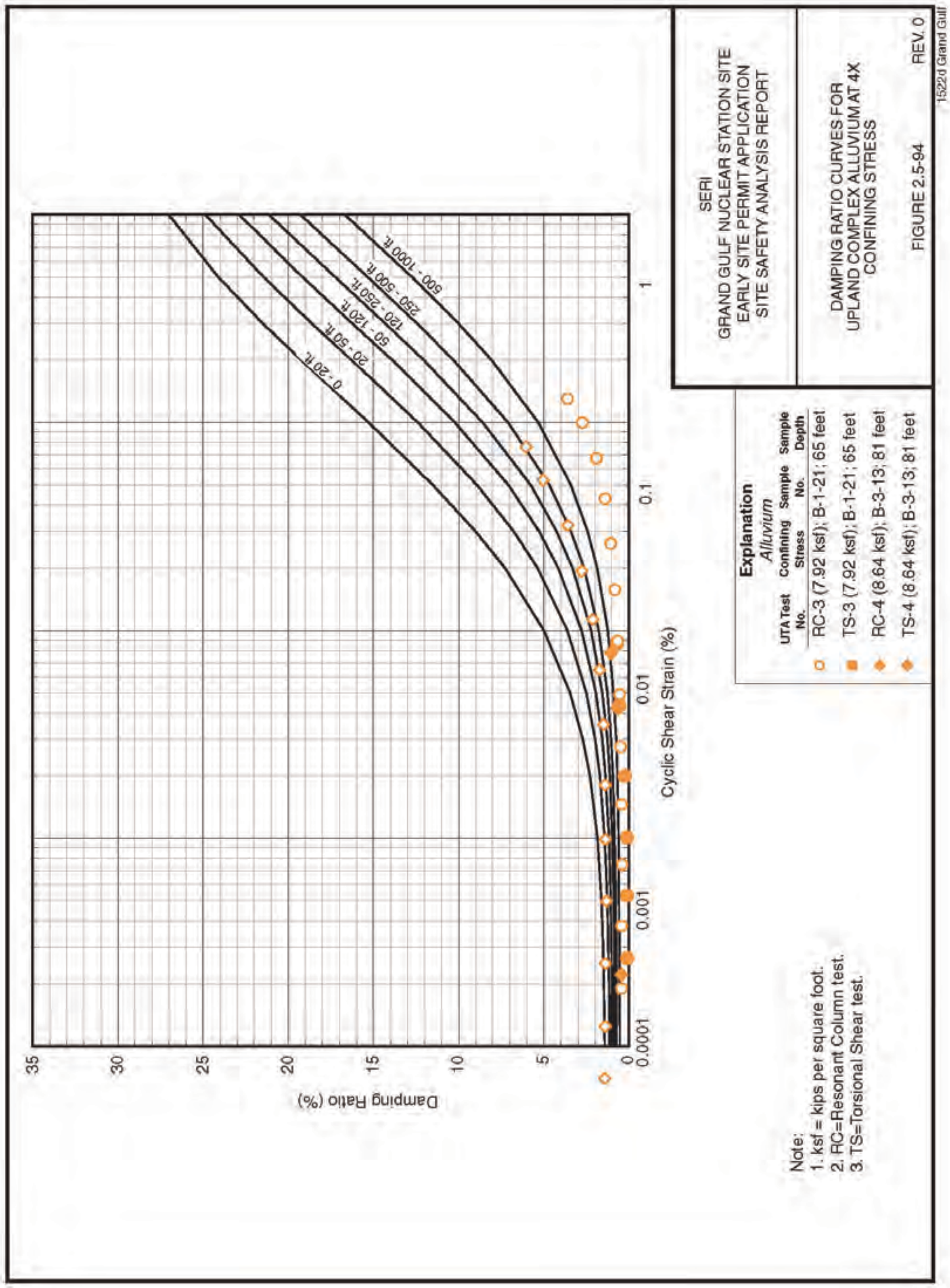


Figure 2.5.4-12 (Updated final version of SSAR Figure 2.5.4-94)
Damping Ratio Curves for Upland Complex Alluvium at
4X Confining Stress

In its response, the applicant further stated that the shear modulus reduction and damping curves adopted for use in the site response analysis represent the best fit to the dynamic soil test results that account for the effects of soil disturbance and overconsolidation. The applicant also considered the uncertainty and variability in these values in the site response modeling by developing randomizing curves about the selected base case EPRI-TR curves using an assumed lognormal distribution. The applicant further discussed the randomization process in its response to RAI 2.5.4-8 (for shear wave velocity input). The applicant considered that the EPRI-TR curves selected for the base case for site response analysis are appropriate for the site soil conditions and account for both sample disturbance and overconsolidation. Therefore, incorporation of these issues would not impact the computed surface UHRS.

Engineering Properties. The applicant summarized in ER-02 the engineering properties of the subsurface materials derived from the ESP field exploration and laboratory testing programs. These properties consist of data typically used in designing heavy foundations subjected to static loads, including natural moisture content, consolidation characteristics, undrained shear strength, effective cohesion, effective friction angle, total unit weight, SPT values, and static earth pressure coefficients. In a design, these properties must be defined or bounded for each individual zone in the profile that is expected to be directly influenced by the foundation loads. The applicant would likely place the foundations of any new Category I facilities at the depth of the Catahoula formation because the surface soils are relatively soft. Therefore, the applicant must only determine the soil property to the depth of the Catahoula formation that is relatively hard and capable of providing adequate support. The data developed during the ESP program, therefore, focus on the loess, the Upland Alluvium, and the Old Alluvium that overlie the Catahoula formation.

In the site response calculations performed to generate the soil design response spectrum, information on low-strain shear wave velocity and hysteretic damping ratio is required for all the soils in the profile, together with the variability from the BE values. No information is available below the upper 197 feet of the profile. Even for the upper 197 feet of the profile, few data are available on which to estimate appropriate UB and LB values of the soil properties. The applicant did not present any information on the values assumed for the site response calculations.

In seismic response analyses, shear and compression wave velocities, material densities, and strain-dependent modulus reduction and hysteretic damping data are necessary for the entire soil column extending to the depth considered in the site response evaluation. As indicated in Figure 2.5.2-4, the applicant assumed that the hard rock, with a shear wave velocity of 9186 fps, is located at a depth of 3281 feet and adopted a generic profile proposed for the Mississippi embayment region. This shear wave profile is relatively smooth, with a shear wave velocity varying from approximately 820 fps at the ground surface to a value of 9186 fps at a depth of 3281 feet. The applicant also replaced the upper 197 feet of the profile with a site-specific velocity profile generated by the geophysical program described previously. Therefore, of the entire 3281 feet of the profile, only the upper 197 feet are reasonably constrained. No site-specific information is available below this depth. However, it is a common practice for the sites where critical facilities are located to have one or more base case shear wave velocity models from site-specific data (e.g., well logs and deep borings) and then to generate soil UHRS using the probabilistic method of NUREG/CR-6728. In RAI 2.5.4-4, the staff asked the applicant to provide the basis for selecting the generic base case velocity model as opposed to any other model that might be generated from available information for the site and its environs. In its response, the applicant stated that no measurements of velocity profiles are known to exist within tens of kilometers of the site. Based on extensive measurements near the Memphis area and surrounding regions, the differences in stratigraphy and wave velocities between the lowlands and uplands extend only to shallow depths (upper several hundred feet), are reasonably well characterized, and are generally considered uniform throughout the embayment.

A number of surface wave analyses as well as low-frequency site amplification studies also suggest generally uniform soil column properties throughout the embayment. The depth to the Paleozoic basement is greatest along the axis of the Mississippi River near the center of the embayment and diminishes to zero northward near Cairo, Illinois, as well as in easterly and westerly directions from the river. The general lateral uniformity of the deeper wave velocities (deeper than several hundred feet) is consistent with other large basins (e.g., the Los Angeles basin and Imperial Valley, California) and provides a basis for employing a generic deep profile beneath the local site profile. Since the profile is randomized, expected fluctuations are accommodated in the mean amplification, which is consistent with a PSHA. Additionally, differences in a mean shear wave velocity profile gradient, apart from the measurement-driven one used, would result in very little difference in mean motions. This arises because the low-strain damping in the deep profile (between 200 and 3000 feet deep) largely controls the response for frequencies above approximately 1 Hz. This is constrained by the use of a kappa value based on observations of motions recorded in the embayment. The applicant considered the empirical kappa value it employed to be conservative since a deeper sedimentary column (over 3 kilometers at the site) over hard rock is expected to show larger kappa values (more cumulative damping) in comparison with shallower sedimentary columns.

Figure 2.5.4-13 shows the base case shear wave velocity profile to the analysis depth of 1 kilometer along with two extreme cases for extrapolation to the hard rock shear wave velocity of 2.8 km/s. The slow profile assumes a uniform extension of the velocity just beneath the site to 1 kilometer, with a jump to the hard rock value of 2.8 km/s. As another extreme alternative, the fast profile assumes a linear (modeled as a stair step) gradient with depth, reaching 2.8 km/s at a depth of 1 kilometer. Based on general experience with measured shear wave velocity profiles in large sedimentary basins, the applicant expected the slow and fast profiles to reflect extreme (i.e., low likelihood) conditions, particularly with regard to the local and regional overall geology.

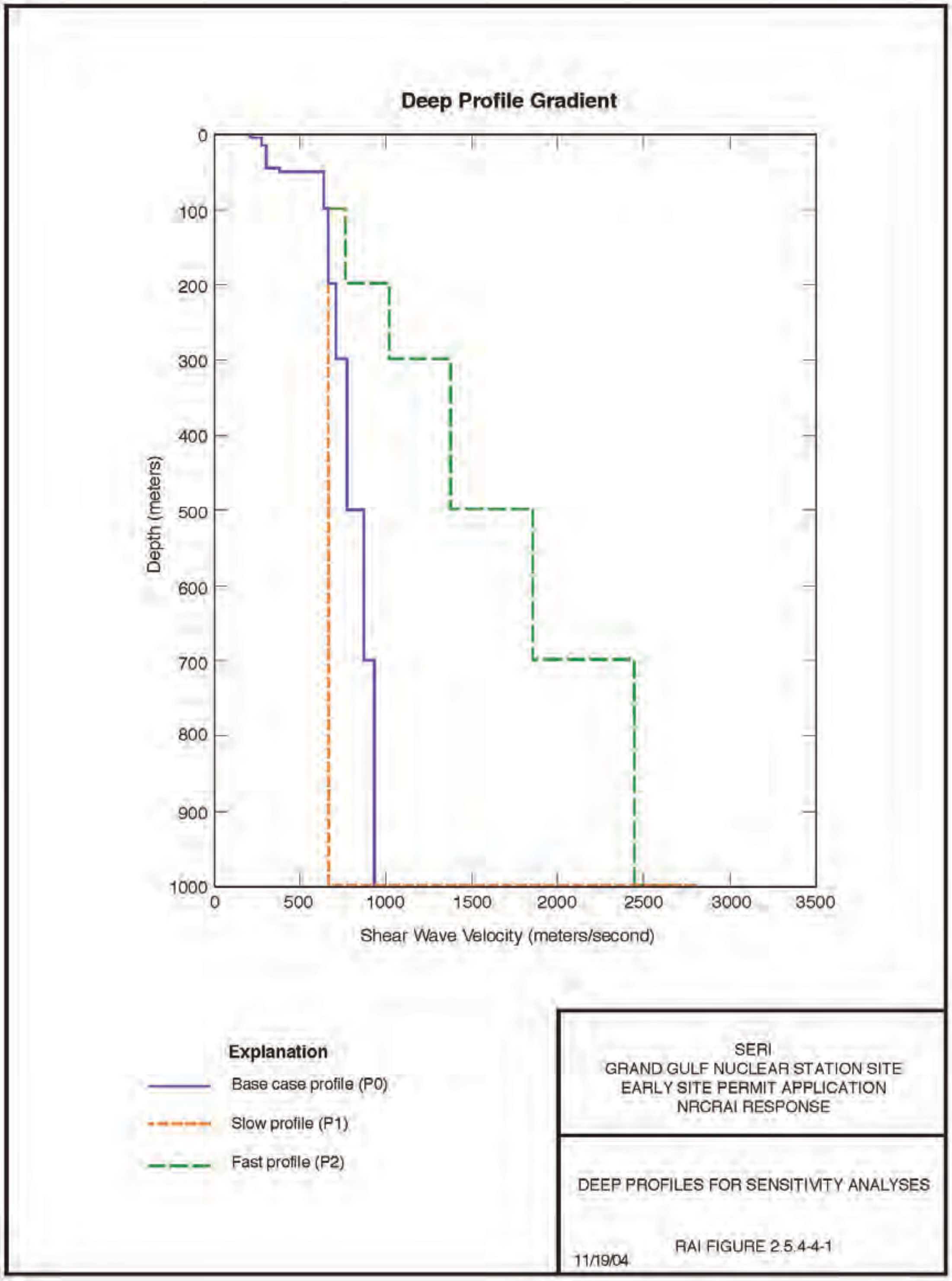


Figure 2.5.4-13 (Figure 2.5.4-4-1 of the RAI response)
Deep Profiles for Sensitivity Analyses

To compare the median motions computed for the three profiles, the applicant stated that it used the 1- to 2-Hz-scaled 10^{-5} APE spectrum as the control motions to excite the column at low as well as high frequency since it is quite similar to the UHRS and sufficiently broad band (i.e., large magnitude) compared to the UHRS. Figures 2.5.4-14 and 2.5.4-15 show the resulting soil median motions in both the logarithmic and linear spectral axes, respectively. As expected, little difference exists between the motions computed for the three profiles from 0.3 to 100 Hz. At peak acceleration, the fast and slow profiles show about a 5-percent increase and decrease, respectively, in motions, as compared to the base case profile. The motions reflecting the fast profile generally exceed those of the base case by about 5 percent. The largest exceedance is near a resonance at about 3 Hz, at which the fast profile motions exceed the base case motions by about 10 percent. Based on regional geology as well as experience with similar geology in deep basins, this fast profile is extremely unlikely and would receive very low weight in a hazard analysis. The applicant stated that these site response analyses illustrate the general insensitivity of the motions to the nature of velocity gradients likely to exist in the deep materials beneath the site.

In SSAR Section 2.5.4.1.3, the applicant summarized velocity properties for the various layers of the shallow soil profile. Section 7.7.1 of ER-02 indicates that the loess has a shear wave velocity that ranges from 243.84 m/s (800 fps) to 274.32 m/s (900 fps). The borehole logger data in Appendix D to ER-02 show values as low as 182.88 m/s (600 fps). Table ER-02-4 indicates values that range from about 182.88 m/s (600 fps) to over 426.72 m/s (1400 fps). Section 8.2 of ER-02 indicates that the BE is 234.7 m/s (770 fps). In RAI 2.5.4-8, the staff asked the applicant to explain why the mean velocity values for all the material layers are not approximately centered on the ranges listed in ER-02 Table 8.2. In its response, the applicant stated that the staff noted apparent inconsistencies in the range of shear wave values presented for the various site stratigraphic units (loess, Upland Complex Alluvium, Upland Complex Old Alluvium, Catahoula formation) in the SSAR and ER-02 text, tables, and figures. These apparent inconsistencies are related to (1) rounding of values for general descriptions of unit properties in the text, (2) presentation of localized extreme values on tables and figures (before data smoothing), and (3) the use of different depth intervals over which averaged values are presented that sometimes cross stratigraphic boundaries.

The staff also asked the applicant to compare the values of shear wave velocity to the BE, UB, and LB values used in the site response calculations. In its response, the applicant stated that Figure 2.5.2-4, which replicates SSAR Figure 2.5-60, presents the BE velocity profile adopted for the site soil response analysis. This velocity profile is based on a visual average of the composite P-S velocity profiles from the three ESP boreholes. It is an averaged, smoothed profile that does not use extreme values. The BE profile consists of five separate interval velocities that incorporate velocity data that were binned differently than the various general and estimated velocity ranges described for different stratigraphic units. The BE interval velocities of the site soil response velocity profile are not set at stratigraphic unit boundaries but rather are assigned at visually determined velocity breaks in the composite P-S profile. For this reason, the BE site soil response average velocities are not centered on the mean values listed for soil layers in ER-02 Table 8.2.

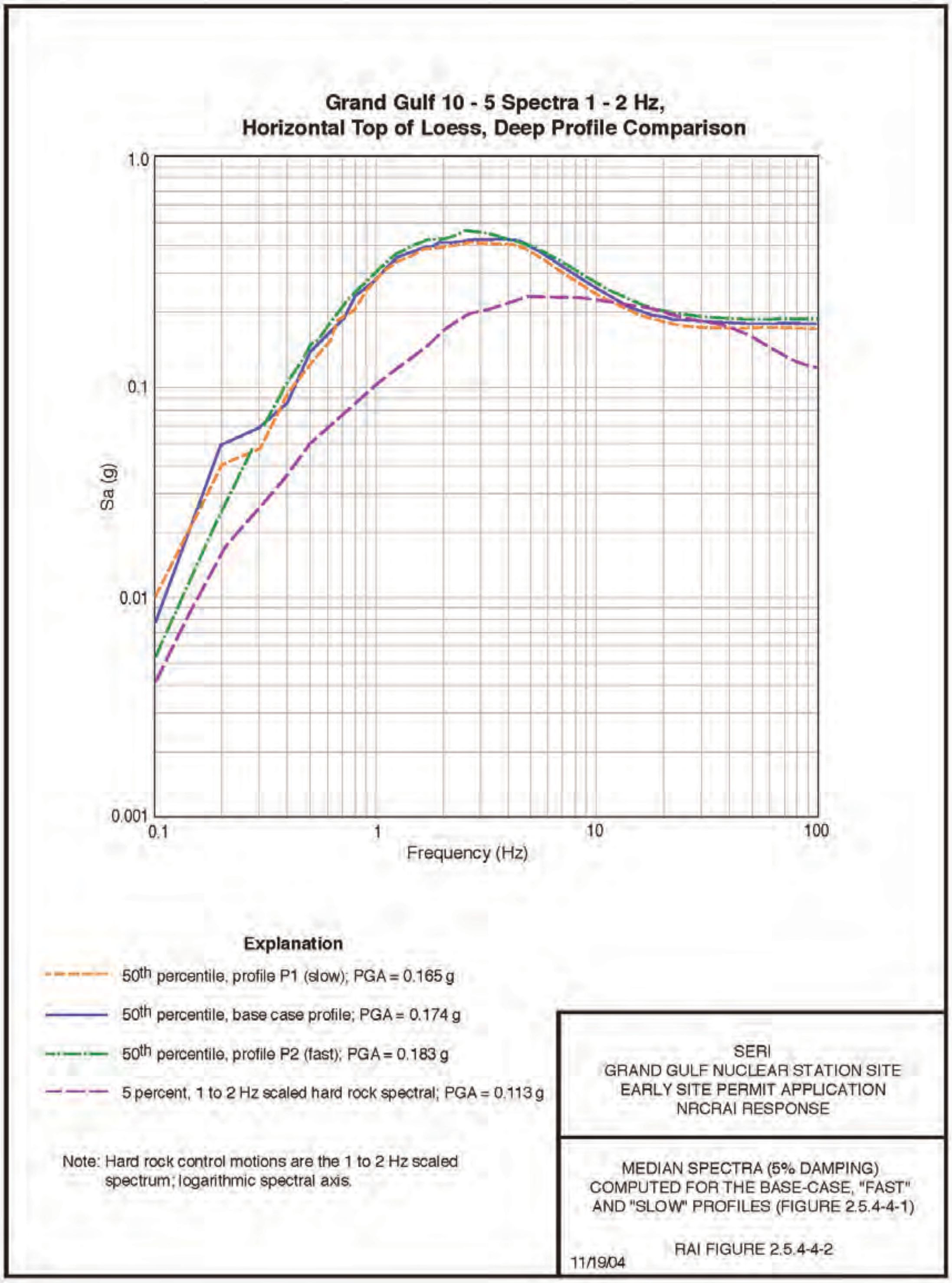


**Figure 2.5.4-14 (Figure 2.5.4-4-2 of the RAI response)
Median Spectra (5% Damping)
Computed for the Base-Case, "FAST"
and "SLOW" Profiles (Figure 2.5.4-4-1)**

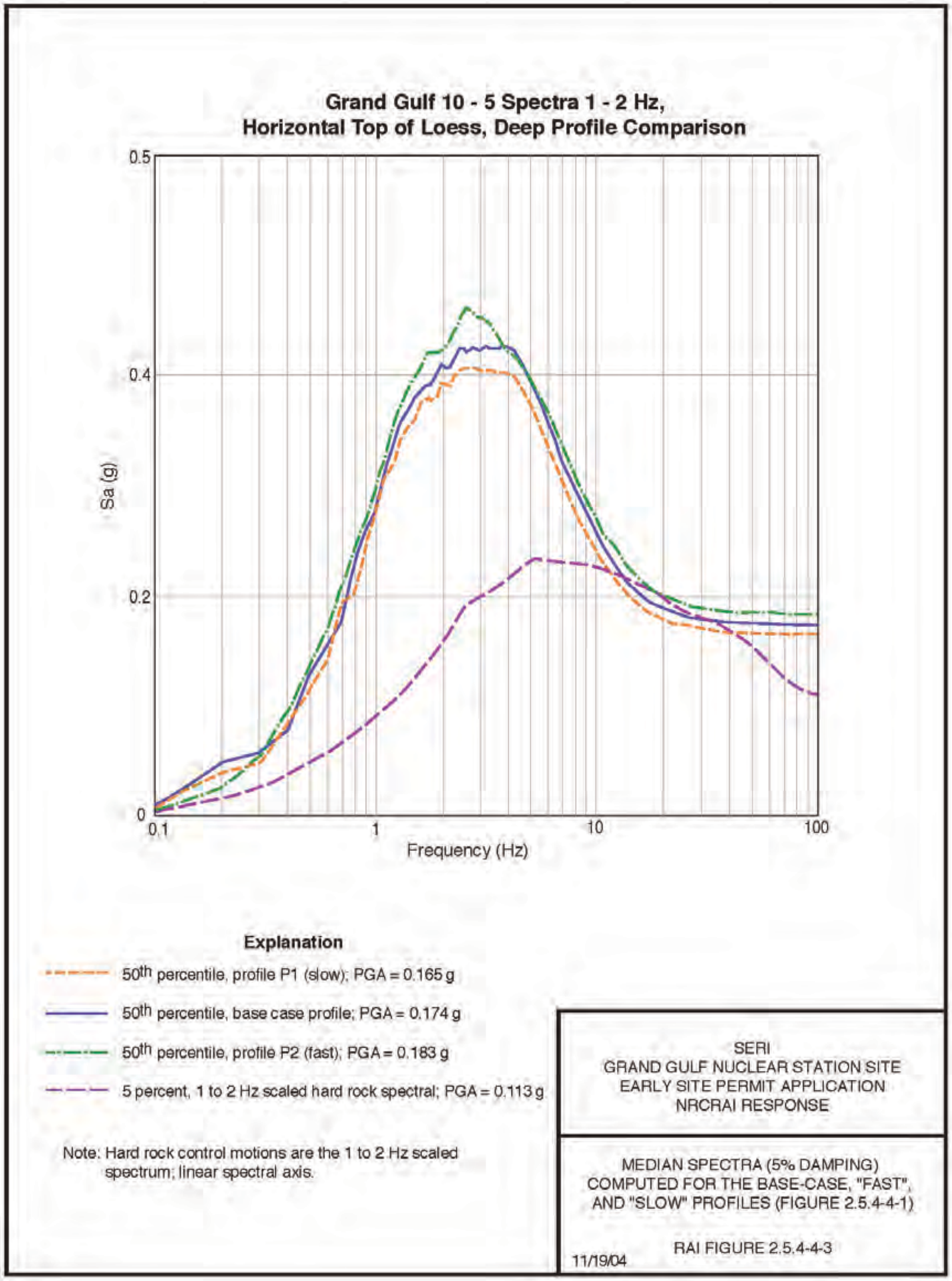


Figure 2.5.4-15 (Figure 2.5.4-4-3 of the RAI response)
Median Spectra (5% Damping)
Computed for the Base-Case, "FAST",
and "SLOW" Profiles (Figure 2.5.4-4-1)

In ER-02 Section 3.3, the applicant stated that it planned to place all safety-related facilities on the Upland Alluvium or the Old Alluvium with an average shear wave velocity of at least 304.8 m/s (1000 fps). The suspension logging data provided in Appendix D to ER-02 indicate that the measured shear wave velocities are as low as 152.4 m/s (500 fps) at depths of up to120 feet (e.g., see results for Boring B-1). This depth is well below the planned depth of foundations indicated in the SSAR. As discussed in RAI 2.5.4-11, because measured shear wave velocities are based on the results from only three borings, and considering the normal variability anticipated in shear wave velocity, the staff asked the applicant to evaluate the impact of such a velocity cutoff on the minimum depth for future siting, particularly because some of the advanced reactor designs may require a minimum shear velocity of 304.8 m/s (1000 fps). In its response, the applicant stated that individual measurements of shear wave velocity obtained using the P-S suspension logger are as low as 161.54 m/s (530 fps). However, these are localized zones in a single boring and generally occur within the loess or the Upland Complex Alluvium, although they also occur less commonly in the Old Alluvium. The lower velocity zones are typically less than 10 to 20 feet thick, representing a relatively small percentage of the strata within each stratigraphic unit, and zones exhibiting greater wave velocities bound the lower velocity zones. The deepest occurrence of a lower velocity zone is at a depth of about 154 feet, and the minimum elevation at the base of a lower velocity zone is at an elevation of about !7.4 feet. The lower velocity zones have zone-specific average wave velocities in the range of 231.65 m/s (760 fps) and 295.66 m/s (970 fps).

The applicant further noted that the minimum required shear wave velocity at the foundation level for all example reactor types considered is 304.8 m/s (1000 fps). Data from the existing three deep borings at the ESP site suggest that this criterion is marginally met in the Upland Complex Alluvium and is easily met in the Upland Complex Old Alluvium. In accordance with RG 1.132, the applicant should drill confirmatory borings at the site during the COL phase site investigations. These borings should include additional borehole velocity surveys to verify the velocity profile under the foundation footprint and to confirm the depth of the target foundation-bearing strata that satisfy the selected plant shear wave velocity design criteria. Based on the existing UFSAR and ESP data, the applicant believed that the depth range to deposits exhibiting a shear wave velocity of 304.8 m/s (1000 fps) will not vary significantly from the results presented in the SSAR.

In ER-02 Section 7.5 and related SSAR sections, the applicant stated that the difference in blow counts for the SPT between previous field programs and the current program performed for the ESP site may result from the difference in hammer equipment used for the samples. As stated in RAI 2.5.4-12, because only three borings were taken for the ESP program, conclusions for this evaluation rely heavily on the previous site investigations. The staff requested that the applicant quantify and evaluate the impact of this difference (such as taking a new boring adjacent to an old boring using new equipment).

In its response, the applicant stated that it performed 38 SPT tests in the ESP borings and the GGNS licensee performed 1069 SPT tests on the UFSAR borings. The applicant segregated the SPT data into the various ESP stratigraphic units from which it obtained the samples. A comparison of the tabulated data demonstrates that the UB and LB ranges of the UFSAR blow counts are about 110 to 250 percent higher than those in the ESP borings for loess, 150 to 300 percent higher for the Upland Complex Alluvium, and 110 to 120 percent higher for the Upland Complex Old Alluvium.

The applicant obtained SPT blow counts for the ESP boreholes using an automatic trip hammer, which is a very consistent and highly efficient delivery system. The GGNS licensee did not document the delivery system for SPT sampling in the UFSAR boreholes. However, based on the vintage of the exploration program (1971–1972), it is unlikely that the licensee performed the UFSAR sampling with automatic trip hammer equipment that did not come into standard usage until the mid-1980s. Rather, it probably obtained the samples using a less efficient and consistent cathead or wireline delivery system. Based on standardized hammer efficiency correction factors, the automatic hammer system used in the ESP investigations has an estimated efficiency factor of approximately 90 percent, compared to the lower efficiency of about 60 percent for the UFSAR SPT testing with an assumed cathead or wireline delivery system. The applicant noted that the efficiency difference in SPT hammer sampling delivery systems could largely account for the markedly lower SPT blow count ranges obtained in the ESP borings for the same stratigraphic units than those sampled in the UFSAR borings.

The applicant further stated that it used the SPT test data for the ESP in a qualitative and relative sense to perform an initial characterization and evaluation of the site subsurface conditions rather than for engineering design or quantitative geotechnical analysis. In this context, the ESP SPT data would provide a conservative general assessment of the material properties. In accordance with RG 1.132, COL-phase investigations will include additional borings and SPT testing throughout the selected power plant footprint area to increase the SPT database. The applicant expected that selected COL borings will be performed with energy calibration equipment to allow accurate measurement and adjustment of the hammer blows for design-level geotechnical analysis and development of foundation and excavation design parameters. The COL borings should also include index borings at the ESP boring locations to allow calibration among these boring sets. The applicant marked the ESP borings with steel stakes set in cement grout at the borehole locations and also performed a survey for future reference purposes.

In ER-02 and SSAR Section 2.5.4.1.6, the applicant stated that it shipped the samples to its contractors either by an automobile or by FedEx. The description in Appendix G to ER-02 indicates that all samples examined for dynamic testing had the appearance of competent and intact materials. Section 11.0 of ER-02 indicates that samples were carefully extracted from the borehole and presumably carefully shipped to the contractor. However, the report notes that the results of the dynamic testing indicate some effect of sample disturbance. In RAI 2.5.4-13, the staff asked the applicant to explain what measures it took, if any (aside from these qualitative statements), to ascertain whether any significant disturbance occurred during the sampling, transportation, or laboratory extrusion process. Since the static testing program includes consolidated undrained (CU) triaxial tests, the staff asked the applicant to address the concern on sample disturbance. In its response, the applicant explained that it carefully extracted sample sets (pressed Shelby tube samples and driven modified California samples) from the borings. Once extracted, the samples were inspected, capped with plastic lids and electrical tape, and sealed with paraffin according to the project protocol. The applicant placed the Shelby tube samples in foam-padded wood crates and delivered them to its contractor using a passenger van. The applicant also placed the modified California tube samples in padded cardboard boxes and shipped these to the testing laboratory.

Based on its review of the laboratory reports and test results, the applicant believed that the stress relief during borehole extraction, movement of shells or gravel-size clasts in the samples during sampling, or movements (e.g., tilting) during laboratory testing might have caused some disturbance to the samples. These effects do not appear to be the result of handling or transportation of the samples because the documentation of the transportation and initial laboratory inspection upon receipt does not indicate any disturbance of the samples.

The applicant noted that the ratios between the shear wave velocities measured in the laboratory and those measured in the field at the same depth for the test samples indicate possible extraction-related sample disturbance. The applicant also suggested that it accounted for these effects in its interpretation of the appropriate shear modulus reduction and damping curves. The applicant did not make corrections to the static triaxial test results since it used these only as index tests to generally compare relative properties between different stratigraphic units and against the triaxial tests performed for the UFSAR. Furthermore, the applicant did not use the triaxial test results as input parameters to calculate foundation or design criteria and stated that the COL applicant would develop these parameters after the selection of a specific reactor, in accordance with RG 1.138.

The applicant presented, in Appendix D to ER-02, the results of the P-S borehole logging in the three boreholes. From these data, the applicant generated P- and S-wave profiles to depths of 180 to 225 feet. In RAI 2.5.4-14, the staff identified the following two issues:

(a) The applicant stated on page 7 of Appendix D that the “shear wave data was of excellent quality in the three boreholes.” The staff asked the applicant to provide the basis for this judgment. In addition, the staff requested that the applicant provide a corresponding evaluation for the quality of the compressive wave (P-wave) data.

(b) The plots of P-wave velocity with depth demonstrate the relatively rapid increase on the P-wave that one would normally expect to occur near the ground water table. The results from Borings 1 and 3 show this characteristic velocity increase. However, the results from Boring B-2A show the characteristic rise followed by a significant reduction at a depth of approximately 70 feet. The staff asked the applicant to explain the cause of this anomaly.

In its response to part (a) of the RAI, the applicant noted that GeoVision (the applicant’s contractor) maintained a quality assurance/quality control program that includes a comparison between the independently acquired source-to-receiver velocities and receiver-to-receiver velocities, as well as an independent review by a second geophysicist. GeoVision’s report discusses the good agreement between the source-to-receiver and receiver-to-receiver interval velocities for both shear wave and P-wave velocities in each borehole, providing verification of the general good data quality. Therefore, the statement as to good data quality refers to both the shear wave and P-wave data, and no implication is made regarding a lower quality with respect to the P-wave data. The applicant also stated that it independently reviewed the GeoVision P-S survey data and found the correlation between source-to-receiver and receiver-to-receiver data to be very good in all boreholes. Additionally, the applicant’s geologists observed the GeoVision P-S survey field setup, calibration, and logging for each borehole. Based on the field review, the applicant concluded that its contractor performed the surveys carefully and according to the approved ESP Project Instruction PI-05.

In its response to part (b) of the RAI, the applicant stated that the initial rise in the P-wave velocities in Boring William Lettis and Associates (WLA) B-2A occurs near the contact between the loess and the Upland Complex Alluvium; the applicant believed that this initial rise results from a perched water table within the base of the loess above the Upland Alluvium. The permanent ground water table is delineated by a P-wave rise within the Upland Alluvium approximately 15 feet deeper in the boring, which does not drop back down, and correlates well with the P-wave rise that marks the top of the ground water table in Borings WLA B-1 and B-2.

In Appendix F to ER-02, the applicant presented the results of standard geotechnical identification tests and CU triaxial strength tests. In RAI 2.5.4-15, the staff identified the following observations:

(a) The sample descriptors provided with the grain size distribution curves present descriptions such as “FINE SAND w/Silt” (see, for example, B1-S22 as well as others) for cases in which the sample contains less than 10 percent fines. The staff asked the applicant to demonstrate that such descriptors will not mislead evaluation based on verbal descriptions.

(b) The tables also include USCS descriptors (such as ML or CL) for samples for which no Atterberg Limits were determined. For these cases, the staff asked the applicant to provide the basis for developing such classifications.

(c) For some samples, the applicant performed only one CU test from which estimates of strength parameters (cohesion and friction angle) are listed. The staff asked the applicant to provide the basis for such judgments.

In its response to this RAI, the applicant explained that it based these soil classification issues on initial field visual-manual descriptions following the guidelines of American Society for Testing and Standards (ASTM) D2488, “Practice for Description and Identification of Soils (Visual-Manual Procedure).” The applicant modified these field descriptions, as necessary, for the final soil classifications based on the results from laboratory index testing, following the guidelines of ASTM D2487, “Test Method for Classification of Soils for Engineering Purposes.” The applicant also stated that it configured the laboratory testing program to confirm or refine the field descriptions and targeted it toward field samples that had uncertain descriptions or soils that fell on the border between two different possible classifications.

The final soil classifications presented in SSAR Table 2.5-7 indicate the final evaluations made by field geologists to accommodate differences between field and laboratory classifications. The applicant, in some cases, kept or slightly modified the field classification, rather than adopting the laboratory classification. The applicant also decided to keep field classifications based on the perceived quality and quantity of the laboratory data, as well as the level of confidence in the field description.

The applicant continued to state that it limited the number of samples submitted for laboratory testing by the number and quality of samples that could be extracted from the borings, as well as on the basis of budget and schedule. Therefore, the applicant extrapolated the results from the laboratory tests by indexing tested samples to the field descriptions, and then developing correlations for other samples that were not tested in the laboratory.

In response to RAI 2.5.4-15a, the applicant stated that it classified the referenced sample, B-1-22, as a fine sand with silt (SP-SM); the sample contains 9.5-percent silt and 2.2-percent clay. The applicant believed that the USCS classification for this sample, "with silt," is correct. The USCS specifies the use of this descriptor when a sand contains between 5 and 12 percent silt. The applicant adhered to the USCS descriptor because it is a universally applied standard soil classification scheme for geotechnical and engineering applications and therefore should not be misleading. To respond to this RAI, the applicant performed another round of review for all the ESP soil classifications and found that the classification for some sand samples was incorrect with respect to the grading (e.g., poorly graded versus well graded (SP/SW-SM)). In addition, some fine-grained soil classifications require a change from lean clay to silt (CL/ML) or vice versa. The applicant presented the modified classifications in SSAR Table 2.5-7 and explained that these soil classification modifications do not change the findings of the investigation or require changes to the analysis input because the overall descriptions for the general properties of the major stratigraphic units remain unchanged. Most of the changes pertain to soils that were on the border of two classifications. In addition, the applicant presented the actual soil testing results in SSAR Table 2.5-7 and included these results in Appendix F to ER-02 for evaluation purposes.

In its response to RAI 2.5.4-15b, the applicant explained that, based on the soil behavior observed by field visual-manual description methods or extrapolated from similar samples that were subjected to Atterberg Limits testing, it made soil classifications for clay or silt samples that did not have Atterberg Limits. The applicant performed 18 Atterberg Limits tests on selected fine-grained ESP samples; these tests included multiple tests from each of the site stratigraphic units (loess, Upland Complex Alluvium, and Old Alluvium) and one sample from the Catahoula formation claystone. With the exception of the Catahoula formation sample that is classified as a fat clay (CH), all other samples fall within the classification zones for lean clay or silt (CL or ML). These samples also exhibit similar visual-manual properties. On this basis, the applicant believed that it is reasonable to extend the classification of lean clay and silt to the samples that have similar field behavior.

In its response to RAI 2.5.4-15c, the applicant also noted that, among the 18 samples prepared for CU triaxial shear testing, only 10 were found to be suitable for triaxial testing or remained intact when placed in the testing load cell. Only one 3-point CU test series and two 2-point CU test series were possible on stratigraphically adjacent intact samples. The applicant obtained the remaining three samples from nonadjacent stratigraphic units and evaluated them using single-point CU tests.

The applicant plotted the triaxial test results on p-q (stress path plot where $p = (s_1-s_2)/2$ and $q = (s_1+s_2)/2$) and Mohr circle (t-s) plots to estimate the cohesion and friction angle components for the shear strength failure envelopes. For tests with a single point, the applicant defined the failure envelope by a line extending from the graphical origin (zero cohesion) and constrained it by a single tangential contact point on the Mohr circle. For multipoint tests, the applicant used a best fit between tangential points on the multiple Mohr circles to estimate these parameters.

The applicant further noted that the single-point test results plot consistently when transferred to the multipoint test plots. Additionally, the one-point and multipoint stress-strain curves for the loess samples have generally similar shapes as the single and multipoint stress-strain curves. The applicant considered these strength values to be reasonable based on its experience performing multipoint triaxial tests on similar materials. These values also fit within the range for soils with similar classifications reported in the literature (e.g., Kulwahy, F.H. and Mayne, P.W., EPRI Report No. EL 6800, "Manual on Estimating Soil Properties for Foundation Design," 1990). As described in its response to RAI 2.5.4-13, the applicant used the ESP triaxial test results only as index tests to generally compare relative properties between different stratigraphic units and also to compare against triaxial tests performed for the UFSAR. The applicant did not use triaxial test results as input parameters to calculate foundation or design criteria; therefore, it considered extrapolation of the single-point test results to estimate shear strength parameters to be valid for the ESP study.

In Appendix G to ER-02, the applicant presented the results of dynamic laboratory testing on six intact samples obtained from Borings B-1, B-2, and B-3 taken at the ESP site. These tests evaluated the linear and nonlinear shear modulus and material damping characteristics of the samples. The dynamic laboratory tests included both RC and TS conducted at different confining pressures and maximum strain levels. The samples tested were all fine-grained soil samples, four having low plasticity (less than 5 percent) and two having more plasticity (PI = 12–13 percent). Table 3 of Appendix G (as well as Table ER-02-6) indicates that three of the samples were confined at pressures based on an assumed value of K_o of 0.5 and three were tested at an assumed value of 1.0.

In RAI 2.5.4-16, the staff requested the applicant to provide the basis of these selections and compare the resulting pressures with current estimated in situ stress levels. In its response, the applicant explained that it performed dynamic laboratory testing for six samples from Borings WLA B-1, B-2, and B-3. In all six cases, the applicant consolidated the test specimens to an isotropic stress equal to the mean estimated in situ stress based on an estimate of k_0, the coefficient of lateral earth pressure. The applicant also consolidated the two loess specimens assuming a k_0 value of 0.5 and the other four test specimens (two each for the Upland Complex Alluvium and the Old Alluvium) assuming a k_0 value of 1.0. The applicant noted that the RAI incorrectly states that three samples were assigned a k_0 value of 0.5 and three samples used a k_0 value of 1.0. The applicant selected a k_0 value of 0.5 for the loess because this material is younger (less consolidated) than the Upland Complex Alluvium and the Old Alluvium. As discussed in the response to RAI 2.5.4-6, in retrospect, it would obtain a better match between the shear wave velocities of the loess measured from the field and from the laboratory using the higher k_0 value of 1.0 for the laboratory samples. This conclusion is reflected by the improved agreement between the field and laboratory velocities for the loess samples that were tested at a confining pressure of 4 times the estimated in situ stress, as shown in SSAR Table 2.5-26. The k_0 value of 0.5 for the loess, therefore, does not sufficiently account for the significantly overconsolidated nature of these deposits. As discussed in the response to RAI 2.5.4-6, the applicant gave a greater weight to the results from the loess samples tested at 4 times the estimated in situ confining stress during the evaluation and selection of the appropriate EPRI 1993 shear modulus reduction and hysteretic damping curves for the site response analysis.

2.5.4.1.2 Site Ground Water Occurrence

SSAR Section 2.5.4.2 indicates that information on the ground water table in the ESP site area is only available from the three borings taken during the ESP site investigation program. However, since water was injected into these borings during the drilling process, direct measurement of ground water tables was not possible. The ground water table can be approximately inferred from the P-S seismic velocity logging conducted in these three borings during the geophysical testing program described previously. These indicate that the ground water table is at a depth of approximately 70–100 feet below grade where the P-wave velocity data show a significant increase in value in all three borings. This increase in velocity is typically associated with saturation of the soil and indicates the effect of ground water on soil compressibility. The SSAR also indicates that the ground water table exhibits a relatively shallow drop of about 1 foot per 100 feet, indicating a gradual flow of the ground water to the southwest. The applicant did not describe the source of this information nor discuss issues for the control of ground water and the influence of ground water on construction settlements in the ESP site area. The applicant implied that this information will be of interest during the COL stage of the project.

2.5.4.1.3 Response of Soil to Dynamic Loading

Based on the results of the geotechnical site investigation, the applicant stated that the geologic materials underlying the proposed site location are not prone to dynamically induced failure or excessive strength loss or deformation. The applicant, by referencing SSAR Section 2.5.4.4, concluded that the susceptibility of soil deposits to liquefaction is low. The applicant also referred to SSAR Section 2.5.4.5.2 for the preliminary assessment of bearing capacity and settlement and SSAR Section 2.5.4.1.4 for the dynamic shear modulus reduction and damping of site soils. In SSAR Section 2.5.4.3, the applicant stated that the site is stable and will not be prone to dynamically induced failures. The applicant further noted, in Section 3.3 of ER-02, that the site does not show any indications of dissolution cavities or sinkholes. Nevertheless, SSAR Section 2.5.1.2.3.1.2.3 indicates that calcareous clays, limestone, and marl formations that are prone to dissolution cavities or sinkholes exist beneath the surface at the ESP site and may even be exposed in the site vicinity. None of the borings shown in the profiles (old or new) reaches to these depths. In RAI 2.5.4-9, the staff asked the applicant to explain its statement that the site is not susceptible to such potential long-term problems. In its response, the applicant explained that calcareous clay, limestone, and marl from the Glendon Limestone and Bryam Marl only exist at depths greater than 390 feet within the Vicksburg Group. These represent the shallowest significant occurrence of calcareous rocks beneath the ESP site, and the Vicksburg Group calcareous units do not appear to be susceptible to karstic dissolution in the site area. Evaluation of aerial photos, topographic maps, and field reconnaissance shows that there are no karstic features either in outcrop areas of this group or expressed within the overlying unconsolidated deposits. In addition, foundations for the existing GGNS unit have performed satisfactorily and have not experienced any settlements related to potential dissolution of strata within the Vicksburg Group at depth.

The applicant's response also involves three separate evaluations, namely (1) evaluation and documentation of the presence or absence of karstic features in the site area (5-mile radius), (2) evaluation and documentation of the presence or absence of karstic features in outcrops of the Vicksburg Group in the site vicinity (25-mile radius) and site region (200-mile radius), and (3) evaluation of the zone of influence of any new proposed foundation on the Vicksburg Group strata.

To evaluate the presence or absence of karstic features in the ESP site area, the applicant reviewed existing literature; examined topographic maps, aerial photos, and orthophotographs; and performed field reconnaissance. The results from these studies show that features indicative of karstic processes are not present in the ESP site area. None of these features have developed within the Pliocene to Pleistocene unconsolidated surficial deposits in the ESP site area. The geologic map shows that no limestone, marl, or calcareous units are exposed in the ESP site area and that the Vicksburg Group does not outcrop in the ESP site area. The applicant prepared geologic maps compiled from existing literature, interpretation aerial photos, and field reconnaissance. The applicant concluded that karst-related geomorphic or topographic features are not present in the ESP site area. The applicant further noted that, although the absence of karstic features at the ground surface does not preclude the potential for dissolution at depth, the absence of such features in the overlying unconsolidated sediments indicates that possible deep dissolution has not extended upward into the thick cover sediments. Based on its evaluation of existing information, the applicant concluded that karstic processes have not influenced the ground surface or shallow subsurface in the ESP site area and that these processes are not likely to affect the ESP site area in the future.

To evaluate the presence or absence of karstic features in outcrop exposures of the Vicksburg Group in the site vicinity and site region, the applicant noted that limestones of the Vicksburg Group crop out in a narrow belt that extends in an east-west direction across the central part of the state of Mississippi. Within the Vicksburg area, the nearest units of the Vicksburg Group crop out about 20 miles north of the ESP site. Available geologic and topographic maps of this area do not indicate karst-related topographic or geomorphic features (e.g., sinkholes, circular depressions) within the outcropping areas of Vicksburg Group carbonate rocks. The maps do define several concentric lakes within the Vicksburg Group outcrop areas that are up to approximately 100 meters in diameter. However, these lakes are also developed in areas where the noncalcareous Catahoula formation crops out (see RG DG-1109, "Laboratory investigations of soils and rocks for engineering analyses and design of nuclear power plants," issued August 2001; NUREG/CR-6728; and NUREG-1488, "Revised Livermore Seismic Hazard Estimates for Sixty-Nine Nuclear Power Plant sites East of the Rocky Mountains," issued 1994), suggesting that the lakes are not associated with carbonate dissolution processes. No records show any of the lakes to be associated with karst formation (see Draft RG DG-1101, "Site Investigations for Foundations of Nuclear Power Plants," issued February 2001).

The applicant stated that, although records do not indicate karst development in the Vicksburg Group outcrops in the vicinity of Vicksburg and the Grand Gulf site, karst features are referenced as occurring within the Vicksburg Group in the area east of Jackson, Mississippi, approximately 50 miles northeast of the Grand Gulf ESP site. Although records do not indicate caves or evidence of karst development, USGS classified the Vicksburg Group as having a potential for karstic development in a regional map compilation of the Appalachian region. The USGS classification is based on descriptions of regional lithology that include descriptions of calcareous units within the Vicksburg Group and do not include field or other verification of karst development in these units. Instead, USGS based its statement regarding the potential for karst development on carbonate lithologies of regional units with a conservative bias towards inclusion of any potentially soluble units.

The applicant further noted that the zone of influence of any new proposed foundation on the Vicksburg Group strata will be well away from any potential karst formations. The ESP plant foundation would have a minimum separation distance of about 300 feet from the top of the limestone. The applicant expected that the foundation influence zone extends about 100–200 feet below the base of the foundation. In accordance with RG 1.132, the applicant will conduct additional site investigations during the COL phase of the project. These investigations should include deep borings in the planned foundation footprint and geotechnical analysis of the bearing pressure and load distribution in the foundation soils based on the specific geometry, embedment, and loading of the selected reactor. In addition, the applicant stated that in case any calcareous clays, limestone, or marl deposits are found within the incremental pressure bulb created by the planned construction, the applicant should drill further borings at sufficiently close spacing to confirm the absence of dissolution cavities within the foundation-bearing zone.

2.5.4.1.4 Liquefaction Potential and Seismic Site Stability

Section 2.5.4.4 of the SSAR indicates that the deposits underlying the proposed site location range in age from Miocene (Catahoula formation) to Pleistocene (loess silts). As mentioned above, these deposits all appear to be overconsolidated. The applicant did not identify any Holocene materials or relatively loose sands or silts that may be susceptible to liquefaction at the ESP site location. The applicant also discussed the paleoliquefaction indicators in Section 2.5.2 of the SSAR, and these indicators are encountered in relatively young Holocene floodplain deposits. The applicant stated that no such deposits underlie the proposed site, and no paleoliquefaction features have been reported in the ESP site vicinity. Soils below the ground water table that are planned to provide foundation support are relatively dense, overconsolidated, and relatively old and thus are not susceptible to liquefaction.

2.5.4.1.5 Static Site Stability

Section 2.5.4.5 of the SSAR discussed several issues associated with the foundation conditions that must be addressed for design and construction of new facilities at the ESP site.

Bearing Capacity and Settlement. SSAR Section 2.5.4.5 indicates that the COL applicant will evaluate issues associated with allowable bearing capacity, excavation rebound, construction settlements, and long-term foundation settlement during the COL phase of the project. This SSAR section also indicates that the applicant would locate the foundations of Category I facilities in the Upland Alluvium, although other sections indicate that the Catahoula is the primary bearing strata of interest. Based on the known site conditions, the applicant noted that bearing capacity and settlement properties of the foundation soils are not expected to be a concern for a new nuclear power plant and should not provide any obstacles to construction.

The applicant has provided no specific calculations to support this conclusion. SSAR Section 2.5.4.5 indicates that new facilities will be found at a depth of about 50 feet below grade in the Upland Alluvium. However, the SSAR also states that the soils below the foundations should have an average shear wave velocity exceeding 304.8 m/s (1000 fps). If soft or compressible soils exist below the foundations, the SSAR indicates that the COL applicant would excavate to the required depth and replace these materials with appropriate engineered fill having the required characteristics. The applicant did not mention in the SSAR anticipated levels of contact pressures for the prospective facilities from dead, live, and seismic loading conditions and how these may compare with approximate allowable pressures for the site soils.

This SSAR section also indicates that excavation will occur through the loess and possibly extend into some of the Upland Alluvium deposits. This excavation will result in the removal of at least about 7 kips per square foot of overburden. The applicant expected several inches of heave or rebound to occur as a result of this excavation. The applicant further stated that this heave should not be sufficient to threaten stability of the excavation. Such excavation heave was encountered during construction of GGNS, and the UFSAR indicates that several inches of heave and recompression occurred during this process.

Lateral Earth Pressures and Hydrostatic Loading. SSAR Section 2.5.4.5.2 indicates that the COL applicant would evaluate issues associated with lateral earth and water pressures during the COL phase of the project. The applicant also noted that several inches of elastic rebound may be associated with the relatively deep site excavations that are planned and that this rebound would be expected to be reversible, presuming that the new structures are fully compensated designs. Assuming that the current GGNS powerblock structures are far enough from the ESP site, the staff, in RAI 2.5.4-10, asked the applicant to demonstrate that no other facilities (piping, conduit, etc.) exist in the ESP area that may be affected by such surface movements. In its response, the applicant explained that it anticipated that a new facility at the ESP site would maintain the existing plant grade of 132–134 feet of elevation. In addition, new facilities would require embedment below the loess deposits into the Upland Complex Alluvium or the Old Alluvium to an elevation where the average shear wave velocity is at least 304.8 m/s (1000 fps). This likely would require excavations to depths of approximately 60–100 feet or deeper. The in situ confining stresses at these embedment depths range between about 24,412 kg/m^2 (5 ksf) to 48,824 kg/m^2 (10 ksf). The confining stress at the maximum manufacturer-listed depth of 140 feet is on the order of approximately 58,589–73,236 kg/m^2 (12–15 ksf). These estimated in situ pressures are in the range of, but somewhat lower than, the minimum static bearing pressure requirements for the various reactors, suggesting that the foundations will be partly compensated.

The applicant also stated that up to several inches of predominantly elastic rebound may occur as a result of excavations for reactor foundations. The applicant estimated this value based on a review of the performance of the existing GGNS containment and turbine buildings. Comparison of the measured rebound and settlement data for GGNS shows that the settlement recovered a significant percentage of the rebound. The applicant further stated that no existing safety-related Class I facilities fall within, or adjacent to, the estimated ESP influence zone. Based on this evaluation, construction and foundation loads from a new plant at the ESP site would not impact the existing power plant structures, operation, or safety. Tied-back sheet piles or other bracing systems would likely support deep excavations in a manner similar to the excavations for the existing power plant.

In accordance with RG 1.132, the applicant will perform additional site exploration, laboratory testing, and geotechnical analyses during the COL phase of the project after the selection of a plant design to verify site conditions for foundation design geotechnical analyses and determination of embedment criteria. These borings and additional engineering analyses should include evaluation of deformation moduli for the subsurface materials to refine estimates of the influence zone related to the selected reactor and foundation configurations. The COL investigations should also consider development of an instrumentation and monitoring program to measure actual construction-related soil movements.

2.5.4.1.6 Design Criteria

Section 2.5.4.6 of the SSAR indicates that the COL applicant would develop the geotechnical criteria needed for the design of new plant foundations, temporary construction, and excavation support during the COL stage. The geotechnical material properties currently available from the ESP study would be supplemented with additional information developed during the COL stage. The SSAR does not discuss geotechnical design criteria (e.g., allowable bearing capacity, safety factors) or criteria that pertain to structural design (e.g., wall rotation, sliding, and overturning).

2.5.4.2 Regulatory Evaluation

SSAR Section 2.5.4 describes the applicant's evaluation of the stability of the subsurface materials and foundations at the ESP site. The applicant stated that it developed the geological, geophysical, and geotechnical information used to evaluate the stability of the subsurface materials in accordance with the guidance presented in 10 CFR Part 52 and Appendix S to 10 CFR Part 50, as well as the requirements in 10 CFR 100.23. In addition, the applicant stated that the ESP program conducted for this site partially conforms to the guidance provided by RGs 1.132 and 1.138.

The staff considered the regulatory requirements in 10 CFR 100.23(c) and 10 CFR 100.23(d)(4) in its review of SSAR Section 2.5.4. Pursuant to 10 CFR 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. According to 10 CFR 100.23(d)(4), siting factors such as soil and rock stability, liquefaction potential, and natural and artificial slope stability must be evaluated. Section 2.5.4 of 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.

2.5.4.3 Technical Evaluation

This section provides the staff's evaluation of the geotechnical investigations conducted by the applicant to determine the static and dynamic engineering properties of the materials that underlie the Grand Gulf ESP site.

Using Attachment 2 (Sections 2.5.4 and 2.5.5) to RS-002 as guidelines, the staff performed its review of SSAR Section 2.5.4 and ER-02, referenced in the SSAR. In order to thoroughly evaluate the surface faulting investigations performed by the applicant, the staff sought the assistance of the contractor from the Brookhaven National Laboratory. The staff and its advisor from the laboratory visited the ESP site and met with the applicant to assist in confirming the interpretations, assumptions, and conclusions it presented regarding the characteristics of the subsurface materials and potential foundation layers. In addition, the staff and its advisor observed soil samples taken from the field explorations.

2.5.4.3.1 Properties of Subsurface Materials

In this section, the staff performed its review of SSAR Sections 2.5.4.2 and 2.5.4.3 and ER-02. In particular, the staff focused its review on the applicant's investigation results for subsurface materials, field investigations, laboratory testing, and engineering soil properties (static and dynamic) of the ESP site subsurface materials. The staff concludes that the methods used by the applicant for the exploration of subsurface materials, field investigations, laboratory testing, and determination of the engineering soil properties (static and dynamic) meet the guidelines of RS-002, and the results obtained are reasonable, except for those issues identified as a result of its review of the SSAR and responses to the RAIs, summarized in Section 2.5.4.1.1 of this report. The following discusses the staff's findings regarding the remaining unresolved issues.

From its review of the applicant's response to RAI 2.5.4-1, as summarized in Section 2.5.4.1.1 of this report, the staff finds that the revised material descriptions for the site indicate a change from the term "Catahoula bedrock" used in the UFSAR to dense sand and gravels in the current descriptions. The information from both the previous extensive site studies described in the UFSAR as well as the limited ESP investigation indicates that the foundation soil properties are consistent and that these soils are stiff enough so as to not impact evaluations of settlement and required strength. The change in nomenclature does not have any significant impact on findings in the SSAR. The staff considered the details provided with this response to be appropriate, except that the applicant did not address the basis to ascertain the layer as the Catahoula formation and correlate it with the supporting soils beneath the GGNS foundation, with only one ESP borehole reaching the depth of the soil and with very limited sampling taken inside this layer. Moreover, the staff noted that the applicant stated in its response to this RAI that the depth of new Category I foundations may have to be lower than the current GGNS foundation in order to have equivalent soil characteristics. To locate the new plant foundations lower than the existing GGNS foundations may cause significant impact on construction procedures anticipated for the site. The staff requested the applicant to evaluate the potential impact on the construction procedures and commit, in the SSAR, to implement possible techniques commonly applied in industry to prevent possible ground movement caused by deep temporary construction excavations.

In its additional response to RAI 2.5.4-1, the applicant committed to add two new paragraphs to the end of SSAR Section 2.5.4.5. In the new paragraphs, the applicant stated that if construction excavations must be lower than the existing plant foundations, excavation walls will be sloped back, reinforced (e.g., soil nails or grout mixing), or supported by temporary tied-back retaining walls similar to those used for the existing plant construction. These industry-standard deep excavation support measures will permit a safe excavation to the required foundation elevations and prevent significant ground movements. The applicant also stated that as an alternative, a combination of ground improvement or back-sloping of the excavation with the tied-back walls will be used. With regard to the ground water table, which is higher than the lower parts of the future excavations, the applicant stated that cutoff walls, collector sumps and pumps, and/or dewatering wells can be used to control the ground water. The staff's review found that the construction techniques committed to by the applicant meet the industry standard; therefore, the applicant's response to this issue is acceptable. The commitment of using excavation walls (or a combination of ground improvement with tied-back walls) and controlling the ground water during the excavations at the COL stage is **COL Action Item 2.5-1.**

In RAI 2.5.4-2, the staff requested the applicant to describe the character of the fill material and controls, if any, that were placed on the fill at the time of its deposition. From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this report, the staff finds that the GGNS licensee filled the original southwest-trending swales that existed in the area during the site grading associated with the prior development of the GGNS site. The fill placed at that time brought the ESP site to its current configuration. The staff also concurs with the applicant's conclusion that, since the fill does not extend to significant depths, it would not impact foundations of any powerblock facilities to be constructed in the area. The staff concludes that the procedure used by the applicant is consistent with industry practice and is acceptable. Therefore, the staff considers RAI 2.5.4-1 resolved. The applicant's commitment to conduct detailed studies of the fill material and the required treatment is **COL Action Item 2.5-2.**

From its review of the applicant's response to RAI 2.5.4-3, as summarized in Section 2.5.4.1.1 of this report, the staff found that the new borings and CPTs taken as part of the ESP investigation present site-specific information only to a maximum depth of approximately 240 feet. The applicant did not obtain detailed information about the deeper materials of the soil column for this evaluation. In addition, the staff considered the number of borings available for the ESP site from which to assess soil characteristics variability and its impact on site ground motion response, particularly at the greater depths, to be insufficient to characterize the site unambiguously, as required in Section 2.5.4.1 of RS-002. In its additional response to RAI 2.5.4-3, the applicant committed in the revised SSAR to perform additional borings, laboratory testing, and a geophysical survey to confirm the current base case material properties and their variabilities throughout the site during the COL stage. If the investigations to be performed during the COL stage indicate differences in material properties which may significantly impact on design ground motions, the applicant agreed to evaluate the need to perform additional site response analyses with the updated properties to develop updated design motions. The applicant's response is acceptable to the staff, and this issue is considered resolved. On this basis, the applicant's commitment is **COL Action Item 2.5-3.**

In RAI 2.5.4-4, the staff asked the applicant to provide the basis for selecting the generic base case velocity model as opposed to any other model that may be generated from available information for the site and its environs. From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this SER, and its additional responses to the staff's comments, the staff concludes that the applicant did not justify why it applied the generic shear wave base profile based on research conducted in the Memphis area to the ESP site. As the applicant stated in its response, the embayment structure is so different in itself that the basement rock depth varies from near zero at Cairo, Illinois, to over 10,000 feet inside the Grand Gulf Basin. Memphis and its surrounding area and the ESP site belong to two completely different tectonic units—the ESP site is inside the Gulf Coast Basin and Memphis and its surrounding area is located inside the Mississippi embayment (see SSAR Section 2.5.1).

In its additional response to the staff's comments on RAI 2.5.4-4, the applicant also explained why it selected the wave velocities of 700 m/s to 2500 m/s at a depth of 1 kilometer for the profiles used in the sensitivity test. The applicant stated that it used the extreme shear wave velocities for the soil profiles. It used a low shear wave velocity of 700 m/s, which is comparable to the shear wave velocity at 656 feet depth below the San Francisco Bay Mud, and it used a high shear wave velocity of 2500 m/s, which is comparable to the shear wave velocity for a firm rock. The staff concurs with the applicant's conclusion that the range in shear wave velocity used for the soil profile represents reasonable bounds for the sensitivity analysis. In the same response to the RAI 2.5.4-4, the applicant also explained why it provided only the sensitivity results from using the 1–2 Hz scaled spectrum, neglecting the 5–10 Hz scaled spectrum, as the control motions to the soil profiles. The applicant stated that the combined transfer function applied to the UHRS is controlled by the transfer function computed with the 1–2 Hz scaled spectrum, and the 1–2 Hz is quite similar to the UHRS and sufficiently broad band compared to the UHRS. Therefore, there is no need to perform a redundant sensitivity study using the 5–10 Hz scaled spectrum as control motions. The staff concurs with the applicant in that using the 1–2 Hz scaled spectrum is sufficient in the sensitivity test. Finally, the applicant also responded to the staff's request to address the uncertainty in kappa value, the impact of the scattering kappa value, and the sensitivity of the computed response to kappa values. As a result, the applicant revised SSAR Section 2.5.2.3. The applicant stated in this revised section that high-frequency ($\geq$ 5 Hz) motions input to the softer portion of the profile, at a depth of about 170 feet, are sensitive to the damping in the deeper profile, which extends to hard rock conditions. This damping is constrained by the site kappa value and is taken as 0.04 seconds, a conservative estimate for this portion of the Mississippi embayment with sediment depths exceeding 10,000 feet (SERI personal communication with Professor R. Herrmann in 2002). The value of 0.04 seconds is taken as the total kappa at the surface of the loess. It includes the contribution of the low-strain damping in the hysteretic damping curves over the nonlinear portion of the profile (top 500 feet) as well as any scattering damping caused by velocity fluctuations in the profile randomization process. Sensitivity of the input motions is such that an increase in kappa to 0.05 seconds or a decrease to 0.03 seconds would result in about a 15 percent decrease or increase, respectively, in motions for frequencies exceeding about 5 Hz (EPRI, "Engineering Characterization of Earthquake Strong Ground Motion Recorded at Rock Sites," issued 1995). As a result, and because kappa can only be estimated from recordings of earthquakes, a conservative estimate of 0.04 seconds is assumed in characterizing the motions. Typical kappa values for deep soils in the western United States (WUS) range from about 0.05 to 0.07 seconds (Anderson, J.G., and S.E. Hough, "A Model for the Shape of the Fourier Amplitude Spectrum of Acceleration at High Frequencies," issued 1984, and Silva, W.M., N. Abrahamson, G. Toro, and C. Costantino, "Description and Validation of the Stochastic Ground Motion Model," issued 1997). Deep soils in the CEUS are not expected to have significantly different dynamic material properties such as shear wave velocity and material damping, particularly at depths exceeding approximately 500 feet. Based on its review of the SSAR and the response to this RAI, the staff concludes that the applicant did not provide sufficient justification for applying the kappa values derived from the observations of motions recorded in the Mississippi embayment area to the ESP site. In summary of the applicant's response to RAI 2.5.4-4, the staff concludes that the applicant needs to further justify its application of the generic shear wave velocity profile derived from the Memphis area to the ESP site and its application of the kappa value derived from ground motion observations in the Mississippi embayment to the site response calculation.

To respond to the above issues addressed in Open Item 2.5-4, the applicant provided comparison of stratigraphic section for the Gulf Coast Basin and the Mississippi embayment that shows the general stratigraphic similarity between the two areas. The extensive geological and geophysical investigations in the Gulf Coastal Plain have shown lateral uniformity of major stratigraphic groups of Cretaceous and younger age. These stratigraphic groups represent a southward thickening sequence of marine and terrestrial deposits that were formed during a long series of marine transgressions and regressions. The applicant also emphasized that the sensitivity analysis implemented demonstrate the insensitivity of ground motions to the nature of velocity gradients likely to exist in the deep materials beneath the ESP site. On the basis of the above discussion, the staff concludes that the applicant's application of the generic shear wave velocity profile and kappa value derived from the Memphis area to the ESP site are acceptable; therefore, this open item is resolved.

In RAI 2.5.4-6, the staff requested the applicant to provide the basis for the selection of the EPRI-TR curves as opposed to other models that may be more appropriate based on site-specific information described in the geotechnical report. From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this report, the staff finds that the applicant used the EPRI-TR curves to represent the nonlinear properties of the three primary units of the shallow portion of the site profile (loess, Upland Alluvium, and Old Alluvium). With respect to the issue of the appropriateness of using the EPRI-TR curves to represent gravel units of the profile, the applicant's response indicates that, at the Grand Gulf site, the gravels of the profile are relatively fine gravels in a sandier matrix. These zones are also indicated to be no more than 5 feet thick and appear to be discontinuous across the site. The samples viewed by the staff during the site visit corroborate this description. On the basis discussed above, the staff considers that the use of EPRI-TR curves (soil model) to represent site soils is consistent with industry practice and, therefore, acceptable.

In RAI 2.5.4-7, the staff asked the applicant to provide the basis for not incorporating the effects of disturbance in the site response calculations and evaluate the potential impact of these effects on the computed surface UHRS. From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this report, the staff concludes that the applicant's procedure for selecting the EPRI-TR modulus reduction and damping curves is appropriate for the site response calculations. The process of selecting curves appropriate for depths greater than the sample depths to approximately account for overconsolidation and aging effects leads to more linear material models than are available for the EPRI-TR models. In turn, this typically leads to more conservative estimates of site response as compared to those computed from the more nonlinear models. In addition, the use of a material model randomization scheme in the probabilistic site response calculations properly accounts for uncertainty in this property of response. On this basis, the staff finds the applicant's response acceptable, and RAI 2.5.4-7 is, therefore, resolved.

In RAI 2.5.4-8, the staff asked the applicant to compare the values of shear wave velocity developed at the ESP site to the BE, UB, and LB values used in the site response calculations and explain why the mean velocity values for all the material layers are not approximately centered on the ranges listed in ER-02 Table 8.2. From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this report, the staff found that the BE shear wave velocity profile used by the applicant in the site response calculations is based on a visually averaged composite of the three P-S velocity profiles. Further, these data are not associated with specific stratigraphic units. Since the modulus degradation and hysteretic damping properties used in the calculations are also not related to stratigraphic units, the staff considers the applicant's response acceptable, and RAI 2.5.4-9 is, therefore, resolved.

In RAI 2.5.4-11, the staff asked the applicant to evaluate the impact of the velocity cutoff on the minimum depth for future siting, especially since all of the advanced reactor designs require a minimum shear velocity of 304.8 m/s (1000 fps). From its review of the applicant’s response as summarized in Section 2.5.4.1.1 of this report, the staff finds that shear wave velocities measured at the ESP site fall below the target velocity of 304.8 m/s (1000 fps) at depths below those indicated in the SSAR to be probable depths for new foundations. The applicant’s response also refers to these low-velocity zones at depth as localized zones. Since only three borings are available for the ESP site evaluation, one may find the shear wave velocity in these soft zones to be even lower during the detailed site investigations to be conducted during the COL stage.

In its additional response to RAI 2.5.4-11, the applicant committed to perform additional site investigations throughout the ESP site during the COL phase and to confirm that soils at the plant foundation depth have a minimum shear wave velocity of 1000 fps. The staff’s review of the applicant’s response thus concludes that this issue is resolved. To locate the new plant foundations on the soil with a minimum shear wave velocity of 1000 fps is a site characteristic (see Section 2.5.4.3.10 of this SER).

In RAI 2.5.4-12, the staff asked the applicant to quantify and evaluate the impact of the difference in blow counts for the SPT between previous field programs and the current program performed for the ESP site (e.g., taking a new boring adjacent to an old boring using new equipment). From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this report, the staff finds that the applicant did not correlate SPT blow count data between the different hammer systems used for the ESP and UFSAR programs. However, the applicant made qualitative judgments to correlate results from the two different data sets. Based on its review experience and understanding of industry practice, the staff finds the applicant’s justification acceptable. In addition, using more recent SPT results leads to generally conservative estimates of site response. On the basis of the above discussion, the staff considers RAI 2.5.4-12 resolved.

In RAI 2.5.4-13, the staff asked the applicant to explain the measures it took, if any, aside from the qualitative statements for ascertaining whether any significant disturbance occurred during the sampling, transportation, or laboratory extrusion process. Since the static testing program included CU triaxial tests, the staff expected the applicant to address whether any concern was expressed about disturbance to these samples as well. From its review of the applicant’s response as summarized in Section 2.5.4.1.1 of this report, the staff found that the applicant evaluated the potential effects of sample disturbance against common industry practice and properly incorporated these effects into its site response calculations. On this basis, the staff considers the applicant's response adequate, and RAI 2.5.4-13 is, therefore, resolved.

In RAI 2.5.4-14, the staff asked the applicant to (1) provide the basis for making the statement that the shear wave data are of excellent quality in the three boreholes, (2) indicate that the statement applies equally well to the quality of the corresponding P-wave profiles, and (3) explain the cause of the difference in P-wave velocity changes at elevations near the water table between boreholes. From its review of the applicant’s response as summarized in Section 2.5.4.1.1 of this report, the staff found that the explanations provided by the applicant with respect to the quality of compression and shear wave data are adequate since (1) the process used to generate wave velocities used multiple measurements and (2) the process was independently reviewed. However, the SSAR must clarify the basis for the statement associated with the rise and fall in P-wave data in Boring WLA B-2A. In its additional response to RAI 2.5.4-14, the applicant agreed to add a new paragraph to SSAR Section 2.5.4.1.4, which refers to SSAR Figure 2.5-71 and justifies the statement that the rise and fall of the localized P-wave velocity may not be a result of a soft or unusually weak soil horizon. The applicant also stated that most proposed foundation excavations will be near or below this zone, such that the zone will either be removed or excavated and recompacted. Geotechnical investigations performed during the COL phase will provide additional verification regarding the soil properties of this zone with rise and fall of P-wave velocity. The staff's review finds that the justification is consistent with industry practice and is acceptable. The applicant's commitment to perform geotechnical investigations during the COL stage is **COL Action Item 2.5-4.**

In RAI 2.5.4-15, the staff asked the applicant to (1) demonstrate that the descriptors used will not mislead evaluations based on verbal descriptions, (2) provide the basis for developing soil classifications, and (3) provide the basis to justify the validation of judgments made for samples for which only one CU test was performed to estimate strength parameters (cohesion and friction angle). From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this report, the staff found that, in general, the responses provided clarify some of the concerns raised in the RAI. With respect to the first issue, the response indicates that the applicant modified SSAR Table 2.5-7 to indicate the samples with modified descriptors. In addition, the response indicates that these modifications do not change the conclusions on potential foundation behavior. The staff finds that this response is appropriate. The response to the second issue indicates that the applicant used the procedures of ASTM D2488, associated with the use of the visual-manual procedures for field descriptions, to estimate the USC categories. This is a common industry procedure and is considered appropriate. The response to the third issue indicates that the applicant used the triaxial test results as index tests to compare strength estimates between stratigraphic layers as well as with more detailed studies performed for the UFSAR.

In RAI 2.5.4-16, the staff asked the applicant to provide the basis for the selection of confining pressures to be used in the dynamic testing and compare the resulting pressures with current estimated in situ stress levels. From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this report, the staff found that the response provided and the updated SSAR table are appropriate to explain the basis for the selection of the testing regimes for the samples provided to the laboratory. The response indicates that the comparison of the laboratory and field shear wave data is generally more appropriate for the assumed value of 1.0. This response is considered adequate and RAI 2.5.4-16 is resolved.

As discussed above, the staff found that the applicant provided a sufficient description of the subsurface material properties to support its ESP application. On this basis, the staff concludes that the subsurface materials presented in this SSAR section are acceptable.

2.5.4.3.2 Relationship of Foundations and Underlying Materials

Section 2.5.4.3 of RS-002 directs the staff to compare the applicant's plot plans and profiles of all seismic Category I facilities with the subsurface profile and material properties. Based on the comparison, the staff can determine if (1) the applicant performed sufficient exploration of the subsurface materials and (2) the applicant's foundation design assumptions contain an adequate margin of safety. The staff concludes that the applicant's description of the relationship of foundations and underlying materials is consistent with the approach taken by industry and is, therefore, acceptable. The applicant will provide this information as part of its COL submittal. Correlating the plot plans and profiles of each seismic Category I facility with the subsurface profile and material properties to ascertain the sufficiency of selected borings to represent the spectrum of soil variations under each structure is **COL Action Item 2.5-5.**

2.5.4.3.3 Excavation and Backfill

The applicant stated that excavations can potentially reach depths of more than 100 feet below grade. It did not discuss issues such as (1) the potential extent of excavation, (2) methods of excavation and temporary support of excavation, (3) backfill sources and quality control requirements of backfill, (4) control of ground water during excavation, and (5) settlement control during excavation and construction. The applicant did not note any unusual experiences encountered during construction of the existing GGNS facilities. However, the applicant has not selected a reactor design or location within the ESP site, and it has not provided detailed excavation and backfill plans or plot plans and profiles as described in Section 2.5.4 of RS-002. These can pose special concerns for deep excavations near the bluff at the edges of the ESP site. Therefore, the staff cannot adequately evaluate the applicant's excavation and backfill plans until an applicant submits these plans as part of a COL or CP application.

The staff notes that the applicant should evaluate potential excavation procedures that may be used, as well as the impact of the adjacent bluff on temporary support conditions and on standoff distance in the ESP area. This is **COL Action Item 2.5-6.**

2.5.4.3.5 Ground Water Conditions

In its review of SSAR Section 2.5.4.2, the staff focused on the information regarding ground water at the ESP site. The applicant has not selected a reactor design or location within the ESP site and did not provide an evaluation of ground water conditions as they affect the foundation stability or detailed dewatering plans as described in Section 2.5.4 of RS-002. Therefore, the staff could not evaluate the ground water conditions as they affect the loading and stability of foundation materials, the applicant's procedure for dewatering during construction, and ground water control throughout the life of the plant. As such, the staff cannot adequately perform its review until the applicant submits these evaluations and plans as part of the COL application. This is **COL Action 2.5-7.**

2.5.4.3.6 Response of Soil to Dynamic Loading

In its review of SSAR Section 2.5.4.3, the staff primarily focused on the low-strain shear wave velocity profiles used to determine the response of the soil and rock underlying the ESP site to dynamic loading. In addition, the staff reviewed the applicant's nonlinear soil models used to incorporate the variation of soil shear modulus and damping with cyclic shear strain. Finally, the staff reviewed the applicant's site dynamic response, which it based on a soil amplification/attenuation analysis using a single base case site profile. From its review, the staff identified several issues.

In RAI 2.5.4-5, the staff asked the applicant to identify the values of the BE, UB, and LB velocities selected for each primary component of the profile and to provide bases for their selection in either SSAR Section 2.5.4 or SSAR Section 2.5.2. From its review of the applicant's response as summarized in Section 2.5.4.1.1 of this report, the staff found that the response provided by the applicant does not describe the implementation of the randomization scheme used in the response calculation. For example, it is typical to specify not only the BE velocity profile but also the corresponding ±1 sigma values of log shear wave velocities for the entire site column above hard rock, from which the randomization scheme can move forward. As discussed in Section 2.5.4.3.1 of this report, the applicant committed in the revised SSAR to perform additional borings, laboratory testing, and a geophysical survey to confirm the current base case material properties and their variabilities throughout the site during the COL stage. However, in consideration of the impact to the calculated surface ground motion from these parameters, the applicant must provide the basis for the selection of such profile properties.

In its response to the issues addressed in Open Item 2.5-5, the applicant indicated that SSAR Figure 2.5-60 shows the BE velocity profile. This profile is based on a visual average of the three P-S suspension log surveys obtained from the ESP site borings. (The applicant provided a discussion of the development of the BE profile in its response to RAI 2.5.4-8 dated December 10, 2004). Because of the small amount of data available for each unit of the BE profile, the applicant did not develop the UB and LB profiles; rather, it used a profile randomization scheme to incorporate typical values of uncertainty across the site. The applicant further stated that the profile analysis of variance uses measured shear wave velocity profiles from alluvial sites located in both the WUS and CEUS, resulting in a generic coefficient of variation (COV) of about 0.3 for shear wave velocity. Based upon experience with measured profiles in the embayment region as well as an examination of the three suspension log profiles taken at the site, as shown in SSAR Figure 2.5-80, the applicant considered the generic model unlikely to underestimate site-specific variability across the foundation footprint. Site-specific footprint (soil) variabilities typically reflect a COV closer to 0.2, but require a minimum of 20–40 profiles to reasonably constrain the model parameters.

In addition to the above discussion, the applicant provided the following information in the SSAR Section 2.5.2.4, Revision 2 of its application:

> The profile analysis of variance (Reference 194; Reference 197) used measured shear-wave velocity profiles from alluvial sites located in both the WUS and CEUS, resulting in a generic COV of about 0.3 for shear-wave velocity. Based upon experience with measured profiles in the Embayment region as well as an examination of the three suspension log profiles taken at the site (Figure 2.5-80), the generic model was considered unlikely to underestimate site-specific variability across the foundation footprint. Site-specific footprint (soil) variabilities typically reflect a COV closer to 0.2, but require a minimum of 20–40 profiles to reasonably constrain the model parameters.

Based on the applicant's response described above and its commitment to the SSAR revision, the staff finds that the selected values of 1 sigma used for the profile randomization process are appropriate, since the range of selected values plays a secondary role in generating mean site amplification factors. On this basis, Open Item 2.5-5 is considered resolved.

In RAI 2.5.4-9, the staff asked the applicant to provide its reasoning for the statement that the ESP site is not susceptible to long-term problems such as dissolution cavities and/or sinkholes. From its review of the applicant's response as summarized in Section 2.5.4.1.3 of this report, the staff concludes that karst formations are probably not of concern in the calcareous clays and limestone deposits at the site. However, the applicant further noted that additional site investigations would be conducted during the COL stage, including deep borings in the footprint of the powerblock structures. The future boring program must evaluate the potential for karst formation. This is **COL Action Item 2.5-8.**

As discussed above, the staff concludes that the applicant provided, in SSAR Section 2.5.4.3, sufficient and acceptable information for it to perform dynamic response analyses for the ESP site. On this basis, the staff concludes that the applicant's discussion of soil responses to dynamic loading is acceptable.

2.5.4.3.7 Liquefaction Potential and Seismic Site stability

As indicated in Section 2.5.4.4 of the SSAR, the soil deposits underneath the ESP range in age from Miocene (Catahoula formation) to Pleistocene (loess). These deposits all appear to be overconsolidated. The applicant does not expect to encounter any Holocene materials or relatively loose sands or silts that may be susceptible to liquefaction at the ESP site location. The applicant did not find any reported paleoliquefaction features in the ESP site vicinity. Soils below the ground water table that are planned to provide foundation support are relatively dense, overconsolidated, and relatively old and thus are not susceptible to liquefaction. The staff concludes that the applicant's description of the liquefaction potential and seismic stability of the site conditions meets with the RS-002 guidelines and is, therefore, acceptable.

2.5.4.3.8 Static Site Stability

In its review of SSAR Section 2.5.4.5, the staff focused on the applicant's evaluation of bearing capacity, potential of settlement, and lateral earth pressure. In SSAR Section 2.5.4.5.2, the applicant stated that several inches of elastic rebound may be associated with relatively deep site excavations and that it expected this rebound to be reversible, presuming that the new structures are fully compensated designs. Assuming that the current GGNS powerblock structures are far enough from the ESP site, the staff requested, in RAI 2.5.4-10, the applicant to demonstrate that no other facilities (e.g., piping, conduit) exist in the ESP area that may be influenced by such surface movements.

The staff reviewed the applicant's response as summarized in Section 2.5.4.1.5 of this report and found that the applicant stated, in SSAR Section 2.5.4.5, that the anticipated settlements associated with the ESP construction will be relatively small (several inches). This is based upon a review of the known soil conditions at the site as well as settlements recorded during construction of the existing GGNS powerblock structures. In addition, no safety-related facilities exist in the zone of influence of the ESP construction. Since the ESP site is immediately adjacent to the existing GGNS site, the staff considers the response provided by the applicant adequate, and RAI 2.5.4-10 is resolved.

On the basis of the above discussion, the staff concludes that the applicant's evaluation of bearing capacity, potential of settlement, and lateral earth pressure for the ESP site meets the RS-002 guidelines and is, therefore, acceptable.

2.5.4.3.9 Design Criteria

In SSAR Section 2.5.4.6, the applicant stated that specific design criteria will be developed during the COL stage when the specific characteristics of the operating system are known. Design criteria associated with structural design, such as potential wall rotations, facility sliding, and overturning, must be developed for specific facilities. Therefore, this is **COL Action Item 2.5-9.**

2.5.4.3.10 Site Characteristics Related to Geotechnical Engineering

Based on its review of SSAR Section 2.5.4, the staff has determined that the site characteristic given in Table 2.5.4-1 should be included in any ESP that might be issued for the proposed site.

Table 2.5.4-1 Staff's Proposed Site Characteristics Related to Geotechnical Engineering

SITE CHARACTERISTIC	VALUE
Minimum Shear Wave Velocity of Soil at Plant Foundation Level	1000 fps

2.5.4.4 Conclusions

Based on its review of SSAR Section 2.5.4 and the applicant's responses to the associated RAIs described above, the staff concludes that the applicant adequately determined the engineering properties of the soil encountered during its field and laboratory investigations, and that the applicant has provided sufficient technical information in the geotechnical area to demonstrate the suitability of the ESP site for building a new nuclear power plant, except for those areas for which more information is needed to allow the staff to make its decision regarding the site. In addition, the applicant used the latest field and laboratory methods, in accordance with RGs 1.132, 1.138, and 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites," issued November 2003, to determine these properties. However, the staff also concludes that the applicant did not perform sufficient field investigations and laboratory testing to adequately define the overall subsurface profile, as well as the potential variability of the properties of the soil underlying the ESP site. The staff notes that the applicant committed to perform additional field investigations once it has selected the locations and facilities for safety-related structures at the COL stage.

2.5.5 Stability of Slopes

Section 2.5.5 of the SSAR discusses issues associated with slope stability at the ESP site.

2.5.5.1 Technical Information in the ESP Application

In SSAR Section 2.5.5, the applicant stated that the ESP site is relatively flat and will not be subject to large-scale landslides or slope failures. The location of the proposed new facility encompasses two flat graded surfaces that are separated by an approximately 22-foot-high, 3:1 (20-degree slope) cut-slope in loess soils. The cut-slope has shown no evidence of instability since its construction in the early 1970s. At the west side of the ESP, the area is bounded by a 65-foot-high erosional escarpment (bluff) that descends to the Mississippi River floodplain. Portions of the bluff are subject to surficial slumps and creeping soils that are confined within the loess soils in the face of the bluff slope. Based on its observation of no evidence of active or incipient slope movements above or around the possible slump scarp on the bluff, the applicant stated that future instability in the bluff slope should not affect the future facilities because the surficial slumping and erosion in the bluff slope are restricted to the loess soils. The applicant also stated that it is likely that the future plant footprint will be located at least 100 feet from the top of this possible slump feature and the plant foundations would extend through the loess soils into the underlying Upland Complex Alluvium or Old Alluvium, which is well below the possible slide planes or toe of the bluff slope.

As stated in the SSAR, no plans exist to perform specific analyses to evaluate the stability of deep foundation excavations for the future facilities at the proposed ESP site until the COL phase. In addition, the applicant stated that it did not find any indications of unstable materials underlying the site that should cause unusual stability conditions for excavations and excavation support. In SSAR Section 2.5.5 and Sections 3.3 and 12.5.2 of ER-02, the applicant noted that a 60–70-foot escarpment that may be subjected to surficial slumps and potential creep of the loess soils bounds the west side of the proposed ESP site. The applicant further stated that, since future safety-related facilities would be founded on Upland Alluvium or Old Alluvium encountered below the loess, future movements of the slope should not have any significant impact on these foundations. However, if such facilities are founded close to the scarp, such slump or creep effects could have an impact on lateral loads applied to such deeply founded facilities. In RAI 2.5.5-1, the staff asked the applicant if it had performed any evaluation to indicate the expected behavior of the loess escarpment or the extent to which such movements could occur. In addition, the staff also asked the applicant if the ESP site should have some exclusionary zones along the west-side boundary that would not be susceptible to such potential future slump. In its response, the applicant stated that SSAR Figure 2.5-69 shows the spatial relationships among the PPBA and the loess bluff and the postulated shallow slump in the bluff near the west boundary of the ESP site. The applicant evaluated the potential hazard to the site from slope failure and creep in the loess bluff by examining geologic cross-sections, evaluating embedment depths and positioning of ESP structure foundations, and qualitatively assessing the bluff slope stability in relation to the relative strength of subsurface materials. The applicant further stated that it developed a simplified cross-section to show the geometric relationships between the loess bluff and the site. In this schematic cross-section, the PPBA is set back over 100 feet from the closest approach of the bluff and top of the postulated slump. The maximum foundation influence zone envelope extends to just within the headscarp of the slump area. However, the likely depth range for the prospective reactor foundations required to satisfy minimum embedment and shear wave velocity criteria places the foundation level about 10–80 feet below the elevation of the toe of the bluff slope. The applicant also stated that it is unlikely to develop a failure plane that extends from the toe of the bluff or headscarp of the postulated slump back to the PPBA. A failure plane would have a very gentle inclination of about 8 degrees and would need to intercept the perimeter of the PPBA at least 5–10 feet below plant grade. The applicant believed that such a low-angle failure plane is very unlikely based on an estimated in situ effective friction angle of 33–34 degrees measured by triaxial UC testing of loess samples. Therefore, the applicant concluded that no kinematically feasible bluff failures could extend back to, or negatively impact, the stability and lateral confinement of prospective reactor foundations within the PPBA. Based on the qualitative stability assessment, the hazard to the ESP site from possible future movements in the loess bluff is very low to none and does not require additional analysis at this ESP stage. The applicant stated that an exclusionary zone between the top of the bluff and the ESP PPBA, therefore, is not necessary.

2.5.5.2 Regulatory Evaluation

SSAR Section 2.5.5 states that the applicant did not analyze the stability of existing slopes since the foundations of safety-related facilities will be located below the soils that may be susceptible to stability problems. As such, the applicant did not list any regulatory guidance or cite any regulations as applicable to this section of the SSAR.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 100.23, which states that the applicant for the ESP must describe the geologic and seismic conditions of the proposed site necessary to determine the site stability. Section 2.5.5 of RS-002 provides specific guidance concerning the evaluation of information characterizing the stability of slopes under SSE conditions.

2.5.5.3 Technical Evaluation

In RAI 2.5.5-1, the staff requested the applicant to perform an evaluation to demonstrate the expected behavior of the loess escarpment or the extent to which such movements will not occur. In its response, the applicant noted that it modified the ESP site plan to restrict the location of the PPBA to a distance of over 100 feet from the bluff area on the west side of the site. The applicant also stated that, based on a qualitative assessment of stability, the hazard to the ESP site from potential future movements of the loess soils is very low to none. However, this qualitative assessment was based on potential failure plane relationships and did not consider the potential impact of differences in elevations on soil-structure interaction (SSI) evaluations of safety-related facilities. In its additional response to RAI 2.5.5-1, the applicant committed to add a new paragraph at the end of SSAR Section 2.5.4.3. In this new SSAR section, the applicant referred to Figures 2.5.5-1 through 2.5.5-2, reproduced below, and provided an assessment of possible behavior of the site topography. The applicant summarized that the possible future slumping or erosion could result in some changes in the local topography, but this should not result in a measurable reduction of soil lateral capacity for plant structures located in the prospective powerblock area, or significantly influence the lateral response of the soils under dynamic loading from the buried structure at the edge of the site. With regard to the potential impact of differences in elevations on SSI evaluations of safety-related facilities, the applicant committed, in the new SSAR section, that the COL applicant will incorporate the effects resulting from the local topography or possible changes in topography in the SSI analyses to be performed for structures located in the southwest quadrant of the ESP site. The staff's review found the commitment made by the applicant in its RAI response acceptable. To incorporate the effects resulting from the local topography or possible changes in topography in the future SSI analyses is **COL Action Item 2.5-10.**

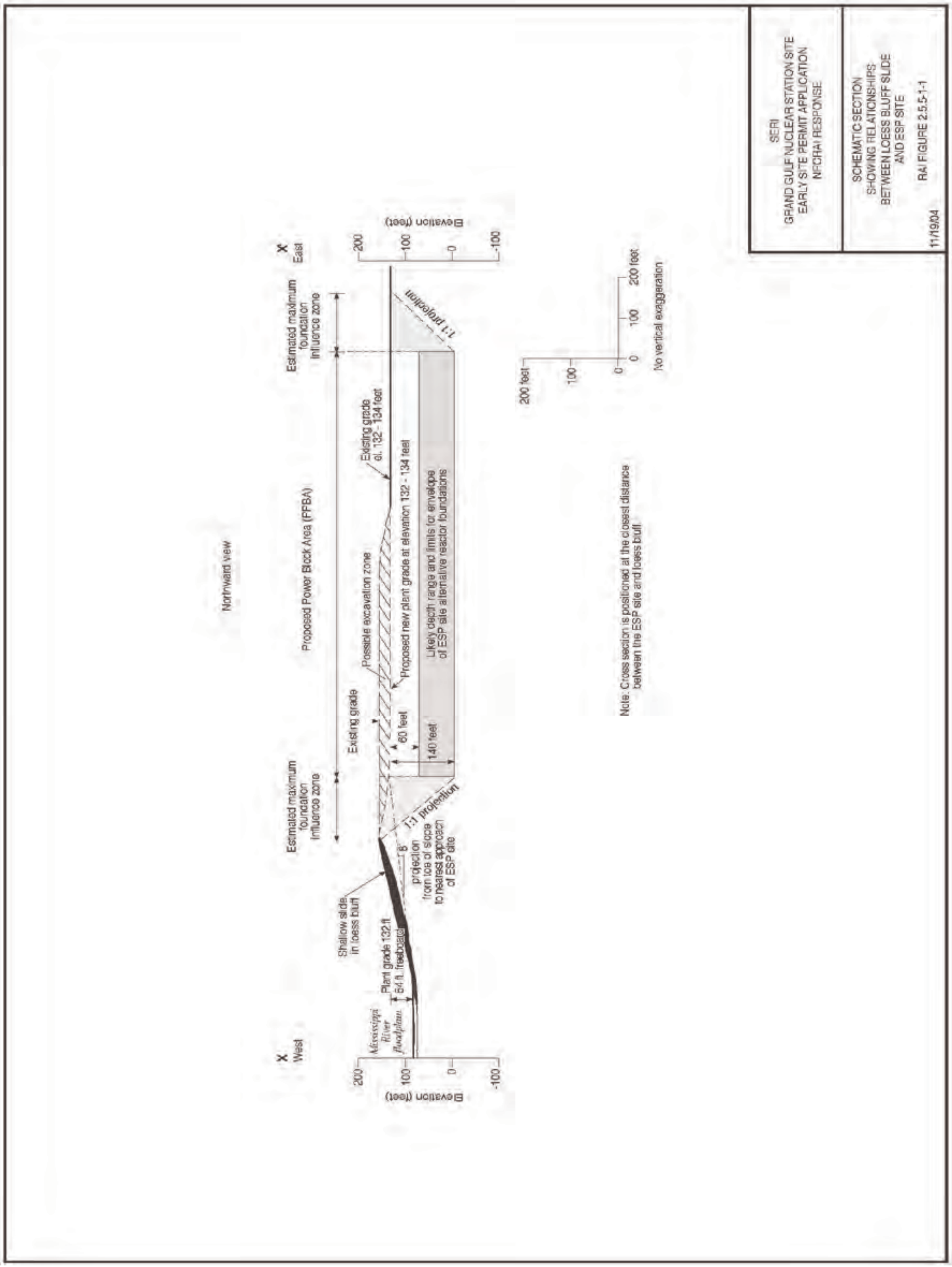


Figure 2.5.5-1 (RAI Figure 2.5.5.1-1)
Schematic Section Showing Relationships
Between Loess Bluff Slide and ESP Site

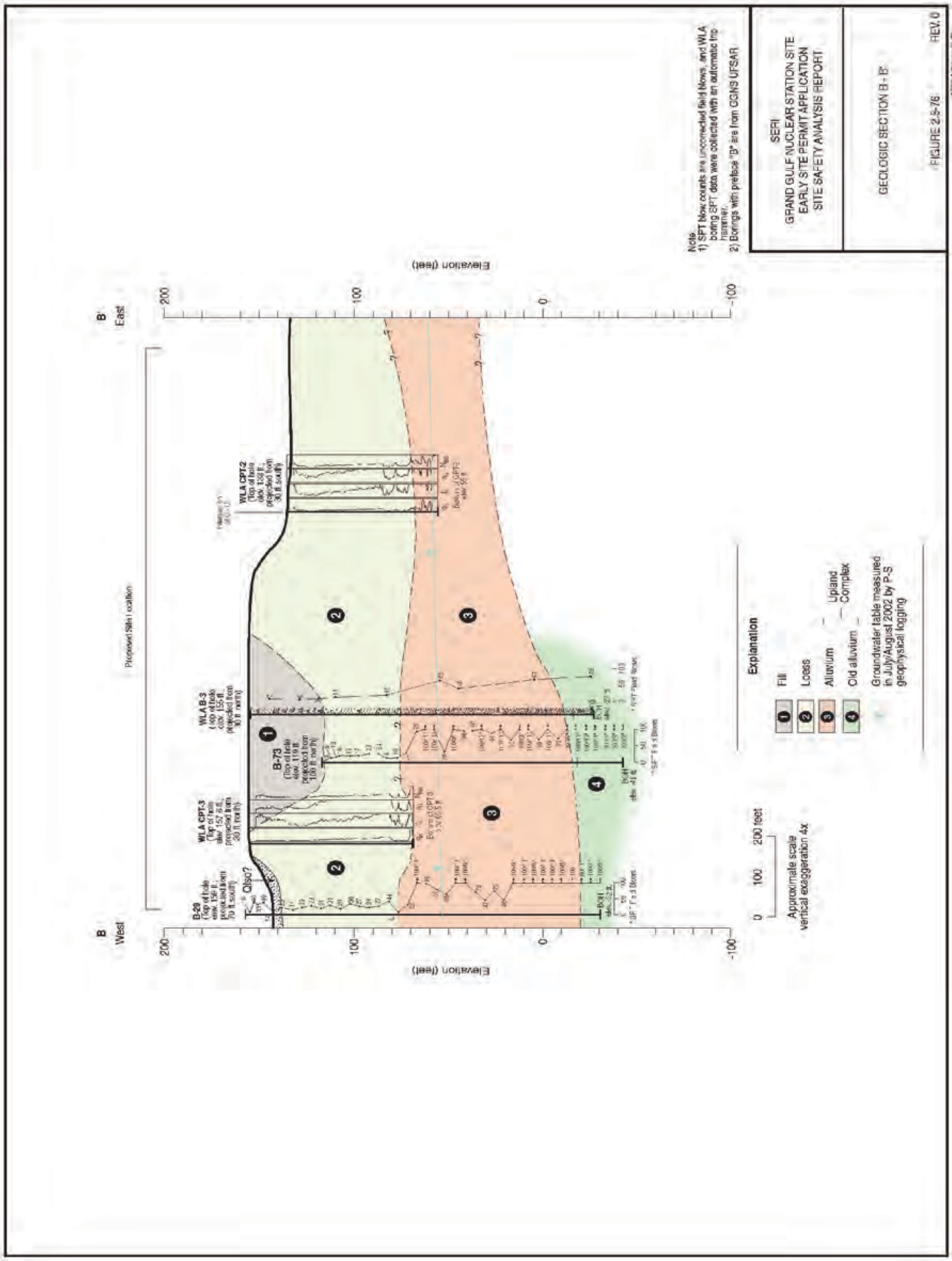


Figure 2.5.5-2 (SSAR Figure 2.5-76)
Geologic Section B - B

As discussed above, the staff found that the applicant provided sufficient description of the stability of slopes in the area to support its application for the ESP. On this basis, the staff concludes that the slope stability assessment presented in this SSAR section is acceptable.

2.5.6 Embankments and Dams

SSAR Section 2.5.6 considers embankments and dams associated with the ESP site.

2.5.6.1 Technical Information in the Application

SSAR Section 2.5.6 indicates that, within the ESP site area, no earth or rock fill embankments are used for flood protection or impounding the cooling water. In addition, no impoundment structures within the ESP site area exist that could pose a hazard to the proposed future facility. Therefore, no significant hazards may be posed by inundation from such facilities. The SSAR does not indicate any influence of flooding from the Mississippi River and its potential to further erode the loess bluff.

2.5.6.2 Regulatory Evaluation

Since the applicant stated that no impoundment structures lie within the ESP area, the applicant did not list any regulatory guidance or cite any regulations as applicable to SSAR Section 2.5.6. Section 2.5.6 of RG 1.70 describes the necessary information and analysis related to the investigation, engineering design, proposed construction, and performance of all embankments used for plant flood protection or for impounding cooling water. RS-002 Sections 2.4.4, and 2.5.5 provide similar information and guidance.

2.5.6.3 Technical Evaluation

The staff's review found that, although no impoundment structures lie within the ESP area, the applicant did not evaluate the effect of potential flooding of the Mississippi River and possible future erosion of the bluff. The COL applicant should evaluate these effects and their impacts on SSI effects. This is **COL Action Item 2.5-11.**

2.5.6.4 Conclusions

The staff found that the applicant provided sufficient descriptions of the embankments and dams in the site vicinity to support its ESP application, except that the applicant must provide additional information to address the COL action item. On this basis, the staff concludes that the assessment of embankments and dams presented in this SSAR section is acceptable for the ESP application.

3. SITE SAFETY ASSESSMENT

3.1 Nonseismic Siting Criteria

3.1.1 Exclusion Area and Low-Population Zone

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

3.1.2 Population Center Distance

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

3.1.3 Site Atmospheric Dispersion Characteristics and Dispersion Parameters

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

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

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

3.1.5 Potential Offsite Hazards

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

3.1.6 Site Characteristics—Security Plans

Section 13.6 of this SER presents the staff's evaluation of the applicant's security plans.

3.1.7 Site Characteristics—Emergency Plans

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

3.1.8 Population Density

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

3.2 Gaseous Effluent Release Dose Consequences from Normal Operations

Chapter 11 of this SER discusses the staff's evaluation of the applicant's estimates of gaseous effluent release dose consequences from normal operations.

3.3 Postulated Accidents and Accident Dose Consequences

Chapter 15 of this SER provides the staff's evaluation of the applicant's information concerning postulated accidents and accident dose consequences.

3.4 Geologic and Seismic Siting Criteria

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

3.5.1.6 Aircraft Hazards

For an ESP application, the NRC staff reviews the applicant's assessment of aircraft hazards to ensure that the risks associated with aircraft hazards are sufficiently low.

3.5.1.6.1 Technical Information in the Application

In Section 2.2.1 of the site safety evaluation report (SSAR) for the Grand Gulf ESP site, SERI presented information concerning the site relative to airports and airways that could affect the design of structures, systems, and components (SSCs) important to the safety of a nuclear power plant(s) falling within the applicant's plant parameter envelope (PPE) that might be constructed on the proposed ESP site.

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

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

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

3.5.1.6.2 Regulatory Evaluation

In SSAR Table 1.4-1, SERI listed the applicable NRC regulations and guidance related to the identification and evaluation of hazards associated with aircraft as (1) Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or after January 10, 1997," of 10 CFR Part 100, "Reactor Site Criteria," and Regulatory Guide (RG) 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition," issued November 1978.

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

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

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

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

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

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

3.5.1.6.3 Technical Evaluation

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

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

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

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

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

3.5.1.6.4 Conclusions

The staff reviewed the applicant's aircraft hazard analysis using the procedures set forth in RS-002, Section 3.5.1.6. As discussed above, the staff reviewed the applicant's assessment of aircraft hazards at the ESP site that result in a probability less than about 1×10^{-7} per year for an accident having the potential for radiological consequences greater than the exposure guidelines in 10 CFR 50.34(a)(1). The staff also conducted its own independent analyses. Based upon these analyses, the staff concludes that aircraft hazards at the proposed ESP site pose no undue risk to the health and safety of the public. Therefore, the staff further concludes, with respect to aircraft hazards, that the proposed site is acceptable for constructing a plant falling within the applicant's PPE, and that the site meets the relevant requirements of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100.

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

Airport	Distance from ESP Site (mi)	Reported Operations per Year[a]	Fraction of RS-002 $1000D^2$ Criterion	Operations by Aircraft Type[a]
Tensas Parish	12	6,987	5.1%	100% general
Newellton	13	6,987	4.4%	100% general
Scott	29	20,075	2.4%	100% general
Vicksburg Municipal	17	7,300	2.4%	94% general, 6% military
Hardy-Anders Field	31	16,425	1.7%	92% general, 4% air taxi, 4% military
John Bell Williams	43	24,455	1.3%	100% general, <1% military
Winnsboro Municipal	39	20,075	1.3%	100% general
Vicksburg Tallulah Regional	24	6,361	1.1%	94% general, 6% military
Copiah County	40	13,505	0.8%	93% general, 7% air taxi
Brookhaven-Lincoln County	47	13,140	0.6%	100% general
Concordia Parish	40	9,125	0.6%	100% general
Delhi Municipal	38	8,030	0.5%	100% general
Hawkins Field	53	62,415	2.2%	88% general, 6% military, 6% air taxi
John H Hooks, Jr. Memorial	54	17,885	0.6%	100% general
Byerley	57	6,987	0.2%	100% general
Jackson International	61	90,155	2.5%	54% general, 25% commercial, 15% air taxi, 6% military

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

11. RADIOACTIVE EFFLUENT DOSE CONSEQUENCES FROM NORMAL OPERATIONS

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the information on radiological effluents and solid radioactive waste provided in Section 3.2 of the site safety analysis report (SSAR) submitted by Systems Energy Resources, Inc. (SERI or the applicant), as part of the early site permit (ESP) application for the Grand Gulf Nuclear Station (GGNS) site, as well as Sections 3.5 and 5.4 of the associated environmental report (ER), to determine whether site characteristics are such that the radiation dose to members of the public would be within regulatory requirements.

11.1 <u>Technical Information in the Application</u>

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

11.2 <u>Regulatory Evaluation</u>

The NRC regulations require that applicants for an ESP address the characteristics of the proposed site that could affect the radiation dose to a member of the public from radiological effluents. The applicant provided a comprehensive listing of NRC regulations applicable to its ESP SSAR and ER in SSAR Section 3.2 and ER Sections 3.5 and 5.4, respectively. These sections contain information that adequately addresses anticipated radiological effluents according to Title 10, Section 52.17(a)(1)(iv), of the *Code of Federal Regulations* (10 CFR 52.17(a)(1)(iv)). Specifically, 10 CFR 52.17(a)(1)(iv) states that an ESP application should describe the anticipated maximum levels of radiological effluents that each facility will produce. Furthermore, 10 CFR 100.21(c)(1) requires that radiological effluent release limits associated with normal operation from the type of facility proposed for the site be met for any individual located off site. The staff reviewed this portion of the application for conformance with the applicable regulations.

11.3 <u>Technical Evaluation</u>

During normal operation, small quantities of radiological materials are expected to be released to the environment through gaseous and liquid effluents from the plant.

11.3.1 Gaseous Effluents

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

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

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

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the gaseous effluents using radiological exposure models based on Regulatory Guide (RG) 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," and the GASPAR II program (NUREG/CR-4653, "GASPAR II—Technical Reference and User Guide," issued March 1987). The applicant evaluated several exposure pathways, including direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground, inhalation of gases and particulates, ingestion of milk contaminated through the grass-cow-milk pathway, and ingestion of foods contaminated by gases and particulates. The calculated gaseous pathway total body dose to a maximally exposed individual at the nearest site boundary is 0.0084 milliSievert per year (mSv/yr) (0.844 millirem per year (mrem/yr)).

11.3.2 Liquid Effluents

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

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

In ER Table 3.0.8, SERI provided the bounding annual average quantity of radioactive liquid effluents that may be released from the ESP facility. This quantity represents the highest activity content of the individual isotopes from the alternative reactor designs under consideration. These data show that the bounding liquid effluent release concentrations will fall within the liquid effluent release concentration limits in Table 2 of Appendix B to 10 CFR Part 20.

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the liquid effluents using radiological exposure models based on RG 1.109, “Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I,” issued October 1977, and the LADTAP II program (NUREG/CR-4013, “LADTAP II—Technical Reference and User Guide,” issued April 1986). The applicant evaluated several exposure pathways, including eating fish or invertebrates caught near the point of discharge, using the shoreline for activities (e.g., sunbathing or fishing), and swimming and boating on the Mississippi River near the point of discharge. The calculated liquid pathway total body dose to a maximally exposed individual at the nearest site boundary is 0.0217 mSv/yr (2.17 mrem/yr).

11.3.3 Solid Waste

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

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

Consistent with the requirements of Subpart B, “Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997” of 10 CFR Part 100 and Subpart A, “Early Site Permits,” of 10 CFR Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants,” SERI did not provide details regarding the solid waste management system. The NRC will evaluate solid waste management at the construction permit or combined license (COL) stage.

11.3.4 Conclusions

The applicant provided adequate information to give reasonable assurance that it will control, monitor, and maintain radioactive gaseous and liquid effluents from the ESP facility within the regulatory limits specified in 10 CFR Part 20, 10 CFR Part 71, and 49 CFR Part 173, as well as maintain them at ALARA levels, in accordance with the effluent design objectives contained in Appendix I to 10 CFR Part 50. A COL applicant that references an ESP for the site should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for any facility to be built on the site are bounded by the radiological doses included in the SSAR for the ESP application and reviewed by the NRC staff as described above. In addition, detailed information on the solid waste management system used to process the radioactive gaseous and liquid effluents will be required. This is **COL Action Item 11.1-1.**

Based upon these considerations, the staff concludes that radiological doses to members of the public from radioactive gaseous and liquid effluents resulting from the normal operation of one or more new nuclear power plants that might be constructed on the proposed ESP site do not present an undue risk to the health and safety of the public. Therefore, the staff concludes, with respect to radiological effluent release dose consequences from normal operations, that the proposed site is acceptable for constructing a plant falling within the applicant's plant parameter envelope (PPE), and that the site meets the relevant requirements of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria."

13. CONDUCT OF OPERATIONS

13.3 Emergency Planning

The U.S. Nuclear Regulatory Commission (NRC) evaluates emergency plans for nuclear power reactors to determine whether there is reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. An early site permit (ESP) application, pursuant to Title 10, Section 52.17(b), of the *Code of Federal Regulations* (10 CFR 52.17(b)), must identify any physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans. The application must also describe the contacts and arrangements that the applicant has made with Federal, State, and local government agencies with emergency response planning responsibilities. In addition, the application may propose major features of the emergency plans, as described in Supplement 2 to NUREG-0654/FEMA-REP-1, Revision 1, “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants—Criteria for Emergency Planning in an Early Site Permit Application—Draft Report for Comment” (hereafter referred to as Supplement 2), issued April 1996, or may propose complete and integrated emergency plans.

In Part 4, “Emergency Plan Information,” of its Grand Gulf ESP application, System Energy Resources, Inc. (SERI), presents the major features of its proposed emergency plan pursuant to 10 CFR 52.17(b)(2)(i). Because the proposed ESP site footprint consists of a portion of the existing Grand Gulf Nuclear Station (GGNS) site and is located immediately adjacent to GGNS Unit 1, very little distinction exists between the GGNS site and the ESP site for the purposes of emergency planning. The ESP application takes advantage of the emergency planning resources, capabilities, and organization that currently exist at the GGNS Unit 1 site. In Part 1, “Administrative Information,” of the ESP application, the applicant indicated that it did not intend to develop a complete and integrated emergency plan until it is necessary to do so, such as at the combined license (COL) phase.

In Section 1.0, “Planning Standards and Evaluation,” of Part 4, the applicant noted that it had developed the current emergency plans supporting GGNS Unit 1 to be consistent with the emergency response plans of the affected States (Mississippi and Louisiana) and localities. The ESP application incorporates by reference the following versions of the State and local plans:

- Louisiana Peacetime Radiological Response Plan (LPRRP), Revision 9, issued December 2000

- LPRRP Supplement II, “Fixed Nuclear Facilities to Louisiana Emergency Operations Plan,” Attachment 2, “Grand Gulf Nuclear Station,” Revision 9, issued December 2000

- LPRRP Supplement II, Attachment 2, Enclosure I, “Tensas Parish Radiological Emergency Response Plan,” Revision 9, issued January 2000

- Mississippi Radiological Emergency Preparedness Plan (MREPP), Volume III to the Mississippi Comprehensive Emergency Management Plan, Revision 6, issued July 2001

- Port Gibson/Claiborne County Radiological Emergency Preparedness Plan (PGCCREPP), Revision 5, issued August 2003

The NRC staff, in consultation with the Federal Emergency Management Agency (FEMA), has reviewed the following documents submitted by the ESP applicant, and generally available reference materials, in accordance with Review Standard (RS)-002, "Processing Applications for Early Site Permits:"

- proposed major features plan (Part 4, "Emergency Planning Information," of the ESP application for the Grand Gulf ESP site), Revision 2, dated October 3, 2005

- proposed major features plan (Part 4, "Emergency Planning Information," of the ESP application for the Grand Gulf ESP site), Revision 1, dated July 4, 2005, and supplement, dated September 16, 2005

- proposed major features plan (Part 4, "Emergency Planning Information," of the ESP application for the Grand Gulf ESP site), Revision 0, dated October 23, 2003, and Draft Revision 2, dated January 25, 2005

- applicable portions of the State and local emergency plans given above

- Appendix E, "Evacuation Time Estimates (ETE) for the Grand Gulf Nuclear Plume Exposure Pathway Emergency Planning Zone," to the Grand Gulf Nuclear Station Emergency Plan, issued March 1986, hereafter referred to as the 1986 ETE

- "Evaluation of Existing Evacuation Time Estimates and Analysis of Potential Impediments to Protective Actions, Grand Gulf Nuclear Station," issued May 2003, hereafter referred to as the 2003 ETE study

- "Evaluation of Existing Evacuation Time Estimates and Analysis of Potential Impediments to Protective Actions, Grand Gulf Nuclear Station," Revision 1, issued January 2005, hereafter referred to as Revision 1 to the 2003 ETE study

- SERI responses to the NRC's requests for additional information (RAIs) (Letter 4, dated October 19, 2004, and Letter 6, dated January 25, 2005)

- SERI responses to the NRC's RAIs to resolve the Grand Gulf Early Site Permit Draft Safety Evaluation Report Open Items, dated June 21, 2005

In addition, clarification was provided by the licensee for the existing GGNS unit in the following documents:

- "Grand Gulf Emergency Plan Clarification Related to Early Site Permit Review; Grand Gulf Nuclear Station, Unit 1; Docket No. 50-416; License No. NPF-29," dated September 15, 2005

- "Response to Grand Gulf Early Site Permit Draft Safety Evaluation Report Open Items 13.3-2 and 13.3-4 Discussion; Grand Gulf Nuclear Station, Unit 1; Docket No. 50-416; License No. NPF-29," dated June 28, 2005

Because the applicant has elected to present and seek NRC acceptance of the major features of the emergency plans, the staff's evaluation addresses, in order, the three aspects of such a submission. The following identifies each aspect and the section of this safety evaluation report (SER) that discusses each aspect:

(1) identify physical characteristics that could pose a significant impediment to the development of emergency plans (SER Section 13.3.1, "Significant Impediments to the Development of Emergency Plans")

(2) describe contacts and arrangements made with Federal, State, and local governmental agencies with emergency planning responsibilities (SER Section 13.3.2, "Contacts and Arrangements with Local, State, and Federal Agencies")

(3) propose major features of the emergency plans (SER Section 13.3.3, "Major Features of the Emergency Plans")

The applicant identified Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," as applicable to the major features it proposed. Appendix E, however, applies to the "major features" option of 10 CFR 52.17(b)(2) only to the extent that it requires a description of the "essential elements of advanced planning that have been considered" (see Section III of Appendix E). The staff has approved the applicant's identification of Appendix E as one of the regulatory requirements applicable to the staff's review of the major features proposed by the applicant. The staff's findings, set forth throughout Section 13.3.3 of this SER, are limited to those particular portions of Appendix E that the staff considered during its review of a particular major feature. More important, any staff finding that a proposed major feature complies with a particular requirement of Appendix E is limited to the description of the major feature approved by the staff in this SER.

Notwithstanding any staff approval of a proposed major feature in this SER, the staff will review all features of the emergency plan requiring description pursuant to Appendix E, but which are not described in the ESP application, in the context of a COL or operating license (OL) application. The staff will review the complete and integrated emergency plans submitted in the COL or OL application to determine whether they comply with such requirements, as well as with the requirements of 10 CFR 50.47, "Emergency Plans."

The staff's evaluation of the proposed major features of the applicant's emergency plan parallels the major features and planning standards in Supplement 2.

13.3.1 Significant Impediments to the Development of Emergency Plans

13.3.1.1 Technical Information in the Application

The applicant provided a preliminary analysis of the time required to evacuate transient and permanent populations from various sectors and distances within the 10-mile plume exposure pathway emergency planning zone (EPZ) in Section 2.2, "Evacuation Time Estimate Preliminary Analysis," of Part 4. In Section 2.2.1, "Introduction," of Part 4, the applicant indicated that a detailed ETE performed in March 1986 for the plume exposure pathway EPZ shows that the maximum evacuation time for the affected area is approximately 3 hours. Summaries of the 1986 ETE appear in Appendix D, “Evacuation Time Estimate,” to Attachment 2 to LPRRP Supplement II; MREPP Annex F, “Evacuation”; and Appendix 6, “GGNS Evacuation Time Estimate Study,” to PGCCREPP Annex F. In Section 2.2.1 of Part 4, the applicant further noted that a detailed evaluation of the original 1986 ETE undertaken in May 2003 more fully considered the impact of historical population growth and transportation system improvements.

In Section 2.2.2, “Methodology,” of Part 4, the applicant stated the following:

> The 2003 ETE evaluation (May 2003 ETE Study) examined evacuation time estimates as determined in 1986 for the GGNS EPZ and evaluated those estimates through: (1) an evaluation of the current population in the GGNS EPZ, using 2000 U.S. Census data and projected 2002 population estimates; (2) an evaluation of the current roadway network in and around the GGNS EPZ; (3) and evaluation of other impediments (e.g., new population growth, new shopping centers, new large employers) in or near the EPZ; and (4) interviews with State and local emergency management and transportation officials, as well as verification of all of the above through a site visit to the GGNS EPZ.

In Section 2.2.4.4, “Results of ETE Evaluation,” of Part 4, the applicant stated that the 2003 ETE study concludes that the maximum evacuation time for the affected area of approximately 3 hours, given in the 1986 ETE, remains valid. In addition, the applicant concluded that no physical characteristics unique to the site exist that could pose a significant impediment to the development of emergency plans and implementation of protective actions for the areas surrounding the proposed new facility. These conclusions are consistent with Section 6.0, “Summary and Conclusions,” of the 2003 ETE study, which stated the following:

> The Emergency Management Directors and Highway Foremen in both Tensas Parish in Louisiana and in Claiborne County in Mississippi all agree that the 1986 ETE, which demonstrates that the entire EPZ can be evacuated in any time of day or weather condition in less than three hours, is still valid, and may now be overstated because of declining populations in some areas and substantial road upgrades along the major evacuation routes.

In its response to RAI Letter 6, the applicant the applicant provided the following changes:

- The applicant revised Section 2.2.3.7, “Plume Exposure EPZ Peak Population,” of Part 4 to include a table, entitled “Comparison of Peak Plume Exposure Pathway EPZ Populations 1986–2002,” and to address the limiting plume exposure pathway EPZ peak population (for ETE purposes) as the daytime population estimated at 20,505, which is an increase of 11.1 percent since the 1986 ETE. Because of several minor adjustments, a slight net increase will occur from 20,369 persons to 20,505 persons. (According to the response to RAI 13.3-45, the applicant made the adjustments primarily because of its responses to RAI questions (i.e., 13.3-78d and 13.3-78k) and the deletion of population because of the closure of a small hospital within the EPZ.)

- The applicant revised Figure 1.1, “Grand Gulf Nuclear Station Emergency Planning Zone,” of the 2003 ETE study and Figure 2-6, “Evacuation Area Population Distribution,” of Part 4 to be consistent and reflect the same total rollup evacuation sums for all population segments in a given protective action area (PAA).

- The applicant revised Table 3-4, “GGNS Population Summary by Evacuation Area and Vehicle Demand,” of the 2003 ETE study to list the rollup evacuee sums for each PAA to allow for a convenient comparison with the subject figures.

In its response to RAI 13.2-45, the applicant further stated that the corrections to these figures do not impact the 2003 ETE study, its results, or its conclusions.

In Section 2.1.1, “Location and Physical Characteristics,” of Part 4, the applicant indicated that the proposed new facility will be located on the site of the existing GGNS Unit 1. Figure 2-1, “Site Layout,” of Part 4 reflects the property boundary for the proposed new facility, which encompasses approximately 2100 acres of land from the GGNS site. No railroads, navigable waterways, or industrial, commercial, institutional, or residential structures exist within or traverse the proposed new facility’s exclusion area, with one county road (Ball Hill Road) crossing the exclusion area for the proposed facility. Figure 2-3, “Site Layout,” of Part 4 outlined the boundary line of the plant exclusion area. In RAI 13.3-1, the staff requested that the applicant clarify inconsistencies in figure titles and referenced notes. In response, the applicant amended Figures 2-1 and 2-3 to clarify their titles and content and deleted associated notes in Part 4 of the application.

Section 2.1.5.1, “Plume Exposure Pathway EPZ Description,” of Part 4 further noted that the plume exposure pathway EPZ for the proposed new facility will be identical to that for the existing GGNS Unit 1. Figure 2-6 of Part 4 illustrated the plume exposure pathway EPZ, which is divided into 16 PAAs. In addition, Section 2.2.4.2, “Protective Action Area Description,” of Part 4 described these PAAs, based on major roadways, political boundaries, and topography.

In Table 2-2, “Evacuation Route Roadway Capacities,” of Part 4, the applicant summarized the roadway capacities for each PAA, which it took from Section 4.0, “Evaluation of GGNS EPZ Roadways,” of the 2003 ETE study. According to Section 2.2.2 of Part 4, data regarding roadways were collected from the Mississippi Department of Transportation (DOT) Web site, interviews with Mississippi and Louisiana DOT supervisors, and direct observation of each major road. The 1986 ETE also evaluated and described the roadway network in Section 4.0, “Evacuation Roadway Network,” and listed the complete network in Section 10, “Roadway Network Definition and Capacities.” Section 6.0 of the 2003 ETE study outlined the various improvements made to certain main evacuation routes (e.g., U.S. Route 61 in Mississippi enlarged from two lanes to a 4-lane freeway, Route 65 in Louisiana widened, Highway 18 in Claiborne County repaved and brought up to State DOT standards, and Route 552 south out of Alcorn State University (ASU) widened to a four-lane freeway).

In RAI 13.3-74a, the staff asked the applicant to clarify whether it based the boundaries of the EPZ and evacuation PAAs, used in Section 2.2 of Part 4, on projected demography, topography, land characteristics, access routes, and jurisdictional boundaries over the ESP period (e.g., 20 years). In response, the applicant stated that the GGNS site and associated plume exposure pathway EPZ are located in regions of Louisiana and Mississippi that are generally rural, with relatively low population densities. Part 3, “Environmental Report (ER),” to the Grand Gulf ESP application projected population estimates for the States of Louisiana and Mississippi, including for 2030, which could be used to represent projected populations at the expiration of the ESP (i.e., more than 20 years from the present). Data in Table 2.5-1, "Projected Population Distribution, 0-10 Miles," of Part 3 projected that population within the 10-mile radius will grow only modestly by 2030 (i.e., approximately 7 percent). This growth rate projection can generally be applied to the plume exposure pathway EPZ, which is slightly larger than the 10-mile radius in some areas. In its response, the applicant stated the following:

> It is expected that officials responsible for monitoring roadway conditions, capacity, use, and projected needs would be reviewing the parameters on a periodic basis to consider and pursue improvements as a matter of prudent highway management. Thus, other improvements to the evacuation roadway network could be expected from now through the life of the Permit (i.e., approximately 2030). For example, the Mississippi Department of Transportation (MDOT) plans improvements to U.S. Highway 61 south (as was done for the highway north of Port Gibson, MS to Vicksburg, MS). Based on the current MDOT schedule, improvements to Highway 61 south making it a 4-lane freeway, are expected to be completed in 2006. Thus, by the time a fully integrated plan was developed and implemented, it is not expected that the major road networks used for evacuation would present a physical characteristic that would be a significant impediment to implementing a fully integrated emergency plan at COL.

In summary, the applicant concluded that, given the current socioeconomic status, in concert with the projected population growth through 2030, it did not expect changes in demography, topography, land characteristics (and use), road networks, and jurisdictional boundaries to impact the plume exposure pathway EPZ and PAA boundaries as defined for GGNS Unit 1 and as proposed in Part 4 for the new facility.

The following sections of the 1986 ETE provided assumptions for determining the number of vehicles:

- Section 3.2, "Permanent Residents"
- Section 3.3, "Transient Populations"
- Section 3.4, "Special Facilities Population"

The general ETE assumptions were revised by the applicant in Section 2.0, "Assumptions Used," of Revision 1 to the 2003 ETE study and Section 2.2.4.1, "Assumptions," of Revision 2 to Part 4 to included the following:

- The applicant revised Assumption 2.10 regarding population to include outage numbers for weeknight and weekend estimates and added an explanatory note.

- The applicant revised Assumption 2.11 to indicate that the 25-percent decrease in traffic capacity includes reductions in average speed and roadway capacity during inclement weather. For an EPZ more prone to adverse weather, such as a New England utility subject to severe ice and snow storms, a 25-percent reduction in roadway capacity and travel speed could be taken. In the case of GGNS, a total reduction of 25 percent in traffic capacity based on reduced speed and roadway capacity is appropriate.

- The applicant modified Assumption 2.14 to indicate that buses will be used to transport special populations from facilities, such as hospitals, nursing homes, and jails and added an explanatory note.

- The applicant modified Assumption 2.15 to include minor clarifications.

Table 5-1, “Summary of Evacuation Time Estimate Assumptions and Differences 1986 to 2002,” of Part 4 compared the population differences and associated changes in vehicle loading on the evacuation network from 1986 to 2003 and described the net effect on the 1986 ETE.

Figure 2-4, “Permanent Resident Population Distribution in GGNS Plume Exposure EPZ,” of Part 4 provided the permanent resident population for the plume exposure pathway EPZ, based on concentric circles drawn in 1-mile increments out to 10 miles and divided into 22.5-degree sectors. The following sections of Part 4 provided population descriptions:

- Section 2.2.3.3, “Transient Population”
- Section 2.2.3.6, “Public Facilities and Institutions”
- Section 2.2.3.7

Table 2-1, “Plume Exposure EPZ Public Facilities and Institutions—Peak Populations,” of Part 4 showed a further breakdown of peak populations in facilities and institutions (i.e., schools, daycare centers, employers, special facilities) within the plume exposure pathway EPZ. According to Section 2.2.3.7 of Revision 2 to Part 4, the peak weekday population grew an estimated 11.1 percent (18,449 to 20,505 people) since the 1986 ETE, with most of this population growth seen in the Port Gibson area and at ASU. The applicant also indicated that a decrease in the peak workforce transient population from a weekday population of 1814 to 1116 resulted from the decreased number of workers at GGNS since 1986. In RAI 13.3-74b, the staff asked the applicant to clarify whether it considered the projected increase in site population because of a proposed new reactor(s) in its preliminary analysis with respect to vehicle queuing. In response, the applicant stated that it did not consider the projected workforce to be a significant concern in future planning because of the much improved capacity of the major evacuation route (i.e., U.S. Highway 61). In its response, the applicant also noted the following:

> However, it is recognized that the total evacuation workforce population for the impacted area, PAA1, would increase. The primary evacuation routing would be from the GGNS site, over the Grand Gulf Road to the east to Highway 61, and then north toward Vicksburg (2003 ETE Study, Table 4-1). As a practical matter, the 1986 ETE actually used a workforce population much larger than the current workforce. Thus, as shown in the 2003 ETE Study, Table 5-1 for PAA1, the difference between PAA vehicle demand decreased from 1986 to 2002 by 500 vehicles. Based on bounding projections for the proposed new facility, the workforce could be as high as 1160 persons (Environmental Report, Table 3.0-1, Item 17.5). Without offering an exact assessment, it can be concluded that the increase in some additional 1200 persons is generally offset by the decrease in vehicle loading from 1986 to 2002. Thus, the overall impact to 1986 conclusions regarding evacuation time would be generally unchanged. Given this quantitative assessment, it is further concluded that the evacuation of the total workforce, including the proposed new facility, would not pose a physical

> characteristic that would be a significant impediment to developing a fully integrated emergency plan.

In RAI 13.3-73, the staff asked the applicant to discuss other factors, in addition to evacuation, such as the availability of adequate shelter facilities, in consideration of local building practices and land use (e.g., outdoor recreational facilities, including camps, beaches, and hunting and fishing areas), for temporary population areas listed in Section 2.2.3.3 of Part 4 and any related significant impediments to the development of emergency plans. In response, the applicant stated that State and local (offsite) plans have been developed and implemented to meet emergency planning requirements for the operating unit at GGNS. The applicant further noted that, given the existence of fully approved, exercised, implemented, and periodically updated State and local plans, a presumption exists concerning the current adequacy of these plans and their effectiveness in providing required protective actions, including evacuation and shelter. The applicant also stated the following:

> No specific review of shelter capacity was undertaken as part of the 2003 ETE Study. By virtue of a presumption of current adequacy, there was no reason to question adequacy of current shelter capacity. Population growth has been determined to be modest (from 1986 to the current time frame). Projections to the end of the requested permit life continue to show modest population growth. State/local officials have indicated their overall willingness to cooperate with the applicant in developing any expansion of current plans. They have also indicated that they are not aware of significant impediments to the development of these plans. This provides sufficient basis for concluding that shelter capacity and other factors, besides evacuation, would not be significant impediments to developing emergency plans to support a proposed new facility at the GGNS site.

13.3.1.2 Regulatory Evaluation

In Section 1.1, “Introduction,” of Part 4, the applicant stated that it developed the major features of an emergency plan to comply with 10 CFR 52.17, “Contents of Applications,” using the guidance in Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(1), which mandate that the ESP applicant identify physical characteristics unique to the proposed site, such as egress limitations from the area surrounding the site, that could pose a significant impediment to the development of emergency plans. The staff further considered 10 CFR 52.18, “Standards for Review of Applications,” which requires consultation with FEMA to determine whether the information required of the applicant by 10 CFR 52.17(b)(1) demonstrates that no significant impediment to the development of emergency plans exists. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information included in an ESP application.

Supplement 2 defines a significant impediment as a physical characteristic or combination of physical characteristics that would pose major difficulties for an evacuation or the taking of other protective actions. Such unique physical characteristics may be identified by performing a preliminary analysis of the time required to evacuate various sectors and distances within the plume exposure pathway EPZ for transient and permanent populations, noting major difficulties for an evacuation (e.g., significant traffic-related delays), or the taking of other protective actions.

According to RS-002, the applicant should address factors such as the availability of adequate shelter facilities, local building practices and land use (e.g., outdoor recreation facilities, including camps, beaches, hunting or fishing areas), and the presence of large institutional or other special needs populations (e.g., schools, hospitals, nursing homes, prisons) when identifying significant impediments to the development of emergency plans. Any ETE or other identification of physical impediments should include the latest population census numbers and the most recent local conditions. In addition, the applicant should describe the proposed means for resolving any impediments identified.

13.3.1.3 Technical Evaluation

In Section 2.1.1 of Part 4, the applicant stated that the proposed new facility will be located on the site of the existing GGNS Unit 1. In Section 2.1.5.1 of Part 4, the applicant noted that the plume exposure pathway EPZ for the proposed new facility will be identical to that for the existing GGNS Unit 1. Since the existing GGNS Unit 1 and ESP sites are essentially the same, the staff finds that the use of the ETE for the GGNS site, as cited in the application, is acceptable and applicable to the proposed site based on the guidance in RS-002.

The 1986 ETE in Appendix E, "Evacuation Time Estimates for the Grand Gulf Nuclear Station Plume Exposure Pathway Emergency Planning Zone," to the emergency plan for GGNS Unit 1 detailed the plume exposure pathway EPZ and determined that the maximum evacuation time for the affected area is approximately 3 hours. In addition, as documented in the addendum to Appendix E, a door-to-door demographic survey in the station's plume exposure pathway EPZ conducted in August 1992 indicated a negligible increase in the permanent population of 0.54 percent (47 people). As such, the addendum concluded that the population change should have no discernible effect on the emergency plan, and that the population figures listed in the 1986 ETE remain valid.

In support of the ESP application, the applicant provided a preliminary analysis of the time required to evacuate transient and permanent populations from various sectors and distances within the 10-mile plume exposure pathway EPZ in Section 2.2 of Part 4. The applicant based this preliminary analysis, performed in May 2003, on the 2003 ETE study, which is a detailed evaluation of the original ETE to more fully consider the impact of the historical population growth and transportation system improvements. The 2003 ETE study showed that, in spite of an increase of 10.4 percent in the plume exposure pathway EPZ population, substantial improvements to major evacuation roadways have added even more surplus capacity since the 1986 ETE. The evaluation is consistent with the guidance for updating ETEs contained in NUREG/CR-4831, "State of the Art Methods for the Development of Evacuation Time Estimate Studies," issued in 1992, which stated the following:

> As a general rule, a 10 percent increase in population indicates a need to check evacuation times. An initial assessment would involve determining whether growth had taken place in areas constrained by roadway capacity. If the possibility exists for increased evacuation times, a detailed analysis is necessary.

The 2003 ETE study met the intent of this initial assessment and concluded that, while EPZ population increased by 10.4 percent, the time estimates in the 1986 ETE remain valid and, in some cases, may now actually overstate actual evacuation times because of substantial improvements to major evacuation roadways since 1986.

The applicant submitted Revision 1 to the 2003 ETE study on January 25, 2005, in response to the NRC's RAI Letter 6, dated August 13, 2004. Revision 1 to the 2003 ETE study updated the EPZ population increase (from 1986 to 2002) to 11.1 percent. In Section 2.2.4.4 of Revision 2 to Part 4, the applicant stated that Revision 1 to the 2003 ETE study concluded that the maximum evacuation time for the affected area of approximately 3 hours in the 1986 ETE remains valid. In addition, the applicant concluded that no physical characteristics unique to the site exist that could pose a significant impediment to the development of emergency plans and implementation of protective actions for the areas surrounding the proposed new facility. These conclusions are consistent with Section 6.0 of Revision 1 to the 2003 ETE study. Based on the general guidance for updating ETEs contained in NUREG/CR-4831, the staff concludes that the ETE is up to date for ESP purposes based on the guidance in RS-002.

The staff notes that the proposed ESP site is adjacent to GGNS Unit 1, which is an operating nuclear power plant with integrated onsite and offsite radiological emergency plans. This demonstrates that no significant impediments exist to the development of an emergency plan for the proposed ESP site.

Given the current socioeconomic status, in concert with the modest population growth projected through 2030 (based on projections in Part 3 of the Grand Gulf ESP application) and both ongoing and scheduled improvements to major roadways currently used for evacuation, the staff agrees with the applicant that changes in demography, topography, land characteristics (and use), road networks, and jurisdictional boundaries are not expected to impact the plume exposure pathway EPZ and PAA boundaries as defined for GGNS Unit 1 and as proposed in Part 4 for the new facility.

The staff finds that the applicant's responses to RAIs 13.3-1, 13.3-56, and 13.3-74, and associated revisions provided in Revision 2 to Part 4 of the application, are acceptable. Based on the changes to the assumptions and data inputs implemented under Revision 1 to the 2003 ETE study and Revision 2 to Part 4, the staff considers the ETE preliminary analysis, contained in Section 2.2 of Part 4, and Revision 1 to the 2003 ETE study to be up to date for ESP purposes, based on current population distributions and roadway improvements, using the guidance in Appendix 4 to NUREG-0654/FEMA-REP-1. The study's use of updated evacuee population, vehicle loading, and roadway networks is acceptable and appropriate for the purposes of identifying physical characteristics that may pose a significant impediment to developing expanded emergency plans to support the proposed new facility.

13.3.1.4 Conclusions

As discussed above, the applicant has shown through use of the ETE that no physical characteristics unique to the proposed ESP site could pose a significant impediment to the development of emergency plans. Based on its review as set forth above, the staff concludes that the information the applicant provided is consistent with the guidelines in RS-002 and Supplement 2. Therefore, the information is acceptable and meets the requirements of 10 CFR 52.17(b)(1) and 10 CFR 52.18.

13.3.2 Contacts and Arrangements with Local, State, and Federal Agencies

13.3.2.1 Technical Information in the Application

Section 3.1, "Assignment of Responsibility/Organization Control," and Section 3.3.2, "Coordination with Governmental Agencies," of Part 4 described the roles of various Federal, State, and local government agencies.

In Section 3.17, "Contacts and Arrangements," the applicant stated that the following agencies provided letters indicating their support for emergency preparedness efforts for the proposed new facility:

- U.S. Department of Energy (DOE)
- U.S. Coast Guard (USCG)
- State of Mississippi
- State of Louisiana
- City of Port Gibson, Mississippi
- Claiborne County Civil Defense
- Tensas Parish Emergency Preparedness
- Port Gibson Police Department
- Claiborne County Sheriff's Department
- Claiborne County Fire Department
- Louisiana Office of Emergency Preparedness (LOEP)

However, correspondence contained in Appendix A, "Agency Letters of Agreement," to Part 4 is not consistent with the listing in Section 3.17 to Part 4. In RAI 13.3-9, the staff asked the applicant to provide an updated listing in Section 3.17 of Federal, State, and local governmental agencies with emergency planning responsibilities. The staff also asked the applicant to provide letters of agreement (LOAs) for those agencies not currently included in Appendix A, where statutory authority is not identified, which reflect the use of the proposed site for the possible construction of a new reactor(s). In response, the applicant stated the following:

> Section 3.17 provides a listing of organizations with which the applicant has established a letter of agreement related to emergency planning for the proposed new facility. The agencies represented in Section 3.17 were selected based on the agreements established in the GGNS Unit 1 Emergency Plan. The listing in Section 3.17 is not intended to be an exhaustive listing of all Federal, State, and local agencies having responsibility for emergency planning and response activities. The applicant expects Federal agencies, including the U.S. Army Corps of Engineers and National Weather Service, to respond in accordance with the Federal Radiological Emergency Response Plan. The applicant expects State and local agencies to respond in accordance with the respective Mississippi and Louisiana plans, which have been incorporated by reference in Section 1.1. The letters of agreement included in Appendix A reflect the willingness of the responsible authorities in the affected States to enter into discussions that may lead to extending the scope of their plans to the proposed

new unit. These revised plans would establish the responsibilities of the affected State and local agencies.

> It is noted that Section 3.17 includes the U.S. Coast Guard and the City of Port Gibson; yet, no letters of agreement are included in Appendix A. The U.S. Coast Guard no longer provides an explicit letter regarding emergency support. The City of Port Gibson was included in Section 3.17 listing in error.

In Revision 2 to Part 4, the applicant amended Section 3.17 to delete references to USCG and the City of Port Gibson and to insert a reference to Claiborne County Hospital.

Each LOA in Appendix A to Part 4 used a standard format, which provides for the clear acknowledgment of the impact of the proposed new facility, including the following:

- names and locations of organizations contacted, including titles/positions
- possible future construction of one or more additional units at the existing GGNS site
- potential impact on existing responsibilities as outlined in the GGNS emergency plan and a statement from both parties of their willingness to enter into discussions to address future emergency preparedness needs based on construction at the GGNS site

Each LOA also included a statement that the signer is not aware of significant impediments to the development and implementation of the site's emergency plans that could include a future nuclear facility (or facilities).

Section 3.3.2.1, "Mississippi Emergency Management Agency and Mississippi State Department of Health/Division of Radiological Health," of Part 4 noted that the letter from the Governor of Mississippi serves as a commitment from all State agencies to perform their actions delineated in the State plan as required by Mississippi law. The executive director signed the letter in Appendix A to Part 4 from the State of Mississippi, rather than the Governor, as stated by the applicant in Section 3.3.2.1. In RAI 13.3-11, the staff asked the applicant to clarify this discrepancy. In response, the applicant stated that the LOA in Appendix A concerns the State's commitment to coordinate with the licensee in developing emergency plans to address the addition of new operating units at the GGNS site. As such, the applicant indicated that the executive director is the appropriate authority for the commitment to participate in emergency planning activities, and therefore, signed this LOA. In Revision 2 to Part 4, the applicant amended Section 3.17 to reflect a LOA with the Mississippi Emergency Management Agency (MEMA) and amended Section 3.3.2.1 to state the following and clarify the nature of the letter:

> The Governor of Mississippi, who bears authority for directing the emergency actions of the affected State agencies, has formally committed the affected State agencies to implement the Mississippi Radiological Emergency Plan, as required by Mississippi law.

13.3.2.2 Regulatory Evaluation

In Section 1.1 of Part 4, the applicant stated that it used the guidance in Supplement 2 to develop the major features of an emergency plan to comply with 10 CFR 52.17.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(3), which mandate, in part, that an ESP application describe the contacts and arrangements made with Federal, State, and local government agencies with emergency planning responsibilities. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information included in an ESP application.

Supplement 2 states that the description of contacts and arrangements should include the name and location of the organization contacted, the title and/or position of the person(s) reached, and the role of the organization in emergency planning. The evaluation criteria in Section V of Supplement 2 provide additional guidance, which applies to the submission of emergency plans under the major features option of 10 CFR 52.17(b)(2)(i).

According to RS-002, for an operating reactor site, the ESP submission should clearly indicate the impact of applying an existing emergency preparedness program element to the expanded use of the site, including addressing any necessary changes to the program in support of a new reactor(s). For example, LOAs reflecting contacts and arrangements made with State and local government agencies with emergency planning responsibilities might need revision to reflect the anticipated presence of an additional reactor(s) at the site. Such revised LOAs should reflect any impact the additional reactor(s) would have on the agencies' emergency response planning responsibilities and should include the agencies' acknowledgment of the proposed expanded responsibilities. The use of separate correspondence would also be acceptable. If the applicant cannot make arrangements with Federal, State, or local governmental agencies with emergency response planning responsibilities, for whatever reason, the applicant should discuss its efforts to make such arrangements, along with a description of any compensatory measures it has taken or plans to take because of the lack of such arrangements.

13.3.2.3 Technical Evaluation

The applicant provided recent LOAs that established contacts with Federal, State, and local governmental agencies with emergency planning responsibilities and address their receipt and understanding of the ESP application for the Grand Gulf site. The staff finds that the LOAs provided in Appendix A to Part 4 are acceptable. These LOAs described the names and locations of the organizations contacted and the titles and/or positions of the persons reached, referenced Appendix D, "Letters of Agreement," to the existing emergency plan for GGNS Unit 1 for a description of the arrangements with the respective government agencies, and provided a statement of their willingness to enter into discussions to address future emergency preparedness needs based on construction of the proposed new facility. Sections 3.1 and 3.3.2 of Part 4 further described contacts and arrangements for support that are relevant to the ESP application.

The staff finds that the applicant's responses to RAIs 13.3-9 and 13.3-11, and associated revisions provided in Revision 2 to Part 4 of the application, are acceptable.

13.3.2.4 Conclusions

As discussed above, the applicant has provided an acceptable description of contacts and arrangements made with Federal, State, and local governmental agencies with emergency response planning responsibilities. Based on its review as described above, the staff concludes that the information the applicant provided is consistent with the guidelines in RS-002 and Supplement 2. Therefore, the information is acceptable and meets the requirements of 10 CFR 52.17(b)(3).

13.3.3 Major Features of the Emergency Plans

13.3.3.1 Emergency Planning Zones

13.3.3.1.1 Technical Information in the Application

Section 2.1.1 of Part 4 indicated that the proposed new facility will be built on the site of the existing GGNS, which is located in Claiborne County in southwestern Mississippi. In Section 2.1.5, "Emergency Planning Zones," of Part 4, the applicant described the establishment of plume exposure pathway and ingestion pathway EPZs, with radii of approximately 10 and 50 miles, respectively. The applicant provided the exact size and description of the plume exposure pathway EPZ in Section 2.1.5.1 and Figure 2-6 of Part 4. The applicant also indicated that the plume exposure pathway EPZ boundary for the proposed new facility will be identical to that for the existing GGNS Unit 1, which encompasses portions of Claiborne County, Mississippi, and Tensas Parish, Louisiana. Furthermore, because of their proximity to the 10-mile radius from the proposed new facility, the applicant indicated that it included the towns of Newellton and St. Joseph in Tensas Parish, Louisiana, and the campus of ASU in Mississippi in the plume exposure pathway EPZ. A small portion of Warren County, Mississippi, is located within the plume exposure pathway EPZ to the north of Claiborne County, but no permanent, transient, or special facility populations are associated with this small section of Warren County.

For the purpose of evacuation planning, Section 2.2.4.2 of Part 4 described the plume exposure pathway EPZ in terms of distinct PAAs (subareas)—1, 2A, 2B, 3A, 3B, 4A, 4B, 5A, 5B, 6, 7, 8, 9, 10, and 11. Figure 2-6 also illustrated these PAAs but identifies PAA 12 as well. In RAI 13.3-2, the staff asked the applicant to clarify this discrepancy between Section 2.2.4.2 and Figure 2-6. In response, the applicant stated that it unintentionally omitted the description of PAA 12. In Revision 2 to Part 4, the applicant amended Section 2.2.4.2 to identify 16 distinct PAAs, consistent with the existing emergency plan for GGNS Unit 1 and the 1986 ETE.

While the descriptions of PAA boundaries remain unchanged from that contained in Appendix E to the existing emergency plan for GGNS Unit 1, the illustration for PAA 11 contained in Figure 2-6 of Part 4 differed from that given in the existing emergency plan. In RAI 13.3-3, the staff asked the applicant to explain this difference. In response, the applicant stated that Figure 2-6 provides information on population by PAA, which was redrawn for the ESP application based on Figure 2-4, "Ten-Mile Emergency Planning Zone," in the existing emergency plan for GGNS Unit 1. The applicant also indicated that, although these figures have small differences in the plume exposure pathway EPZ boundary, these discrepancies are not considered significant.

In Section 2.1.5.2, “Ingestion Pathway EPZ Description,” of Part 4, the applicant noted that only those counties in Mississippi within the 50-mile EPZ are listed. However, the table below this statement also listed affected parishes in Louisiana. In RAI 13.3-4, the staff asked the applicant to resolve this discrepancy. In response, the applicant stated that the political jurisdictions in the ingestion pathway EPZ include both counties in the State of Mississippi and parishes in the State of Louisiana. In Revision 2 to Part 4, the applicant amended Section 2.1.5.2 to reference both the counties in Mississippi and parishes in Louisiana within the 50-mile EPZ. Additionally, in RAI 13.3-5, the staff asked the applicant to explain the inclusion of Sharkey County in the 50-mile EPZ for the proposed new facility, which the applicant listed in the 50-mile EPZ description contained in Section 2.1.5.2 to Part 4 but did not reference in Section 2.2.3, “Emergency Planning Zones,” of the existing emergency plan for GGNS Unit 1. In response, the applicant stated that the existing ingestion pathway EPZ for GGNS Unit 1 includes a small portion of Sharkey County.

The existing GGNS 10- and 50-mile EPZs are described in the following State and local plans:

- MREPP Basic Plan—Section V.B, “Emergency Planning Zones”; Appendix 1, “Protective Action Areas for Claiborne County,” to Annex F; and Appendix 1, “GGNS 10-Mile (Plume Exposure Pathway) EPZ,” and Appendix 2, “GGNS 50-Mile (Ingestion Pathway) EPZ,” to Annex O

- PGCCREPP Basic Plan—Section V.B, “Emergency Planning Zones” and Appendix 4, “GGNS 10-Mile EPZ,” and Appendix 5, “GGNS 50-Mile EPZ,” to Annex O

- LPRRP Supplement II, Attachment 2—Tab A of Chapter 4, “Parish and County Listing for the Ingestion Exposure Pathway (50-Mile) EPZ”; Appendix B, “Plume Exposure Pathway (10-Mile) EPZ Maps”; and Appendix C, “Ingestion Exposure Pathway (50-Mile) EPZ Map”

In general, the applicant’s description of the plume exposure (10-mile) EPZ in Section 2.1.5 of Part 4 is consistent with that in the State and local plans, as described above. However, the MREPP Basic Plan—Section V.B.1, “Plume Exposure Pathway,” and PGCCREPP Basic Plan—Section V.B.1, “Plume Exposure Pathway,” also stated that the plume exposure pathway EPZ includes a small portion of Jefferson County. While the 10-mile EPZ approaches the county line, it did not cross over the Claiborne-Jefferson County line. In addition, Jefferson County is currently not included in the planning basis for EPZ evacuation, nor included in the protective action areas defined in the MREPP and PGCCRERP Basic Plans and Section 2.2.4.2 and Table 2-2 to Part 4 of the application. This inconsistency will be addressed as part of the periodic review and revision to existing State and local plans.

The 50-mile EPZ as described in the State and local plans, as set forth above, is consistent with Section 2.1.5 of Part 4.

13.3.3.1.2 Regulatory Evaluation

In Section 1.1 of Part 4, the applicant stated that it developed the major features of an emergency plan to comply with 10 CFR 52.17 using the guidance in Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i) and 10 CFR 52.18. In addition, the staff considered the regulatory requirements in 10 CFR 50.33(g), 10 CFR 50.47(c)(2), and Sections I, III, and IV of Appendix E to 10 CFR Part 50 in its review of the size and configuration of the EPZs. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of an emergency plan for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those which apply in determining the size and configuration of the EPZs.

Section III.A of Supplement 2 states that an ESP applicant choosing the option of proposing major features of the emergency plans should give special emphasis to the exact size of the EPZs. Generally, the plume exposure pathway and ingestion pathway EPZs consist of an area about 10 miles and 50 miles in radius, respectively. The applicant should determine the exact size and configuration of the EPZs with respect to local emergency response needs and capabilities, since conditions such as demography, topography, land characteristics, access routes, and jurisdictional boundaries can affect the EPZs.

13.3.3.1.3 Technical Evaluation

Section 2.1.1 of Part 4 stated that the proposed new facility will be located on the site of the existing GGNS. Thus, the proposed new facility will use the existing GGNS 10-mile and 50-mile EPZs. Section 2.1.5.1 indicates that the plume exposure pathway EPZ boundary for the proposed new facility will be identical to that for the existing GGNS Unit 1. The size and configuration of the plume exposure pathway EPZ and PAAs were compared to, and are consistent with, those contained in the existing GGNS Unit 1 emergency plan, the 2003 ETE study, and the Louisiana and Mississippi State and local emergency plans. However, the MREPP Basic Plan—Section V.B.1 and PGCCREPP Basic Plan—Section V.B.1 also stated that the plume exposure pathway EPZ included a small portion of Jefferson County. This small portion of Jefferson County is currently not included in the GGNS planning basis for EPZ evacuation, nor is it included in the protective action areas defined in the MREPP and PGCCRERP Basic Plans and Part 4 of the application. This is considered a minor discrepancy in the existing GGNS, State, and local emergency plans and is being addressed outside the ESP process.

Section 2.1.5.2 of Part 4 identified the Mississippi counties and Louisiana parishes within the 50-mile EPZ for both GGNS Unit 1 and the proposed new facility. This description is consistent with the Louisiana and Mississippi State and local emergency plans.

The staff finds that the applicant's responses to RAIs 13.3-2 and 13.3-4, and associated revisions provided in Revision 2 to Part 4 of the application, are acceptable. The staff also finds that the size and configuration of the plume exposure pathway EPZ reflect local emergency response needs and capabilities, including conditions such as demography, topography, land characteristics, access routes, and jurisdictional boundaries. As such, the staff finds that use of the existing GGNS 10-mile and 50-mile EPZs for the ESP site is appropriate and acceptable.

13.3.3.1.4 Conclusions

As discussed above, the applicant has proposed a plume exposure pathway (10-mile) EPZ and an ingestion pathway (50-mile) EPZ, both of which reflect local emergency response needs and capabilities. The staff also noted that the proposed ESP site currently has an operating reactor with integrated onsite and offsite radiological emergency plans and that the proposed new facility will use the existing GGNS 10-mile and 50-mile EPZs (operating plant). Based on its review, the staff concludes that the proposed major feature, which addresses the size and configuration of the EPZs, is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this major feature is acceptable and meets the requirements of 10 CFR 50.33(g), 10 CFR 50.47(c)(2), 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections I, III, and IV of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for the emergency planning zones, as set forth above.

13.3.3.2 Assignment of Responsibility (Organization Control) (Major Feature A)

13.3.3.2.1 Technical Information in the Application

The applicant described Federal, State, local, and private sector organizations intended to be part of the overall response organization for the EPZ.

Section 3.1 of Part 4 listed the various Federal, State, and parish/county agencies with responsibilities in support of the proposed new facility in the event of a significant radiological emergency. Section 3.3, "Emergency Response Support and Resources," of Part 4 identified additional local services and Federal and private sector support, as well as the coordination of government agencies. In RAI 13.3-6, the staff asked the applicant to describe in Section 3.3 the Federal organizations identified in other sections of Part 4 to the application as supporting licensee response efforts (i.e., the National Weather Service (NWS), U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency (EPA)). In response, the applicant stated that Sections 3.1.2 and 3.3 described support provided by Federal agencies, addressing Supplement 2 criteria. In Revision 2 to Part 4 of the application, the applicant amended Section 3.1.2, "Federal Agencies," to indicate that it expected Federal agencies to respond in accordance with the Federal Radiological Emergency Response Plan (FRERP). The applicant also inserted Section 3.3.2.8, "Other Federal Agencies," of Part 4, which stated the following:

> Other Federal agencies may provide back-up support for emergency response efforts. For example, should there be a failure of the primary and secondary meteorological stations, the tertiary means of obtaining wind speed and direction data would be through the National Weather Service or the U.S. Army Corps of Engineers, Waterways Experiment Station in Vicksburg, MS. EPA Region IV may provide a mobile environmental sample laboratory.

Section 3.1.1, “State and Local Governmental Agencies,” of Part 4 further indicated that the applicant did not expect that the addition of the proposed new facility will affect these roles and responsibilities defined in various emergency plans currently supporting GGNS Unit 1. In RAI 13.3-8, the staff asked the applicant to identify other Federal, State, and local organizations supporting overall licensee response activities within the ingestion pathway EPZ. The staff also asked the applicant to describe the contacts and arrangements pertaining to the concept of operations developed between Federal, State, and local agencies and other support organizations having an emergency response role within the ingestion pathway EPZ. In response, the applicant stated that the MREPP and LPRRP establish the responsibilities of State and local organizations supporting overall licensee activities within the ingestion pathway EPZ, including the concept of operations. The applicant also indicated that Section 1.1 of Part 4 incorporates these plans by reference. In addition, the FRERP established the responsibilities of Federal organizations, including the concept of operations.

Section 3.3.2.3, “Port Gibson/Claiborne County Civil Defense,” of Part 4 referred to the Port Gibson/Claiborne County Civil Defense (PGCCCD) Office, which appeared to be inconsistent with Section 3.1.1.5, “County and Parish Emergency Services,” Section 3.17, and Appendix A to Part 4 that referred only to the Claiborne County Civil Defense Agency. In RAI 13.3-12, the staff asked the applicant to clarify this discrepancy. In response, the applicant stated that the affected organization, located in Port Gibson, Mississippi, is known as the PGCCCD Office. In Revision 2 to Part 4, the applicant amended Section 3.3.2.3 to clarify that these multiple terms refer to a single organization.

Section 3.3.3, “Other Organizations,” of Part 4 identified the Institute of Nuclear Power Operations (INPO) as a private sector organization that will provide emergency assistance in the location of sources of manpower and equipment, analysis of operational aspects, and help in organizing industry experts to advise on technical matters. In RAI 13.3-7, the staff asked the applicant to describe in Section 3.3 the contacts and arrangements with other private sector organizations (e.g., utilities) that are expected to support licensee response activities within the plume exposure pathway (10-mile) and ingestion pathway (50-mile) EPZs, including identifying radiological laboratories and their general capabilities during an emergency. In addition, the staff asked the applicant to describe the contacts and arrangements made with these organizations. In response, the applicant stated that it expected to finalize arrangements with the nuclear steam supply system (NSSS) vendor, similar to routine operational and emergency support for the operating unit, before or at the time of COL issuance. With regard to contacts and arrangements (LOAs), the applicant further stated that the affected organizations are private support organizations and, therefore, outside the scope of the 10 CFR 52.17(b)(3) requirement to describe contacts and arrangements with Federal, State, and local agencies with emergency planning responsibilities. In Revision 2 to Part 4, the applicant amended Section 3.3.3 to describe the following expected support from the NSSS supplier and radiological laboratories:

> *Nuclear Steam System Supplier*
> GGNS Unit 1 maintains an arrangement with the supplier of its nuclear steam supply system (NSSS) to provide technical support under both routine and emergency conditions. The applicant expects that similar arrangements would be made with the NSSS supplier for the proposed new facility.

Private Sector Radiological Laboratories

The required capabilities of commercial radiological laboratories may be affected by the technology of the selected plant design. The applicant expects that suitable commercial arrangements would be made with one or more private sector radiological laboratories at the time of, or before, issuance of the combined operating license for the proposed new facility.

Section IV, "Organization and Responsibilities," of the MREPP Basic Plan identified the Federal, State, local, and volunteer organizations with primary and support responsibilities for radiological emergency response in the State of Mississippi. Section IV.A, "Claiborne County," and Section IV.B, "City of Port Gibson," of the PGCCREPP Basic Plan identified governmental organizations with emergency response functions, and Section IV.C, "Volunteer Organizations," lists volunteer organizations that support local response efforts.

Section VI, "Continuity of Government," of the Louisiana Emergency Operations Plan (LEOP) identified the numerous State agencies with primary and support responsibilities in an emergency response in the State of Louisiana. Section 6 of Executive Order MJF 2001, contained in the LEOP following the table of contents, and Section 6.c, "Radiological, Federal Agencies," of LEOP Annex P listed the Federal agencies that would be involved in a radiological emergency. Attachment 4V, "Volunteer Organizations," to the LEOP described the role of volunteer organizations. The LEOP annexes described the emergency responsibilities, participants, and specific volunteer organizations.

Section IV, "Concept of Operations," and Section VI, "Responsibilities of Department of State Government," of the LPRRP Basic Plan identified the State agencies responsible for radiological emergency response. Figure 2, "Primary State and Direction and Control Elements for Radiological Emergencies," in Section VI of the LPRRP Basic Plan listed the specific primary and support responsibilities for each State agency, and the attachments to the LPRRP detailed the specific functions. Section VII, "Support and Resources," of the LPRRP Basic Plan listed the Federal, State, nongovernment, cooperating State, and local organizations. Section C, "Direction and Control," of Enclosure I to Attachment 2 to LPRRP Supplement II identified the local governments (Tensas Parish and the municipalities of St. Joseph and Newellton) as responsible for radiological emergency response.

The applicant described the functions and responsibilities for major elements of emergency response. Section VI.A, "Direction and Control, General," as well as Section II.C, "Responsibilities," Appendix 1, "State Command and Control/Coordination Chart," and Appendix 2, "State Functional Matrix," to Annex A of the MREPP Basic Plan described State and local functions and responsibilities for major elements of emergency response in the State of Mississippi. The Governor has overall responsibility for direction and control to ensure the protection of health and welfare, including implementing protective action recommendations (PARs) and evacuation orders. Sections IV and VI.A of the MREPP Basic Plan indicated that MEMA coordinates State-level emergency operations for the Governor. Annex A, "Direction and Control," to the MREPP described the emergency response responsibilities of MEMA during a radiological emergency. Section IV of the MREPP Basic Plan further identified the Mississippi State Department of Health/Division of Radiological Health (MSDH/DRH) as the lead technical responder in the event of a radiological emergency. Appendix 2 to MREPP

Annex A also identified the primary and support functions of MSDH/DRH, as well as the functions of other State, local, and private organizations involved in radiological response. Section VI, “Direction and Control,” of the MREPP Basic Plan discussed the functions of each State, local, and private organization.

The PGCCCD director, at the direction of county and Port Gibson elected officials, was responsible for alert and notification, evacuation, transportation, and special needs populations, according to Appendix 3, “Local Functional Matrix,” to Section IX to the PGCCREPP Basic Plan and Appendix 3, “Claiborne County Emergency Operations Center (EOC) First Responding Personnel and Designated Alternates,” to PGCCREPP Annex A. Appendix 3 to Annex A also included a matrix of Claiborne County organizations and their emergency functions.

The following LEOP sections described State and local functions and responsibilities for the major elements of emergency response:

- LEOP Section V.A, “Direction and Control,” delegates responsibility to direct State-level emergency operations.

- LEOP Attachment 4A, “Louisiana Office of Emergency Preparedness,” describes the primary emergency response functions relevant to a radiological emergency.

- LEOP Annex P, “Radiological,” identifies the Louisiana Department of Environmental Quality (LDEQ) as having the lead technical response role in the event of a radiological emergency.

- LEOP Attachment 4H, “Department of Environmental Quality,” describes the emergency response functions of LDEQ relevant to a radiological emergency.

- LEOP Attachment 4, “Organizational Functions,” in its entirety, details the primary and support functions of each Federal and State agency and private organization.

- LEOP annexes, in general, specify organizational responsibility by emergency response function.

Section VI of the LPRRP Basic Plan identified the respective State agencies responsible for radiological emergency response. Figure 2 in Section VI of the LPRRP Basic Plan listed the specific primary and support responsibilities for each State agency.

Section D, “Organization and Responsibilities,” of Enclosure I to Attachment 2 to LPRRP Supplement II identified Tensas Parish as responsible for local direction and control, alert and notification, emergency communications, public education, protective response, radiological exposure control, emergency medical services, traffic control, and reentry and recovery. Section D.1.b, “Local Government, Municipal Governments,” stated that the municipalities of St. Joseph and Newellton support parish emergency operations.

The applicant described the legal basis for State and local authorities for the major elements of emergency response (as identified above). In the State of Mississippi, the MREPP Promulgation Statement and Section IX, “Plan Development and Maintenance, Authorities and

References,” of the Basic Plan provided the following legal citations to support the State’s general emergency response activities:

- Constitution of Mississippi
- Title 33, Chapter 15, Mississippi Code of 1972
- Emergency Management Law of 1980, Section 33-15, Mississippi Code 1972, Annotated
- Radiation Protection Law of 1978, Section 45-14, Mississippi Code 1972, Annotated
- Executive Order 653 (November 16, 1990)

Appendix 1, “Authorities and References,” to Section IX of the PGCCREPP Basic Plan cited the Port Gibson/Claiborne County Joint Ordinance/Resolution, dated April 3, 1978, as the authority for local government emergency response.

Section 3.3.2.2, “Louisiana Department of Environmental Quality/Louisiana Office of Emergency Preparedness,” of Part 4 indicated that, under Act 97 of 1983 (L.R.S. 30:2001 et seq.), also known as the Louisiana Environmental Quality Act, and specifically L.R.S. 30:2109, the secretary of LDEQ has the authority to develop and implement a State-wide radiological emergency preparedness plan and to coordinate the development of specific emergency plans for nuclear power facilities. The LPRRP referred to Act 97 of 1983 (L.R.S. 30:2109) as the Louisiana Environmental Affairs Act, as opposed to the Louisiana Environmental Quality Act.

Section IX, “Authorities and References,” of the LEOP provided the legal citations to support the State’s general emergency response activities (Chapter B), and it cited Federal authorities (Chapter A), local authorities (Chapter C), and authorities to support volunteer organizations (Chapter D). Act 114, the Emergency Interim Local Executive Succession Act of 1963, authorized the emergency planning and response activities of Tensas Parish.

Section I.B, “Introduction, Authority,” of the LPRRP Basic Plan cited the following State laws:

- Louisiana Environmental Affairs Act, LA. R.S. 30:1051 et seq.
- Louisiana Disaster Act of 1974, LA. R.S. 29:701 et seq.
- Executive Reorganization Act, LA. R.S. 36:358(E) and 408(F)

Section I.A, “Authority,” of Attachment 2 to LPRRP Supplement II stated that the authority for parish planning for an emergency response is consistent with and pursuant to provisions of the Tensas Parish Police Jury Ordinances for Emergency Preparedness. Section B, “Authority,” of Enclosure I to Attachment 2 to LPRRP Supplement II also indicated that the authority for the development of the parish plan is consistent with the Tensas Parish Police Jury Ordinance for Emergency Preparedness. In RAI 13.3-60, the staff asked the applicant to identify the legal basis (e.g., reference specific acts, codes, or statutes) for Louisiana parishes and municipalities, including the towns of St. Joseph and Newellton, which are not provided in Attachment 2 to LPRRP Supplement II. In response, the applicant stated that issues related to State and local plans discussed in RAI 13.3-60 should be deferred to the COL review.

Section 3.3 and Appendix A to Part 4 described the contacts and arrangements made by the applicant with Federal, State, and local government agencies with emergency planning responsibilities.

In the State of Mississippi, Appendix 1, “Letters of Agreement,” to MREPP Annex M cited LOAs between MEMA and Entergy, River Region Health Systems, Vicksburg Fire Department Emergency Medical Services, Riverland Medical Center, and American Medical Response. Annex M, “Letters of Agreement,” to the PGCCREPP provided the LOAs between Claiborne County and other organizations.

In the State of Louisiana, the LEOP did not describe specific contacts pertaining to the concept of operations developed between Federal, State, and local agencies and other support organizations. The LEOP did, however, detail relationships between Federal, State, local, and private organizations with responsibilities for emergency response. The LEOP and LPRRP described the relationships that are specific to radiological emergencies at fixed nuclear facilities and GGNS, respectively. Enclosure I to Attachment 2 fo LPRRP Supplement II described the relationship between the parish and local governments, and between the parish and LOEP and other State government agencies. Appendix I-1, “List of Letters of Agreement,” to Enclosure I of Attachment 2 to LPRRP Supplement II cited LOAs between the parish and nongovernment providers of reception and care services, emergency broadcasting, emergency transportation, emergency medical services, and telephone service.

13.3.3.2.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2. In Section 1.1 of Part 4, the applicant indicated that it developed the major features of an emergency plan to comply with 10 CFR 52.17 using the guidance in Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of an emergency plan for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for the major features of emergency plans, including those which apply to major feature A, “Assignment of Responsibility—Organization Control.”

Major feature A calls for the applicant to identify emergency response organizations (EROs), including the functions and responsibilities for the major elements of response and the legal basis for State and local authorities. The application should also describe contacts and arrangements between agencies and other support organizations having a response role within the EPZs and include any written LOAs.

13.3.3.2.3 Technical Evaluation

The staff finds that the applicant’s responses to RAIs 13.3-6, 13.3-7, 13.3-8, and 13.3-12 are adequate. As such, the staff finds that Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LEOP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II are adequate, since they identified the Federal, State, local, and private sector organizations (as well as utilities) that are intended to be part of the overall response organization for EPZs.

The MREPP, PGCCREPP, LEOP, LPRRP, and Enclosure I of Attachment 2 to LPRRP Supplement II identified the functions and responsibilities for the major elements of emergency response, such as command and control, alerting and notification, communications, public information, accident assessment, public health and sanitation, social services, fire and rescue, traffic control, emergency medical services, law enforcement, transportation, protective response, and radiological exposure control.

The staff reviewed Part 4, the MREPP, PGCCREPP, LEOP, and Enclosure I of Attachment 2 to LPRRP Supplement II and finds that they identified (by reference to specific acts, codes, or statutes) the legal basis for State, local, and private sector organizations that are part of the overall organization for the EPZs to carry out their identified functions and responsibilities. In RAI 13.3-60, the staff asked the applicant to specifically address the legal basis for Louisiana parishes and municipalities, including the towns of St. Joseph and Newellton. Upon further review, the staff finds that the existing documents referenced above address RAI 13.3-60 because the proposed ESP site currently has an operating reactor with integrated offsite radiological emergency plans that FEMA has determined to provide reasonable assurance of a proper response in the event of an emergency. As such, the applicant’s response to RAI 13.3-60 is acceptable.

Revision 2 to Part 4 of the application, the MREPP, LEOP, and Enclosure I of Attachment 2 to LPRRP Supplement II described contacts and arrangements pertaining to the concept of operations developed between Federal, State, and local agencies, and other support organizations having an emergency response role within the EPZs, and contained or referenced LOAs as appropriate. Sections 13.3.2, 13.3.3.4, “Emergency Response Support and Resources,” 13.3.3.7, “Emergency Communications,” 13.3.3.10, “Accident Assessment,” and 13.3.3.13, “Medical and Public Health Support,” of this SER described the contacts and arrangements pertaining to the concept of operations developed between Federal, State, and local agencies and other support organizations having an emergency response role within the EPZs.

13.3.3.2.4 Conclusions

As discussed above, the applicant has identified the EROs, including the functions and responsibilities for major elements of response, and the legal bases for State and local authorities. In addition, the applicant has described contacts and arrangements among the agencies and other support organizations having a response role within the EPZ. Based on its review, the staff concludes that proposed major feature A is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for organization control, as set forth above.

13.3.3.3 Onsite Emergency Organizations (Major Feature B)

13.3.3.3.1 Technical Information in the Application

The applicant described the interfaces between and among the onsite functional areas of emergency activities, local services support, and State and local government response organizations. Sections 3.2.1, “Onsite Emergency Organization,” and 3.2.2, “Offsite Emergency Organization,” of Part 4 outlined the basic framework and disciplines that comprise the applicant’s onsite and offsite emergency organizations. Section 3.3 described the support from local service organizations and the coordination between State and county/parish agencies. In addition, Figure 3-1, “Interrelationships of Emergency Response Organizations,” illustrated an overview of interrelationships between the applicant’s emergency response facilities, field monitoring teams, and Entergy corporate, Federal support, and State and local EOCs. In RAI 13.3-13, the staff asked the applicant to identify in Figure 3-1 the interfaces between and among it and local support services responding to or assisting the proposed reactor(s). In RAI 13.3-14, the staff asked the applicant to identify the interfaces between and among its proposed emergency response facilities and State and local government response organizations for onsite major functional areas of emergency activities. In Revision 2 to Part 4, the applicant amended Figure 3-1 to identify these interfaces.

Section 3.2.1.1, “Emergency Director,” of Part 4 assigned the responsibility for interfacing with Federal, State, and local agencies for protective actions, requesting additional resources/assistance, and updating the applicant’s emergency directory concerning pertinent facts and developments. In Section 3.2.1.1, the applicant designated specific offsite interface responsibilities that it will transfer to its offsite emergency coordinator once the emergency operations facility (EOF) is operational.

Section 3.3.1, “Local Services Support,” of Part 4 showed the services that local agencies will provide for handling emergencies and described the arrangements for supplying these services:

> The potential nature of some emergencies may warrant the utilization of offsite individuals, organizations, and agencies. As a result, local support service arrangements will be made with offsite groups to provide aid in the event of an emergency situation at the proposed new facility. Support services encompasses such things as medical assistance, fire control, evacuation, ambulance services, and law enforcement. Since it is imperative that the availability of these support agencies be on short notice, written agreement will be entered into with the organizations. The agencies, in letters of support provided in Appendix A, have established their commitment to enter into discussions that may lead to agreements to provide emergency preparedness and response support for the proposed new facility.

Section 3.3.1.2, “Fire Support,” identified the Claiborne County Fire Department as the primary provider of fire support 24 hours per day. The applicant also indicated that the Claiborne County Fire Department has an informal pact with the Port Gibson Fire Department to furnish each other with firefighting personnel, resources, and facilities. The applicant noted that in all cases the Claiborne County Fire Department Fire Chief will direct all offsite firefighting personnel. Appendix A to Part 4 provided an LOA for the Claiborne County Fire Department, indicating its support for emergency preparedness efforts associated with the proposed new facility. In RAI 13.3-15, the staff asked the applicant to describe the support from the Port Gibson Fire Department provided as part of the informal pact with the Claiborne County Fire Department and to state whether the Port Gibson Fire Department will receive training according to Section 3.15, "Radiological Emergency Response Training," of Part 4 to respond to emergencies at the proposed reactor site. In addition, the staff asked the applicant to clarify whether agreements with offsite fire support organizations are adequate to provide coverage 24 hours per day, 7 days per week, and 365 days per year. In response, the applicant stated that the informal pact consists of an undocumented agreement established to ensure mutual support for firefighting activities. Both fire departments will offer training as discussed in Section 3.15 and are currently available to support activities 24 hours per day, 7 days per week for GGNS Unit 1. In Revision 2 to Part 4, the applicant amended Section 3.3.1.2 to clarify the nature of the informal pact and the fire departments' capabilities to provide continuous support to the facility:

> The Claiborne County Fire Department has an informal aid pact with the Port Gibson Fire Department, which is also available on a 24 hour per day, seven day per week basis. This pact consists of a verbal agreement to furnish each other with fire fighting personnel, resources, and facilities and to render such fire protection services which may be necessary to suppress any fire or disaster which goes beyond the control of either of the agencies.

Section 3.3.1.3, "Law Enforcement Agencies," of Part 4 indicated that a radiological emergency at the proposed new facility may require that the local law enforcement agencies be activated to assist in the emergency effort. The applicant also noted that the Claiborne County Sheriff's Department and the Port Gibson Police Department will be called on to provide support, consistent with the LOAs currently in place for GGNS Unit 1. Such support included controlling matters of civil disorder, directing communications, furnishing personnel and equipment in accordance with security plans, securing access into areas affected by the emergency, and directing area evacuation. Appendix A to Part 4 provided letters from both organizations indicating their support for emergency preparedness efforts associated with the proposed new facility.

Section 3.3.1.1 of Part 4 referenced Section 3.12, "Medical and Public Health Support," which indicated that regional ambulance service will normally provide transportation for injured persons to the medical facility. In RAI 13.3-16, the staff asked the applicant to describe (1) the contacts and arrangements made with the regional ambulance service to transport contaminated persons with injuries to the designated primary and backup hospitals and (2) the service's ability to provide coverage for the proposed new reactor(s) 24 hours per day, 7 days per week, and 365 days per year. In response, the applicant stated that the affected ambulance services currently provide coverage 24 hours per day and 7 days per week for GGNS Unit 1. Should a new facility be constructed, the applicant expected that the existing arrangements would be expanded to provide the same degree of support for the new facility. According to the applicant, the affected organizations are private sector organizations and, therefore, outside the scope of the 10 CFR 52.17(b)(3) requirement to describe contacts and arrangements with Federal, State, and local agencies with emergency response planning responsibilities. In Revision 2 to Part 4, the applicant amended Section 3.12 to include the following:

> In certain instances, medical emergencies may require the transport of an injured person from the station to an offsite medical facility. Transportation of injured persons to the medical facility normally will be provided by regional ambulance service. These services have the capability to provide support on a 24 hour per day, seven day per week basis. In the event that these services are unavailable, provisions will be in place to transport injured persons in company-owned or private vehicles. Ambulances will be equipped with radios to maintain communications with the medical facility. The applicant expects that similar arrangements will be made for support for the proposed new facility.

In Section 3.12, the applicant stated that Claiborne County Hospital serves as the primary medical unit for the transport of injured personnel, with or without contamination. The backup facilities, Vicksburg Medical Center and Parkview Regional Medical Center, have the same emergency medical capabilities as Claiborne County Hospital. In addition, the applicant indicated that it has an agreement with the Ochsner Clinic to provide services if the medical treatment of injured and/or contaminated personnel requires assistance or medical expertise beyond the capabilities of the local facilities. Appendix A to Part 4 provided an LOA for the Claiborne County Hospital, which indicated its support for emergency preparedness efforts associated with the proposed new facility. In RAI 13.3-17, the staff asked the applicant to provide LOAs with Vicksburg Medical Center, Parkview Regional Medical Center, and the Ochsner Clinic documenting their commitment to enter into discussions that may lead to agreements to provide emergency preparedness and response support for the proposed reactor(s). In addition, the staff asked the applicant to describe the ability to provide coverage 24 hours per day, 7 days per week, and 365 days per year. In response, the applicant stated that Vicksburg Regional Medical Center and Parkview Regional Medical Center have merged to form River Region Medical Center. The applicant also noted that the affected hospitals currently provide coverage 24 hours per day, 7 days per week for GGNS Unit 1. Should a new facility be constructed, the applicant expected that the arrangements would be expanded to provide this same degree of support to the new facility. Since the affected organizations are private sector organizations, the applicant considered them to be outside the scope of the 10 CFR 52.17(b)(3) requirement to describe contacts and arrangements with Federal, State, and local agencies with emergency planning responsibilities. In Revision 2 to Part 4, the applicant amended Section 3.12 to state the following:

> Both of the back-up medical facilities, River Region Medical Center and The Oschner Clinic, have the ability to provide support of a 24 hour per day, seven day per week basis. The applicant expects that similar arrangements for primary and back-up medical facilities will be made for the proposed new facility. Training for both primary and back-up medical facilities will be offered as described in Section 3.15.

13.3.3.3.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature B, “Onsite Emergency Organizations.”

Major feature B calls for the applicant to identify interfaces between and among the onsite functional areas of emergency activities, local services support, and State and local government response organizations, including the services to be provided by local agencies.

13.3.3.3.3 Technical Evaluation

In its responses to RAIs 13.3-13 and 13.3-14, the applicant amended Figure 3-1 in Revision 2 to Part 4 of the application to illustrate the interfaces identified in Sections 3.2.1 and 3.2.2. The staff finds that the applicant’s responses to RAIs 13.3-13 and 13.3-14 are acceptable. As discussed above, Sections 3.2.1 and 3.2.2 of Revision 2 to Part 4 of the application identified the interfaces between and among the onsite functional areas of emergency activities, local services support, and State and local government response organizations.

The staff finds that the applicant’s responses to RAIs 13.3-15, 13.3-16, and 13.3-17, which were implemented in Revision 2 to Part 4 of the application, are acceptable. Revision 2 to Part 4 of the application identified the services that local agencies (e.g., police, ambulance, medical, hospital, and firefighting organizations) will provide for handling emergencies.

The applicant also described the arrangements involving these services in Part 4 to the application, and provided LOAs with local government agencies. The applicant further indicated in its responses to RAIs 13.3-16, and 13.3-17 that LOAs with private sector organizations are outside the scope of the 10 CFR 52.17(b)(3) requirement and will be provided at the COL stage. The staff finds that the applicant’s responses to RAIs 13.3-16 and 13.3-17 are consistent with the requirements of 10 CFR 52.17(b)(3), and therefore, are acceptable.

13.3.3.3.4 Conclusions

As discussed above, the applicant has identified the interfaces between and among the onsite functional areas of emergency activity, local services support, and State and local government response organizations for the ESP site. In addition, the applicant has identified the services and described the arrangements to be provided by various local agencies, and has provided adequate letters of agreement. Based on its review, the staff concludes that proposed major feature B is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.A of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for the onsite ERO as described above.

13.3.3.4 Emergency Response Support and Resources (Major Feature C)

13.3.3.4.1 Technical Information in the Application

The applicant described the provisions for requesting Federal assistance through the FRERP. Section 3.1.2.1, "Department of Energy," of Part 4 stated that the FRERP establishes the responsibilities of affected Federal agencies during an emergency at the proposed new facility. The applicant also indicated that the notification and support of certain Federal agencies, in addition to State and local agencies, may be necessary in the event of a significant radiological emergency.

Section 3.3.2.5, "Nuclear Regulatory Commission," of Part 4 described NRC response activities, including the NRC initial response site team, and outlined activation times for the NRC Operations Center. Section 3.3.2.6, "Department of Energy," of Part 4 described DOE response activities and references the Radiological Assistance Plan and Interagency Radiological Assistance Plan. Section 3.3.2.6 of Part 4 also referred to the assistance provided by DOE through specialized radiation monitoring equipment and in the radiological monitoring of food, water, livestock, and agricultural products. In addition, Section 3.9.2, "Field Monitoring," of Part 4 discussed mobile laboratory capabilities available from the applicable DOE and EPA regions. In RAI 13.3-10, the staff asked the applicant to explain its reason for detailing NRC and DOE response capabilities and times in the plan instead of referencing the FRERP. In Revision 2 to Part 4, contained in the applicant's response to RAI Letter 6, the applicant amended Sections 3.3.2.5 and 3.3.2.6 to reflect NRC and DOE response activities under the FRERP.

Section 3.9.1, "Meteorological Data," of Part 4 identified NWS and U.S. Army Corp of Engineers as sources of alternate meteorological data in the event of a concurrent failure of both the applicant's primary and secondary meteorological systems.

Section 3.3.2.7, "U.S. Coast Guard," of Part 4 described the jurisdictional control by USCG over traffic on the Mississippi River. The applicant further indicated that MEMA will notify USCG for emergencies requiring traffic exclusion.

Section 3.2.1.1 of Part 4 identified the emergency director as responsible for requesting assistance from Federal and State agencies, if required. The applicant noted that the offsite emergency coordinator will assume this responsibility once the EOF is declared operational. The applicant indicated in Section 3.2.2.4, "Additional Offsite Personnel," that emergency organization personnel will be assigned to coordinate requests for offsite assistance and serve in a technical and operational liaison capacity, if requested.

Section IV.A.1, "State, Governor's Office," and Appendix 6, "Radiological Emergency Preparedness Support and Resources," to Section IX of the MREPP Basic Plan, and Section II.E.2, "Federal Radiological Emergency Response Plan (FRERP)," of Annex D to the MREPP, indicated that the Governor of Mississippi has the ultimate authority to request Federal assistance and that either the Governor or MEMA has the authority to request, through FEMA Region IV, activation of the FRERP. Appendix 6 to the MREPP Basic Plan also assigned to MSDH/DRH the role of requesting Federal technical support. Section II.E.2 of MREPP Annex D described the respective roles for activation of the FRERP by MEMA and MSDH/DRH, as well as available Federal support.

Section IV, “Organization and Assignment of Responsibilities,” of LEOP described the role of FEMA in coordinating disaster relief. The State-Federal connectivity guide in the LEOP diagramed the connections between State and Federal response agencies. Section 6.c of LEOP Annex P listed the Federal agencies with responsibilities for radiological response.

Section V, “Direction and Control,” of LPRRP indicated that the secretary of LDEQ, or, if the secretary is not available, the official designee, is authorized to request technical assistance from the NRC, DOE, EPA, or other Federal agencies in the event of a radiological emergency at a fixed nuclear facility in the State of Louisiana.

The applicant described radiological laboratories and their general capabilities and expected availability to provide radiological monitoring and analysis during an emergency. In Section 3.9.2 of Part 4, the applicant indicated that the new facility will have isotopic analysis capability for onsite radiological analysis. In addition, MSDH may deploy mobile laboratory facilities in the vicinity of the proposed facility within 2 to 4 hours in support of environmental monitoring during a site area emergency or general emergency. In Section 3.9.2, the applicant also stated that additional mobile laboratories with similar capabilities are available from DOE (Region III) and EPA (Region IV), with estimated response times of 12 hours and 9 hours, respectively. In RAI 13.3-7, the staff asked the applicant to identify whether private sector organizations will provide additional radiological laboratory and analysis capabilities during an emergency (e.g., analysis of reactor coolant and other inplant media samples collected, and field monitoring team airborne and environmental samples collected). In response, the applicant stated that it expected to finalize arrangements with the NSSS supplier, similar to routine operational and emergency support for the operating unit, before or at the time of COL issuance. In Revision 2 to Part 4, the applicant amended Section 3.3.3 to describe the expected support from the NSSS supplier and radiological laboratories:

> *Private Sector Radiological Laboratories*
> The required capabilities of commercial radiological laboratories may be affected by the technology of the selected plant design. The applicant expects that suitable commercial arrangements would be made with one or more private sector radiological laboratories at the time of, or before, issuance of the combined operating license for the proposed new facility.

Section II.B.3.e, “State Government, Emergency Environmental Sampling,” of MREPP Annex D described the sampling of various media and agricultural commodities by MSDH/DRH. Section II.B.3.f, “State Government, Sample Analysis,” of MREPP Annex D also discussed sample analysis in either the fixed MSDH/DRH laboratory or at the Mobile Environmental Emergency Response Lab (MEERL), as well as the capabilities of other fixed and mobile laboratories. The MREPP indicated that if MEERL sample analysis capabilities are exceeded, the radiological accident assessment officer at the State emergency operations center (SEOC) will arrange for additional capability with the NRC, DOE, or EPA.

Section VI.B.5, “Louisiana Department of Environmental Quality,” of the LPRRP Basic Plan indicated that LDEQ will conduct offsite field monitoring and environmental sampling analysis. In addition, Tab 3, “Field Monitoring Team Operational Methods, Procedures, and Equipment,” of LPRRP Chapter 6 generally described the field monitoring activities of LDEQ, and Table 1, “Sampling and Monitoring Equipment,” in Tab 3 describes the environmental laboratory equipment and capabilities of LDEQ. Section VII.B, “State and Local,” of LPRRP also indicated that the Louisiana State University (LSU), Department of Physics, Nuclear Science Laboratory may provide laboratory support and sample analysis during the accident assessment and for postaccident analysis. In addition, Section VII.B stated that the Southern Mutual Radiation Assistance Plan (SMRAP) will provide manpower for field and laboratory analysis activities.

The applicant described nuclear and other facilities and organizations that it can rely on for assistance in an emergency. Section 3.3.3 of Part 4 identified INPO as a private sector organization that will provide requested emergency assistance to locate sources of manpower and equipment, analysis of operational aspects, and organization of industry experts to advise on technical matters. In RAI 13.3-7, the staff asked the applicant to identify other private sector organizations (e.g., architect engineer, owners group, Entergy) expected to assist in an emergency. In addition, the staff asked the applicant to describe the contacts and arrangements made with these organizations. In response, the applicant stated that it expected to finalize arrangements with the NSSS supplier, similar to routine operational and emergency support for the operating unit, before or at the time of COL issuance. With regard to contacts and arrangements (LOAs), the applicant indicated that the affected organizations are private support organizations and, therefore, outside the scope of the 10 CFR 52.17(b)(3) requirement to describe contacts and arrangements with Federal, State, and local agencies with emergency planning responsibilities.

Section II.E, “Additional Assessment and Monitoring Support,” of MREPP Annex D described the Federal nontechnical support available to the State of Mississippi through FEMA, technical support through DOE, and the use of the FRERP to access Federal support. Section II.E also noted that the SMRAP will provide manpower to field sampling and laboratory analysis activities in response to a radiological emergency. Appendix 2 to Annex A of the MREPP presented specific emergency support functions expected from Federal, State, and local organizations and GGNS.

Section IV.C of the PGCCREPP Basic Plan described the roles of the American Red Cross and Christian Volunteers in supporting the county in an emergency. In addition, Section IV, “Organization and Responsibilities,” of the PGCCREPP Basic Plan listed all Federal, State, and local organizations that will play an active role in an emergency. Appendix 3 to Section IX of the PGCCREPP Basic Plan provided this information in a matrix.

The LEOP described the potential roles for volunteer organizations to undertake specific emergency response actions with given functions, such as communications and warning (Annex A), damage assessment (Annex B), emergency direction and control (Annex D), engineering and traffic management (Annex F), law enforcement/security (Annex J), mass feeding (Annex L), medical and public health/sanitation (Annex M), shelter operation and control (Annex R), and traffic control/evacuation routes (Annex S).

Section VII of the LPRRP Basic Plan identified Federal support through the FRERP, as well as State and local support, including: the analysis of samples by LSU and State participation in the SMRAP to provide manpower for field and laboratory analysis activities. Various local community services and other public and private resources are also available, including hospitals, nursing homes, emergency medical services, transportation companies, and schools. Chapter 14, “Agreements,” of the LPRRP briefly described the agreements.

Section D of Enclosure I to Attachment 2 to LPRRP Supplement II listed the parish and participating municipality emergency response agencies, as well as the State and private agency organizations, which will play an active role in an emergency. Figure D-2, "Emergency Function and Responsibility Chart," of Enclosure I provided this information in a matrix. Appendix I-1 to Enclosure I listed nongovernmental agencies that have agreed to assist in emergency response.

The applicant described the contacts and arrangements made with the Federal, State, and local response organizations listed above and other organizations identified in the application in Section 3.3 and Appendix A to Part 4. Section 3.9.1 also discussed the contacts and arrangements between the applicant, NWS, and U.S. Army Corp of Engineers.

Appendix 6 to Section IX of the MREPP Basic Plan discussed the arrangements with the Federal agencies, States (through SMRAP), and local agencies that will provide a range of support. Section II.E of MREPP Annex D described the arrangements for implementing the SMRAP and accessing assistance through the FRERP and the Federal Radiological Monitoring and Assessment Center. Section IV.C, "Volunteer," of the MREPP Basic Plan further described the role for the Salvation Army, American Red Cross, and Radio Amateur Civil Emergency Service (RACES).

Annex M to the PGCCREPP included copies of the letters that specify the arrangements between the PGCCCD Council and five other Mississippi counties, city/county governing bodies, department heads, and responding agencies with the Pattison/Hermanville Fire Stations. Section IV.C of the PGCCREPP Basic Plan listed support activities for the American Red Cross and Christian Volunteers. Similarly, the Salvation Army will assist with mass feeding, according to Appendix 9, "Emergency Human Services," to PGCCREPP Annex F.

Although the LEOP did describe contacts, it detailed the relationships among Federal, State, local, and private response organizations (e.g., LEOP Annex P). Section VII of the LPRRP Basic Plan described the resources and support from Federal, State, and local organizations. In addition, Chapter 14 of the LPRRP Basic Plan generally described these arrangements. Tab 1, "Letters of Agreement," of Chapter 14 of the LPRRP Basic Plan listed the organizations with which the State of Louisiana has LOAs.

Enclosure I to Attachment 2 to LPRRP Supplement II identified the arrangements between the parish and local governments, and between the parish, LOEP, and other State government agencies. Appendix I-1 to Enclosure I listed the LOAs between the parish and nongovernment providers of reception and care services, emergency broadcast, emergency transportation, emergency medical services, and telephone service.

13.3.3.4.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.C, IV.D, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature C, "Emergency Response Support and Resources."

Major feature C calls for the applicant to describe the contacts and arrangements for requesting Federal assistance, as well as assistance from radiological laboratories and nuclear or other facilities and organizations. The application should also identify the general capabilities and expected availability of radiological monitoring and analysis services.

13.3.3.4.3 Technical Evaluation

The staff finds that the applicant's response to RAIs 13.3-10, which was implemented in Revision 2 to Part 4 of the application, is acceptable. The Federal government maintains an indepth capability to assist licensees, States, and local governments. Revision 2 to Part 4 of the application, the LPRRP, LEOP, and MREPP addressed provisions by the applicant and State governmental authorities for requesting Federal assistance.

The staff finds that the applicant's response to RAIs 13.3-7, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4 of the application, the MREPP, and LPRRP identified radiological laboratories, their general capabilities, and their expected availability to provide radiological monitoring and analysis services during an emergency. In addition, Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LEOP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II identified nuclear and other facilities and organizations that can be relied on for assistance in an emergency.

Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II provided the contacts and arrangements made with response organizations, as discussed above.

13.3.3.4.4 Conclusions

As discussed above, the applicant has described provisions for requesting Federal assistance and identified nuclear and other facilities and organizations that it can rely on for assistance in an emergency, including the general capabilities and availability of radiological laboratories. In addition, the applicant has described the contacts and arrangements made with the various response organizations. Based on its review, the staff concludes that proposed major feature C is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.C, IV.D, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for emergency planning support and resources, as set forth above.

13.3.3.5 Emergency Classification System (Major Feature D)

13.3.3.5.1 Technical Information in the Application

In Section 3.4, “Emergency Classification System,” of Part 4, the applicant established a classification scheme consistent with Section IV.C of Appendix E to 10 CFR Part 50 and Appendix 1 to NUREG-0654/FEMA-REP-1, including notification of (1) an unusual event, (2) alert, (3) site area emergency, and (4) general emergency. Section 3.4 also provides descriptions and general response actions for each emergency class. In RAI 13.3-18, the staff asked the applicant to compare the class descriptions and licensee actions in Section 3.4 with those listed in Appendix 1 to NUREG-0654/FEMA-REP-1 and justify any deviations from the guidance. In Revision 2 to Part 4, the applicant amended Section 3.4 and deleted the class descriptions and general response actions for each emergency class to instead reflect the intent to establish an emergency classification scheme consistent with NUREG-0654/FEMA-REP-1 or Regulatory Guide (RG) 1.101, Revision 4, “Emergency Planning and Preparedness for Nuclear Power Reactors” issued July 2003, as appropriate.

In Section 3.4 of Part 4, the applicant stated that the emergency action levels (EALs) will comprise a combination of plant parameters (such as instrument readings and system status) that can give a relatively quick indication to station operating staff of the accident situation. In RAI 13.3-19, the staff asked the applicant to clarify that the EALs will also be based on onsite and offsite monitoring, in accordance with Section IV.B of Appendix E to 10 CFR Part 50. In Revision 2 to Part 4, the applicant amended Section 3.4 to reflect its intent to establish an emergency classification scheme consistent with NUREG-0654/FEMA-REP-1 or RG 1.101, as appropriate, and to confirm that these schemes include onsite and offsite monitoring results as the bases for emergency classification.

In addition, Section 3.4 of Part 4 noted that, to the extent appropriate, the applicant will develop EALs from guidance provided in Appendix 1 to NUREG-0654/FEMA-REP-1. In RAI 13.3-20, the staff asked the applicant to clarify its basis for not naming Revision 4 to RG 1.101, which identifies and approves the use of acceptable alternate EAL schemes. In Revision 2 to Part 4, the applicant amended Section 3.4 to state the following:

> To the extent appropriate, the EALs will be developed from guidance provided in Appendix 1 to NUREG-0654 or Regulatory Guide 1.101, “Emergency Preparedness for Nuclear Power Reactors” (Reference 1), as appropriate. Should NUREG-0654 and Regulatory Guide 1.101 be determined to be inappropriate due to the technology of the proposed plant design, then the EALs will be developed consistent with applicable guidance, with appropriate technical bases provided for any deviations.

In Section 3.4 of Part 4, the applicant also indicated that the emergency director may declare an unusual event based on other plant conditions and the potential for the degradation of these conditions. In RAI 13.3-21, the staff asked the applicant to clarify its basis for not addressing discretionary judgment for alert, site area emergency, and general emergency classifications in accordance with Appendix 1 to NUREG-0654/FEMA-REP-1 or acceptable alternatives under RG 1.101, Revision 4. In Revision 2 to Part 4, the applicant amended Section 3.4 to state the following:

> The EALs, while comprehensive, are not meant to be all inclusive. The Emergency Director may declare any class of emergency based on the Director's assessment of plant conditions and consideration of the facility's emergency action levels.

The applicant described an emergency classification scheme established by State and local governmental agencies. Section V.C, "Emergency Classification Levels," of the MREPP and PGCCREPP Basic Plans defined the emergency classification levels used by both the State of Mississippi and local jurisdictions. The four classifications, including the associated definitions, are consistent with the emergency classification scheme in Appendix 1 to NUREG-0654/FEMA-REP-1 and that listed by the applicant in Section 3.4 of Part 4.

Tab 1, "Emergency Classes and Guidelines," of LPRRP Chapter 1 identified the State and local emergency classification system to be used in the event of an emergency at GGNS. Chapter 1, "Emergency Classification System," of Attachment 2 to LPRRP Supplement II also described the emergency classification scheme and definitions. The LPRRP provided the four classifications, including the associated definitions, that are consistent with the emergency classification scheme in Appendix 1 of NUREG-0654/FEMA-REP-1 and that listed by the applicant in Section 3.4 of Part 4.

13.3.3.5.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which the applicant will develop consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/ FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.C of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature D, "Emergency Classification System."

Major feature D calls for the applicant to establish a standard emergency classification scheme that is consistent with Appendix 1 to NUREG-0654/FEMA-REP-1. Major feature D also calls for the State and local organizations to establish an emergency classification scheme that is consistent with that proposed by the applicant.

13.3.3.5.3 Technical Evaluation

In response to RAIs 13.3-18, 13.3-19, 13.3-20, and 13.3-21, the applicant amended Section 3.4 in Revision 2 to Part 4 of the application to accomplish the following:

- Reflect the intent to establish an emergency classification scheme consistent with NUREG-0654/FEMA-REP-1 or RG 1.101, as appropriate, and to have these schemes include onsite and offsite monitoring results as bases for emergency classification, and

- Clarify that the emergency director will have the authority to declare any of the listed emergency classifications, based on his or her assessment of conditions and consideration of the facility's EALs.

The staff finds that the applicant's responses to RAIs 13.3-18, 13.3-19, 13.3-20, and 13.3-21, which were implemented in Revision 2 to Part 4 of the application, are acceptable. As such, the standard emergency classification scheme, specified by the applicant in Revision 2 to Part 4 of the application, is consistent with that set forth in Appendix 1 to NUREG-0654/FEMA-REP-1. The staff also finds that the standard classification scheme established by the State and local emergency response organizations in the MREPP, PGCCREPP, LPRPP, and Attachment 2 to LPRPP Supplement 2 are consistent with that proposed by the applicant.

13.3.3.5.4 Conclusions

As discussed above, the applicant has specified a standard emergency classification scheme, which is consistent with that set forth in Appendix 1 to NUREG-0654/FEMA-REP-1 and with those established by the State and local EROs. Based on its review, the staff concludes that proposed major feature D is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.C of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for the emergency classification scheme, as set forth above.

13.3.3.6 Notification Methods and Procedures (Major Feature E)

13.3.3.6.1 Technical Information in the Application

The applicant described the basis for the notification of response organizations. Section 3.2.1.1 of Part 4 indicated that the shift manager will act as emergency director upon declaration of an emergency, notify and recommend protective actions to authorities responsible for offsite measures, and inform offsite support officials of pertinent facts and developments. The applicant stated that, once the EOF is declared operational, the offsite emergency coordinator will relieve the shift manager of these offsite communication responsibilities.

Section 3.5.1, "Basis for Notification of Response Organizations," of Part 4 indicated that the shift manager will ensure that at least one of the following agencies is notified within 15 minutes of an emergency declaration:

- primary

    - Mississippi Highway Patrol
    - Louisiana Office of Emergency Preparedness
    - Claiborne County Sheriff's Department
    - Tensas Parish Sheriff's Department
    - City of Port Gibson Police Department

- secondary

    - Mississippi Emergency Management Agency
    - Louisiana Department of Environmental Quality
    - Claiborne County Civil Defense

The respective offsite radiological emergency response plans for the States of Mississippi and Louisiana and Claiborne County required the licensee to notify each of the States and counties/parishes at risk within 15 minutes of event classification. In RAI 13.3-22, the staff asked the applicant to clarify the requirements for the notification of the States of Louisiana and Mississippi and counties/parishes at risk, consistent with respective offsite radiological emergency response plans. In Revision 2 to Part 4, the applicant amended Section 3.5.1 to state the following:

> Where both a primary and secondary contact are listed, only one contact (primary or secondary) is required.

Primary	Secondary
MS Emergency Management Agency	MS Hwy Patrol
LA Office of Homeland Security and Emergency Preparedness	LA Dept of Environmental Quality
Claiborne County Sheriff's Dept	Claiborne County Civil Defense
Tensas Parish Sheriffs Dept	
Port Gibson Police Dept	

In Section 3.6, "Emergency Communications," of Part 4, the applicant stated that it will provide for State representatives to call and verify the authenticity of the accident and obtain additional information. In RAI 13.3-23, the staff asked the applicant to clarify the requirements for local agencies to call and verify the authenticity of the accident under their respective emergency plans. In Revision 2 to Part 4, the applicant amended Section 3.6 to clarify that it has provided for both State and local authorities to call the facility to authenticate emergency messages and to obtain additional information.

Section V.E, "Notification," of the MREPP Basic Plan summarized the State of Mississippi's process for notifying State and local organizations in response to a radiological emergency. Section V.E, "Notification," of the PGCCREPP Basic Plan also described notification and response procedures for the at-risk county and municipalities based on the emergency class declared by GGNS.

Annex A, "Communications and Warning," of the LOEP contained the procedures for communications and warnings for all disasters and emergencies in the State of Louisiana. Chapter 2, "Accident Notification," of the LPRRP described the procedures for notification based on the four emergency classes, consistent with NUREG-0654/FEMA-REP-1 for fixed nuclear facility accidents. Section E, "Notification and Activation," to Enclosure I of Attachment 2 to LPRRP Supplement II also described the notification and response procedures for the at-risk parish and municipalities based on the emergency class.

The applicant described the method(s) for alerting, notifying, and mobilizing emergency response personnel. In Section 3.5.1 of Part 4, the applicant indicated that the licensee emergency organization personnel will be notified of the emergency and their expected responses through one or more of the communication systems described in Section 3.11, "Radiological Exposure Control," of Part 4, rather than in Section 3.6 of Part 4. In RAI 13.3-24, the staff asked the applicant to clarify the apparent discrepancy. In Revision 2 to Part 4, the applicant amended Section 3.5.1 to reference Section 3.6.

In Section 3.6.2.2, "Notification of Facility Personnel," of Part 4, the applicant further indicated that the facility will use a computerized notification system to alert emergency response personnel upon declaration of an emergency and that site telephones will serve as a backup to this system.

In the State of Mississippi, Section V.E of the MREPP Basic Plan indicated that, at the alert classification, MEMA will notify offsite response agencies and activate the SEOC. All State agencies will put their personnel and equipment required for further response on standby. Appendix 5, "MEMA Standard Operating Procedures for a Fixed Nuclear Facility Emergency," to MREPP Annex A also described the process for alerting and activating emergency response personnel.

Section V.E of the PGCCREPP Basic Plan generally described the procedure to be used by Claiborne County for notifying and mobilizing emergency personnel. Appendix 1, "Claiborne County EOC Standard Operating Procedures," to PGCCREPP Annex A also detailed the contacts the County makes to alert and mobilize emergency personnel.

In the State of Louisiana, LEOP Section III.C, "Emergency Action Levels," generally described the procedures that the State agencies use to mobilize and activate emergency response personnel for the various emergency classes. The LDEQ Radiological Emergency Response Operational Procedure 2, "Notification and Headquarters Activation," described the mobilization of LDEQ personnel. Section IV.A, "Responsibilities of Departments of State Government, Common Responsibilities," of the LPRRP Basic Plan also required each State agency with a response role to develop internal procedures for notifying and mobilizing State emergency personnel assigned emergency functions.

Section F, "Emergency Communications," of Enclosure I to Attachment 2 to LPRRP Supplement II described the various communications systems to be used by Tensas Parish for communications with principal organizations and emergency personnel. Section F provided specific mobilization and activation procedures for the parish and municipalities within the plume exposure pathway EPZ.

The applicant described the administrative and physical means for notifying and promptly instructing the public within the plume exposure pathway EPZ. Section 3.5.3, “Notification of the Public Within the Plume EPZ,” of Part 4 stated the following:

> An Alert Notification System will be provided that meets the design objectives of NUREG-0654, Appendix 3. Because of the close physical proximity and common EPZ boundaries, the proposed new facility is expected to share the system used for GGNS. The current system consists of 43 sirens located in Claiborne County and Tensas Parish. Institutions located in the Plume Exposure EPZ will be supplied with tone activated receivers which supplement the siren system. PGCCCD and Tensas Parish Emergency Preparedness will be responsible for activating the portion of the system within their respective jurisdictions. Additional alert notification details will be addressed in local and State emergency plans, the GGNS Emergency Public Information publication, and the Alert Notification System Final Report. The Alert Notification System (ANS) will also provide information concerning protective measures to transient population.

In RAI 13.3-25, the staff asked the applicant to describe the capabilities of the ANS (sirens) to provide this function (i.e., public address capability). In Revision 2 to Part 4, the applicant amended Section 3.5.3 to state the following:

> Following activation of the Alert Notification System, information concerning protective measures will be provided via State and local emergency communication systems and commercial broadcast media. See also, Section 3.7.1 regarding additional measures taken to provide emergency information to the transient population.

In the State of Mississippi, Section VI.D, “Alert Notification System,” of the MREPP Basic Plan described the ANS operation and its use in informing the public of emergencies at GGNS. Section VI.D specifies that, in the event of an initial notification of a general emergency classification, the MEMA public information officer will prepare and release an emergency alert system (EAS) message directing the public to take required protective actions. Section VI.D of the MREPP Basic Plan also stated the following:

> An alert and notification system is in place in accordance with FEMA-REP-10. In the State of Mississippi, the system consists of 30 fixed rotating sirens located within the 10-mile EPZ in Claiborne County. Businesses, schools, hospitals and other facilities that contain large numbers of people located within the 10-mile EPZ are supplied with tone-activated receivers (tone alerts). These tone alerts supplement the siren system. Two additional receivers are located in a high noise area and are equipped with visual alarms. Claiborne County has 50 tone-alert receivers. Claiborne County is responsible for the activation of their sirens and tone-alert receivers. Route alerting supplements these systems, as necessary. (See Annex C, Appendix 4.)

> The ANS system and procedures provide the State of Mississippi the capability for transmitting both an alert signal and an informational or instructional message, via the Emergency Alert System (EAS), to essentially 100% of the population within 15 minutes of a protective action decision.

Section VI.I, “Public Information,” to the MREPP Basic Plan, and Section III, “Radiological Emergency,” MREPP Annex J, discussed the State’s responsibility for the activation of the EAS. Appendix 3, “GGNS ANS Coordination Flow Chart,” to MREPP Annex C also described the process for siren activation and the EAS message broadcast over EAS radio stations.

Section VI.H, “Direction and Control, Public Information,” of the PGCCREPP Basic Plan described Claiborne County’s coordination of EAS messages with the SEOC and the Joint Public Information Center. Section VI.D, “Alert Notification System,” of the PGCCREPP Basic Plan also discussed the ANS and the county’s procedures for operating the ANS upon instruction from MEMA.

In the State of Louisiana, LEOP Annex O, “Pubic Information,” identified the use of the ANS to inform the public. Chapter 4, “Public Alert/Notification,” of the LPRRP described the system for alerting and notifying the public in the event of an accident at GGNS. Chapter 4 also described the State, parish, and utility components of the public alert/notification system, the development and use of messages, and system coverage.

Section F.7, “Alert Notification System,” of Enclosure I to Attachment 2 to LPRRP Supplement II provided the Tensas Parish procedures for operating the ANS and addresses the use of mobile units with public address systems for backup public notification. Section E.5, “Notification of the Public,” of Enclosure I further indicated that Tensas Parish will coordinate the preparation of messages to be sent out over the EAS with LOEP and that USCG will notify ships along the Mississippi River.

13.3.3.6.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.D of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of emergency plans submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature E, “Notification Methods and Procedures.”

Major feature E calls for the applicant to describe the mutually agreeable bases for notifying response organizations, consistent with the emergency classification scheme in Appendix 1 to NUREG-0654/FEMA-REP-1, including the method for alerting, notifying, and mobilizing personnel. The application should also describe the administrative and physical means for notifying and promptly instructing the public within the plume exposure pathway EPZ.

13.3.3.6.3 Technical Evaluation

The staff finds that the applicant's responses to RAIs 13.3-22 and 13.3-23, which were implemented in Revision 2 to Part 4 of the application, are acceptable. Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LEOP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement 2 described a mutually agreeable basis for the notification of response organizations, consistent with the emergency classification scheme.

The staff finds that the applicant's response to RAI 13.3-24, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LEOP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II described a method for alerting, notifying, and mobilizing emergency response personnel.

In addition, the staff finds that the applicant's response to RAI 13.3-25, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LEOP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II described the administrative and physical means for notifying and promptly instructing the public within the plume exposure pathway EPZ.

13.3.3.6.4 Conclusions

As discussed above, the applicant has described the mutually agreeable basis for notifying response organizations, which is consistent with that set forth in Appendix 1 to NUREG-0654/FEMA-REP-1, and includes the method for alerting, notifying, and mobilizing personnel. In addition, the applicant has described the administrative and physical means for notifying and promptly instructing the public within the plume exposure pathway EPZ. Based on its review, the staff concludes that proposed major feature E is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III and IV.D of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for notification and procedures, as set forth above.

13.3.3.7 Emergency Communications (Major Feature F)

13.3.3.7.1 Technical Information in the Application

Section 3.6.1.1, "Facility Telephone System," of Part 4 indicated that the applicant will maintain a high-reliability telephone system at the proposed new facility to provide telephone communications with licensee management and operating and support organizations. The applicant further noted that the plant telephone system provides communications among the control room, technical support center (TSC), operations support center (OSC), EOF, news/information centers, and the public.

The applicant also described provisions for communications with contiguous State and local governments within the EPZ. Section 3.6.2.1, “Dedicated Telephone Lines,” of Part 4 indicated that the applicant will establish dedicated telephone links to provide a continuous (24-hour) means of communication between the applicant and contiguous State and local governments within the plume exposure pathway EPZ. The applicant will use the Operational Hotline for initial notification and ongoing communications for the duration of the emergency. Use of the Operational Hotline will activate the emergency response network by notifying each location simultaneously. The ultrahigh frequency (UHF) radio system will serve as an alternate means of communication to notify offsite authorities of an emergency. In RAI 13.3-26, the staff asked the applicant to explain the differences, if any, between the Operational Hotline and the emergency response network. In response, the applicant stated that the Operational Hotline is a communications system used to allow the simultaneous notification of State and local agencies. The emergency response network, in practice, refers to the affected emergency response organizations.

Section VI.C, “Communications,” of the MREPP Basic Plan stated that the Operational Hotline serves as the primary means of communication for the State of Mississippi with GGNS. The MREPP further indicated that telephones provide the primary point-to-point communications for State and local response organizations. Communications with field monitoring teams will occur through a satellite network, which is a combination satellite/radio system. The MREPP Annex B, “Communications,” and Annex C, “Alert and Notification,” provided details about the primary and backup systems.

Section VI.C, “Direction and Control, Communications,” of the PGCCREPP Basic Plan described the various communications systems, including the Operational Hotline, commercial telephone, and radio for field units, that Claiborne County will use for communicating with principal organizations and emergency personnel and as backup communication. The PGCCREPP Annex B, “Communications,” detailed communication procedures for coordinating with county and municipal organizations.

Chapter 3, “Communications,” of the LPRRP described the State of Louisiana’s concept of operations for notification and the exchange of information, with the GGNS dedicated line as the primary communication system and commercial telephone and radio as backup systems. The LPRRP also indicated that radio and satellite radio systems are a backup for interstate communications.

Section F to Enclosure I of Attachment 2 to LPRRP Supplement II described the various communication systems including the Operational Hotline, radio, commercial telephone, and pagers, that Tensas Parish will use for communicating with principal organizations and emergency personnel.

The applicant also described the provisions for communications with Federal emergency response organizations, as needed. Section 3.5.1 of Part 4 indicated that the applicant will notify the NRC, as the lead Federal response agency, immediately after the appropriate State and local agencies, and not later than 1 hour after the declaration of one of the emergency classes. Section 3.6.2.1 of Part 4 established the NRC Emergency Telephone System as the applicant’s intended means of providing direct communication with the NRC Operations Center.

The applicant also described the purpose and locations of the various circuits and links provided by the NRC Emergency Telephone System, including the emergency notification system (ENS), health physics network, and NRC counterpart links. In RAI 13.3-27, the staff asked the applicant to describe the location of the protective measures counterpart link drop in its emergency facilities, consistent with the description provided for other circuits. In response, the applicant stated that Supplement 2 guidance did not request a detailed description of the locations of NRC telecommunication system circuits and lines. Thus, the applicant deleted the locations for the various NRC telecommunications circuits in Revision 2 to Part 4 of its application.

The applicant also described the Emergency Response Data System (ERDS) in Section 3.6.2.1 of Part 4. It indicated that it will activate the ERDS, which will be available in the control room, at an alert or higher declaration. In RAI 13.3-28, the staff asked the applicant to clarify the requirement to activate the ERDS within 1 hour of a declaration with a classification of an alert or higher in accordance with 10 CFR 50.72(a)(4). In response, the applicant stated that the guidance in Supplement 2 did not request a detailed description of the ERDS and its activation. Thus, the applicant deleted the discussion of ERDS activation in Revision 2 to Part 4 of the application.

Annex B of the MREPP described the use of various systems by the State of Mississippi to communicate with Federal, State, and local response organizations. Appendix 1, "Communications at SEOC," to MREPP Annex B included a table listing the communication capabilities and the coverage area of the SEOC. Section IV.E, "Federal," of the PGCCREPP Basic Plan indicated that a request to MEMA will gain access to Federal resources.

Section VII, "Administration and Logistics," of the LEOP indicated that a system of emergency communications exists between Federal, State, local, and private organizations for the coordination and direction of emergency/disaster relief efforts. The LEOP further indicated that this system comprises internal, external, and support communications, located in most cases within a local sheriff's office and otherwise in an EOC.

Section III.B, "Direction and Control," of LPRRP Chapter 3 indicated that the LOEP will use the national communication system, referred to as NACOM, to work with FEMA (Region IV) for the coordination of Federal support for protective response operations in the event of an accident. The LPRRP further stated that the national warning system, referred to as NAWAS, will serve as a backup for Federal/State communications.

The applicant also described the provisions for alerting and activating emergency personnel in each response organization. In Section 3.5.2, "Mobilization of Emergency Response Personnel," of Part 4, the applicant stated the following:

> If an Unusual Event has been declared, those members of the operating shift needed to handle the emergency would be activated. If the Emergency Director feels that there is a reasonable possibility of escalation of the emergency to a higher classification, applicable portions of the Emergency Organization would be activated.

> If an Alert has been declared, the appropriate portions of the Emergency Organizations will be activated. If a Site Area Emergency or General Emergency has been declared, the entire Emergency Organizations will be activated.

However, in Sections 3.8.1, “Technical Support Center (TSC),” 3.8.2, “Operations Support Center (OSC),” and 3.8.3, “Emergency Operations Facility (EOF),” of Part 4, the applicant indicated that the TSC, OSC, and EOF will be activated at an alert, site area emergency, or general emergency classification. In RAI 13.3-29, the staff asked the applicant to clarify this discrepancy. In Revision 2 to Part 4, the applicant amended Section 3.5.2 to indicate that the entire emergency organization will be activated at the declaration of an alert, site area emergency, or general emergency.

In Section 3.6.2.2 of Part 4, the applicant discussed the use of a computerized system to notify facility emergency response personnel. Site telephones were used as a backup to this system.

Appendix 6, “Fixed Nuclear Facility Incident Notification Procedures,” to MREPP Annex C contained detailed procedures for alerting and notifying agency emergency personnel in the State of Mississippi. According to these procedures, MEMA communications personnel or the MEMA operations officer will call the listed agencies and relay emergency notification messages received from GGNS by the Operational Hotline using call lists and instructions provided for each emergency class.

Appendix 1, “Port Gibson/Claiborne County EOC Activation Chart by Emergency Classification Level,” to PGCCREPP Annex C provided for the receipt of the notification of emergency classification from GGNS via the Operational Hotline. The appendix also gave a matrix of officials and response organizations to be notified.

Attachment 4 to the LEOP specified the responsibilities of State agencies and directs individual agencies in the State of Louisiana to provide for the alerting and notification of their emergency personnel. The LDEQ emergency personnel are alerted by pager, the State’s 800-megahertz band radio (when in official vehicles), or commercial telephone, in accordance with LDEQ Radiological Emergency Response Operational Procedure 2. Section III.A, “Notification and Exchange of Information,” of LPRRP Chapter 3 indicated that dedicated telephone lines are the primary means of notifying and mobilizing State and local emergency response personnel. Commercial telephone or radio systems served as backup.

Section E of Enclosure I to Attachment 2 to LPRRP Supplement II stated that Tensas Parish receives an initial notification from GGNS via the Operational Hotline. Subsequently, the alert/notification call system of the response agency will call emergency response personnel to duty.

The applicant also described the communications arrangements for fixed and mobile support facilities. Section 3.12 of Part 4 indicated that the regional ambulance service will transport injured persons to an offsite medical facility. Ambulances will be equipped with radios to maintain communications with the medical facility. In RAI 13.3-30, the staff asked the applicant to describe its arrangements to communicate with the medical facility and request ambulance support. In Revision 2 to Part 4, the applicant amended Section 3.12 to state the following:

Communications with both primary and backup medical facilities, including requests for ambulance support, are provided by the commercial telephone system. Backup communications are provided by the UHF radio system.

Appendix 10, "Medical and Public Health Services," to MREPP Annex F listed the ambulance services and medical facilities in the State of Mississippi that will transport and treat injured individuals who are radiologically contaminated. The MSDH/DRH will advise agencies with the responsibility for transporting injured individuals with radiological contamination and decontaminating transportation providers and equipment. Appendix 1 and Appendix 2, "Mobile Communication Links," to MREPP Annex B described the means for communicating with fixed installations and mobile units, but did not identify hospitals and ambulance services. Instead, Appendix 1, "Communications at Port Gibson/Claiborne County EOC," to PGCCREPP Annex B described the use of radio as a means of EOC communication with the statewide hospital network. Appendix 5, "Claiborne County EOC Notification/Staffing List," to Annex C included a representative from Claiborne County Hospital on the EOC roster. In RAI 13.3-61 and subsequently Open Item 13.3-1a, the staff asked the applicant to clarify communications arrangements with fixed and mobile medical support for the State of Mississippi and with mobile medical support for Claiborne County. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

Annex M, "Medical and Public Health/Sanitation," to the LEOP assigned primary responsibility for emergency medical and hospital services in the State of Louisiana to the Department of Health and Hospitals representative at the SEOC, who coordinates support for the local communities. Section III.D, "Medical Support," of LPRRP Chapter 3 stated that existing fixed and mobile medical facilities will use local emergency medical communications systems. Arrangements will be established to provide for a coordinated communications system in support of a medical emergency.

Section F.4, "Medical Support Facilities Communication Systems," of Enclosure I to Attachment 2 to LPRRP Supplement II described a coordinated communications link, consisting of either fixed/mobile radios or commercial telephones, between the Tensas Parish EOC, Riverland Hospital, and American Medical Response ambulances.

13.3.3.7.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.D, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature F, “Emergency Communications.”

Major feature F calls for the applicant to identify communication provisions with State and local governments within the EPZs, with Federal EROs, and with fixed and mobile medical support facilities. The application should also describe provisions for alerting and activating emergency personnel.

13.3.3.7.3 Technical Evaluation

The staff finds that the applicant’s responses to RAIs 13.3-26, 13.3-27, and 13.3-29, which were implemented in Revision 2 to Part 4 of the application, are acceptable. As such, the communications plans for emergencies described in Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LEOP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II described provisions for the following:

- communications with contiguous State and local governments within the EPZ
- communications with Federal emergency response organizations
- alerting and activating emergency personnel

In the response to RAI 13.3-28, the applicant indicated that an appropriate description of the NRC ERDS and requirements for its activation, in accordance with Section VI of Appendix E to 10 CFR Part 50, will be provided at the COL stage as part of the applicant’s complete and integrated plan. The staff finds that the applicant’s response to RAI 13.3-28 is acceptable.

Revision 2 to Part 4 of the application, the LEOP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II described the communications arrangements for fixed and mobile medical support facilities between the applicant and the State of Louisiana, Tensas Parish. The staff finds that the applicant’s response to RAI 13.3-30, which further clarifies the applicant’s communication arrangements with the designated medical facilities and for requesting ambulance support, is acceptable. In RAI 13.3-61, the staff also asked for further information related to communications arrangements with fixed and mobile medical support for the State of Mississippi and with mobile medical support in Claiborne County. The staff identified consideration of this information as Open Item 13.3-1a in the draft SER. The staff reviewed the applicant’s response, and finds it acceptable for an ESP application, except to the extent that the arrangements would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a COL or OL application. The staff will determine the adequacy of such incorporation during a COL or OL review. Therefore, Open Item 13.3-1a is resolved.

13.3.3.7.4 Conclusions

As discussed above, the applicant has identified communications provisions with State and local governments within the EPZs, with Federal EROs, and with fixed and mobile medical support facilities. In addition, the applicant has described provisions for alerting and activating emergency personnel. Based on its review, the staff concludes that the proposed major feature F is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.D, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for emergency communications, as set forth above.

13.3.3.8 Public Education and Information (Major Feature G)

13.3.3.8.1 Technical Information in the Application

The applicant described the program to coordinate the dissemination of information to the public. Section 3.7.1, "Provision of Information to the General Public," of Part 4 of the application indicated that, in conjunction with State and local agencies, the proposed new facility will provide written information addressing emergency preparedness to members of the general public who reside within the plume exposure pathway EPZ. Section 3.7.1 also noted that this information will include the following, which will be disseminated through an emergency public information publication mailed annually to residents within the 10-mile EPZ:

- educational information on radiation
- personnel to contact for further information
- protective measures (e.g., evacuation routes, relocation centers, and shelter)
- respiratory protection and radioprotective drugs
- special needs of the handicapped

According to the applicant, the public education and information program will provide the permanent and transient adult population within the plume exposure pathway EPZ with an adequate opportunity to become aware of the above information on an annual basis. In RAI 13.3-31, the staff asked the applicant to clarify that the information on the special needs of the transient population will be disseminated periodically to members of the general public. In Revision 2 to Part 4, the applicant amended Section 3.7.1 to state that it will provide the following written information to members of the general public residing within the plume exposure pathway EPZ:

> Information addressing provisions for protecting the special needs population, including information on a process for registering the locations of the special needs population.

In RAI 13.3-32, the staff asked the applicant to describe the means for providing information to the transient population. In Revision 2 to Part 4, the applicant amended Section 3.7.1 to state the following:

> Appropriate information, such as evacuation routes, will be provided to the transient population through media that are likely to be available to this population group, such as postings in public places and notices in telephone books (commonly distributed to temporary lodging facilities). During an emergency, additional information will be made available through public emergency information systems, such as commercial broadcast media.

Section III.A, "Concept of Operation, Non-Emergency," of MREPP Annex J and Section III.A, "Concept of Operation, Non-Emergency," of PGCCREPP Annex J described the program for distributing information in the State of Mississippi to educate the general public, including information concerning the nature of the radiation hazard, procedures for the notification of a radiological emergency, evacuation routes and assembly points, and other protective measures such as sheltering, the use of thyroid-blocking agents, and respiratory protection.

Appendix 8, “Special Needs Population,” of PGCCREPP Annex F described the provisions made for the physically impaired to move outside an affected area without special assistance. In RAI 13.3-62 and subsequently Open Item 13.3-1b, the staff asked the applicant to clarify the mechanism for the periodic dissemination of information regarding the special needs of the handicapped to the general public in the State of Mississippi. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

Section III.A of MREPP Annex J also indicated that the nuclear facility operator was responsible for making available for distribution literature on public actions in the event of an emergency. Section III.A also stated that written materials are distributed annually to all residents, businesses, and transient populations within the 10-mile EPZ. In addition, the information is published in calendars and posters and as an advertisement in a two-county telephone book, according to Section III.A of PGCCREPP Annex J. In RAI 13.3-72 and subsequently Open Item 13.3-2, the staff asked the applicant to clarify its responsibility to make information available to offsite authorities for distribution consistent with MREPP Annex J. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

Chapter 2, “Public Education and Information,” of Attachment 2 to LPRRP Supplement II included information regarding the public education and information program in the State of Louisiana. It provided educational information on radiation; points of contact for additional information; emergency planning zones; PAAs, protective measures such as evacuation routes, reception centers, sheltering, and respiratory protection; transportation availability; and the special needs of the handicapped. The program description did include information on radioprotective drugs because the State of Louisiana did not recommend their use for the general public. Public information is distributed in an information brochure mailed to individual residences and commercial businesses throughout the 10-mile EPZ. Emergency information for the transient population is placed in buildings, visitor centers, and retail outlets in the 10-mile EPZ.

The applicant described the program for periodically updating the news media. Section 3.7.2, “News Media Information,” of Part 4 indicated that the proposed new facility will maintain a news media emergency information program, which will (1) include details on arrangements for the timely exchange of information among designated spokespersons and news media representatives, and (2) provide for an annual training session to acquaint the news media with the procedure for obtaining information during an emergency, as well as information about overall emergency preparedness for the proposed new facility. In RAI 13.3-33, the staff asked the applicant to describe the method by which the periodic training offered to news media representatives will address information concerning radiation. In Revision 2 to Part 4, the applicant amended Section 3.7.2 to state the following:

> The News Media Emergency Information Program will include a training program that will provide information concerning radiation, emergency plans, and points of contact for release of public information during an emergency.

Section III.A, "Concept of Operations, Non-Emergency," of MREPP Annex J stated that the GGNS emergency preparedness staff contacts the various news media outlets in the State of Mississippi, both verbally and through mailings, to provide points of contact for public information in an emergency and to discuss radiological emergency planning in general. In addition, Section III.A of PGCCREPP Annex J indicated that sessions will be conducted to discuss radiation in general.

Chapter 2 of Attachment 2 to LPRRP Supplement II indicated that LDEQ, LOEP, Tensas Parish, and Entergy Operations, Inc., will conduct an annual program to acquaint the news media in the State of Louisiana with the emergency plan, radiation information, and points/places of contact for the release of public information.

13.3.3.8.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.D, IV.E, and IV.F of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature G, "Public Education and Information."

Major feature G calls for the applicant to describe a program to provide information to the public and news media on a periodic basis. The program should address how the applicant will notify the public, including the actions the public should take in an emergency, and the applicant's means for acquainting the news media with emergency information.

13.3.3.8.3 Technical Evaluation

Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, and Attachment 2 to LPRRP Supplement II described a program for the coordinated dissemination of information to the public on a periodic basis. The staff finds that the applicant's responses to RAIs 13.3-31 and

13.3-32, which further clarified in Part 4 of the application how information will be disseminated to the special needs and transient populations, are acceptable.

In RAI 13.3-62, the staff asked for further information related to the MREPP and PGCCREPP on the mechanism for the periodic dissemination of information regarding the special needs for the handicapped in the State of Mississippi. The staff identified consideration of this information as Open Item 13.3-1b in the draft SER. The staff reviewed the applicant's response, and finds it acceptable for an ESP application, except to the extent that the description would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a COL or OL application. The staff will determine the adequacy of such incorporation in this area during a COL or OL review. Therefore, Open Item 13.3-1b is resolved.

In RAI 13.3-72, the staff also asked the applicant for further information to clarify its responsibility to make information available to offsite authorities for distribution consistent with MREPP Annex J. The staff identified consideration of this information as Open Item 13.3-2 in the draft SER. The staff reviewed the applicant's response, and finds that the level of detail contained in Revision 2 to Part 4 of the application is acceptable for an ESP application. Therefore, Open Item 13.3-2 is resolved.

The staff finds that the applicant's response to RAI 13.3-33, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, and Attachment 2 to LPRRP Supplement II described a program for periodically acquainting the news media with emergency plans, information concerning radiation, and points of contact for the release of public information in an emergency.

13.3.3.8.4 Conclusions

As discussed above, the applicant has described a program to provide information to the public and news media on a periodic basis and which addresses public notification and emergency actions. Based on its review, the staff concludes that the proposed major feature G is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III. IV.B, IV.D, IV.E, and IV.F of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for public education and information, as set forth above.

13.3.3.9 Emergency Facilities and Equipment (Major Feature H)

13.3.3.9.1 Technical Information in the Application

Section 3.8.1 of Part 4 provided the following description of the TSC:

> The TSC will provide an area outside the Control Room that can accommodate management, engineering personnel and the NRC acting in support of the command and control function during emergency conditions and the emergency recovery operations. Personnel staffing the TSC assist in accident assessment and will provide advice to the Control Room and communication with the EOF, the Control Room, OSC and offsite support agencies. The TSC will be habitable

to the same degree as the Control Room for all postulated accident conditions. The TSC may be activated at any time, and will be activated at an Alert, Site Area Emergency, or General Emergency. Once activated, the TSC will become operational as soon as possible. During emergencies, the TSC will provide for the classification, accident assessment, notification, and dose assessment functions if these functions are unavailable at the EOF.

Section 3.8.2 of Part 4 provided the following description of the OSC :

> The OSC will provide an area for operations, maintenance, health physics, chemistry, and operations personnel to assemble and be assigned to duties in support of emergency response activities. The OSC will be activated at the declaration of an Alert, Site Area Emergency, and General Emergency.

Section 3.8.3 provided the following description of the EOF and the ability to provide information to Federal, State, and local authorities:

> The EOF provides a location from which evaluation and coordination of all Licensee activities related to an emergency will be carried out. The facility will provide information to other offsite groups, assess the impact of the emergency offsite and provide the necessary support to assist the Emergency Organization.
>
> The EOF will be staffed by key technical personnel of the Emergency Organization. Space and communications will be provided for Federal, State and local representatives. The EOF also will provide a base of operation for Offsite Monitoring Teams and be the central point for the receipt of field monitoring data.
>
> The EOF may be activated at any time, and will be activated at an Alert, Site Area Emergency, and General Emergency declaration. Once activated, the EOF will become operational as soon as possible (without delay) after declaration of these emergency classifications.

Although Section 3.8, "Emergency Facilities and Equipment," of Part 4 indicated that the ESP site may share the emergency response facilities for the existing GGNS Unit 1, the applicant did not describe the existing emergency facilities in sufficient detail consistent with the guidance contained in NUREG-0696, "Functional Criteria for Emergency Response Facilities—Final Report," issued in February 1981. In RAI 13.3-34, the staff asked the applicant to discuss the extent to which it intended the ESP application to address Evaluation Criteria H.1 and H.2 of Supplement 2 for the TSC, OSC, and EOF and to clarify its decision to use the existing facilities that support GGNS Unit 1. In response, the applicant stated:

> Therefore, although NUREG-0696 (cross-referenced in NUREG-0654 Supplement 2, Criteria H.1 and H.2) was used as a reference when preparing Part 4 of the application, the applicant does not believe it is appropriate to provide additional information regarding adherence to the guidance provided in NUREG-0696 at the ESP application stage of facility development. No evaluation or decision has been made as to whether the existing Unit 1 OSC and EOF facilities could or would be shared. The TSC facility will not be shared;

current Part 52 design certifications would also need to be incorporated as appropriate.

The applicant also described the EOCs for each State and local organization.

Section IV.A.2, “State, MEMA,” of the MREPP Basic Plan authorized MEMA to activate and staff the SEOC. MREPP Annex A describes the concept of operations for directing the SEOC response, its staffing, and its location. In Section 3.8.5, “Mississippi State EOC,” of Part 4, the applicant further indicated that the State EOC is currently located in the MEMA building in Jackson, approximately 75 miles from the site, and has supplies and equipment to support state emergency operation activities, including communications links with other EOCs.

Section II, “Concept of Operation,” of PGCCREPP Annex A described the location and operation of the EOC in directing county and municipality emergency response functions, as well as staffing and responsibilities for performing EOC functions. In Section 3.8.4, “Claiborne County EOC,” of Part 4, the applicant further noted that the Claiborne County EOC, currently located at the PGCCCD office in Port Gibson, Mississippi, will be equipped to communicate with the control room, TSC, EOF, the Jackson SEOC, and State supporting agencies.

Section V of the LEOP described the SEOC and its use in directing and controlling response functions. Annex D, “Emergency Direction and Control,” of the LEOP described the role of LOEP in coordinating and directing the SEOC response. In addition, LPRRP Section IV covered SEOC activation, staffing, and operations. Implementing procedures cover the details of SEOC operation. In Section 3.8.7, “Louisiana State EOC,” of Part 4, the applicant further indicated that the Louisiana EOC is located in Baton Rouge, approximately 125 miles from the site, and has equipment and supplies to support state emergency operation activities, including communications links with other emergency centers.

Section C of Enclosure I to Attachment 2 to LPRRP Supplement II described the location, staffing, and responsibilities of the Tensas Parish EOC, where parish and municipality emergency response functions take place. In Section 3.8.6, “Tensas Parish EOC,” of Part 4, the applicant stated that the Tensas Parish EOC is currently located adjacent to the Tensas Parish Sheriff’s Office and is equipped to communicate with the TSC, control room, EOF, Mississippi SEOC, Baton Rouge SEOC, and Louisiana State supporting agencies.

13.3.3.9.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using the guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.B, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature H, “Emergency Facilities and Equipment.”

Major feature H calls for the applicant to describe the TSC, onsite OSC, and EOF, in accordance with NUREG-0696. The following are the general guidance criteria from NUREG-0696 for these facilities:

- The TSC is an onsite facility located close to the control room that must provide plant management and technical support to the reactor operating personnel located in the control room during emergency conditions. It must have technical data displays and plant records available to assist in the detailed analysis and diagnosis of abnormal plant conditions and any significant release of radioactivity to the environment. The TSC shall be the primary communications center for the plant during an emergency.

- The OSC is an onsite assembly area separate from the control room and the TSC where licensee operations support personnel shall report in an emergency. There shall be direct communications between the OSC and the control room, and between the OSC and the TSC, so that the personnel reporting to the OSC can be assigned to duties in support of emergency operations.

- The EOF is a near-site support facility for the management of overall licensee emergency response (including coordination with Federal, State, and local officials), coordination of radiological and environmental assessments, and determination of recommended public protective actions. The EOF shall have appropriate technical data displays and plant records to assist in the diagnosis of plant conditions to evaluate the potential or actual release of radioactive materials to the environment.

In addition, major feature H calls for the application to describe an EOC for each offsite organization, for use in directing and controlling response functions.

13.3.3.9.3 Technical Evaluation

In Sections 3.8.1, 3.8.2, and 3.8.3 of Part 4, the applicant described in general the function, activation, and staffing of these facilities. In its response to RAI 13.3-34, the applicant stated that it has not made an evaluation or decision as to whether the existing Unit 1 OSC and EOF facilities could or would be shared, and that Part 52 design certifications, which establish the TSC design criteria, would need to be incorporated as appropriate. Thus, the applicant stated it did not believe that it was appropriate to provide additional information regarding NUREG-0696 adherence at the ESP application stage. The staff identified in Open Item 13.3-3 the need for this information related to the OSC, TSC, and EOF.

In its submittal dated June 21, 2005, the applicant stated that it considered the remaining open questions regarding the OSC, TSC, and EOF to be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than the ESP application. For the staff to determine the acceptability of major feature H, the applicant needs to address specifically the adequacy of the facilities and related equipment in support of emergency response in terms of their location, size, structure, habitability, communications, staffing, training, radiation monitoring, instrumentation, data system equipment, power supplies, technical data and data systems, and record availability and management.

The staff finds that Part 4 of the application, the MREPP, PGCCREPP, LEOP, and Enclosure I to Attachment 2 of LPRRP Supplement II described the EOCs for the States of Mississippi and Louisiana, Claiborne County, and Tensas Parish for use in directing and controlling response actions.

13.3.3.9.4 Conclusions

As discussed above, the applicant has not described in sufficient detail the emergency facilities and related equipment for the TSC, OSC, and EOF, consistent with the guidance in RS-002 and Supplement 2 (Evaluation Criteria H.1 and H.2). Therefore, the staff concludes that the proposed major feature H is unacceptable.

13.3.3.10 Accident Assessment (Major Feature I)

13.3.3.10.1 Technical Information in the Application

The applicant described the contacts and arrangements made with offsite organizations for acquiring and evaluating meteorological information.

In Section 3.9.1 of Part 4, the applicant stated the following:

> The proposed new facility will rely on the existing GGNS Unit 1 facility meteorological data system, which includes an onsite meteorological tower, located approximately 5,300 feet northwest of the facility, or if deemed necessary due to site-specific factors, a similar system. The facility also utilizes a back-up meteorological system which provides meteorological information to the Control Room, if primary meteorological system fails. In the unlikely event that both the primary and backup meteorological systems were inoperable, the tertiary means of obtaining wind speed and direction data would be through the National Weather Service or the U.S. Army Corps of Engineers, Waterway Experiment Station in Vicksburg, MS.
>
> Meteorological data obtained from the site instrumentation, National Weather Service, or U.S. Army Corps of Engineers may be communicated to affected states using the communication systems described in Section 3.7.

In addition, the applicant described the contacts and arrangements for field monitoring within the plume exposure EPZ in Section 3.9.2:

> The environmental monitoring program for the proposed new facility would provide for: (1) gathering of data on environmental radiation levels and the Station's degree of influence on these levels; (2) checks for specific radioisotopes to detect their introduction into the surroundings; and (3) a background for a continually developing program of radiological assessment.

> Ambient radiation will be measured by thermoluminescent dosimeters (TLDs) or other appropriate exposure integrating devices. These devices will be installed at various onsite and offsite locations....
>
> ...The offsite radiation monitoring teams will have the capability to determine the extent of the radiological hazard in the environment. Environmental air samplers and portable equipment will be available for the following assessments in the field within the Plume Exposure EPZ:
>
> - Beta-gamma radiation from the plume and/or ground contamination,
> - Iodine concentration and assessment of inhalation and thyroid dose by using air samplers with iodine-specific cartridges and portable and fixed analyzers, and
> - Water sampling for later analysis to assess contamination due to liquid release pathways can also be done by offsite monitoring teams.
>
> Transportation for the offsite monitoring teams will be available using site vehicles, with normal deployment expected to be within approximately 90 minutes following notification.

In RAI 13.3-35, the staff asked the applicant to explain the intent of its statement, “the Station’s degree of influence on these levels,” in relation to its environmental monitoring program described in Section 3.9.2 of Part 4. In response, the applicant noted that it had intended this statement to reflect that the environmental monitoring program provides data that may be used to determine if the plant effluents have any detectable effect on radiation levels present in the environment.

In RAI 13.3-36, the staff asked the applicant to describe its capability to sample environmental media, besides water. In Revision 2 to Part 4, the applicant amended Section 3.9.2 to state the following:

> The offsite radiation monitoring teams will have the capability to determine the extent of the radiological hazard in the environment, including collection of air, water, soil, and vegetation samples.

Section II.B.3, “Operational Procedures, State Government,” of MREPP Annex D, described field monitoring within the portion of the plume exposure pathway EPZ located in the State of Mississippi. Radiological emergency response team (RERT) members perform accident assessment activities and field sampling. The team for field monitoring and plume tracking activities primarily comprises personnel from MSDH/DRH and MDOT. Various state agencies provide support functions when requested by the RERT. Per Section II.B.2, “Operational Procedures, Local Government,” of Annex D to the MREPP and PGCCREPP, local governments have no accident assessment function and rely on offsite radiological monitoring provided by GGNS before the arrival of MSDH/DRH RERT members.

Tab 3 of LPRRP Chapter 6 described field monitoring team methods, procedures, and equipment, and Tab 4, “LDEQ Fixed Nuclear Facility Monitoring Program,” of LPRRP Chapter 6 described the emergency sample program for the ingestion pathway EPZ. The LDEQ emergency response teams are dispatched when plant conditions deteriorate such that they may jeopardize the health or safety of the public. The LDEQ was responsible for radiological monitoring, sample collection, and analyses and will supply and maintain its own specialized equipment and modes of transportation. Section IV.3, "Accident Assessment," of Attachment 2 to LPRRP Supplement II assigned responsibility solely to LDEQ. It indicates that Tensas Parish has no responsibility in accident assessment but is expected to carry out protective response measures based on recommendations from LDEQ.

The applicant also discussed contacts and arrangements to locate and track an airborne radioactive plume, using Federal and/or State resources. Section 3.9.2 of Part 4 of the application stated that, when necessary, special aerial radiological surveys and meteorological services available through arrangements with DOE may augment the proposed new facility's field monitoring activities. Section 13.3.3.4.1, "Technical Information in the Application," of this SER also described the mobile laboratory capabilities available through MSDH, DOE (Region III), and EPA (Region IV). In RAI 13.3-36, the staff asked the applicant to clarify whether the site will rely on MSDH environmental monitoring and analysis capabilities for environmental samples collected by the applicant and to describe the environmental monitoring capability of the State of Louisiana. In Revision 2 to Part 4, the applicant amended Section 3.9.2 to state the following:

> Environmental samples collected by applicant personnel may be analyzed either in the applicant's facility, by the State of Mississippi State Department of Health Mobile Laboratory, or in commercial laboratory facilities.

In Revision 2 to Part 4, the applicant also amended Section 3.9.2 to clarify responsibility for environmental monitoring in the State of Louisiana.

Section II.E to MREPP Annex D described the plume tracking resources available in the State of Mississippi through the SMRAP and Federal resources, including those of DOE, available through the FRERP.

Section III.A.2.d, "Concept of Operations," of LPRRP Chapter 6 indicated that LDEQ, through its Radiological Emergency Planning and Response Unit, will address the need for any additional equipment or personnel for sampling and monitoring operations in the State of Louisiana. According to LPRRP Section VII.A, "Support and Resources, Federal," Federal agency support provided under the FRERP, primarily through DOE, may include offsite radiological condition assessment and radiological monitoring.

13.3.3.10.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.C, IV.D, and IV.E of

Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature I, "Accident Assessment."

Major feature I calls for the applicant to describe the methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition. The applicant should also describe the capability and resources associated with acquiring meteorological information and performing field monitoring and contacts and arrangements with offsite organizations (including Federal and State resources).

13.3.3.10.3 Technical Evaluation

The applicant described the contacts and arrangements made with offsite organizations for acquiring and evaluating meteorological information in Part 4 of the application. The applicant also described its plan for making suitable meteorological data available to the affected States.

The staff finds that the applicant's responses to RAIs 13.3-35 and 13.3-36, which were implemented in Revision 2 to Part 4 of the application, are acceptable. Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LPRRP, and Attachment 2 to LPRRP Supplement II described the contacts and arrangements made for field monitoring within the plume exposure pathway. In addition, Revision 2 to Part 4 of the application, the MREPP, and LPRRP described the contacts and arrangements to locate and track the airborne radioactive plume, using Federal and/or State resources.

13.3.3.10.4 Conclusions

Based on its review, the staff concludes that proposed major feature I is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.C, IV.D, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for accident assessment, as set forth above.

13.3.3.11 Protective Response (Major Feature J)

13.3.3.11.1 Technical Information in the Application

The applicant described the evacuation routes and transportation for onsite individuals to a suitable location. Section 3.10.1, "Evacuation of Onsite Personnel," of Part 4 indicated that, should evacuation of onsite personnel be necessary, predetermined evacuation routes will be established, and onsite personnel may be evacuated to designated offsite locations to facilitate personnel accountability and radiological monitoring activities. Site personnel will receive training on site evacuation routes, be escorted by a trained person, or receive a map that gives instructions and routes away from the site. Appendix 5, "Reception Center and Shelter Facility

Operations," to MREPP Annex F stated that GGNS personnel will proceed to Warren County Reception Center for monitoring and registration should the evacuation traffic control management plan be activated and the reception center opened.

In addition, Section 3.10.1 of Part 4 noted that the evacuation announcement will specify site evacuation instructions and routes. Provisions will be made for considering weather conditions, traffic, or radiological impediments to evacuation. Such a practice is consistent with Section II.J, "GGNS Onsite Evacuation," of MREPP Annex F, which stated that GGNS onsite personnel could be ordered to evacuate and follow prescribed routes out of the area, as outlined in the GGNS emergency plan.

In Part 4, the applicant stated that Figure 3-1 illustrated these routes. Figure 3-2, "Designated Evacuation Routings Within the EPZ," of Part 4 depicted designated evacuation routes for the general public but did not specifically address the evacuation of onsite individuals to designated offsite locations. In RAI 13.3-37, the staff asked the applicant to describe the evacuation routes for onsite individuals to designated offsite locations, consistent with MREPP Annex F. In addition, the staff asked the applicant to describe provisions (alternatives) to be considered for a site evacuation, based on inclement weather, high traffic density, and specific radiological conditions. In Revision 2 to Part 4, the applicant amended Section 3.10.1 to state the following:

> Should evacuation of onsite personnel be necessary, pre-determined evacuation routes will be established and evacuating personnel will be directed to the preferred route based on an evaluation of conditions existing at the time of the evacuation. Onsite personnel may be evacuated to designated offsite locations to facilitate personnel accountability and radiological monitoring activities. If it is necessary to conduct a site evacuation during a release, such that a likelihood exists for radioactive contamination of evacuating personnel or vehicles, then site evacuees will be directed to report to a State reception center for monitoring and, if needed, decontamination.
>
> As an alternative to site evacuation, site personnel may be directed to assemble in a safe onsite location by a member of the emergency response organization. The assembly location will be selected based on an assessment of conditions, such as meteorological, traffic, and operational conditions, at the time of the assembly.

The applicant also indicated that nonessential personnel will be expected to evacuate the property in the same vehicles used for initial access. In RAI 13.3-38, the staff asked the applicant to describe measures for the evacuation of any onsite individuals who might not have their personal vehicles available on site. In response, the applicant stated that any onsite individuals without access to the vehicle in which they arrived will obtain rides with evacuating personnel who do have vehicles.

The applicant described its mechanism for recommending protective actions to the appropriate State and local authorities. Section 3.10.2, "Offsite Areas," of Part 4 stated that the proposed new facility will provide PARs to the State and local civil defense agencies. These agencies will implement protective actions within the plume exposure pathway EPZ. The minimum standard PAR for a general emergency classification will call for the evacuation of the 2-mile radius and 5 miles downwind and for sheltering the remainder of the plume exposure pathway EPZ.

Section 3.10.2 also indicates that evacuation will be recommended for those within 5–10 miles downwind if dose projections or actual field measurements correspond to radiation levels to the public that exceed the EPA protective action guides (PAGs). In RAI 13.3-40, the staff asked the applicant to describe the use of sheltering versus evacuation to meet the requirements of 10 CFR 50.47(b)(10). In response, the applicant stated that it will develop PARs consistent with EPA-400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," issued May 1992, which addresses both sheltering and evacuation, in accordance with Section 3.10.2.

In addition, the staff asked the applicant in RAI 13.3-41 to describe the use, including for prophylaxis, of potassium iodide (KI) as a supplement to evacuation/sheltering in considering a range of protective actions to comply with 10 CFR 50.47(b)(10). In Revision 2 to Part 4, the applicant amended Section 3.10.2 to state the following:

> If the committed dose equivalent to the thyroid of any member of the public is projected to exceed 5 rem, the Emergency Director may recommend to State and local officials that they consider distribution of radio protective drugs to members of the public, including those members of the affected population who may be confined to various institutions.

In RAI 13.3-39, the staff asked the applicant to clarify whether the term "EPA PAG" refers to the guidance specifically contained in EPA-400-R-92-001. In Revision 2 to Part 4, the applicant amended Section 3.10.2 to include the reference to EPA-400-R-92-001 guidance.

The applicant described the time estimates for evacuation within the plume exposure EPZ. In Section 2.2 of Part 4, the applicant provided a preliminary analysis of the time required to evacuate transient and permanent populations from various sectors and distances within the 10-mile plume exposure pathway EPZ. The applicant indicated in Section 2.2.1 of Part 4 that a detailed ETE for the plume exposure pathway EPZ performed in March 1986 shows a maximum evacuation time for the affected area of approximately 3 hours. In May 2003, a detailed evaluation of the original 1986 ETE more fully considered the impact of the historical population growth and transportation system improvements.

In Section 2.2.2 of Part 4, the applicant stated the following:

> The 2003 ETE evaluation *(2003 ETE study)* examined evacuation time estimates as determined in 1986 for the GGNS EPZ and evaluated those estimates through: (1) an evaluation of the current population in the GGNS EPZ, using 2000 US Census data and projected 2002 population estimates; (2) an evaluation of the current roadway network in and around the GGNS EPZ; (3) and evaluation of other impediments (e.g., new population growth, new shopping centers, new large employers) in or near the EPZ; and (4) interviews with State and local emergency management and transportation officials, as well as verification of all of the above through a site visit to the GGNS EPZ.

In Section 2.2.4.4 of Part 4, the applicant noted that the 2003 ETE study concludes that the maximum evacuation time for the affected area of approximately 3 hours in the 1986 ETE remains valid. In addition, no physical characteristics unique to the site could pose a significant impediment to the development of emergency plans and implementation of protective actions for the areas surrounding the proposed new facility. This conclusion is consistent with Section 6.0 of the May 2003 evaluation study.

In its response to RAI Letter 6, the applicant provided Revision 1 to the 2003 ETE study, and incorporated associated changes in Revision 2 to Part 4 of the application. The revisions included the following changes:

- The applicant revised Section 2.2.3.7 of Part 4 to include a table, entitled "Comparison of Peak Plume Exposure Pathway EPZ Populations 1986–2002," to address the limiting plume exposure pathway EPZ peak population (for ETE purposes) as the daytime population estimated at 20,505, an increase of 11.1 percent since the 1986 ETE. Because of several minor adjustments, the net value will increase slightly from 20,369 to 20,505 persons. (According to the applicant's response to RAI 13.3-45, the adjustments primarily result from its answers to the RAI questions (i.e., 13.3-78d and k) and the loss of population after the closure of a small hospital within the EPZ.)

- The applicant revised Figure 1.1 of the 2003 ETE study and Figure 2-6 in Part 4 of the application to be consistent and reflect the same total rollup evacuation sums for all population segments in a given PAA.

- The applicant revised Table 3-4 of the 2003 ETE study to provide a listing of the rollup evacuee sums for each PAA to allow for a convenient comparison with the subject figures.

According to the applicant's response to RAI 13.3-45, the corrections to these figures do not impact the 2003 ETE study, its results, or its conclusions.

13.3.3.11.1.1 Site Location and Emergency Planning Zones. Section 1.2, "The Grand Gulf Site and Environs," of the 2003 ETE study provided a general description of the physical area surrounding the existing GGNS Unit 1 site. Section 2.1.1 of Part 4 of the application described in detail the location and physical characteristics for the proposed new reactor(s), which would be located on the existing GGNS Unit 1 site. Figures 2-1, "Property Boundary," and 2-3, "GGNS Unit 1 and Proposed New Facility Exclusion Area Boundaries," in Revision 2 to Part 4 illustrated the site layout, exclusion area, and property line boundaries for the proposed new reactor(s).

Figure 2.4 in Part 4 depicted the plume exposure pathway EPZ, the EPZ boundaries, and topographical features surrounding the existing GGNS, consistent with Section 1.2, "Site Location and Emergency Planning Zone (EPZ)," of the 1986 ETE. Figure 1.1 of the 2003 ETE study also illustrated the plume exposure pathway EPZ, including the transportation network, PAAs, and 22.5-degree sectors at 2, 5, and 10 miles. In addition, Figure 2, "GGNS Plume Exposure Pathway EPZ," of the 1986 ETE showed the plume exposure pathway EPZ. In RAI 13.3-84, the staff asked the applicant to provide a figure(s) for the plume exposure pathway (10-mile) EPZ with discernible prominent topographical features, political boundaries, and road segment numbers. In response, the applicant stated the following:

> Figure 2-6 presents the plume exposure pathway EPZ illustrating prominent topographical features, i.e., the Mississippi River and other important bodies of water that contribute to jurisdictions and roadway layouts. The figure also

includes major roadways involved in evacuation, defines the boundaries of the various protective action areas, and State, county, and parish boundaries. "Road segments," which would be components of a more detailed ETE, analysis were not defined or used in the 2003 ETE Study, given the purpose and nature of the Study.

13.3.3.11.1.2 General Assumptions. Regarding the preparation of time estimates for evacuation within the plume exposure pathway EPZ, Section 2.2.1 of Part 4 indicated that a detailed ETE was performed in 1986 and, in 2003, a detailed evaluation of the original ETE more fully considered the impact of the historical population growth and transportation system improvements. According to Section 2.2.4.4 of Part 4, the 2003 ETE study concluded that the radiological response plans for the States of Louisiana and Mississippi, Claiborne County, and Tensas Parish are more than adequate to address a nuclear emergency at GGNS that requires public protective actions.

In RAI 13.3-95, the staff asked the applicant to clarify if this evaluation considers the impact of the estimated increase in plume exposure pathway population between the 1986 and 2003 ETE studies on offsite response capabilities (e.g., monitoring/decontamination and congregate care center capacity). In response, the applicant stated that, because of the presence onsite of an existing operating unit with fully implemented emergency plans (and supporting offsite plans), a presumption of adequacy exists regarding the effectiveness of current emergency plans and protective actions. This assumption provided an adequate basis for concluding at the ESP stage that the applicant has considered the essential elements of advance planning and made provisions to cope with emergency situations. The applicant did not specifically review shelter adequacy in the 2003 ETE study. However, the overall increase in evacuee population is modest and did not represent a physical characteristic that could significantly impede the development of expanded emergency plans to support the proposed new facility.

Sections 1.3, "Sources of Data and General Assumptions," and 1.4, "Summary of Methodology," described the general assumptions and methodology, respectively, of the 1986 ETE analysis. In the 2003 ETE study, the applicant considered the assumptions from the 1986 ETE to be acceptable, with the addition of Assumption 2.15 regarding the ASU population. The general assumptions identified in Section 2.0 of the 2003 ETE study, Revision 1, and Section 2.2.4.1 of Part 4 are the same, except for the following differences:

- The applicant revised Assumption 2.10 to include outage population numbers for weeknight and weekend estimates and added an explanatory note.

- The applicant revised Assumption 2.11 to indicate that the 25-percent decrease in traffic capacity includes reductions in average speed and roadway capacity during inclement weather. For an EPZ more prone to adverse weather, such as a New England utility subject to severe ice and snow storms, a 25-percent reduction in roadway capacity and travel speed could be taken. In the case of GGNS, a total reduction of 25 percent in traffic capacity based on reduced speed and roadway capacity is appropriate.

- The applicant modified Assumption 2.14 to indicate that buses will be used to transport special populations from facilities such as hospitals, nursing homes, and jails and added an explanatory note.

- The applicant modified Assumption 2.15 to include minor clarifications.

Roadway capacities were calculated using the computer model NETVAC. Assumption 2.11 in the 2003 ETE study, Revision 1, and Section 1.4 of the 1986 ETE stated that roadways will operate at 75 percent of their normal capacity during adverse weather conditions, which is consistent with the Highway Capacity Manual. In RAI 13.3-94, the staff asked the applicant to clarify the effect of adverse weather conditions on traffic speeds and their impact on overall evacuation estimates. In response, the applicant stated the following:

> The applicant believes that the concepts of roadway capacity and traffic speed are closely linked (i.e., any change in traffic speed is reflected in changes in roadway capacity). NUREG/CR-4831 indicates that rain may reduce traffic capacity by 10–20%, but provides no detailed information regarding additional impact on evacuation times due to reduced traffic speed. NUREG/CR-4831 suggests that adverse weather may reduce traffic capacity by 10–25%.
>
> The guidance provided in NUREG/CR-4831 is applicable to a broad range of conditions that may affect domestic nuclear plants, including significant icing, snowfall and other winter weather conditions, some of which are not expected to apply to the GGNS site. These winter weather conditions (in more northern climates) may affect evacuation route capacities and speeds by limiting access to travel lanes and road shoulders. However, such effects [are] not expected as a result of the rains that are common to the GGNS area. Even though these winter weather effects are not expected at the GGNS site, the applicant assumed a 25% reduction in roadway capacity for the 2003 ETE Study. This 25% roadway capacity reduction, compared to the guidance provided by NUREG/CR-4831, is conservative by a factor of 1.25–2.5. As a result, the applicant believes that the 25% reduction in roadway capacity is appropriate for the GGNS area and that the 2003 ETE Study provides a conservative estimation of the effects of adverse weather on evacuation times. As discussed in Section 6.0 of the 2003 ETE Study, the results of the 1986 ETE remain valid and in some cases may overstate actual evacuation times.

Section 3.1, "General Methodology," of the 1986 ETE referenced the methodology and assumptions regarding population estimates and automobile occupancy rates. Population estimates were based on surveys of residents and emergency preparedness officials.

Assumption 2.6 in the 2003 ETE study, Revision 1, and Section 2.2.4.1 of Part 4 indicated that law enforcement officers will control traffic at key intersections. In RAI 13.3-82, the staff asked the applicant to clarify the modeling of this practice in NETVAC. In response, the applicant stated the following:

> As discussed in the response to RAI 13.3-77, per the goals (and constraints) of the 2003 ETE Study, there was no attempt to update (or review) the modeling used in the 1986 ETE. Assumption 2.6 was considered realistic and appropriate for the 2003 ETE Study since the current State emergency plans provide for traffic control. The presence or absence of traffic control points was not explicitly considered in the 2003 ETE Study. However, broadly speaking, the use of effective traffic control would be expected to improve evacuation performance.

Thus, the 2003 ETE Study is considered to provide a conservative update of the previously-estimated evacuation times.

Assumption 2.13 in the 2003 ETE study estimated an occupancy of two persons per vehicle for GGNS employees and three persons per vehicle for ASU students. Assumption 2.15 indicated that most students and residents at ASU have their own vehicles. In addition, the 2003 ETE study included an assumption of 60 schoolchildren per bus but did not describe the assumptions for jails, nursing homes, or hospitals. In RAI 13.3-81, the staff asked the applicant to provide the basis for these occupancy rates, as well as vehicle occupancy factors for special facilities. In response, the applicant stated the following:

> Because the 2003 ETE Study was used to validate the results of the 1986 ETE, the assumptions used in the 2003 ETE Study, including vehicle occupancy factors, are essentially identical to those used in the 1986 ETE.
>
> In the revised 2003 ETE Study, clarifications have been included with the assumptions to address GGNS staffing levels, adverse weather conditions, and non-auto owning residents. For evacuation of special facilities, a vehicle occupancy factor of 3 persons per vehicle was assumed, consistent with the 1986 ETE. This rate was applied to persons in jails, nursing homes, and hospitals.

In response to RAI 13.3-81, the applicant made appropriate revisions to Assumptions 2.10, 2.11, and 2.14 in Revision 1 to the 2003 ETE study, and Section 2.2.4.1 in Revision 2 to Part 4 of the application.

13.3.3.11.1.3 Methodology. Section 1.4 of the 1986 ETE described the methodology used for the analysis, which is based on a time-distribution approach and uses the NETVAC computer model. The 2003 ETE study examined changes in population and the roadway system since 1986 and made a qualitative determination of their impact on the 1986 ETE. However, the 2003 ETE study did not rerun the computer model.

Section 1.5, "Conditions Modeled," of the 1986 ETE noted that the analysis modeled weekday fair weather, weekday adverse weather, nighttime fair weather, and weekend-day fair weather. The applicant further indicated that it did not model the weekend case for adverse weather (assumed to be a thunderstorm) because recreational facilities would not be at peak capacity under such conditions, identified as sudden rainstorms in Section 1.3 of the 1986 ETE. In RAI 13.3-83, the staff asked the applicant to clarify the reason that adverse weather conditions would apply for weekday but not weekend-day cases. In response, the applicant stated the following:

> The basis for the assumptions regarding adverse weather conditions in the 1986 ETE is not clear. However, the peak EPZ population and evacuation traffic flow for both the 1986 ETE and 2003 ETE Study were determined to occur on weekdays. The peak weekday evacuation population (sum of all population segments) is over 5,000 greater than the peak weekend scenario.

> As summarized in Study Table 3-1, the same permanent population is applied to each scenario. In each case, for other population segments, the population value for the weekday scenario is limiting. The primary component that decreases for the weekend scenario is in special facilities which largely reflects the elimination of weekday school attendance.
>
> The adverse weather condition (reduced roadway capacity to 75% per Section 2.2.4.1 and 2003 ETE Study Assumption 2.11) was applied to the limiting evacuation traffic scenario in the 2003 ETE Study, i.e., weekday. Given the substantial difference (>5000 persons) between the peak weekday and peak weekend populations, there is no need to explicitly consider the impact of adverse weather on a weekend evacuation.

In RAI 13.3-86, the staff asked the applicant to clarify the evacuation route characteristics and modeling of traffic control measures to support the NETVAC model results. In response, the applicant stated the following:

> [N]o attempt was made to evaluate the specific method, modeling, etc. used internally to the 1986 ETE, in particular the detailed input of road network characteristics or modeling of traffic control. However, in support of the 2003 ETE Study, an appropriately thorough drive-through review of each principal evacuation route was made, noting route characteristics such as number of lanes, traffic signals and signs, road conditions, etc. This was performed with a site Emergency Preparedness staff person knowledgeable in emergency planning. The results were considered both quantitatively and qualitatively. It was quantitative in applying standard road capacity values, based on professional judgement, to a given set of road characteristics. It was qualitative in the final assessment as to how the evacuation performance might compare with 1986 ETE results. As a general conclusion, it is believed that the road networks have much improved over that observed and modeled in 1986. This was confirmed in informal discussions with local officials, knowledgeable on evacuation and emergency planning matters.

In addition, RAI 13.3-87 asked the applicant to provide the site-specific information used to develop trip generation times, according to the guidance in NUREG/CR-4831, as a basis for the time distributions. In response, the applicant stated the following:

> The 1986 Evacuation Time Estimate was performed before the publication of NUREG/CR-4831 and therefore is not fully consistent with that NUREG. While the 1986 ETE does not use the term “trip generation time,” Section 1.1 of the 1986 ETE indicates that the time estimates include times required for public notification, preparation and mobilization, and actual movement out of the EPZ under various areas, times, and weather conditions. These concepts appear to be consistent with those concepts included in the NUREG/CR-4831 discussion of trip generation times. Section 3.1 of the 1986 ETE indicates that the double-counting of some segments of the population (e.g., permanent residents who are using recreational facilities) is intentionally included to simulate traffic friction on the roadway network due to individuals returning home prior to the actual evacuation.

The actual time distributions used in the 1986 ETE are discussed in Section 5.2–5.4 of the 1986 ETE. Section 1.3 of the 1986 ETE indicates that the assumed times were developed based on a review of site-specific EPZ characteristics and discussions with local emergency preparedness officials and that these officials concurred with the assumed notification, mobilization, and preparation times.

[T]he 2003 ETE Study's method was a comparative analysis of vehicle loading from the 1986 ETE to that determined in the 2003 ETE Study, followed by an assessment of how the loading would likely be handled by current evacuation roadway networks. The Study, therefore, did not specifically evaluate trip generation times. However, this method was considered adequate for the purposes of the 2003 ETE Study.

13.3.3.11.1.4 <u>Demand Estimation/Permanent Residents</u>. Section 3.2 and Figure 5, "Permanent Population Distribution Within the Grand Gulf EPZ," of the 1986 ETE estimated the permanent resident population within the plume exposure pathway EPZ as 8702 people. The 2003 ETE study, Revision 1, and Section 2.2.3.7 of Revision 2 to Part 4 of the application listed the permanent resident population as 9846 based on a 2002 population estimate. In RAI 13.3-76, the staff asked the applicant to describe the methodology used to calculate the 2002 permanent population estimate. In response, the applicant stated the following:

As described in Section 2.2.3, population data were primarily based on the 2000 U.S. Census. As noted in this section, LandView software was used to apply and translate Census data (using Census "block points") to develop permanent population data in each required area segment. Additional discussion on the use of LandView 5 is provided in the SSAR and ER sections on population assessment. The standard presentation of permanent population information, using 1 mile segments through each 22.5 degree arc centered on the 16 cardinal points, is provided in Figure 2-4. This is described in Section 2.2.3.1. As described in this section, this presentation of resident population within the plume exposure pathway was based on the 2000 Census (not a projection to 2002). (The 2002 projection was applied only to the broader ingestion pathway EPZ, as described in Section 2.2.3.2 and is illustrated in Figure 2-5.)

The primary use of permanent population data within the plume exposure EPZ is to support protective action planning. For this purpose, the GGNS Unit 1 E-Plan divides this EPZ into Protective Action Areas (PAA). The same PAAs are proposed for use for the new facility and are described in Section 2.2.4.2 of the Application. As discussed in Footnote 1 to the methodology discussion in Section 2.2.2, the permanent resident portion of the plume exposure population was based on the 2000 Census due to the complex geometries of the plume exposure pathway EPZ. The complexities in this case related not only to the expanded areas outside 10 miles (to address Alcorn State University and the communities of St. Joseph and Newellton, LA) but also the challenging translation of Census block data into the boundaries of each PAA which are generally defined by road and/or topographic features.

> This region of Mississippi and Louisiana experienced modest growth in population (Section 2.2.1). Therefore, as noted in Footnote 1, the difference between 2000 and 2002 would not be expected to significantly impact the outcome of the 2003 ETE Study. Population projections for 0 to 10 miles and for 10 to 50 miles from the site are provided in ER Tables 2.5-1 and 2.5-6, respectively. From this data, the net projected growth rate for nearly 3 decades up to 2030 for the permanent population within 50 miles is approximately 7%. This confirms that the 2000 to 2002 differences would be relatively small. The use of 2000 Census data information for permanent population estimates is considered adequate and appropriate for the purposes of the 2003 ETE Study.

The 1986 and the 2003 ETE studies did not divide the permanent population into auto-owning versus transport-dependent groups. In RAI 13.3-89, the staff asked the applicant to provide information on its determination of the transport-dependent population and of the number of vehicles that would be needed for that segment of the population. In response, the applicant stated the following:

> Sections 1.3 and 3.2 of the 1986 ETE indicate that the transport-dependent population was identified through a comprehensive demographic survey of Claiborne County and Tensas Parish.
>
> While the current state and local plans establish provisions for identifying the numbers and locations of transport-dependent individuals and for evacuating these individuals, for vehicle loading purposes, the 2003 ETE Study assumed that all of the transport-dependent persons living outside of special facilities would be transported in privately-owned vehicles. With regard to the number of vehicles, the transport-dependent population was combined with the auto-owning population and the same vehicle loading rate was used, that is, 2.5 persons per household (Note 2 to Table 3-4); 1 vehicle per household (Assumption 2.12); thus, 2.5 persons per vehicle. Because some portion of the transport-dependent population is likely to be transported in higher-capacity vehicles, this provides a conservative estimation of the impact of vehicle loading and evacuation times.

Section 3.2 of the 1986 ETE indicated that the 1985 Claiborne County and Tensas Parish demographic surveys identify the number of permanent population households having access to at least one automobile. The 1986 ETE estimated the number of vehicles at one vehicle per household for the auto-owning population, with an auto-occupancy factor of 2.5 persons per vehicle in Claiborne County, and a transport-dependent auto-occupancy rate of 25 people per bus in Tensas Parish. Note 2 in Table 3-4, “GGNS Population Summary by Evacuation Area and Vehicle Demand 2002,” of the 2003 ETE study stated that one vehicle will evacuate for each household, and each household has 2.5 people. Therefore, for every 100 persons, 25 vehicles will evacuate. In RAI 13.3-88, the staff asked the applicant to clarify its estimation of vehicles based on the permanent population and the data used in the initial NETVAC model. In response, the applicant stated the following:

> The second part of Note 2 on Table 3-4 (Study), which discusses the use of 25 vehicles for every 100 people is incorrect and, as the Staff notes, should have indicated a requirement of 40 vehicles (per 100 persons of permanent population evacuated).

This is a typographical error in the note. The rate of 2.5 persons per household and, thus, 40 vehicles per 100 persons in the permanent population evacuated, was actually used in the Study. The note will be corrected; however, the change has no impact on vehicle loads presented in Table 3-4 (Study).

The applicant amended Note 2 in Table 3-4 as stated above in Revision 1 to the 2003 ETE study.

13.3.3.11.1.5 Demand Estimation/Transient Population. Section 3.3 of the 1986 ETE described the transient population within the plume exposure pathway EPZ in terms of employee workforce and recreational groups and estimates the population as 1814 employees (weekday) and 2728 recreational (weekend) visitors in Table 1, "Transient (Employee Work Force) Population," and Table 2, "Transient (Recreational) Population," respectively. In RAI 13.3-78, Items a through m, the staff asked the applicant to respond to the following apparent inconsistencies in the transient population between Part 4 of the application and the 2003 ETE study:

- Table 3-3, "Special Facilities and Transient Populations 1986–2002," of the 2003 ETE study states that the county hospital has a population of 56 on weekdays and 32 on weeknights and weekends. In RAI 13.3-78a, the staff asked the applicant to verify the figures for weeknights and weekends. In response, the applicant stated that PGCCCD officials provided the Claiborne County Hospital population figures to GGNS Unit 1 emergency preparedness personnel. Table 2-1 in Part 4 reflects only the peak population of 56, which is consistent with Table 3-3 in the 2003 ETE study.

- In RAI 13.3-78b, the staff asked the applicant to describe its method for determining the Young Men's Christian Association (YMCA) population estimates in the 2003 ETE study. In response, the applicant stated that it established these estimates based on communications with YMCA camp officials in November 2002.
- In RAI 13.3-78c, the staff asked the applicant to clarify a discrepancy between Section 2.2.3.3 of Part 4, which lists 800 campers from late May to the end of August, and the 2003 ETE study, which lists 120 campers per weekday/weekend/weeknight. In response, the applicant stated that the numbers provided for the YMCA camper population do not contradict one another. The figure of 800 campers covers the entire period from May through August. The figure of 120 campers is an estimate of peak population for any single day during this period.

- In RAI 13.3-78d, the staff asked the applicant to clarify its rationale for the nonconservative population estimate in the 2003 ETE study, which uses 250 visitors per day at the Grand Gulf Military Park, rather than the 250–300 visitors per day identified in Section 2.2.3.3 of Part 4. In response, the applicant stated that, although 300 people may visit each day, not all these visitors would realistically be present at the same time. The applicant amended Table 3-3 in Revision 1 to the 2003 ETE study to conservatively estimate a figure of 300 visitors and carried this change forward into the ensuing tables and related figures. However, the applicant indicated that this slight increase in total evacuee population (0.25 percent) does not impact the overall study conclusions for the affected PAA.

- In RAI 13.3-78e, the staff asked the applicant to provide information on its derivation of the estimated population of 225 visitors per day for Lake Bruin State Park in Table 3-3 of the 2003 ETE study. In response, the applicant stated that Lake Bruin State Park officials provided the estimate of 225 visitors per day based on their knowledge of park usage.

- In RAI 13.3-78f, the staff asked the applicant to provide its rationale for the population decrease at the Lake Bruin Country Club, as shown in Table 3-3 of the 2003 ETE study. In response, the applicant stated that country club officials supplied the Lake Bruin Country Club population. The applicant did not know the reasons for this decrease in club population between 1986 and 2002.

- In RAI 13.3-78g, the staff asked the applicant to provide information on the decrease in the number of people in the hunting/fishing camps from 1986 to 2002 shown in the 2003 ETE study. In response, the applicant stated that cognizant State officials provided the updated (2002) figures for the usage of hunting/fishing camps. The applicant did not know the reason for the decrease in camp usage.

- Section 2.2.3.3 of Part 4 of the application states that as many as 250 people fish on the weekends and 500–600 people hunt for deer on opening day. The application does not specify totals for other types of hunting (upland game and waterfowl). If opening day is on a November weekend, up to 600 deer hunters, 250 fishermen, and an unspecified number of small game/bird hunters could be present. Therefore, the staff believes that the estimate of 875 people in the original 1986 ETE is more realistic. In RAI 13.3-78h, the staff asked the applicant to provide information on its derivation of the figure of 600 for the estimate used in the 2003 ETE study. In response, the applicant stated the following:

  > The figure provided for the population of hunters was derived through conversations with Mississippi state officials. There is significant redundancy in the figures for the hunting and fishing population (i.e., the figure of 600 deer hunters includes some number of those persons who occupy the hunting and fishing camps). The text related to fishermen indicates that this peak population occurs during the April through September period, while the peak period for the hunting population occurs in the November through January period; therefore, it is unlikely that there will be peak populations of both fishermen and hunters at the same time. Note that the figures provided in Section 2.2.3.3 for hunting clubs include primarily, but not exclusively, deer and duck hunters. Therefore, at least part of the population of waterfowl and upland game hunters has been included. Given the fact that there is likely to be significant overlap between the deer, waterfowl, and upland game and bird hunting populations and that many members of these groups are also included in the permanent resident population, the applicant believes that the evaluation includes sufficient redundancy in population estimates to provide a conservative validation of the original 1986 ETE.

> Even if one assumes a total transient hunting and fishing population of 850 to 1,000, this would add only 125–200 vehicles to the total evacuation vehicle demand (see Table 3-3 of the 2003 ETE Study). Due to the significant overcapacity built into the evacuation roadway network, there would be no significant change to the estimated evacuation times and no impact on the study's conclusion that there are no significant impediments to the development of emergency plans for the proposed new facility.

- In RAI 13.3-78i, the staff asked the applicant to clarify the discrepancy between the 2003 ETE study, which assumes 8–10 hunters per hunting camp, and Section 2.2.3.3 of Part 4, which states that each camp could have up to 20–30 hunters on a weekend day. In response, the applicant stated that the figure of 20–30 hunters represents a peak population figure for the most heavily used camps. Therefore, the figure of 8–10 hunters is a realistic average population for all of the camps. The applicant amended Section 2.2.3.3 of Revision 2 to Part 4 to clarify the difference between the peak and average population figures.

- In RAI 13.3-78j, the staff asked the applicant to provide information on the method for notifying the segment of the transient population associated with hunting and fishing. In response, the applicant stated that Section 3.5.3 of Part 4 gives information on this topic. For this notification, the applicant will use the ANS established to support GGNS Unit 1, which has been installed, tested, and found to be adequate for the entire plume exposure EPZ.

- In RAI 13.3-78k, the staff asked the applicant to clarify discrepancies between the 2003 ETE study, which estimates 80 workers (weekend), 700 workers (weekday), and 80 workers (weeknight), and Section 2.2.3.3 of Part 4, which reports that an outage requires 210 workers (weekend day), 800 workers (weekday), and 170 workers (weeknight). In response, the applicant stated that the 2003 ETE study uses updated site population figures that are more recent and lower than the figures described in the ER and Part 4 of the application. It updated Section 3.3.3, "Grand Gulf Nuclear Station," and Table 3-3 of the 2003 ETE study in Revision 1 to use the higher Part 4 site population figures. This change also resulted in additional modifications to population and vehicle-loading figures carried forward into related tables and figures. The applicant also stated the following:

  > The use of revised GGNS workforce population figures does not affect the conclusions of the 2003 ETE Study. As a practical matter, the 1986 ETE actually used a much higher workforce population (than the current workforce). Thus, as shown in 2003 ETE Study Table 5-1 for PAA 1, the difference between PAA vehicle demand decreased from 1986 to 2002 by 500 vehicles. Based on bounding projections for the proposed new facility, the workforce could be as high as 1160 persons (ER Table 3.0-1, Item 17.5). Without offering an exact assessment, it can be concluded that the increase in some additional 1200 persons is generally offset by the decrease in vehicle loading from 1986 to 2002. Thus, the overall impact to 1986 conclusions regarding evacuation time would be generally unchanged. Given this qualitative assessment, it is further concluded

that the evacuation of the total site workforce, including the proposed new facility, would not pose a physical characteristic that would be a significant impediment to developing a fully integrated emergency plan.

- Section 2.0 of the 2003 ETE study assumes a vehicle occupancy rate of 2.0. However, Table 3-3 of the 2003 ETE study uses a factor of 1.0 on weekends and weeknights. Finally, the 1986 ETE assumes that, during the weekdays, employees will evacuate at a weighted average of 1.9 persons per vehicle. In RAI 13.3-78l, the staff asked the applicant to clarify these discrepancies. In response, the applicant stated that, as initially constructed, Table 3.3 of the 2003 ETE study uses a vehicle occupancy rate of 1.0 persons per vehicle evacuating from GGNS on nights and weekends, which is consistent with Table 1 of the 1986 ETE. To provide consistency with the stated assumptions, the applicant updated Table 3-3 of the 2003 ETE study, Revision 1, to use a vehicle occupancy rate of 2.0 persons per vehicle evacuating from GGNS. However, the peak weekday scenario is limiting and uses an assumption of 2.0 persons per vehicle, consistent with the 1986 ETE. Thus, this change in Table 3-3 computations for weekend and weeknight vehicle loading will have no impact on the study's final results in Table 3-4, which presents outcomes for the limiting peak weekday scenario.

- In RAI 13.3-78m, the staff asked the applicant to clarify whether it considered commercial fishermen as part of the transient population. In response, the applicant stated the following:

  > As noted in Section 2.2.3.3 there is only limited commercial fishing on the Mississippi River and within the plume exposure pathway area. The number is considered statistically so small (i.e., less than 20) and would likely be distributed in several waterway areas such that they have essentially no meaningful additional impact to evacuation times. As such commercial fishermen, as a unique transient population segment, were not explicitly considered in the 2003 ETE Study computation of vehicle loading. However, there is sufficient double counting of various population segments to more than make up for this omission.

Table 3-3 of the 2003 ETE study considered special facilities and transient populations together, instead of as separate populations, which is consistent with the assumption in the 1986 ETE and Part 4. Assumption 2.2 in the 2003 ETE study also stated that, based on the applicant's interpretation of NUREG-0654/FEMA-REP-1, the ETE need only consider evacuation of permanent and transient populations, since special facilities populations are evacuated separately. In RAI 13.3-77, the staff asked the applicant to clarify why the evacuation estimates did not consider population segments separately, as identified in Section II of Appendix 4 to NUREG-0654 (e.g., permanent residents, transients, and persons in special facilities). In response, the applicant stated the following:

> The 2003 ETE Study was conducted to determine if the results of the 1986 ETE remained valid under current conditions. The overall method involved evaluation of updated population data and transportation roadway characteristics and a qualitative assessment of the potential impact on the results of the 1986 ETE. The 2003 ETE Study made no attempt to update the computer modeling used in the 1986 ETE. While some limited clarifications to the 1986 ETE's assumptions

> were used in the 2003 ETE Study, the Study was generally constrained by the 1986 computer modeling and underlying assumptions. At the same time, the Study's method in using updated evacuee population, vehicle loading, and roadway networks, is considered appropriate and adequate for the purpose of identifying physical characteristics that may represent a significant impediment to developing expanded emergency plans to support the proposed new facility.
>
> Table 3-3 of the 2003 ETE Study includes separate tabulations of the special facility, recreational transient, and workforce transient populations and expected vehicle loads. Therefore, the population of the individual segments may be readily determined by reviewing the table. Table 3-4 transfers these populations and vehicle loads to Protective Action Areas. Table 4-2 compares the estimated vehicle loads to the estimated roadway capacities as a means of validating the findings of the 1986 ETE. See Tables 3-1 through 3-4 and Table 4-2 of the 2003 ETE Study. Thus, the Study did consider the primary population segments (permanent, workforce, special facility, and transient recreational) separately in computing vehicle loading by PAA. However, the Staff is correct in noting that vehicles are summed together for a given PAA (applying Assumption 2.14 regarding the translation of busses to vehicles entering the transportation network). As a result of this approach, there was no explicit determination of evacuation time by population segment. Such an approach was beyond the scope and purpose of this Study.

Section 5.3, "Evacuation Preparation Times and Departure Distributions," of the 1986 ETE noted that the transport-dependent population will begin to evacuate between T=75 and T=135 minutes. The total ETE shown in Table 6, "Evacuation Clear-Time Estimates," of the 1986 ETE is 145–150 minutes. In RAI 13.3-92, the staff asked the applicant to clarify whether this estimate includes the transport-dependent population. In response, the applicant stated the following:

> Section 1.1 of the 1986 ETE indicates that the ETEs include time required for notification, mobilization, and movement. Various sections of the 1986 ETE discuss the details of evacuating the transport-dependent population, indicating that this population segment was considered in the 1986 ETE. If the transport-dependent population begins to evacuate between T=75 and T=135 minutes, and the estimated total evacuation time is 145–150 minutes, then the actual on-road travel time (to reach the boundary of the plume exposure EPZ) for the transport-dependent population could be expected as between 10 and 75 minutes.

In addition, Evacuation Analysis Area 8 in the 2003 ETE study included a large transient population during the peak weekend scenario. In RAIs 13.3-87a and 13.3-87e, the staff asked the applicant to clarify whether it developed specific trip generation times for this group, including an assessment of whether a portion of this group returns home to gather belongings and evacuate as a family unit. In response, the applicant stated that the 1986 ETE was performed before the publication of NUREG/CR-4831; therefore, it is not fully consistent with that document. The applicant also noted that, while the 1986 ETE did not use the term "trip generation time," Section 1.1, "Study Purpose," of the 1986 ETE indicated that the time estimates include the times required for public notification, preparation, and mobilization, as well as actual movement out of the EPZ from various areas, at different times, and under a range of weather conditions. These concepts appeared to be consistent with those included in the NUREG/CR-4831 discussion of trip generation times. In addition, the applicant stated the following:

> With regard to the weekend transient population in Evacuation Analysis Area 8, the applicant notes that Evacuation Analysis Area 8 includes the entire EPZ. Table 3-1 of the 2003 ETE Study indicates that the weekend recreational transient population has dropped from 2728 (in 1986) to 1820 (in 2002). Therefore, the applicant believes that the estimated evacuation times for this population segment are adequately bounded by the 1986 ETE, as updated by the 2003 ETE Study.

13.3.3.11.1.6 <u>Demand Estimation/Special Facility Population</u>. Section 3.4, “Special Facilities Population,” of the 1986 ETE described the special facilities population within the plume exposure pathway EPZ. Table 3, “Special Facilities Population,” of that study estimated the special population to reach 5713 (weekdays), 2144 (weeknights), and 2144 (weekends). Table 3-3, “Special Facilities and Transient Populations,” of the 2003 ETE study, Revision 1, estimates the total special facility population as 7673 (weekdays), 2944 (weeknights), and 2910 (weekends). Section 2.2.3.6 and Table 2-1 of Part 4 also listed special facilities populations.

The 1986 ETE, 2003 ETE study, and Revision 0 to Part 4 of the application contained various apparent inconsistencies in the special needs population. Section 2.2.3.6 of Part 4, and Section 3.3.1, “Alcorn State University,” of the 2003 ETE study reported that 2000 students live on campus. The permanent resident population estimate did not include these students, but they were considered part of the special facilities population segment. Part 4 and the 2003 ETE study stated that 1800 of these students have their own vehicles. In RAI 13.3-79a, the staff asked the applicant to clarify the derivation of this number and whether the other 200 students are considered as part of the transport-dependent population. In addition, the staff asked the applicant in RAI 13.3-79b to clarify where it addressed the families of the 182 staff members and to identify the population segment that includes these families.

In response, the applicant stated the following:

> The number of Alcorn State University students having their own cars was determined through conversations with campus security officials. However, this information was not specifically used in the 2003 ETE Study calculations. While the current state and local plans establish provisions for identifying the numbers and locations of transport-dependent individuals and for evacuating these individuals, for vehicle loading purposes, the 2003 ETE Study assumed that all of the Alcorn State University evacuee population would be transported in privately-owned vehicles (see 2003 ETE Study Assumption 2.13).
>
> Per Assumption 2.15, the ASU student population was set at 2,400. An additional 750 persons were added, accounting for ASU employees, resulting in a sub-total of 3,150 persons. Further, some portion of staff and their families reside on campus (estimated at 182 persons; rounded conservatively up for the Study to 200 persons). Even though some double counting was incurred, this

value of 200 was added to 3,150 to arrive at what is considered an appropriately conservative value for the ASU evacuee population. This value of 3,350 persons was used as the special facility population in PAA 6. See Table 3-3 and 3-4. Thus, there was no explicit distinction made between auto-owning and transportation-dependent persons for the ASU evacuation population. This assumption provides a conservative estimate of evacuation roadway vehicle loading.

> As discussed in Section 2.2.3.6, the ASU housing/campus complex is located on the outer boundary of the plume exposure pathway EPZ with the majority of the campus just outside the 10 mile circle. Assumptions regarding ASU's population are considered appropriate for the purposes and goals of this Study. In addition, evacuees must only proceed a relatively short distance to move out of the defined EPZ. Furthermore, the primary evacuation route from the campus is MS State Highway 552 which, within a short distance from the campus, becomes a 4-lane freeway with a 55 mph speed limit (2003 ETE Study, Section 3.3.1). Thus, small to moderate changes in ASU related populations and vehicle capacity assumptions are likely to have very little impact on evacuation from the plume exposure pathway EPZ.

The applicant updated Assumption 2.15 in Revision 1 to the 2003 ETE study and in Revision 2 to Part 4 of the application to clarify the treatment of the total ASU evacuee population, as described above.

The State and local plans identified in the application do not provide information regarding school bus availability or capacity. In RAI 13.3-79c and subsequently Open Item 13.3-1g, the staff asked the applicant to provide additional information regarding the availability of buses and drivers and the process for mobilizing them during an evacuation to transport students in Claiborne County and Tensas Parish (e.g., whether evacuations can occur in a single trip or require return trips). In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

In RAI 13.3-79d, the staff asked the applicant to provide travel times for special facility populations and information supporting the assumptions for the time distributions. In response, the applicant stated the following:

> The 2003 ETE Study did not explicitly evaluate travel times and time distributions, but rather made comparisons of likely changes in vehicle loadings from those described in the 1986 ETE to the resulting figures of the 2003 ETE Study, using updated population values. The results of this comparison were then assessed in light of the capacity of the current evacuation roadway network. This approach is considered adequate and appropriate for the purposes of this Study.

In RAI 13.3-93, the staff asked the applicant to clarify inconsistencies between the schools and special facilities listed in Table 2-1 of Part 4 and the special facilities for Claiborne County and

Tensas Parish identified in the 2003 ETE study. In response, the applicant stated the following:

> Sections 3.1, "Tensas Parish, Louisiana," and 3.2, "Claiborne County, Mississippi," of the 2003 ETE Study should have listed only those special facilities for which special transportation resources are required:
>
> 1. Alcorn State University (ASU) and Lake Bruin Country Club should not have been listed in these sections. See response to RAI 13.3-79 regarding ASU. Persons at Lake Bruin Country Club were included in the transient recreational segment and would evacuate by private vehicles.
>
> 2. The Richardson School should have been listed as a special facility population segment. Table 2-1 of Part 4 listed all of the special facilities in the Plume Exposure EPZ, regardless of transportation arrangements.

The applicant amended Table 2-1 in Revision 2 to Part 4 of the application and Sections 3.1, "Tensas Parish, Louisiana," and 3.2, "Claiborne County, Mississippi," of the 2003 ETE study, Revision 1, to provide a consistent listing of special facilities, as described above. The applicant noted that these updates relate only to the presentation of information and do not alter the accounting of evacuees in the various population segments; thus, the changes have no impact on the study's conclusions.

Section D.1.g, "Local Government, School Board," of Enclosure I to Attachment 2 to LPRRP Supplement II indicated that the school board was responsible for providing buses and drivers for the evacuation of students, residents, and transients from affected areas. Section II.F, "Special Needs Facilities," of MREPP Annex F also identified the use of buses and ambulances from neighboring communities, such as Natchez and Vicksburg, for transporting special needs persons in the event of an evacuation. In RAIs 13.3-87b and 13.3-87c, the staff asked the applicant to provide trip generation times for these population groups that address the mobilization and availability of buses (e.g., whether single trips will suffice or if return trips will be necessary). In addition, in RAI 13.3-87d, the staff asked the applicant to clarify whether the trip generation times estimated for the evacuation include the mobilization of available transportation for mobility-impaired people and special needs populations, as described in Section II.F, "Special Needs Facilities," of PGCCREPP Annex F.

In response to RAIs 13.3-87b, 13.3-87c, and 13.3-87d, the applicant stated that the 1986 ETE was performed before the publication of NUREG/CR-4831; therefore, it was not fully consistent with that document. The applicant also indicated that, while the 1986 ETE did not use the term "trip generation time," Section 1.1 of the 1986 ETE stated that the estimates included the times required for public notification, preparation, mobilization, and actual movement out of the EPZ from various areas, during different times, and under a range of weather conditions. These concepts appeared to be consistent with those included in the NUREG/CR-4831 discussion of trip generation times. In addition, the applicant stated the following:

> With regard to the weekend transient population in Evacuation Analysis Area 8, the applicant notes that Evacuation Analysis Area 8 includes the entire EPZ. Table 3-1 of the 2003 ETE Study indicates that the weekend recreational transient population has dropped from 2728 (in 1986) to 1820 (in 2002). Therefore, the applicant believes that the estimated evacuation times for this

population segment are adequately bounded by the 1986 ETE, as updated by the 2003 ETE Study.

13.3.3.11.1.7 Emergency Planning Zone and Subareas. Section 2, “Emergency Planning Zone and Sub-Areas,” of the 1986 ETE described the subareas analyzed, including one 0–2 mile case, two 0–5 mile cases, four 0–10 mile cases, and one full EPZ. This approach was consistent with Section 5.1, “Description of the Evacuation Sub Areas,” of the 2003 ETE study. However, Appendix 4 to NUREG-0654/FEMA-REP-1 stated that applicants should consider analysis areas of approximately 2 miles and 5 miles, both with four 90-degree sectors. Section 2 of the 1986 ETE indicated that the study did not evaluate two 90-degree cases from 0–5 miles because these areas have virtually no population.

Table 6, “Evacuation Clear-Time Estimates,” of the 1986 ETE provided estimates for each of the eight subareas for the four scenarios evaluated, with times ranging from 135–150 minutes. These estimates were consistent with those provided in Table 5-1, “Summary of Evacuation Time Estimate Assumptions and Differences,” of the 2003 ETE study.

13.3.3.11.1.8 Traffic Capacity. The 1986 ETE described the evacuation roadway network in Section 4.0 and Table 5, “Primary Evacuation Routes,” and illustrated it in Figure 11, “Designated Evacuation Routings Within the EPZ.” The analysis of evacuation traffic flow operations, described in Section 7.0, “Analysis of Evacuation Traffic Flow Operations,” of the 1986 ETE, concluded that only two areas would experience minor vehicle queuing and that all other roadways have surplus capacity to meet the demand from evacuation. According to the 1986 ETE, the major area of vehicle queuing and delay within the plume exposure pathway EPZ (until approximately 100 minutes into the evacuation) will occur northeast of the plant through Ingleside as a result of the relatively high vehicle demand associated with GGNS during weekday periods. The 1986 ETE also identified temporary queuing along State Route 128, out of St. Joseph, Louisiana.

A subsequent evaluation of significant changes to major roads, described in Section 4.0 of the 2003 ETE study, concluded that, with the exception of the two areas of roadway identified in 1986 where vehicle queuing would occur, all other roadways in the evacuation network have excess capacity such that traffic tends to remain in free-flow conditions. Section 3.3.3 of the 2003 ETE study further indicated that queuing in this area should no longer occur because the workforce has decreased. The applicant stated in response to RAI 13.3-74b, discussed previously, that the projected workforce is not considered a significant concern in future planning because of the much improved capacity of the major evacuation route (i.e., U.S. Highway 61). The applicant also stated the following:

> However, it is recognized that the total evacuation workforce population for the impacted area, PAA1 [Protective Action Area 1], would increase. The primary evacuation routing would be from the GGNS site, over the Grand Gulf Road to the east to Highway 61, and then north toward Vicksburg (2003 ETE Study, Table 4-1). As a practical matter, the 1986 ETE actually used a workforce population much larger than the current workforce. Thus, as shown in the 2003 ETE Study, Table 5-1 for PAA1, the difference between PAA vehicle demand decreased from 1986 to 2002 by 500 vehicles. Based on bounding projections for the proposed new facility, the workforce could be as high as 1160 persons

> (Environmental Report, Table 3.0-1, Item 17.5). Without offering an exact assessment, it can be concluded that the increase in some additional 1200 persons is generally offset by the decrease in vehicle loading from 1986 to 2002. Thus, the overall impact to 1986 conclusions regarding evacuation time would be generally unchanged. Given this quantitative assessment, it is further concluded that the evacuation of the total workforce, including the proposed new facility, would not pose a physical characteristic that would be a significant impediment to developing a fully integrated emergency plan.

Section 10 of the 1986 ETE provided the analysis for the road segment characteristics, consistent with Appendix 4 to NUREG-0654/FEMA-REP-1. Table 4-1, "GGNS EPZ Roadway Analysis 1986–2002," of the 2003 ETE study described roadway improvements made within each defined PAA and lists a revised estimated roadway capacity. Table 2-2 of Part 4 also summarized the roadway capacities, but these estimates are not consistent with the 2003 ETE study. In RAI 13.3-90, the staff asked the applicant to clarify the differences in the evacuation route roadway capacities provided in Table 4-1 of the 2003 ETE study and Table 2-2 of Part 4. In response, the applicant stated that it updated the roadway capacities in Tables 4-1 and 5-1 in Revision 1 to the 2003 ETE study and Table 2-1 of Revision 2 to Part 4 to ensure consistency between the documents. In addition, the applicant stated that these changes have no impact on the findings for a given PAA or on the study's conclusions.

Section II.H.4, "Evacuation Travel," of PGCCREPP Annex F indicated that potential impediments (e.g., natural disasters and the seasonal impassability of roads) may create a major problem in the use of evacuation routes. In RAI 13.3-91a, the staff asked the applicant to clarify whether the ETE adverse weather scenarios consider the evacuation roadways known to be impacted by seasonal conditions (e.g., flooding). In response, the applicant stated the following:

> Assumption 2.11 of the 2003 ETE Study indicates that the applicant conservatively assumed a 25% reduction in roadway traffic capacity for adverse weather conditions. (See also the response to RAI 13.3-95.) This is consistent with the approach used in the 1986 ETE. No roadways were given unique consideration (or penalty) in the 2003 ETE Study due to the special weather-related situations.
>
> For the purposes of the Study, it is considered appropriate and sufficient to apply a conservative traffic capacity penalty across the board to all routes rather than consider unique, local impacts to one area. It is recognized, however, that planning must consider possible changes and impact to planned routes due to adverse weather conditions. Consideration of these impacts is a prudent component of contingency planning and is evidenced by the referenced local plan's discussion and procedural guidance, if such physical impediments arise.

In addition, in RAI 13.3-91b, the staff asked the applicant to clarify whether the ETE analysis considers the impact of traffic passing through the EPZ and any potential effect on an evacuation. In response, the applicant stated the following:

> The GGNS site and EPZ are located in a rural area where traffic congestion is rare. The 2003 ETE Study found that surplus capacity exists on many of the

> evacuation roadways. Table 4-1 of the 2003 ETE Study includes information on average daily traffic counts on the designated evacuation roadways. A comparison of the average daily traffic count to the corresponding roadway capacities indicates that the background traffic is a small fraction of the roadway capacity. Because traffic control measures will limit traffic into the EPZ following declaration of an emergency, the applicant believes it is unlikely that background traffic will have a significant effect on evacuation times. In addition, interviews with state DOT officials and local emergency management officials indicated that they believe that the evacuation time estimated by the 1986 ETE remains accurate or conservative. (See also response to RAI 13.3-96 regarding discussions with local officials.)

In Section 2.2.3.6 of Part 4, the applicant indicated that ASU Stadium may have 20,000 or more visitors on some football game days, which may occur five or six times in the fall. While Section 2.2.3.6 of Part 4 indicated that traffic control in the campus areas was adequate to ensure that a large temporary traffic increase on the roads from an ASU football game will not prevent or preclude other residents from accessing roadways to evacuate if necessary, the 1986 ETE analysis did not include this assumption. Therefore, it may not have been analyzed. In RAI 13.3-80, the staff asked the applicant to provide further information in support of its conclusion. In response, the applicant stated the following:

> The proximity of Alcorn State University (ASU) to the GGNS site is clearly recognized in the planning efforts of the licensee and state/local agencies. The most obvious indication of this is that the standard 10 mile plume exposure pathway EPZ has been expanded to include and define a unique Protective Action Area (PAA 6) along the SW compass point. Thus, population estimates, evacuation, etc. for PAA 6 are included in emergency planning efforts. However, the NRC is correct in noting that the particular circumstance involving the presence of potentially large crowds on the ASU campus for football games was apparently not specifically considered in the 1986 ETE. As a matter of completeness, the applicant considered it to be prudent to address this special situation in the 2003 ETE Study, even though the probability of an emergency at the GGNS severe enough to warrant evacuation occurring coincidentally with a particular type of high attendance athletic contest at ASU is considered quite low. The following summarizes the treatment of this subject:
>
> 1. This special circumstance was, in general, approached in a more qualitative manner. The following repeat key points already stated in Study Section 2.2.3.6:
>
>   a. The event itself is relatively infrequent, that is 5 or 6 games per year.
>
>   b. The campus itself is located on the extreme boundary of the 10 mile circle (from the site); thus, as a practical matter the physical evacuation requires only a short travel distance to be beyond the EPZ boundary.

c. The primary evacuation route utilizes State Highway 552 which is a relatively high capacity, four lane freeway allowing efficient movement of evacuees east to the primary roadway south, U.S. Highway 61.

d. Effective traffic control measures are expected since, as a practical matter, the movement of these game day populations is demonstrated each year. The campus police, in effect, must implement their traffic plans to control and facilitate outbound traffic several times each year, far more often than the exercising of broader emergency plans.

e. Also, while not explicitly mentioned in Study Section 2.2.3.6, given a student population of 3100 (Study Section 3.3.1), it can be concluded that the bulk of the stadium population would be not students and that these would likely have come to the game with 2 to 4 persons per vehicle. Thus, evacuation of the crowd would take advantage of higher vehicle loading.

2. To provide greater confidence on this matter, as part of the 2003 ETE Study, informal discussions were held with ASU campus police staff involved in the handling of game-day traffic, including the explicit issue of evacuating the stadium crowd in the event of a simultaneous emergency at the GGNS site. Interviews with the campus police indicated that they remained confident that the stadium/campus crowd could be evacuated within the estimated 3 hour ETE estimate, determined in 1986.

3. Regarding the potential constraint of ASU game traffic, there would be no overall changes to the conclusions, namely, that evacuation would occur to other outbound emergency evacuation traffic in that PAA or other PAAs.

a. Referring to Figure 2-6 and 2003 ETE Study Table 4-1, there are 5 PAAs in the southern portion of the EPZ, namely 4a, 4b, 5a, 5b, and 6 (which includes ASU).

b. Of these 5 PAAs, only 5a and 6 (per Study Table 4-1) are to use Highway 552 and then Highway 61 South. Of the remaining 3 areas, only PAA 5b is to use Highway 61.

c. PAA 5a: It is recognized that should evacuation of 5a be required concurrent with a game on the ASU campus, the evacuation of PAA 5a would likely be delayed. However, the vehicle load evacuating PAA 5a is quite small, i.e., less than 15 vehicles (2003 ETE Study Table 5-1). Their evacuation would be delayed by being incorporated into the ASU traffic flow but would be expected to be within the 3 hour ETE estimate, based on the above discussion.

d. PAA 5b: This PAA is directed to Highway 61 south. Its evacuating vehicle load is greater than PAA 5a but still small, i.e., approximately 200 vehicles (2003 ETE Study Table 5-1). The evacuation of PAA 5b on Highway 61 south could be delayed by the Highway 552 merger of game traffic on Highway 61 (well outside of the 10 mile EPZ). However, it is expected that the addition of 200 additional vehicles would not substantially change the overall result, that game traffic can be moved off campus and out of the area within 3 hours. Another consideration is that ASU game day exits are accomplished using the current Highway 61 which to the south is 2 lanes. As noted in Table 4-1 of the 2003 ETE Study, Mississippi Department of Transportation planning calls for the additional improvement of Highway 61 South to a four lane freeway similar to the current portion of the highway north of Port Gibson (to Vicksburg). With the added capacity, the evacuation of PAAs 5a, 5b, and 6 would be significantly more rapid.

e. PAA 4a, 4b: These PAAs, while south of the GGNS site, are evacuated to the east towards Hazelhurst, MS on Highway 547 (Study Table 4-1) and would expected to have no practical impact on the evacuation of ASU game-day traffic to the south.

In summary, it is recognized that the potential football game-day crowd can be significant. However, it is considered a rare event and is handled effectively when the games do occur. A qualitative assessment of the evacuation, coupled with interviews with local authorities having the responsibility for the safety of the campus visitors, gives confidence that this location on the extreme boundary of the EPZ can be evacuated effectively. While a more rigorous, quantitative approach was not used, it is expected that such an effort would yield the same conclusion and is not warranted in this instance. The alternative, qualitative assessment described above is considered adequate for this purpose. The evacuation of ASU game-day crowds is not considered an emergency planning concern and does not represent a significant impediment to the development of emergency plans in support of the proposed new facility. Furthermore, this analysis demonstrates that the essential elements of advance planning have been considered and that provisions have been made to cope with emergency situations.

In RAI 13.3-85, the staff asked the applicant to clarify whether it had verified the evacuation routes in the field to determine if the assessment of changes addresses potential impediments in the roadway network. If so, the applicant should describe the method(s) used. In response, the applicant stated the following:

As indicated in Section 1.4 of the 2003 ETE Study, the evaluation included interviews with Mississippi and Louisiana Department of Transportation (DOT) supervisors. Following these interviews, a field verification was conducted by the 2003 ETE Study author, accompanied by a representative of the GGNS Emergency Planning staff, to validate information on the major evacuation

> roadways provided by DOT personnel. The interviews and personal observations included sufficient detail to identify potential impediments in the roadway network.
>
> In general the "field verification" involved the verification of roadway network improvements that were described by local officials in the above noted introductory interviews. This activity generally consisted of the observation of various qualities of the roadway, as needed, such as number of lanes, posted speed limits, lines of sight availability, intersection markings, traffic control devices, etc. One goal of the field work was to note if any obvious physical characteristics existed that might represent a significant impediment to the later expansion of current emergency plans. No such characteristics were noted. Beyond that, the overall goal was to provide additional assurance that roadway capacities, as described by the state DOT, were reasonable based on the roadway qualities observed and the professional judgement of the verification team. This method was considered sufficient and appropriate to support use of roadway capacities in the 2003 ETE Study.

Section 6.0 of the 2003 ETE study indicated that the emergency management directors and the highway foremen in Tensas Parish, Louisiana, and Claiborne County, Mississippi, agreed with the conclusion of the 1986 ETE, that the entire EPZ can be evacuated in less than 3 hours at any time of day or in any weather conditions, remained valid. In RAI 13.3-96 and subsequently in Open Item 13.3-4, the staff asked the applicant to clarify whether the applicable State emergency management and transportation officials/agencies have reviewed the conclusions from the 2003 ETE study and the preliminary analysis described in Section 2.2.4.4 of Part 4 of the application. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application. Subsequently, the GGNS licensee, in response to a RAI, stated the following in its letter dated June 28, 2005:

> All agencies in the States of Louisiana and Mississippi agreed that the 2003 ETE results support the conclusion in the 1986 ETE study, that the entire EPZ can be evacuated in any time of day or weather conditions in less than 3 hours and remains valid.

The applicant described its concept for implementing protective measures for the plume exposure pathway and provided maps showing evacuation routes, evacuation/shelter areas, and relocation centers in host areas. Figure 3-2 in Part 4 illustrated the designated evacuation routes within the plume exposure pathway EPZ based on those currently contained in the GGNS Unit 1 emergency plan and the 1986 ETE. In RAI 13.3-42, the staff asked the applicant to provide a legible version of Figure 3-2 or a description of evacuation routes. In Revision 2 to Part 4, the applicant provided an updated version of Figure 3-2 in electronic format to facilitate its enlargement and review by the NRC.

Figure 3-3, "Mass Care Reception Center Locations," in Part 4 showed the locations of mass care reception centers in the State of Mississippi based on those currently contained in the GGNS Unit 1 emergency plan. In Section 3.10.2 of Part 4, the applicant indicated that

Figure 3-2, instead of Figure 3-3, depicted the locations of existing mass care reception centers. In RAI 13.3-43, the staff asked the applicant to provide a legible version of Figure 3-3 or a description of the mass care reception center locations in the State of Mississippi, and clarify the discrepancy in the figure reference. In Revision 2 to Part 4, the applicant provided an updated version of Figure 3-2 in electronic format to facilitate its enlargement and review by the NRC. The applicant revised the figure to illustrate the mass care reception center locations in the State of Mississippi. In addition, Revision 2 to Part 4 of the application also modified Section 3.10.2 to clarify that Figure 3-2 illustrated the planned evacuation routes and that Figure 3-3 depicted the locations of existing mass care reception centers for evacuees.

In RAI 13.3-44, the staff asked the applicant to provide a map illustrating the location of and general routes to reception centers in the State of Louisiana. In Revision 2 to Part 4, the applicant amended Figure 3-3 to comply with this request.

Appendix 1, “GGNS 10 Mile (Plume Exposure Pathway) EPZ,” to MREPP Annex O included a map showing the sectors. Appendix 3, “GGNS Evacuation,” to MREPP Annex O provided maps showing the evacuation routes and reception and shelter facilities in the State of Mississippi. In RAI 13.3-63 and subsequently Open Item 13.3-1h, the staff asked the applicant to provide a map of the evacuation/shelter areas or, as referred to in Part 4, PAAs (e.g., Area 1, 2A/B) for MREPP Annex O. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

Appendix B to Attachment 2 to LPRRP Supplement II included a map showing the PAAs within the established plume exposure pathway EPZ for GGNS. Tab C, “Evacuation Routes for the Established Plume Exposure Pathway 10-mile EPZ for GGNS,” of Appendix D to Attachment 2 to LPRRP Supplement II provided the evacuation routes in the State of Louisiana. Enclosure I to Attachment 2 to LPRRP Supplement II depicted the reception centers for the State of Louisiana in Figure G-1, “Tensas Parish Reception Centers and Shelter Locations,” and Figure G-1a, “Reception Center and Shelter Listing.”

The applicant included maps showing population distribution around the site. Section 2.2 of Part 4 described the 2003 ETE study and included the following figures illustrating population distribution around the site:

- Figure 2-4
- Figure 2-5, “Projected 2002 Population Distribution 10–50 Mile Radius”
- Figure 2-6

However, Figure 2-6 in Part 4 appeared to be inconsistent with Figure 1.1 of the 2003 ETE study, which showed an evacuee population of 197 in Area 2b and 400 in Area 3b. Figure 2-6 gave an evacuee population of 365 in Area 2b and 509 in Area 3b. In RAI 13.3-45, the staff asked the applicant to provide an updated Figure 2-6 for Part 4, consistent with Figure 1.1 of the 2003 ETE study. In response, the applicant stated the following:

> Both of the subject figures, that is Figure 1.1 from the 2003 ETE Study and Figure 2-6 in Part 4, not only present the boundaries of the plume exposure

> pathway EPZ, but also are provided for illustrative purposes, giving an overall sense of evacuation population by protective action area (PAA). The key data results for evacuation are found in Table 3-4 of the Study.
>
> In general, the staff is correct in noting inconsistencies in the 2003 ETE Study Figure 1.1 and Part 4 Figure 2-6. Upon further review of the figures, it is concluded that both Figure 1.1 (Study) and Figure 2-6 (Part 4) should be updated and reflect the same totals for each PAA. Table 3-4 was reviewed and confirmed to accurately present the total evacuation population (for the limiting scenario, that is, peak weekday). The total limited evacuation value, as currently described in Sections 2.3.3.7, is 20,369 persons. Due to several minor adjustments, there will be a slight, net increase in this value to 20,505 persons.

According to the applicant, because the subject figures illustrated results, corrections to these figures do not impact the 2003 ETE study, its results, or its conclusions.

Figure 2-5 of Part 4 illustrated a projected 2002 population distribution for a 10–50-mile radius. However, Part 4 did not discuss the source for these population estimates, nor was it readily apparent in the 2003 ETE study. In RAI 13.3-46, the staff asked the applicant to identify the source for the estimates. In response, the applicant stated that, as indicated by the footnote in Section 2.2.2 of Part 4, it derived the 2002 population projections from 2000 data published by the U.S. Census Bureau.

Appendix 1, “Maps and Supporting Attachments, Evacuation Route Protective Action Area/Population Density Maps,” to PGCCREPP Annex O contained maps which showed the boundaries, evacuation route, permanent resident population, estimated transient population, and estimated evacuee population for each area.

Tab B, “1985 Projected Permanent and Transient Populations,” of Appendix B to Attachment 2 of LPRRP Supplement II included a map showing the population within the Louisiana PAAs for the established GGNS plume exposure pathway (10-mile) EPZ.

The applicant also discussed its proposed means for notifying all segments of the transient and resident populations.

Section 3.5.3 of Part 4 indicated that, because of the proximity to and common EPZ boundaries with GGNS Unit 1, the applicant expected the proposed new facility to share the existing ANS used for GGNS as the primary means for notifying the population within the plume exposure pathway EPZ, including the transient population. In addition, the applicant will supply institutions located in the plume exposure pathway EPZ with tone-activated receivers to supplement the siren system.

In Section 3.10.2 of Part 4, the applicant stated that the affected counties or parishes will be responsible for warning and/or advising the population at risk of an impending emergency. The State of Mississippi will prepare written messages for emergency dissemination to the public, accompanied by support information provided by the proposed new facility. In RAI 13.3-48, the staff asked the applicant to state whether the written messages refer to the EAS and to identify the responsibility for the preparation of written messages in the State of Louisiana. In Revision 2 to Part 4, the applicant amended Section 3.10.2 to state the following:

> Warning and/or advising the population-at-risk of an impending emergency will be the responsibility of the counties or parishes affected. These counties or parishes also will be responsible for the preparation and dissemination of informational material concerning protective actions for the general public. Written messages for emergency dissemination to the public will be prepared by the States of Mississippi and Louisiana with supporting information provided by the proposed new facility. These messages will be distributed via the Emergency Alert System. These prepared messages will be documented in the affected state emergency plans.

Section II, "Concept of Operations, General," of MREPP Annex C provided extensive information concerning the ANS and the notification process in the State of Mississippi. The MREPP further stated that the public ANS provided the State of Mississippi with the capability to transmit both an alert signal, via sirens, and an informational or instructional message, via the ENS, to essentially 100 percent of the population throughout the plume exposure pathway EPZ within 15 minutes of a protective action decision. State and local officials shared the responsibility for activating this system. In addition, tone-alert receivers placed in various locations supplemented the siren system.

Section II.C, "Responsibilities," of MREPP Annex C designated MEMA as responsible for activating the ENS and noted that PGCCCD activates the ANS, including the tone-alert receivers. The Claiborne County Sheriff's Office will supplement the ANS through route alerting to ensure adequate coverage in the event of a siren failure.

Section II.B, "Protective Response," of PGCCREPP Annex E provided for the activation of the siren system, in coordination with MEMA and MSDH/DRH, should any protective action for the general public be implemented. The PGCCCD will advised Tensas Parish before siren activation.

Section II.A, "Situation," to LPRRP Chapter 4 indicated that the public ANS combines parish/State and utility alert systems (e.g., sirens, monitors, and mobile loudspeakers), as well as alert stations for notification. Section F.7 of Enclosure I to Attachment 2 to LPRRP Supplement II further stated the following:

> An Alert Notification System located throughout the 10 mile EPZ will be used to alert the public to listen to...the ENS radio stations. That portion of the system located within the [Tensas] Parish will be activated from the Parish EOC.... Special notification devices (tone activated alarm pagers) are provided by special facilities including schools, hospital, and major employers....
>
> Mobile sirens and public address systems mounted on patrol cars, fire department and other emergency vehicles could provide backup to the Alert Notification System.

Section E.5 of the enclosure listed the primary alert system for Tensas Parish as comprising a combination of fixed sirens, tone-activated radios, and reliance on the USCG for the notification of ships along the Mississippi River. Should an element of the primary alert system fail, a number of backup methods were available, including route alerting in populated and wetland areas, commercial telephones, and tone-activated radios.

The applicant described the proposed means for protecting those persons whose mobility may be impaired. Section 3.10.2 of Part 4 indicated that the proposed new facility will provide PARs to State and local civil defense agencies. The States of Mississippi and Louisiana and the counties/parishes within the plume exposure pathway EPZ are responsible for implementing protective actions offsite.

Tab C, "Special Needs Population," of Appendix 5 to MREPP Annex F noted that, in the State of Mississippi, a precautionary transfer of the special needs population out of the area may occur during a site area emergency classification in order to effectively remove that population segment from the traffic flow associated with an evacuation during a general emergency classification. The special needs population will be transported to the host county reception centers; those members of this population who require medical attention will be transported to the nearest support hospital.

Appendix 8 to PGCCREPP Annex F addressed actions for the special needs population and stated that the Claiborne County public transportation coordinator was responsible for notifying special needs groups and/or persons, except for schools, within Claiborne County.

Section III, "Concept of Operations," of LPRRP Chapter 7 noted that private automobiles, augmented by buses, will serve as the principal means of transportation in the event of an evacuation in the State of Louisiana. Specific arrangements existed for the transportation of institutionalized persons and schoolchildren. Section IV.A.5, "Potassium Iodide," of LPRRP Chapter 7 provided information on the use of KI for institutionalized persons who are unable to evacuate quickly. It defined institutionalized persons as those individuals residing in nursing homes or confined to hospitals or penal institutions. Section G.3, "Protective Response for the Plume Exposure Pathway, Evacuation," of Enclosure I to Attachment 2 to LPRRP Supplement II also addressed evacuation for special needs populations, including schools, medical facilities, and incarceration facilities.

The applicant also proposed the methodology for the use of radioprotective drugs for emergency workers and institutionalized persons. Appendix 5, "Potassium Iodide Policy," to MREPP Annex G provided information about KI and its use and indicated that the State of Mississippi had opted not to provide KI to the general public. In addition, KI in tablet form was available to emergency workers, hospitals, and nursing homes located within the plume exposure pathway EPZ. The Claiborne County plan specified those facilities, municipalities, agencies, and teams that receive KI for use by emergency workers.

Section II.E, "The Use of Potassium Iodide," of PGCCREPP Annex G indicated that KI will be taken only at the direct order of the State health officer, in accordance with MSDH policy. The PGCC radiological officer will ensure that KI was distributed at the time of an emergency, according to established arrangements. Other guidance contained in Appendix 3, "Potassium Iodide Policy," to PGCCREPP Annex G was consistent with the MREPP. In RAI 13.3-64 and subsequently Open Item 13.3-1c, the staff asked the applicant to describe the means for using radioprotective drugs for institutionalized persons within the Mississippi portion of the plume exposure pathway EPZ whose immediate evacuation may be infeasible or very difficult. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

Section IV.A.5 of LPRRP Chapter 7 provided information on the use of KI for institutionalized persons in the State of Louisiana who are unable to evacuate quickly. Section V.B, "Radiological Exposure Control Measures for Emergency Workers," of LPRRP Chapter 9 stated that KI will be available for use by emergency workers operating in the risk area during an emergency. Section V.B further stated that KI will be administered with the approval of the Department of Health and Hospitals (DHH) State health officer, in accordance with State policy.

Section IV.5, "Radiological Exposure Control, Concept of Operations," of Attachment 2 to LPRRP Supplement II indicated that arrangements will be made for the acquisition, distribution, and use of KI at the time of an accident. The use of KI will be considered for emergency workers and institutionalized persons in the State of Louisiana who may not be able to evacuate immediately. Section D.2, "Parish-Level State Support Agencies," of Enclosure I to Attachment 2 to LPRRP Supplement II indicated that the Parish Health Unit of the State DHH was responsible for assisting with the expedient acquisition of radioprotective drugs and for their use by emergency workers and institutionalized persons, if required. In RAI 13.3-65 and subsequently Open Item 13.3-1c, the staff asked the applicant to describe the means for the use of radioprotective drugs by emergency workers and institutionalized persons within the plume exposure pathway EPZ in the State of Louisiana whose immediate evacuation may be infeasible or very difficult. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

The applicant described the proposed means for relocation. Section II.B, "Protective Action," of MREPP Annex E provided information on the actions taken by the State and local governments at the establishment of the alert, site area emergency, and general emergency notification classes in the State of Mississippi. Section II, "Concept of Operations," of MREPP Annex F provided additional details on actions taken to support the evacuation of the plume exposure pathway EPZ, including the evacuation of special populations.

Section IV, "Organization and Responsibilities," of the PGCCREPP Basic Plan listed the responsibilities of organizations in Claiborne County and the City of Port Gibson, relative to their involvement with identifying and providing for transportation needs during an evacuation. Section II.F and Section II.G, "Medical and Public Health Facility Evacuation," of PGCCREPP Annex F provided details on the evacuation of special needs facilities, including hospitals and nursing homes.

Section III of LPRRP Chapter 7 noted that private automobiles, augmented by bus transportation, will serve as the principal means of transportation in the event of an evacuation. In addition, Section III.E indicated that specific arrangements have been made for the transportation of institutionalized persons and schoolchildren. Section II.N, "Concept of Operation," of Attachment 2 to LPRRP Supplement II stated that privately owned vehicles will be the primary mode of transportation, which was consistent with Section G.3 of Enclosure I to the attachment. Section D.1.g, "Local Government, School Board," of Enclosure I also indicated that the Tensas Parish School Board was responsible for providing school buses and drivers to assist in the evacuation of residents and transients from the affected areas. In addition, Section D.1.h, “Local Government, American Medical Response Ambulance Service,” assigned the responsibility of providing transportation support for nonambulatory evacuees.

The applicant discussed potential relocation centers in host areas. Section II.D, “Reception Centers,” and Section II.E, “Shelter Facilities,” of MREPP Annex F listed the reception centers and shelter facilities for GGNS in the State of Mississippi. Appendix 5 to MREPP Annex F provided the addresses for these facilities. Appendix 7, “Reception Center and Shelter Facility Operations,” to PGCCREPP Annex F also listed the reception centers and shelter facilities (at least 20 miles from the GGNS site) and their locations. Tab B, “GGNS Shelter Facilities,” of Appendix 5 to MREPP Annex F and Tab B, “GGNS Shelter Facilities,” of Appendix 7 to PGCCREPP Annex F addressed the availability of shelters and indicated that their total capacity in the State of Mississippi is 7217.

Figures G-1 and G-1a in Enclosure I to Attachment 2 to LPRRP Supplement II provided a map and addresses for the three reception centers in the State of Louisiana, as well as their relative locations from the GGNS site, but did not provide information on shelter capacity. In RAI 13.3-75 and subsequently in Open Item 13.3-1i, the staff asked the applicant to describe its plans to address shelter facility capabilities based on any anticipated population increase within the plume exposure pathway. In response to RAI 13.3-75, the applicant stated that the currently implemented State and local plans, which provided for sheltering as a possible protective action, must be periodically reviewed and updated. According to the applicant, the 2003 ETE study, made available to State and local agencies, will be considered for possible impacts to State and local plans, including shelter capacity adequacy. In addition, the applicant’s response to Open Item 13.3-1i stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

In Table 2-2 of Part 4 of the application, the applicant projected the traffic capacities of the evacuation routes under emergency conditions. Table 2-2 also listed the roadway capacity (vehicles per hour) for each of the primary evacuation routes, based on the 2003 ETE study.

The applicant also described the control of access to evacuated areas. Section 3.3.1.3 of Part 4 stated that the Claiborne County Sheriff’s Department and the Port Gibson Police Department may be activated to assist in emergency efforts, including controlling access to areas affected by the emergency. The applicant did not specify the organization(s) responsible for such control in Louisiana. In RAI 13.3-47, the staff asked the applicant to clarify whether it intended Section 3.3.1.3 of Part 4 to describe measures to control access to areas at the proposed reactor site or within the plume exposure pathway. In response, the applicant stated that, with respect to the provisions for controlling access to areas affected by the emergency, the local law enforcement agencies control entry to public roads and other areas accessible to the public. Although this necessarily affects the accessibility of the site via public roadways, the site security force retains responsibility for controlling site access. The applicant expected that similar arrangements will be made for the proposed new facilities. In Revision 2 to Part 4, the applicant amended Section 3.3.1.3 to clarify the roles of local law enforcement agencies, consistent with Supplement 2 guidance:

Law enforcement responsibilities will include controlling matters of civil disorder within Claiborne County (provided by Sheriff's Department) and within the city limits of Port Gibson (provided by Sheriff's Department and Port Gibson Police Department).

In addition, the applicant indicated in Section 3.3.2.7 of Part 4 that USCG has jurisdiction over Mississippi River traffic, and that the USCG Captain of the Port exercised his authority to control traffic through the establishment of a safety zone in the immediate area.

Appendix 6, "Traffic Management Concepts," to MREPP Annex F and Appendix 5, "Traffic Management Concepts," to PGCCREPP Annex F assigned the responsibility for controlling access to the evacuated areas around GGNS in the State of Mississippi to the Highway Patrol, local law enforcement, the National Park Service, and MDOT.

Section IV.A.3, "Access Control," of LPRRP Chapter 7 defined access control as a protective action used to prevent undue radiological exposure to members of the public entering a PAA in the State of Louisiana. In addition, the LPRRP indicated that access control may be used as a separate action or in conjunction with other actions, such as evacuation or sheltering. Such control was the responsibility of the law enforcement office of the parish at risk, which will be augmented, as necessary, by the Louisiana State Police. Section D.1.d, "Local Government, Sheriff's Office," of Enclosure I to Attachment 2 to LPRRP Supplement II assigned the sheriff's office as the lead law enforcement and traffic control agency within Tensas Parish, with responsibility for instituting access control and area security. Section D.2 of Enclosure I also identified State Police Troop F as responsible for assisting the sheriff's office in establishing access control to affected areas. In addition, Section G.1, "Control of Entrance into Affected Areas," of the enclosure indicated that the Tensas Parish Sheriff's Office and St. Joseph and Newellton law enforcement personnel provided support in controlling access, with assistance as requested from the Louisiana State Police. Finally, Section G.3 of the enclosure stated that strict traffic control measures will govern ingress to and egress from affected areas.

The applicant also described the plan for identifying and dealing with potential impediments when implementing protective measures for the plume exposure pathway. Appendix 6 to MREPP Annex F referenced specific procedures and checklists for traffic control point and access control point conduct. Section II.H.4 to PGCCREPP Annex F indicated that potential impediments will require implementation of the alternatives, depending on the impediment.

Section III of LPRRP Chapter 7 indicated that procedures for dealing with potential impediments along primary evacuation routes will essentially follow parish enclosures to the LPRRP. Section D.1.j, "Local Government, Tensas Parish Police Jury Highway Department," of Enclosure I to Attachment 2 to LPRRP Supplement II assigned the responsibility for clearing impediments to allow road passage. Section G.3 of the enclosure also stated that strict traffic control measures will be used to remove impediments on evacuation routes.

The applicant gave time estimates for the evacuation of various sectors and distances based on a dynamic analysis of the plume exposure pathway EPZ. Section 2.2 of Part 4 of the application provided a preliminary analysis of the time required to evacuate transient and permanent populations from various sectors and distances within the 10-mile plume exposure pathway EPZ. Section 2.2.1 of Part 4 noted that a detailed ETE for the plume exposure pathway EPZ, performed in March 1986, showed a maximum evacuation time for the affected area of approximately 3 hours. Appendix D to Attachment 2 to LPRRP Supplement II, MREPP Annex F, and Appendix 6, “GGNS Evacuation Time Estimate Study,” to PGCCREPP Annex F summarized the 1986 ETE. The applicant further indicated in Section 2.2.1 that a detailed evaluation in May 2003 of the original ETE more fully considered the impact of historical population growth and transportation system improvements.

The applicant prepared Revision 1 to the 2003 ETE study, dated January 2005, and provided it in response to RAI Letter 6. Associated changes were also incorporated by applicant into Revision 2 to Part 4 of the application. While Revision 1 to the 2003 ETE study updated the increase in population (1986–2002) from 10.4 to 11.1 percent, both Revision 1 to the 2003 ETE study and Revision 2 to Part 4 confirmed that the original 1986 ETE of 3 hours continued to be valid because of substantial roadway improvements.

The applicant provided the bases for choosing recommended protective actions along the plume exposure pathway during emergency conditions. Annex E, “Protective Actions,” of the MREPP and PGCCREPP Annex E, “Protective Response,” provided information on the bases for the choice of recommended protective actions in the State of Mississippi, given the emergency class and in accordance with EPA PAGs.

Section IV, “Protective Response Options,” of LPRRP Chapter 7 discussed the PAR options available (e.g., sheltering, respiratory protection, access control, evacuation, KI, and limitation to duration of exposure) in the State of Louisiana and the considerations for each population (e.g., general public, emergency workers, institutionalized individuals, and schoolchildren). Tab 1 of LPRRP Chapter 7 provided the technical bases for recommending sheltering or evacuation as a protective action.

The applicant also discussed the means for registering and monitoring evacuees at reception centers in host areas. Appendix 5 to MREPP Annex F provided information on the functioning of the reception centers and shelter facilities in the State of Mississippi. The Mississippi Department of Human Services will supply the registration forms to the reception centers. The county civil defense/emergency management department, under the supervision of the MSDH/DRH, will assure that evacuees and their vehicles are monitored and decontaminated. Appendix 3, “Evacuee Monitoring and Decontamination Procedures for People and Vehicles,” to MREPP Annex G detailed the methods and equipment to be used to monitor evacuees and their vehicles upon their arrival at a reception center.

Appendix 7 to PGCCREPP Annex F also provided basic information on the reception center and shelter facility operations in the State of Mississippi. All reception centers and shelter facilities were located in host (support) counties, which are referenced in PGCCREPP Annex N, “Supporting Plans and Procedures.”

Section IV, “Radiological Exposure Control Measures for the General Public,” of LPRRP Chapter 9 detailed the monitoring and registration of evacuees in the State of Louisiana. At-risk and support parishes will perform contamination surveys at reception centers for all anticipated evacuees within 12 hours of the completion of the evacuation. Chapter 5, “Radiological Exposure Control,” of Attachment 2 to LPRRP Supplement II indicated that surveying and decontamination for members of the public will take place at reception centers in the State of Louisiana, which will be established in Franklin, Concordia, and Madison Parishes.

Section D of Enclosure I to Attachment 2 to LPRRP Supplement II indicated that the American Red Cross was responsible for providing reception and care for evacuees. Section H.1, "Public Health Support, Reception and Care," of Enclosure I also indicated that the reception center extension service will register evacuees initially. The American Red Cross, in conjunction with the Office of Family Security, will perform a second, more detailed registration of evacuees at the shelters.

13.3.3.11.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using the guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.D, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature J, "Protective Response."

Major feature J calls for the applicant to describe protective actions for the plume exposure pathway EPZ for the public and emergency workers, including evacuation routes, transportation, and handling evacuees. The application should identify guidelines for the choice of protective actions, consistent with Federal guidance, as well as the bases and mechanism for recommending protective actions to State and local authorities. The application should describe each organization's concept for implementing protective actions and describe contacts and arrangements with offsite agencies. In addition, the applicant should prepare an ETE for the 10-mile plume exposure pathway EPZ.

13.3.3.11.3 Technical Evaluation

The staff finds that the applicant's responses to RAIs 13.3-37 and 13.3-38, which were implemented in Revision 2 to Part 4 of the application, are acceptable. Revision 2 to Part 4 of the application and the MREPP described the evacuation routes and transportation for onsite individuals to suitable locations, including alternatives for inclement weather, high traffic density, and specific radiological conditions. In addition, Section 3.10.1 of Part 4 of the application described the methods for notification and accountability of site personnel. Because this information is outside the scope of the ESP application review, the staff deferred its evaluation to the COL application process.

The staff finds that the applicant's responses to RAIs 13.3-39, 13.3-40, and 13.3-41, which were implemented in Revision 2 to Part 4 of the application, are acceptable. In Revision 2 to Part 4 of the application, the applicant described a mechanism for recommending protective actions to the appropriate State and local authorities in accordance with EPA-400-R-92-001 and consistent with the guidance contained in Supplement 3, “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants—Criteria for Protective Action Recommendations for Severe Accidents—Draft Report for Interim Use and Comment,” to NUREG-0654/FEMA-REP-1, Revision 1.

The applicant performed a detailed ETE for the plume exposure pathway EPZ in March 1986 and determined that the maximum evacuation time for the affected area is approximately 3 hours. Appendix E to the Grand Gulf Nuclear Station Emergency Plan, Revision 50, contained this detailed ETE of the GGNS Emergency Plan, referred to as the 1986 ETE. In addition, as documented in the addendum to Appendix E, a door-to-door demographic survey conducted in August 1992 in the GGNS plume exposure pathway EPZ showed a negligible increase in the permanent population of 0.54 percent (47 people). As such, the addendum concluded that the population change should have no discernible effect on the emergency plan and that the population figures listed in the 1986 ETE remained valid.

In support of the ESP application, in Section 2.2 of Part 4, the applicant provided a preliminary analysis of the time required to evacuate transient and permanent populations from various sectors and distances within the 10-mile plume exposure pathway. This preliminary analysis, performed in May 2003, involved a detailed evaluation of the original ETE to more fully consider the impact of historical population growth and transportation system improvements. The 2003 ETE study showed both an increase of 10.4 percent in the plume exposure pathway EPZ population and substantial improvements to major evacuation roadways that have increased the surplus capacity since the 1986 review. The evaluation was consistent with the guidance on updates contained in NUREG/CR-4831, which stated the following:

> As a general rule, a 10 percent increase in population indicates a need to check evacuation times. An initial assessment would involve determining whether growth had taken place in areas constrained by roadway capacity. If the possibility exists for increased evacuation times, a detailed analysis is necessary.

The 2003 ETE study met the intent of this initial assessment and concluded that, although the EPZ population increased by 10.4 percent, the time estimates in the 1986 ETE remained valid and, in some cases, may even have overstated actual evacuation times because of substantial improvements to major evacuation roadways since 1986.

On January 25, 2005, the applicant submitted Revision 1 to the 2003 ETE study in response to RAI Letter 6, dated August 13, 2004, which updated the peak EPZ population increase (1986–2002) to 11.1 percent. Associated changes were also incorporated in Revision 2 to Part 4 of the application. The staff finds that the applicant’s responses to RAIs 13.3-76, 13.3-77, 13.3-78a through 78m, 13.3-79a, 79b and 79d, 13.3-80, 13.3-81, 13.3-82, 13.3-83, 13.3-84, 13.3-85, 13.3-86, 13.3-87a through 87e, 13.3-88, 13.3-89, 13.3-90, 13.3-91, 13.3-92, 13.3-93, 13.3-94, and 13.3-95 are acceptable. .

In Section 2.2.4.4 of Revision 2 to Part 4 of the application, the applicant indicated that Revision 1 to the 2003 ETE study concluded that the maximum evacuation time for the affected area of approximately 3 hours from the 1986 ETE remains valid. In addition, the applicant also concluded that no physical characteristics unique to the site could pose a significant impediment to the development of emergency plans and the implementation of protective actions for the areas surrounding the proposed new facility. This conclusion was consistent with Section 6.0 of Revision 1 to the 2003 ETE study.

The 1986 ETE was prepared in accordance with Appendix 4 to NUREG-0654/FEMA-REP-1, which was consistent with the guidance contained in Evaluation Criterion J.3 for ESP applications in Section V of Supplement 2. The format used and contents of the 1986 ETE were consistent with the guidance in Appendix 4 to NUREG-0654/FEMA-REP-1.

Because the 1986 ETE preceded the publication of NUREG/CR-4831, it was not fully consistent with that document. Since the 2003 ETE study essentially updated the 1986 ETE, in that it evaluated population growth and evacuation roadway changes, the 2003 ETE study was also not fully consistent with NUREG/CR-4831. In addition, the applicant made no attempt and was not required to update the specific method or computer modeling used in the 1986 ETE for the 2003 ETE study. As such, the 1986 computer modeling and underlying assumptions also generally constrained the 2003 ETE study.

Based on the changes to the assumptions and data inputs implemented under Revision 1 to the 2003 ETE study and Revision 2 to Part 4 of the application, the staff considers that the ETE preliminary analysis, contained in Section 2.2 of Part 4, and Revision 1 to the 2003 ETE study adequately describe the current population distributions and roadway improvements, using the guidance in Appendix 4 to NUREG-0654/FEMA-REP-1. In RAI 13.3-79c, the staff asked for further information regarding the availability and capacity of school buses or other transportation methods, the availability of drivers, and the process for mobilizing them during an evacuation for the transport of students, residents, transients, and special needs populations in Claiborne County and Tensas Parish (e.g., whether evacuations can occur in a single trip or require return trips). The staff identified consideration of this information as Open Item 13.3-1g in the draft SER. The staff reviewed the applicant's response, and finds it acceptable for an ESP application, except to the extent that the arrangements would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a COL or OL application. The staff will determine the adequacy of such incorporation during a COL or OL review. Therefore, Open Item 13.3-1g is resolved.

Section 6.0 of the 2003 ETE study indicated that the emergency management directors and local transportation department officials (highway foreman) for both Tensas Parish, Louisiana, and Claiborne County, Mississippi, agreed that the conclusion in the 1986 ETE, that the entire EPZ can be evacuated at any time of day or in any weather conditions in less than 3 hours, remained valid. In RAI 13.3-96, the staff asked the applicant for further information to clarify that the 2003 ETE study results had been reviewed by applicable State emergency management and transportation officials/agencies in accordance with NUREG/CR-4831. The staff identified consideration of this information as Open Item 13.3-4 in the draft SER. The staff reviewed the applicant's response, as supplemented by a letter from the GGNS licensee dated June 28, 2005, and finds that the results of the 2003 ETE study were subsequently review and concurred on by the appropriate State officials. Therefore, Open Item 13.3-4 is resolved.

The staff finds that the applicant's responses to RAIs 13.3-42, 13.3-43, and 13.3-44, which were implemented in Revision 2 to Part 4 of the application, are acceptable. Revision 2 to Part 4 of the application, the MREPP, and Enclosure I to Attachment 2 of LPRRP Supplement II, provided maps showing evacuation routes, evacuation/shelter areas, and relocation centers, as applicable. In RAI 13.3-63, the staff asked for further information illustrating the evacuation/shelter areas or, as referred to in Part 4 of the application, PAAs (e.g., Area 1, 2A/B) for MREPP Annex O. The staff identified consideration of this information as Open Item 13.3-1h in the draft SER. The staff reviewed the applicant's response, and find the maps acceptable for an ESP application, except to the extent that the arrangements would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a COL or OL application. The staff will determine the adequacy of such incorporation during a COL or OL review. Therefore, Open Item 13.3-1h is resolved.

The staff finds that the applicant's responses to RAIs 13.3-45 and 13.3-46, which were implemented in Revision 2 to Part 4 of the application and Revision 1 to the 2003 ETE study, are acceptable. Revision 2 to Part 4 of the application, the PGCCREPP, and Attachment 2 to LPRRP Supplement II, provided maps showing the population distribution around the site based on sectors or designated evacuation areas.

The staff finds that the applicant's response to RAI 13.3-48, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LPRRP, and Enclosure I of Attachment 2 to LPRRP Supplement II, discussed the proposed means for notifying all segments of the transient and resident populations.

Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LPRRP, and Enclosure I of Attachment 2 to LPRRP Supplement II discussed the proposed means for protecting those persons whose mobility may be impaired (e.g., because of institutional or other confinement).

The MREPP, PGCCREPP, LPRRP, and Enclosure I and Attachment 2 of LPRRP Supplement II discussed the use of radioprotective drugs within the plume exposure EPZ. In RAIs 13.3-64 and 13.3-65, the staff asked for further information to describe the means for using radioprotective drugs for emergency workers and institutionalized persons within the plume exposure pathway EPZ in the States of Louisiana and Mississippi, whose immediate evacuation may be infeasible or very difficult. The staff identified consideration of this information as Open Item 13.3-1c in the draft SER. The staff reviewed the applicant's response, and finds State/local plans acceptable for an ESP application, except to the extent that the arrangements would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a COL or OL application. The staff will determine the adequacy of such incorporation during a COL or OL review. Therefore, Open Item 13.3-1c is resolved.

The MREPP, PGCCREPP, LPRRP, and Enclosure I and Attachment 2 to LPRRP Supplement II discussed the proposed means of relocation. In addition, the MREPP, PGCCREPP, and Enclosure I to Attachment 2 to LPRRP Supplement II identified potential relocation centers in host areas which are at least 10 miles beyond the boundaries of the plume exposure EPZ. Annexes to the MREPP and PGCCREPP Annex F addressed the availability of shelters and indicate their total capacity in the State of Mississippi. In RAI 13.3-75, the staff asked for further information to describe shelter facility capabilities based on any anticipated population increase within the plume exposure pathway EPZ. The staff identified consideration of this information as Open Item 13.3-1i in the draft SER. The staff reviewed the applicant's response, and finds it acceptable for an ESP application, except to the extent that the arrangements would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a

COL or OL application. The staff will determine the adequacy of such incorporation during a COL or OL review. Therefore, Open Item 13.3-1i is resolved.

Part 4 of the application projected the traffic capacities of evacuation routes under emergency conditions and listed the roadway capacity (vehicles per hour) for each of the primary evacuation routes, based on the 2003 ETE study.

The staff finds that the applicant's response to RAI 13.3-47, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II, discussed the control of access to evacuated areas and organizational responsibilities for such control.

The MREPP, PGCCREPP, LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II discussed the identification of and the means for dealing with potential impediments (e.g., seasonal impassability of roads) to the use of evacuation routes, as well as contingency measures.

Appendix D to Attachment 2 to LPRRP Supplement II, MREPP Annex F, and PGCCREPP Appendix 6 summarized the time estimates for the evacuation of the various PAAs, based on the dynamic analysis performed in the 1986 ETE.

The MREPP, PGCCREPP, and LPRRP discussed the basis for the choice of recommended protective actions from the plume exposure pathway during emergency conditions. In addition, the MREPP, PGCCREPP, LPRRP, and Enclosure I and Attachment 2 to LPRRP Supplement II described the means for registering and monitoring evacuees at reception centers in host areas.

13.3.3.11.4 Conclusions

As discussed above, the applicant has described a range of protective actions for the plume exposure pathway EPZ for the public and emergency workers, including guidelines for the choice of protective actions that are consistent with Federal guidance, and protective actions for the ingestion exposure pathway EPZ. Based on its review, the staff concludes that the proposed major feature J is consistent with the guidelines in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, IV.D, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for accident assessment, as set forth above.

13.3.3.12 Radiological Exposure Control (Major Feature K)

13.3.3.12.1 Technical Information in the Application

Section 3.11.1, "Personnel Dose Limits and Controls," of Part 4 of the application described the guidelines for dose limits and gave exposure guidance for individuals, including support personnel and facility employees. These guidelines restricted the radiation dose to support personnel to administrative limits and provided additional guidance for exposures to emergency workers at the site. The applicant also provided emergency worker dose limits consistent with

Table 2-2 in EPA-400-R-92-001 and addressed lifesaving activities (e.g., removing injured persons, providing first aid, performing personnel decontamination), as well as taking corrective and assessment actions or field monitoring measurements necessary to protect valuable property or large populations (e.g., prevent or mitigate a release, assess impact of a release).

In Section 3.11.2, “Onsite Radiation Protection Program,” of Part 4, the applicant indicated that, should the need arise for State and local agency emergency workers located outside of the site boundaries to receive exposures in excess of the PAGs for the general public, the authority for such exposures would rest with the affected State and county agencies. Should these workers be located inside the site boundaries when such a need arises, the site emergency director would issue the necessary authorizations, in consultation with the appropriate agency authority.

Section 3.11.2 of Part 4 provided the following description of the emergency onsite radiation protection program, including methods to implement dose limits:

> The facility will maintain an onsite radiation protection program adequate to ensure compliance with the requirements of 10 CFR 20, Standards for Protection Against Radiation, and any specific facility license requirements. Such radiation protection programs typically include a combination of physical and administrative controls as are appropriate to direct station activities and maintain individual and collective doses as low as is reasonably achievable. Some of the routine administrative controls included in the radiation protection program may be suspended during a declared emergency as may be necessary to provide timely assessment and control of the situation. However, pre-approved procedures and lines of authority that are specifically developed for such conditions will be implemented to ensure appropriate response to the conditions that exist.

The applicant provided further guidance in Section 3.11.1 of Part 4 concerning the authorization of KI to reduce radioiodine uptake for emergency organization personnel, including approval authority by the emergency director or offsite emergency coordinator.

The applicant described the process for determining doses received by emergency personnel, including volunteers, in any nuclear emergency. In Section 3.11.3, “Monitoring of Individual Doses,” of Part 4, the applicant indicated that it will make provisions for a 24-hour-per-day capability to determine the doses received by emergency personnel. In addition, it will write specific emergency procedures for the issuance of permanent record dosimetry devices and self-reading dosimeters to emergency personnel. Finally, it will determine radionuclide intakes by in vitro or in vivo radioactivity measurements and/or an analysis of facility air and water samples, as appropriate. Following its determination of individual radionuclide intakes, the applicant will determine internal doses using technically justified biological models. In addition to the onsite capabilities described, Section 3.11.3 also indicated that the applicant will develop and maintain provisions to allow for offsite performance of these analyses.

In the State of Mississippi, the State and local emergency plans referenced the following materials:

- MREPP Section II.C, “Radiological Exposure Control Measures for Emergency Workers, Responsibilities,” of Annex G

- MREPP Section II.C, “Emergency Worker Personnel Monitoring,” of Appendix 4 to Annex G

- PGCCREPP Section II.B.2, “Recovery Operation,” of Annex H

Section II.B, “Radiological Exposure Control Measures for Emergency Workers, Organization,” of PGCCREPP Annex G detailed the methods used to determine doses received by emergency personnel. Tab A, “Hospital Survey for Radiation Accident Capabilities,” of Appendix 10 to PGCCREPP Annex F also indicated that the Riverland Medical Center can provide radiological support to individuals requiring assessment for internal contamination (whole body count or radiological assay). In RAI 13.3-66 and subsequently in Open item 13.3-1d, the staff asked the applicant to describe the State of Mississippi’s guidance related to bioassay or whole body counting for use in determining offsite emergency worker doses caused by the uptake of radioactive material (e.g., ingestion). In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

For the State of Louisiana, information regarding emergency personnel dose determination appears in Chapter 5 of Attachment 2 to LPRRP Supplement II, which stated that emergency workers, as volunteers, were advised of risks and trained in the proper use of dosimeters; limitation of exposure (time, distance, shielding); and the use, administration, limitations, and precautions of KI.

Section V of LPRRP Chapter 9 indicated that each LDEQ (or other appropriate State agency) emergency worker will be provided with dosimeters. Emergency workers performing services during an incident in a location that was not directly impacted by the radioactive plume may use area dosimetry.

The applicant described the process for acquiring and distributing dosimeters. In Section 3.11.1 of Part 4, the applicant noted that it will write specific emergency procedures for the issuance of permanent record dosimetry devices and self-reading dosimeters to emergency personnel. These procedures will also include instructions on how often to read the dosimeters and how to maintain appropriate records. In RAI 13.3-50, the staff asked the applicant to clarify whether emergency procedures for issuance of dosimetry will cover offsite emergency personnel (e.g., firefighting, ambulance, law enforcement) required to enter a protected area of the proposed reactor(s). In Revision 2 to Part 4, the applicant amended Section 3.11.3 to state the following:

> Specific emergency procedures will be written for the issuance of permanent record dosimetry devices (or systems) (e.g., thermoluminescent dosimeters) and self-reading dosimeters to emergency personnel, including both onsite and offsite emergency response personnel who must enter areas within the protected area where personnel dosimeters are required.

For the State of Mississippi, the applicant referenced the following information and indicated that all emergency workers in the State of Mississippi are required to use direct-reading dosimeters and a permanent record dosimeter (e.g., TLD) or film badge:

- MREPP Section II.C of Annex G
- MREPP Appendix 4, "Emergency Worker Monitoring and Decontamination Procedures for Personnel and Vehicles," to Annex G
- PGCCREPP Section II.B.2 of Annex H

Section II.C of MREPP Annex G also stated that MEMA did not pre-position dosimeters and TLDs and that State emergency workers will receive dosimetry from kits in the SEOC. Civil defense/emergency management personnel at a local EOC in the State of Mississippi will issue dosimetry to local emergency workers.

For the State of Louisiana, the following material contained information regarding the distribution of dosimetry:

- LPRRP Chapter 5 of Attachment 2 to Supplement II
- LPRRP Section D of Enclosure I to Attachment 2 to Supplement II
- LDEQ Radiological Emergency Response Operating Procedure 4, "Radiation Exposure Control"

At-risk and support parishes in the State of Louisiana were responsible for maintaining dosimeters and necessary decontamination survey equipment in a state of readiness to facilitate a State response at the time of an accident. The applicant suggested that resources to protect local government emergency workers will be drawn primarily from at-risk and support parishes and augmented by the State government, as necessary. These resources will include dosimeters and permanent exposure recording devices (e.g., TLDs) as described in Section V of LPRRP Chapter 9.

Section D.1.c, "Local Government, Tensas Parish Emergency Preparedness," of Enclosure I to Attachment 2 of LPRRP Supplement II noted that the Tensas Parish radiological officer was responsible for distributing dosimetry devices and issuing pocket dosimeters and TLDs to emergency workers.

Section 3.11.1 of Part 4 partially described the decision chain for authorizing emergency workers to incur exposures in excess of the EPA dose limits while performing emergency services. In this section, the applicant stated that management authorization will be required before an emergency worker can exceed the exposure limits listed in EPA-400-R-92-001. Section 3.11.2 of Part 4 further indicated that the applicant will implement preapproved procedures and lines of authority to ensure an appropriate response and will develop and conduct training on these procedures and lines of authority. In RAI 13.3-49, the staff asked the applicant to describe a decision chain for authorizing emergency workers to incur exposures in excess of the EPA dose limits while performing emergency services. In Revision 2 to Part 4, the applicant amended Section 3.11.2 to state the following:

> Authorization for personnel exposures exceeding the routine occupational dose limits will be requested by the responsible supervisor in the affected emergency response facility and approved by either the Emergency Director or Offsite Emergency Coordinator. To ensure effective implementation under emergency conditions, training on these procedures and lines of authority will be developed and conducted in accordance with Section 3.16 of this Plan.

Section II.E, “Emergency Worker Authorization for Exceeding EPA PAGs,” of MREPP Annex G and Section II.D, “Emergency Worker Authorization for Exceeding EPA PAGs,” of PGCCREPP Annex G stated that emergency workers are instructed to leave the risk area and report to their supervisors if they register an exposure of 1 rem on their dosimeters. Local emergency workers must obtain authorization to exceed the PAG limits of 5 rem total effective dose equivalent (TEDE) and 25 rem committed dose equivalent (CDE) to the thyroid from the RERT coordinator and the State health officer/MSDH, with the concurrence of city and county elected officials, as described in Section II.E of MREPP Annex G. Beyond the emergency PAG level of 25 rem TEDE or 125 rem CDE to the thyroid, emergency workers were restricted to lifesaving missions and required to obtain specific authorization from the State health officer/MSDH. An emergency worker exposure limit for lifesaving did not exist under the MREPP and PGCCREPP if all the following criteria were met:

- The mission involves saving a human life and is the last option available.
- The maximum radiological exposure control protection available will be provided to the emergency worker and time will be limited to the greatest extent possible.
- Emergency workers are volunteers and are fully cognizant of the potential risk.

The applicant referenced Section V.D of LPRRP Chapter 9. In addition, Chapter 5 of Attachment 2 to LPRRP Supplement II included information regarding the decision chain for authorizing emergency worker exposure in excess of EPA dose limits contained in EPA-400-R-92-001. The LDEQ Radiological Emergency Response Operational Procedure 1, “Radiation Exposure Control,” contained additional information. The State and parish emergency management team in the State of Louisiana used a 1-rem TEDE notification and a 5-rem TEDE turnback value for emergency worker exposure control. As described in Section V.D of LPRRP Chapter 9, if exposures for emergency workers beyond 5 rem whole body dose (TEDE) were determined to be necessary, the principal decisionmaker for the involved unit of government will be required to authorize such activities. The secretary of LDEQ was the State’s decisionmaker for authorizing any dose in excess of 25 rem for all State and local emergency workers. The LDEQ Radiological Emergency Response Operational Procedure 1 required the radiological defense officer at the parish level to be briefed and advised accordingly; a final decision will be communicated to the parish emergency director. The president of the Tensas Parish Police Jury was responsible for authorizing emergency workers within his/her jurisdiction to incur exposures in excess of the EPA PAGs for the general public in EPA-400-R-92-001 (up to 25 rem). As discussed in Chapter 5 of Attachment 2 to LPRRP Supplement II, in the State of Louisiana, authorization would be considered after consultation with LDEQ.

The applicant also described specific action levels for determining the need for the decontamination of emergency workers, equipment and vehicles, and members of the general public and their possessions. Section 3.11.4, "Decontamination and First Aid," of Part 4 indicated that when contamination exceeding values specified in site procedures is detected, preventive measures (e.g., containment, decontamination, or storage for decay of short-lived radionuclides) will be initiated to mitigate the possibility of the spread of contamination. Routine site contamination limits, as delineated in the proposed new facility's radiation protection program, will apply during emergency situations. However, the emergency director may alter these limits, as necessary, to ensure the appropriate level of overall safety. In RAI 13.3-51, the staff asked the applicant to describe the action levels for the decontamination of emergency workers, equipment, and vehicles at, and/or from, the proposed reactor(s). In Revision 2 to Part 4, the applicant amended Section 3.11.4 to state the following:

> Contamination action levels for decontamination of emergency workers, equipment, and vehicles are established in GGNS Unit 1 Radiation Protection Procedures. The applicant expects that similar action levels will be made in Radiation Protection Procedures associated with the proposed new facility. The Emergency Director may alter these contamination action levels as necessary to ensure the appropriate level of overall safety.

The following sources described required action levels and guidance for decontamination of the public, emergency workers, and their possessions in the State of Mississippi:

- Appendix 3, "Evacuee Monitoring and Decontamination Procedures for People and Vehicles," to MREPP Annex G
- Appendix 4, "Emergency Worker Monitoring and Decontamination Procedures for Personnel and Vehicles," to MREPP Annex G
- Appendix 6, "Monitoring and Decontamination Procedures for Emergency Worker Vehicles and Personnel," to PGCCREPP Annex G

Section IV of LPRRP Chapter 9 indicates that persons in the State of Louisiana surveyed and found to have a reading greater than 0.1 millirem per hour (mrem/hr) above background are considered contaminated. Chapter 5 of Attachment 2 to LPRRP Supplement II also included information regarding the action level for determining the need for decontamination. Section IV of LPRRP Chapter 9 required that clothing with levels of contamination greater than 0.1 mrem/hr be stored in a separate, restricted area and vehicles containing interior contamination be impounded.

Section 3.11.4 of Part 4 described, in part, the means for radiological decontamination of emergency personnel wounds, supplies, instruments, and equipment. This section indicated that onsite personnel decontamination stations for emergency conditions will be fully equipped with decontamination material. The final radiological emergency plan for the proposed new facility will describe the location of the primary and alternate decontamination facilities. These facilities will be equipped for disrobing, collecting contaminated clothing, showering of contaminated personnel, and distributing clean clothing. In RAI 13.3-52, the staff asked the applicant to describe the means for decontamination of personnel wounds for individuals from the proposed new facility. In Revision 2 to Part 4, the applicant amended Section 3.11.4 to state the following:

Provisions for decontamination of personnel wounds are established in GGNS Unit 1 Radiation Protection Procedures. These provisions include, for minor wounds, the use of tepid water and mild detergents. For more serious wounds, decontamination is performed under the direction of qualified medical personnel. The applicant expects that similar provisions for decontamination of personnel wounds will be made in Radiation Protection Procedures associated with the proposed new facility.

The applicant also identified primary and backup medical facilities in Section 3.12 of Part 4 for injured personnel with radiological contamination from the proposed new facility who require emergency treatment for radiation-related accidents. These facilities will maintain hospital emergency kits for the treatment of contaminated personnel.

For the State of Mississippi, Section III, "Decontamination Procedures," of Appendix 4 to MREPP Annex G and Section III, "Decontamination Procedures," of Appendix 6 to PGCCREPP Annex G indicated that local governments will be responsible for providing facilities and personnel to conduct radiological monitoring and decontamination of emergency workers under the guidance of MSDH/DRH. Tab A, "Emergency Worker Decon Station Locations," of Appendix 3 to MREPP Annex G identified three locations in Claiborne and Warren Counties as the primary locations for emergency worker decontamination and listed backup locations in Warren, Adams, Copiah, and Hinds Counties. Tab G, "Reception Center Supply Inventory," of Appendix 3 to MREPP Annex G included an inventory list of decontamination supplies. The civil defense/emergency management offices in Warren, Copiah, Adams, and Hinds Counties store monitoring and decontamination supplies and will transfer these supplies to specific monitoring and decontamination facilities when needed.

Both State and local plans in Mississippi detailed the process for the monitoring and decontamination of emergency workers, equipment, and vehicles and provided the procedures for general decontamination methods. If more extensive decontamination were required, MSDH/DRH would be available to assist and to advise whether an emergency worker should be transported to a hospital. Tab A of Appendix 10 to PGCCREPP Annex F listed three hospitals with the capability of decontaminating wounds.

For the State of Louisiana, Section V.C, "Radiological Exposure Control Measures for Emergency Workers," of LPRRP Chapter 9 indicated that decontamination surveys and decontamination procedures for parish and State emergency workers will take place at the same sites as those used for the general public, unless a specific emergency worker decontamination center is designated. The following material contained information regarding decontamination of emergency personnel and equipment:

- LPRRP Chapter 5 of Attachment 2 to Supplement II
- LPRRP Section D of Enclosure I to Attachment 2 to Supplement II
- LPRRP Tab A, "Resource Requirements for Radiological Exposure Control," of Chapter 5 of Attachment 2 to Supplement II, which includes a list of supplies and resource requirements for the reception/survey/decontamination center

Section V.C of LPRRP Chapter 9 required that emergency workers report to a reception or decontamination center at the conclusion of their shift during the emergency. Decontamination for personnel, supplies, and equipment will also take place at reception or decontamination centers, in accordance with implementing procedures. In addition, Section V.C indicated that the medical treatment of contaminated emergency workers will take place at the same medical facilities used for the general public.

Section IV of LPRRP Chapter 9 required that each reception center have the following available:

- shower facilities for men and women
- a change of clothing for contaminated individuals
- facilities for storing contaminated items, including clothing
- vehicles and drivers to transport contaminated individuals to medical facilities

13.3.3.12.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature K, "Radiological Exposure Control."

Major feature K calls for the applicant to describe an onsite radiation protection program and the means for determining and controlling radiological exposures to emergency workers and volunteers (on site and off site), including a decision chain for authorizing exposures in excess of EPA dose limits. The ESP application should also describe specific action levels and the means for radiological decontamination of personnel (including wounds), vehicles, equipment, supplies, and possessions.

13.3.3.12.3 Technical Evaluation

Part 4 of the ESP application described guidelines on dose limits for emergency workers consistent with Table 2-2 in EPA-400-R-92-001, the performance of lifesaving activities (e.g., removing injured persons, providing first aid, performing personnel decontamination), and the corrective and assessment actions or field monitoring measurements necessary to protect valuable property or large populations (e.g., prevent or mitigate a release, assess impact of a release). In addition, Part 4 described an onsite radiation protection program that the applicant will implement during emergencies which are consistent with 10 CFR Part 20, "Standards for Protection Against Radiation," and EPA-400-R-92-001, including methods to implement dose limits.

Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LPRRP, and Attachment 2 to LPRRP Supplement II described how the applicant and State and local agencies will determine the doses received by emergency personnel, including volunteers, involved in any nuclear accident. In RAI 13.3-66, the staff asked for further information to describe guidance established in the PGCCRERP related to bioassay or whole body counting for determination of offsite emergency worker dose due to uptake of radioactive material. The staff identified consideration of this information as Open Item 13.3-1d in the draft SER. The staff reviewed the applicant's response, and finds it acceptable for an ESP application, except to the extent that the arrangements would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a COL or OL application. The staff will determine the adequacy of such incorporation during a COL or OL review. Therefore, Open Item 13.3-1d is resolved.

The staff finds that the applicant's response to RAI 13.3-50, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4, the MREPP, PGCCREPP, Attachment 2 to LPRRP Supplement II, and Enclosure I to Attachment 2 of LPRRP Supplement II, described how the applicant and State and local agencies will acquire and distribute dosimeters.

The staff finds that the applicant's response to RAI 13.3-49, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4, the MREPP, LPRRP, Attachment 2 to LPRRP Supplement II, described a decision chain for authorizing emergency workers to incur exposures in excess of the EPA dose limits for workers performing emergency services.
The staff finds that the applicant's response to RAI 13.3-51, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4, the MREPP, PGCCREPP, LPRRP, Attachment 2 to LPRRP Supplement II, discussed specific action levels, as applicable, for determining the need for the decontamination of emergency workers, equipment and vehicles, and members of the general public and their possessions.

The staff finds that the applicant's response to RAI 13.3-52, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4, the MREPP, PGCCREPP, LPRRP, Attachment 2 to LPRRP Supplement II, and Enclosure I to Attachment 2 of LPRRP Supplement II, described an appropriate means for radiological decontamination of emergency personnel wounds, supplies, instruments, and equipment.

13.3.3.12.4 Conclusions

As discussed above, the applicant has described the means for controlling radiological exposures to emergency workers in an emergency. Based on its review, the staff concludes that the proposed major feature K is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.B, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for radiological exposure control, as set forth above.

13.3.3.13 Medical and Public Health Support (Major Feature L)

13.3.3.13.1 Technical Information in the Application

Section 3.12 of Part 4 described the contacts and arrangements the applicant has made for the evaluation of radiation exposure and uptake. This section indicated that Claiborne County Hospital, as the primary medical facility, will accept victims of radiation-related accidents for emergency medical and surgical treatment and observation. Vicksburg Medical Center and Parkview Regional Medical Center will serve as backup medical facilities, having the same emergency medical capabilities as Claiborne County Hospital. Appendix D to the existing GGNS Emergency Plan (Revision 50) has an agreement with the Ochsner Clinic to provide hospital and medical services for injured, radiologically contaminated, or overexposed personnel. In RAI 13.3-53, the staff asked the applicant to clarify whether personnel of the backup medical facilities will receive training equivalent to that received by personnel of the primary facility. In Revision 2 to Part 4, the applicant amended Section 3.12 to state the following:

> Both of the back-up medical facilities, River Region Medical Center and The Oschner Clinic, have the ability to provide support on a 24 hour per day, seven day per week basis. The applicant expects that similar arrangements for primary and back-up medical facilities will be made for the proposed new facility. Training for both primary and back-up medical facilities will be offered as described in Section 3.15.

The applicant further indicated that the training will address emergency medical and surgical treatment and observation of victims of radiation-related accidents, including the evaluation and treatment of personnel who are injured or radiologically contaminated or who received radiation overexposure and uptake.

For the State of Mississippi, Appendix 10 to MREPP Annex F and Section II, "Medical and Health Services," of Appendix 10 to PGCCREPP Annex F identified River Region Medical Center as the primary facility and Riverland Medical Center and Claiborne County Hospital (PGCCREPP only) as backup facilities. Appendix 1 to MREPP Annex M cited a letter of agreement with Riverland Medical Center to provide care for accident victims with radiation exposure, internal contamination, external contamination, and contaminated wounds. Riverland Medical Center can also evaluate the radiation status of a patient by performing radiological assay of specimens and whole body counting. In addition, Claiborne County Hospital can provide care for individuals with radiation exposure. The State of Mississippi has obtained letters of agreement to ensure medical support for any injured individual from a fixed nuclear facility that is radiologically contaminated, should primary and backup medical resources be exhausted. Appendix 10 to MREPP Annex F cited the Radiation Emergency Assistance Center in Oak Ridge, Tennessee, and the National Disaster Medical System in Rockville, Maryland, as having the potential to provide additional radiological emergency services, as necessary.

As further described in Tab A of Appendix 10 to PGCCREPP Annex F, River Region Medical Center and Claiborne County Hospital can evaluate the radiation status of a patient using handheld instruments. Tab A of Appendix 10 to PGCCREPP Annex F stated that Riverland Medical Center also has the capability to evaluate the radiation status of a patient using a whole body counter and the radiological assay of collected specimens (e.g., blood, urine, smears, tissues).

For the State of Louisiana, Section D of Enclosure I to Attachment 2 to LPRRP Supplement II identified the Louisiana State Department of Health and Hospitals and the Parish Health Unit as responsible for assisting in the coordination of required medical services. Appendix I-1 to Enclosure I to Attachment 2 to LPRRP Supplement II listed both Riverland Medical Center (primary) and the Ochsner Clinic (secondary) for emergency medical services. Tab 2, “Hospitals Capable of Treating Contaminated Injured Personnel,” of LPRRP Chapter 10 identified Riverland Medical Center in Ferriday, Louisiana, as the primary medical facility for Tensas Parish and Our Lady of the Lake Regional Medical Center in Baton Rouge, Louisiana, as backup. The Ochsner Foundation was identified as the primary hospital for St. John the Baptist and St. Charles Parishes. However, Tab 1 of Chapter 14 of the LPRRP Basic Plan did not list Riverland Medical Center as having an agreement with the State of Louisiana. In RAI 13.3-67 and subsequently in Open Item 13.3-1e, the staff asked the applicant to clarify these apparent inconsistencies between the LPRRP, and Enclosure I to Attachment 2 to LPRRP Supplement II regarding the description of contacts and arrangements for local and backup hospital services. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

The applicant also described the emergency medical services facilities capable of providing medical support for an injured individual who may be radiologically contaminated. For the State of Mississippi, Tab A of Appendix 10 to PGCCREPP Annex F listed the location of hospitals and described their capabilities for providing treatment to radiation accident victims for internal and external contaminations, as well as contaminated wounds.

For the State of Louisiana, Tab 2 of LPRRP Chapter 10 identified hospitals that have the capability to provide appropriate medical services to injured persons who may be radiologically contaminated, including the location, type, and capacity of the facility. In RAI 13.3-68 and subsequently in Open Item 13.3-1, the staff asked the applicant to describe special radiological capabilities for the hospitals listed. In response, the applicant stated that SERI believed it had provided sufficient information regarding emergency plans in accordance with 10 CFR 52.17, and that this issue would be more appropriately addressed in the context of full and integrated emergency plans, which would be submitted with a COL application, rather than this ESP application.

13.3.3.13.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.C, and IV.E of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of an emergency plan, including those which apply to major feature L, "Medical and Public Health Support."

Major feature L calls for the applicant to describe the contacts and arrangements it made for medical services for injured individuals who may be radiologically contaminated and to develop lists indicating the locations and capabilities of emergency medical services facilities.

13.3.3.13.3 Technical Evaluation

The staff finds that the applicant's response to RAI 13.3-53, which was implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4, the MREPP, PGCCREPP, LPRRP, and Enclosure I to Attachment 2 of LPRRP Supplement II, described the contacts and arrangements made for local and backup hospital and medical services having the capability to evaluate radiation exposure and uptake. However, in RAI 13.3-67, the staff asked for further information to clarify inconsistencies between the LPRRP and Enclosure 1 to Attachment 2 of LPRRP Supplement 2, regarding the description of contacts and arrangements for local and backup hospital services. The staff identified consideration of this information as Open Item 13.3-1e in the draft SER. The staff reviewed the applicant's response, and finds it acceptable for an ESP application, except to the extent that the arrangements would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a COL or OL application. The staff will determine the adequacy of such incorporation during a COL or OL review. Therefore, Open Item 13.3-1e is resolved.

The PGCCREPP and LPRRP identified the location of public and private hospitals, as well as other emergency medical services facilities within the State or contiguous States, considered capable of providing medical support for any injured individual that may be radiologically contaminated. In RAI 13.3-68, the staff asked for further information to describe special radiological capabilities for hospitals listed in the LPRRP Chapter 10. The staff identified consideration of this information as Open Item 13.3-1f in the draft SER. The staff reviewed the applicant's response, and finds it acceptable for an ESP application, except to the extent that the arrangements would need to be expanded to incorporate relevant aspects of a proposed new reactor design in a COL or OL application. The staff will determine the adequacy of such incorporation during a COL or OL review. Therefore, Open Item 13.3-1f is resolved.

13.3.3.13.4 Conclusions

As discussed above, the applicant has described the contacts and arrangements for medical services capable of evaluating radiation exposure and uptake. Based on its review, the staff concludes that the proposed major feature K is consistent with the guidance in RS-002 and Supplement 2. Therefore, this feature is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.C, and IV.E of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for medical and public health support, as set forth above.

13.3.3.14 Radiological Emergency Response Training (Major Feature O)

13.3.3.14.1 Technical Information in the Application

The applicant described the training program for instructing and qualifying personnel responsible for implementing radiological response plans. Specifically, Sections 3.15.2, "Facility Staff," and 3.15.5, "Training Development and Conduct," of Part 4 described the overall process the applicant will use to establish the training program. The applicant further stated in Section 3.15.1, "Licensee Staff," of Part 4 that it will appoint an appropriate manager to ensure that required emergency preparedness training, commensurate with their positions, will be provided for all personnel who are part of the emergency response organization.

Section 3.15 of Part 4 indicated that the applicant will provide initial training to all identified emergency organization positions/duties and emergency services organizations before the stage of facility construction and licensing requiring an active emergency plan is reached. Section 3.15.3, "Emergency Response Organization," of Part 4 also stated that personnel from the applicant's emergency response organization will receive initial and periodic retraining tailored to their responsibilities. All emergency response personnel will undergo plant access training, fitness-for-duty training, and emergency plan specialized and procedure training.

In RAI 13.3-54, the staff asked the applicant to describe the specialized initial and periodic retraining for the following categories of individuals in its emergency organization:

- directors or coordinators of the response organizations
- personnel responsible for accident assessment
- radiological monitoring teams and radiological analysis personnel
- first aid and rescue personnel (station fire aid team/fire brigade)
- personnel responsible for transmission of emergency information and instructions

In response, the applicant stated that the training described in Sections 3.15.1 through 3.15.4, "Orientation and Training Program for Offsite Support Agencies," of Part 4 applied to the categories of personnel listed above.

Section 3.15.4 of Part 4 addressed the scope of training and the means of providing such training to representatives of local fire departments, law enforcement, and ambulance and hospital services, who may be required to enter the site during an emergency or provide medical treatment to personnel from the site. The applicant further indicated that this training will include, at a minimum, the following information:

- station layout
- communication interfaces and procedures between the onsite organizations and the offsite support organizations
- expected responses to emergencies

- anticipated protective actions

- basic health physics and radiation protection

- primary and alternate plant access routes and access procedures

The applicant further addressed the training provided to local civil defense/emergency preparedness personnel, and the means by which this training will be conducted, in Section 3.15.4 of Part 4. The applicant indicated that it may assist in the training of county/parish emergency organization personnel, if requested. While Section 3.15.4 outlined the training to be offered, it did not specify the frequency for conducting continuing training to ensure proficiency. According to Section II.B.3, "Concept of Operations, Responsibilities, Utility," of MREPP Annex K, the licensee will also provided training for transportation personnel in support of the MREPP. In RAI 13.3-55, the staff asked the applicant to describe the frequency for conducting training for offsite support agencies to ensure proficiency. In Revision 2 to Part 4, the applicant amended Section 3.15.4 to state the following:

> Refresher training will be offered at an established frequency as necessary to ensure the affected agencies are able to effectively discharge their responsibilities. The adequacy of the selected training frequency may be assessed through the evaluation of periodic drills and exercises and the training content and frequency may be modified as necessary to ensure the continued effectiveness of the emergency response organization.

With regard to training for State and local responders in the States of Mississippi and Louisiana, the following documents described the responsibilities for, and contents of, initial and continuing radiological emergency response training programs for offsite response organizations:

- MREPP Basic Plan, Section VII, "Training," and Annex K, "Training"

- PGCCREPP Basic Plan, Section VII, "Training," and Annex K, "Training"

- LPRRP Chapter 12, "Training"

- LPRRP Chapter 8, "Radiological Emergency Response Training," of Attachment 2 to Supplement II

The applicant will provide the following specific types of training, depending on the category of personnel:

<u>Directors or coordinators of the response organizations</u>. Section II.M, "Detailed Course Descriptions, Task Specific Courses," of Appendix 2 to MREPP Annex K indicated that, because of the wide variety of responsibilities involved in a response to an accident at a fixed nuclear facility, task-specific training will be developed on the use of checklists and standard operating procedures (SOPs) in the State and/or local REP plans. As discussed in Section II.B.1.a, "Responsibilities, Claiborne County," of PGCCREPP Annex K, training of the director and staff for this responsibility will be assigned in accordance with the requirements of the county and city governments, MEMA, and FEMA.

Section III.A.4, "Training Programs, Response Plan Implementing Personnel," of LPRRP Chapter 12 established that personnel who will receive training on radiological emergency response include directors or coordinators and staff of the response organizations. The LOEP, in conjunction with LDEQ, provided for the initial and followup training of parish emergency preparedness personnel who will evaluate protective response recommendations and coordinate the implementation of parish protective response in accordance with Chapter 8 of Attachment 2 to LPRRP Supplement II.

Personnel responsible for accident assessment. The PGCCREPP referred to the MREPP Basic Plan which, according to Appendix 1, "List of Available Training," and Appendix 2, "Detailed Course Descriptions," to MREPP Annex K, listed courses that include the knowledge base required by personnel responsible for radiological accident assessment. Section II.D, "Accident Assessment, Training," of MREPP Annex D indicated that each agency will train its own personnel to accomplish assigned missions with the assistance of MSDH/DRH and MEMA.

Section III.A.4 of LPRRP Chapter 12 established that personnel who will receive training on radiological emergency response include accident assessment personnel. Section IV, "Federal Training Programs," of LPRRP Chapter 12 indicated that selected LDEQ assessment personnel will attend the Radiological Accident Assessment Course offered by FEMA at the Emergency Management Institute (EMI). Section IV of LPRRP Chapter 12 also stated that selected individuals from LDEQ will attend the Health Physics in Radiation Accidents Course for health physicists.

Radiological monitoring teams and radiological analysis personnel. The PGCCREPP referenced the MREPP Basic Plan which, according to Appendices 1 and 2 to MREPP Annex K, listed courses offered by EMI (at the Federal level) and by MEMA (at the State level). These courses include the knowledge base required by radiological monitoring teams and radiological analysis personnel.

Section III.A.4 of LPRRP Chapter 12 established that personnel who will receive training on radiological emergency response include radiological monitoring personnel. Section III.B.1, "Training Programs, Response Organization Personnel," of LPRRP Chapter 12 indicated that LDEQ will provide for the technical training of department staff who will perform field sampling, sample analysis, accident assessment, dose calculations, and protective response evaluations. Section IV of LPRRP Chapter 12 also noted that selected LDEQ response team personnel will attend the Radiological Emergency Response Operations Course funded by FEMA.

Police, security, and firefighting personnel. Appendices 1 and 2 to MREPP Annex K listed courses that include the knowledge base required by police, security, and firefighting personnel. Section II.M of Appendix 2 to MREPP Annex K further stated that, because of the wide variety of responsibilities involved in a response to an accident at a fixed nuclear facility, task-specific training will be developed on the use of checklists and SOPs in the State and/or local radiological emergency plans (REPs).

Section III, "Training Programs," of LPRRP Chapter 12 established that personnel who will receive training on radiological emergency response include police security and firefighting personnel. Chapter 8 of Attachment 2 to LPRRP Supplement II indicated that radiological emergency response training will be given to sheriffs and deputies, security personnel, and firefighting and rescue personnel.

First aid and rescue personnel. Appendices 1 and 2 to MREPP Annex K listed courses that include the knowledge base required by first aid and rescue personnel. Section II.C.3.c, "Medical and Public Health Services, Concept of Operations," of Appendix 10 to PGCCREPP Annex F indicated that support ambulance services in Mississippi will participate in training and exercises to ensure the adequate treatment and care of contaminated individuals.

Section III.A.4 of LPRRP Chapter 12 noted that personnel who will receive training on radiological emergency response include first aid and rescue personnel. Chapter 8 of Attachment 2 to LPRRP Supplement II indicated that training will be provided for emergency response personnel and ambulance/rescue workers. The training will include notification procedures, basic radiation protection concepts, and the specific roles of each support organization.

Local support services personnel, including civil defense/emergency services personnel. Section 3.15.4 of Part 4 stated that civil defense/emergency preparedness agency personnel will be provided training through participation in joint utility/State/local status meetings and invitations to attend the training offered to the agencies listed above, as well as their respective State emergency preparedness organizations.

Section II.M of Appendix 2 to MREPP Annex K indicated that, because of the wide variety of responsibilities involved in a response to an accident at a fixed nuclear facility, task-specific training will be developed on the use of checklists and SOPs in the State and/or local REPs. Chapter 8 of Attachment 2 to LPRRP Supplement II discussed radiological emergency response training for the various support organizations that the utility has not trained.

Medical support personnel. Section 3.15.4 of Part 4 identified hospital services. Section II.B.3 of MREPP Annex K indicated that GGNS provides training for hospital staff in support of the MREPP.

Section IV.B of LPRRP Chapter 12 stated that selected individuals will attend the Medical Planning and Care in Radiation Accidents Course designed for physicians who may be called upon to provide first aid or medical care in the event of a radiation accident. This section also indicated that selected individuals will attend the Handling of Radiation Accidents by Emergency Personnel Course for emergency room surgeons and nurses who may be called upon to administer initial hospital aid to a radiation accident victim. Attachment 2 to LPRRP Supplement II noted that, for each primary and backup hospital designated to provide medical support for injured personnel who may be radiologically contaminated, initial and periodic retraining programs will be provided on evaluating and treating injured patients with radiological contamination.

Personnel responsible for transmission of emergency information and instructions.

Section 3.15 of Part 4 indicated that a training program will include personnel responsible for the transmission of emergency response information and instructions.

Section II.M of Appendix 2 to MREPP Annex K stated that, because of the wide variety of responsibilities involved in a response to an accident at a fixed nuclear facility, task-specific training will be developed on the use of checklists and SOPs in the State and/or local REPs. Additionally, Section III, "Concept of Operations," to MREPP Annex J noted that GGNS staff will contact various news media outlets annually to provide points of contact for public information in an emergency and to discuss radiological emergency planning. Section III, "Concept of Operations," of PGCCREPP Annex J contained additional information.

Section III.A.4 of LPRRP Chapter 12 indicated that communications personnel are among those who will receive training on radiological emergency response. Section D.1.c of Enclosure I to Attachment 2 to LPRRP Supplement II stated that the Tensas Parish Emergency Preparedness Coordinator was responsible for supervising the development and implementation of training, as well as public information and education programs, within the parish.

13.3.3.14.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, and IV.F of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature O, "Radiological Emergency Response Training."

Major feature O calls for the applicant to describe a radiological emergency response training program for personnel who would implement radiological emergency response plans.

13.3.3.14.3 Technical Evaluation

The staff finds that the applicant's responses to RAIs 13.3-54 and 13.3-55, which were implemented in Revision 2 to Part 4 of the application, are acceptable. Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, LPRRP, Attachment 2 to LPRRP Supplement II, and Enclosure I to Attachment 2 of LPRRP Supplement II, described a training program for instructing and qualifying personnel who will implement radiological response plans. The applicant and responsible State and local agencies/organizations will provide specialized initial training and periodic retraining for the following categories of personnel, as applicable:

- directors or coordinators of the response organizations
- personnel responsible for accident assessment
- radiological monitoring teams and radiological analysis personnel
- police, security, and firefighting personnel

- first aid and rescue personnel
- local support services personnel, including civil defense/emergency services personnel
- medical support personnel
- personnel responsible for transmission of emergency information and instructions

13.3.3.14.4 Conclusions

As discussed above, the applicant has described a radiological emergency response training program for those who may be called on to assist in an emergency, including a training program for instructing and qualifying personnel who would implement the radiological emergency response plans. In addition, the applicant has described specialized initial training and periodic training. Based on its review, the staff concludes that proposed major feature O is consistent with the guidelines in RS-002 and Supplement 2. Therefore, it is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, and IV.F of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for radiological emergency response training, as set forth above.

13.3.3.15 Responsibility for the Planning Effort: Development, Periodic Review, and Distribution of Emergency Plans (Supplement 2, Major Feature P)

13.3.3.15.1 Technical Information in the Application

The applicant described the training of individuals responsible for the planning effort. Section 3.16.1, “Licensee Responsibility,” of Part 4 indicated that the licensee will assign an individual with significant expertise to the position of manager for emergency preparedness and to those positions that provided technical or management support for emergency preparedness efforts. The licensee will also undertake an ongoing effort to provide these individuals with opportunities to periodically enhance and update their knowledge of pertinent subject matter.

As discussed in Section II.B.1, “Concept of Operations, Responsibilities, State,” of MREPP Annex K, MEMA, in coordination with MSDH/DRH, provided for training of personnel who implement the MREPP. Additionally, Appendices 1 and 2 of MREPP Annex K listed available training, including EMI courses that provide appropriate instruction for emergency planning personnel. Section II.B.1, “Concept of Operations, Responsibilities,” of PGCCREPP Annex K indicated that the PGCCCD Council was responsible for assuring that persons who are assigned to duties in emergency response organizations are scheduled to attend training.

Section IV of LPRRP Chapter 12 noted that the personnel of key response organizations who will be coordinating their organizations’ response activities during an accident receive orientation and training on their assigned functions. Specifically, this section stated that designated personnel responsible for those individuals involved in radiological emergency response planning at the State and parish level will attend the following courses:

- Radiological Emergency Preparedness Planning
- Radiological Accident Assessment
- Radiological Emergency Response Operations
- Medical Planning and Care in Radiation Accidents
- Health Physics in Radiation Accident
- Handling of Radiation Accidents by Emergency Personnel

Section 3.16.1 of Part 4 described, in part, the title of the individual with overall authority and responsibility for radiological emergency response planning. An appropriate manager who will have overall authority and responsibility for the emergency planning effort will be appointed to discharge the responsibilities of the emergency planning coordinator.

Section 3.3.2 of Part 4 established MEMA as the designated State authority in the State of Mississippi; as such, MEMA has the responsibility for the general planning and coordination of the State of Mississippi's response to nuclear plant accidents, as detailed in the MREPP. MREPP Section IX, "Plan Development and Maintenance," indicated that MEMA was responsible for the development and maintenance of the MREPP. In RAI 13.3-69, the staff asked the applicant to identify, by title, the MEMA individual who has the overall authority and responsibility for radiological emergency response planning, development and updating of plans, and coordination of these plans with other response organizations. In response, the applicant stated the following:

> The Director of MEMA, subject to the direction and control of the Governor of Mississippi, is the executive head of the emergency management agency and is responsible to the Governor for carrying out the program for emergency management of this State. He coordinates the activities of all organizations for emergency management within the State, and maintains liaison with and cooperates with emergency management agencies and organizations of other States and of the Federal government, and has such additional authority, duties, and responsibilities authorized by Title 33, Chapter 15, of the Mississippi Code, as amended, as may be prescribed by the Governor.

In Section 3.3.2 of Part 4, the applicant further indicated that the PGCCCD Director was the designated county and executive authority with responsibility for planning and coordinating the county's emergency response activities.

Section V of the LPRRP Basic Plan stated that the LDEQ has jurisdiction over matters affecting the environment, including the regulation and control of radiation. In addition, the secretary of LDEQ, or official designee, was authorized to direct the development and implementation of emergency response plans for fixed nuclear facility accidents.

Section 3.3.2 of Part 4 also noted that the president of the Tensas Parish Police Jury, as the chief executive of Tensas Parish, was responsible by law for emergency preparedness operations. Section D.1.c of Enclosure I to Attachment 2 to LPRRP Supplement II indicated that the Tensas Parish Emergency Preparedness Office, which is under the direction of the emergency preparedness coordinator, was responsible for the development and maintenance of implementing procedures.

The applicant described the emergency planning coordinator, who has the responsibility for the development and updating of emergency plans and coordination of these plans with other response organizations. Section 3.16.1 of Part 4 stated that the appointed manager (emergency planning coordinator) will discharge responsibility for (1) developing and updating plans, (2) coordinating the plans with those of affected response organizations, and (3) coordinating periodic reviews and updates of the plan as needed.

Section IX of the MREPP stated that MEMA was responsible for the development and maintenance of the MREPP. All State and local agencies were required to submit supporting plans and procedures to MEMA for review; MEMA then coordinated all revision efforts and ensured that all agencies involved conduct an annual review of the MREPP and individual support plans.

Section IV.A.2, "Organization and Responsibilities, Claiborne County," of the PGCCREPP indicated that the PGCCCD planning coordinator was responsible for updating and maintaining the plan (including annual reviews) and all supporting SOPs, as well as assisting other county and city organizations to establish plans and procedures in support of the PGCCREPP. According to PGCCREPP Section IX, county and city agencies with responsibilities under the PGCCCD submitted supporting plans and procedures to the PGCCCD for review and approval. In addition, as described in PGCCREPP Section IV.D.2, "Organization and Responsibilities, State," MEMA assisted local governments in the development and maintenance of REPs and procedures and provides affected counties, State agencies, and fixed nuclear facilities with copies of the MREPP and any subsequent revisions.

Section V of the LPRRP Basic Plan authorized the secretary of LDEQ, or official designee, to direct the development and implementation of emergency response plans for fixed nuclear facility accidents. In addition, LPRRP Section VI of the Basic Plan established that all State departments involved in responding to a radiological emergency at a fixed nuclear facility will develop detailed procedures for the implementation of assigned support responsibilities and will coordinate these implementing procedures with other State and local agencies. In RAI 13.3-70, the staff asked the applicant to identify, by title, the LDEQ individual/position with authority and responsibility for updating and coordinating emergency plans with other response organizations. In response, the applicant stated the following:

> The Secretary, Louisiana Department of Environmental Quality has authority and responsibility for updating the Louisiana Peacetime Radiological Response Plan (LPRRP). The LPRRP in its entirety is a component of the Louisiana Emergency Operations Plan (LEOP). The Director, Louisiana Office of Homeland Security and Emergency Preparedness (under the Louisiana Military Department), formerly the Louisiana Office of Emergency Preparedness, is responsible for coordination of the activities of all organizations involved in emergency management in the State of Louisiana.

The staff noted that Section 3.A, "LDEQ Required Action/Primary Function," of LEOP Attachment 4H assigned the responsibility for preparing the LPRRP and detailed implementing procedures for all primary functions to the Department of Environmental Quality. These functions included requirements for supporting departments, agencies, and offices to initiate coordination with other supporting departments to ensure that they are aware of their roles and are prepared to take necessary action.

Section D.1.c of Enclosure I to Attachment 2 to LPRRP Supplement II stated that the Tensas Parish Emergency Preparedness Office, under the direction of the emergency preparedness coordinator, was responsible for supervising the development and maintenance of plans and procedures for the parish's response to an accident at GGNS, including an annual review and update of emergency implementing procedures. Additionally, Enclosure I further directed that the Tensas Parish emergency preparedness coordinator will act as liaison with municipalities within the parish, with responsibility for ensuring the coordination of special facility (e.g., industry and school) emergency procedures and protective actions with parish plans.

Section 3.16.1 of Part 4 further described the updating of plans and agreements. This section stated that LOAs with offsite organizations and agencies will be reviewed during the periodic plan reviews and updated as necessary. In addition, the applicant indicated that the appointed manager, by virtue of his or her involvement with the emergency preparedness program, will ensure that other individuals affected by the plan, including both licensee employees and Federal, State, and local officials, are informed of revisions to the plan.

For the State of Mississippi, MREPP Section IX noted that MEMA was responsible for the development and maintenance of the MREPP and that all State and local agencies are required to submit supporting plans and procedures to MEMA for review. MEMA will coordinate all revision efforts and ensure that all involved agencies conduct an annual review of the MREPP and support plans. Section IV.A.2 of the PGCCREPP indicated that the PGCCCD planning coordinator was responsible for updating and maintaining the plan (including annual reviews) and supporting SOPs and will assist other county and city organizations to establish plans and procedures in support of the PGCCREPP.

For the State of Louisiana, LPRRP Section VIII.B, "Administration, Review and Revision," stated that the LDEQ will conduct an annual review of the plan and related agreements and will update or certify the plan to be current. Furthermore, LPRRP Section VIII.B stated that the LDEQ will revise the plan based on the annual review, as well as address deficiencies resulting from drills, exercises, responses to real events, and interagency coordination. Section D.1.c of Enclosure I to Attachment 2 to LPRRP Supplement II indicated that the Tensas Parish Emergency Preparedness Office, under the direction of the emergency preparedness coordinator, was responsible for supervising the development and maintenance of plans and procedures for the parish's response.

In RAI 13.3-71, the staff asked the applicant to clarify its procedure for updating the contacts and arrangements described in the MREPP, PGCCREPP, and LPRRP. In response, the applicant stated that issues related to State and local plans should be deferred to the COL review stage.

Section 3.16.2, "Plan Distribution," of Part 4 described the forwarding of emergency response plans and approved changes to organizations and individuals with implementation responsibilities. The major features plan will not be distributed because it is not associated with an operating facility. Furthermore, copies of the completed emergency plan will be distributed only when construction and licensing of the proposed new facility reach a stage requiring an active emergency plan. In RAI 13.3-56, the staff asked the applicant to describe its method for marking revisions made to the plan. In Revision 2 to Part 4, the applicant amended Section 3.16.2 to state the following:

> Changes to the plan will be indicated, using generally accepted administrative practices and word processing technology to clearly indicate the subject changes. The expected method used will most likely consist of providing dates and/or revision numbers on each page and change markings, such as text or margin markings, to indicate where changes have been made.

Section IX of the MREPP indicated that all changes/updates are submitted to MEMA for review and comment; MEMA then coordinated all revision efforts. Sections III and IV of MREPP provided the record of revisions and a distribution list for the plan, respectively. All plan pages are marked with a revision number and date. Section IV.A of MREPP, “Organization and Responsibilities, State,” also noted that MEMA will provide affected counties, State agencies, and fixed nuclear facilities with copies of the MREPP and any subsequent revisions.

Section IX, “Plan Development and Maintenance,” of PGCCREPP stated that county and city agencies with responsibilities under the PGCCCD will submit supporting plans and procedures to the PGCCCD for review and approval. For the PGCCREPP to be effective, the contents must be known and understood by those who are responsible for its implementation. All pages of the PGCCREPP are dated and marked with the revision number.

Section VIII.C, “Administration, Distribution,” of the LPRRP directed the LDEQ to forward the plan to all affected organizations and appropriate individuals responsible for implementation of the plan. The LDEQ will also distribute sufficient copies of the plan to the State library system to provide members of the general public ample access. In addition, LPRRP Section VIII.C indicated the following:

- LDEQ will maintain a distribution list of controlled-copy holders of the plan.
- LDEQ will forward approved changes to controlled-copy holders of the plan.
- LDEQ will forward dated inserts to controlled-copy holders of the plan to bring their copies to current status.

The applicant described the development of a table of contents and cross-reference to Supplement 2 criteria. The table of contents provided in the front of Part 4 of the ESP application listed various sections and subsections based on Supplement 2, including major elements. Part 4 of the ESP application also provided Table 4-1,“NUREG-0654, Revision 1, Supplement 2, Cross-Reference.” In RAI 13.3-57, the staff asked the applicant to clarify Table 4-1 to reflect changes made by the applicant in response to the staff’s RAIs. In Revision 2 to Part 4, the applicant amended Table 4-1 to identify the correct cross-references between Supplement 2 and the content of Part 4 of its ESP application.

Section 1.0 of Part 4 indicated that the current emergency plans supporting GGNS Unit 1 were developed to be consistent with the emergency response plans of the affected States (Mississippi and Louisiana) and localities. In RAI 13.3-58, the staff asked the applicant to explain why it did not include references to the entire LPRRP and LEOP in Section 1.2, “References,” of Part 4 since this section contains basic plan information for the State of Louisiana which the applicant used in the ESP review. In Revision 2 to Part 4, the applicant amended Section 1.2 to reference Revision 9 to the LPRRP.

In addition, the staff asked the applicant, in RAI 13.3-59, to clarify whether the ESP application should incorporate relevant sections of the existing GGNS Unit 1 emergency plan to the extent that they support the emergency planning description in the ESP application. In response, the applicant stated that it did not intend to broadly incorporate sections of the GGNS Unit 1 emergency plan into the ESP application. The applicant further explained that it may have referred to specific sections of the GGNS Unit 1 emergency plan as needed to clarify or support the ESP application.

The MREPP, PGCCREPP, and LPRRP each contain a table of contents and a cross-reference to the planning standards and associated evaluation criteria in NUREG-0654/FEMA-REP-1.

13.3.3.15.2 Regulatory Evaluation

Part 1 of the ESP application stated that the emergency planning information in Part 4 identifies the major features of an emergency plan, which will be developed consistent with the requirements of 10 CFR 52.17(b)(2)(i), using guidance provided in NUREG-0654/FEMA-REP-1 and Supplement 2.

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.F, and IV.G of Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(i), an applicant for an ESP may propose the major features of the emergency plans for NRC review and approval, in consultation with FEMA, in the absence of complete and integrated emergency plans. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the major features of an emergency plan submitted under 10 CFR 52.17(b)(2)(i) are acceptable. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of emergency planning information given in an ESP application. Supplement 2 also provides specific evaluation criteria for major features of emergency plans, including those which apply to major feature P, “Responsibility for the Planning Effort: Development, Periodic Review, and Distribution of Emergency Plans.”

Major feature P calls for the applicant to describe the development, review, distribution, and update of emergency plans. The application should also designate an emergency planning coordinator for each organization and identify (by title) individuals with emergency planning responsibilities. In addition, the application should describe training for those responsible for the planning effort.

13.3.3.15.3 Technical Evaluation

Revision 2 to Part 4 of the application, the MREPP, PGCCREPP, and LPRRP provided for the training of individuals responsible for the planning effort.

The staff finds that the applicant’s response to RAI 13.3-69 is acceptable. Revision 2 to Part 4, the MREPP, PGCCREPP, LPRRP, and Enclosure I to Attachment 2 of LPRRP Supplement II, identified, by title, the individual with the overall authority and responsibility for radiological emergency response planning.

The staff finds that the applicant's response to RAI 13.3-70 is acceptable. Revision 2 to Part 4, the MREPP, PGCCREPP, LPRRP, Enclosure I to Attachment 2 of LPRRP Supplement II, and LEOP, designated an emergency planning coordinator with responsibility for the development and update of emergency plans and the coordination of these plans with other response organizations. In addition, Part 4, the MREPP, PGCCREPP, LPRRP, and Enclosure I to Attachment 2 of LPRRP Supplement II discussed how the applicant and State and local organizations will update their respective plans and agreements, as needed. In this evaluation, the staff considered the updating of agreements as part of the process for the updating of plans, which is described above. Therefore, the staff finds that the applicant's response to RAI 13.3-71 is acceptable.

The staff finds that the applicant's response to RAI 13.3-56, which were implemented in Revision 2 to Part 4 of the application, is acceptable. Revision 2 to Part 4, the MREPP, PGCCREPP, and LPRRP, discussed forwarding the emergency response plans and approved changes to the plans to all organizations and appropriate individuals with responsibility for their implementation, as well as the appropriate marking of the revised pages.

The staff finds that the applicant's responses to RAIs 13.3-57, 13.3-58, and 13.3-59 are acceptable. Revision 2 to Part 4 of the application contained a specific table of contents and a cross-reference to the major features and associated evaluation criteria in Supplement 2 for the ESP applicant. Existing State and local plans currently provide a cross-reference to the evaluation criteria as specified in Section II to NUREG-0654/FEMA-REP-1.

13.3.3.15.4 Conclusions

As discussed above, the applicant has described the responsibilities for plan development and review and for distributing and updating emergency plans. In addition, the applicant has identified those responsible for the planning effort and has described the training that they receive. Based on its review, the staff concludes that proposed major feature P is consistent with the guidelines in RS-002 and Supplement 2. Therefore, it is acceptable and meets the requirements of 10 CFR 52.17(b)(2)(i), 10 CFR 52.18, and Sections III, IV.A, IV.F, and IV.G of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning that have been considered for the development, periodic review, and distribution of emergency plans, as set forth above.

13.6 Site Characteristics—Security Plans

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

13.6.1 Technical Information in the Application

In Section 3.1.6 of the GGNS SSAR, the applicant, SERI, stated that it has sufficient land area to accommodate any new unit(s) constructed on the ESP site. The applicant indicated that the site characteristics are such that the applicable NRC regulations, guidance documents, and orders can be met. The applicant based this conclusion on the size of the owner-controlled area, which is large enough to provide adequate distance between vital areas and the probable location of a security boundary.

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

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

13.6.2 Regulatory Evaluation

In SSAR Sections 1.8 and 3.1.6, SERI identified Title 10, Section 100.21(f), of the *Code of Federal Regulations* (10 CFR 100.21(f)) and 10 CFR 73.55, “Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors against Radiological Sabotage,” as the applicable regulations. The applicant also noted that RG 4.7, Revision 2, “General Site Suitability Criteria for Nuclear Power Stations,” issued April 1998, provides applicable guidance. The staff finds that the applicant correctly identified the applicable regulations and guidance, as requested in RAI 1.4-1.

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

RS-002 states that the NRC staff provided guidance to the first three prospective ESP applicants in three substantially identical letters (Agencywide Documents Access and Management System (ADAMS) Accession No. ML030980029). These letters serve as review guidance for the ESP applications to which they apply. However, RS-002 also indicates that the NRC security orders referenced in the letters are, by their nature, subject to modification depending on changes in the terrorist threat level. The security orders do not form part of the licensing basis of the ESP and should not be imposed as conditions of prospective permits. Therefore, the NRC staff based the security review of ESP applications on the requirements of 10 CFR Part 100 and 10 CFR Part 73, “Physical Protection of Plants and Materials,” or other applicable existing regulations.

13.6.3 Technical Evaluation

The staff reviewed the application and RAI responses. It also examined aspects of the application during an onsite visit. The proposed ESP site is located adjacent to the Mississippi River in Claiborne County, Mississippi, near one licensed nuclear power reactor (GGNS Unit 1) owned by SERI and operated by Entergy Operations, Inc. The GGNS site is defined by a trapezoidal-shaped 2100 acre plot of land located directly adjacent to the Mississippi River. The ESP facility power block location, or site footprint, that bounds the prospective location for any new nuclear power reactor(s) that might be constructed on the proposed ESP site is located west of the existing GGNS protected area and no closer than 900 yards from the site boundary.

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

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

With respect to water approaches, the staff noted that vital equipment for the existing GGNS unit is sufficiently far from the Mississippi River that restrictions to river access are not required. The need for such restrictions for any new units would depend on the design of the units and their location on the ESP footprint (i.e., the proposed power block). The site configuration would not present any significant impediments to the development of such restrictions.

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

With respect to threats posed by deliberate vehicle explosions on nearby transportation routes, the staff noted that the nearest public road is 3000 feet from the proposed powerblock area. A gasoline tanker explosion involving 8500 gallons of gasoline detonated at a distance of 3000 feet would not result in an overpressure greater than 1 pound per square inch (psi) at the proposed powerblock area (see RG 1.91, Revision 1, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," issued February 1978). The pressure threshold for human eardrum rupture is 5 psi, which is the first point of human incapacitation (see U.S. Army Technical Manual 5-1300, “Structures to Resist the Effects of Accidental Explosions,” issued November 1990). A peak positive overpressure of 1 psi is a conservative threshold below which no significant damage would be expected for structures, systems, and components of concern (see RG 1.91).

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

With respect to nearby hazardous material facilities and nearby pipelines, the staff found that the distances to those facilities and the associated hazardous materials identified did not pose an impediment to the development of adequate security plans or measures.

Considering RG 4.7, special measures may be needed to support the security response strategy timeline requirements of 10 CFR 73.55(c). Because the exact locations and design of barriers are not known at the ESP stage, the staff identified a COL action item for the COL or CP applicant to provide specific designs for protected area barriers to support the security response strategy timelines. This is **COL Action Item 13.6-1.**

13.6.4 Conclusions

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

15. POSTULATED ACCIDENTS AND ACCIDENT DOSE CONSEQUENCES

15.1 Technical Information in the Application

In Section 3.3 of the site safety analysis report (SSAR) submitted by Systems Energy Resources, Inc. (SERI or the applicant), as part of the early site permit (ESP) application for the Grand Gulf Nuclear Station (GGNS) site, the applicant analyzed and provided the radiological consequences of design-basis accidents (DBAs) to demonstrate that a new nuclear unit(s) could be sited at the proposed ESP site without undue risk to the health and safety of the public, in compliance with the requirements of Title 10, Section 52.17, "Contents of Applications," of the *Code of Federal Regulations* (10 CFR 52.17) and 10 CFR Part 100, "Reactor Site Criteria." The applicant did not identify a particular reactor design to be considered for the proposed ESP site. Instead, SERI developed a set of reactor DBA source term parameters using surrogate reactor characteristics. The applicant used these parameters, in conjunction with site characteristics for accident analysis purposes, to assess the suitability of the proposed ESP site. These plant parameters collectively constitute a plant parameter envelope (PPE).

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

In selecting DBAs for dose consequence analyses, the applicant primarily focused on two light-water reactors (LWRs), the certified ABWR and a version of the AP1000[1], to serve as surrogates. The applicant stated that it selected these two reactor designs because they are (or are based on) previously certified standard designs and have recognized bases for postulated accident analyses. Using source terms developed from these two designs, the applicant performed and provided radiological consequence analyses for the following DBAs:

- pressurized-water reactor (PWR) main steamline break
- PWR feedwater system pipe break
- locked rotor accident

[1] As discussed later in this section, the applicant referenced a version of the AP1000 design available at the time the applicant submitted its ESP application. Westinghouse subsequently revised the AP1000 design before the U.S. Nuclear Regulatory Commission staff's issuance of a final safety evaluation report for the AP1000 design certification.

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

The applicant presented the dose consequence assessment results in a series of tables found in SSAR Section 3.3 which provide the postulated radiological consequences of the DBAs identified above at the proposed exclusion area boundary (EAB) and the low-population zone (LPZ). The dose consequence assessment results in the tables also demonstrate that any potential doses would be within the radiological dose consequence evaluation factors set forth in 10 CFR 50.34(a)(1). The applicant provided the accident-specific source terms (release rates of radioactive materials from the ESP footprint (PPE values) to the environment) and resulting site-specific dose consequences for each DBA in Tables 3.3.2 through 3.3-28 of the SSAR.

In Request for Additional Information (RAI) 3.3-1, the staff asked the applicant to clarify whether the 0- to 2-hour EAB doses presented in the SSAR are for the 2-hour period with the greatest EAB doses. In its response, the applicant stated that the 0- to 2-hour EAB doses presented in the SSAR are for any 2-hour period with the greatest EAB doses. For the ABWR, the EAB doses are calculated for the first 2 hours of the accident. The applicant clarified and provided this information in Revision 2 of its application.

In RAI 3.3-2, the staff asked the applicant to provide references and explain the methodology it used to determine time-dependent activity releases for each DBA and to provide the curie content in such releases for each DBA. The applicant stated in its response that the methodologies used for calculating time-dependent activity releases for the ABWR and AP1000 appear in the respective design certification documents. In Revision 2 of the ESP application, the applicant provided new tables in Section 3.3 to show the time-dependent activity releases in curies for each DBA. The staff finds the methodologies used in the respective design certification documents and new tables to be acceptable.

In RAI 3.3-3, the staff asked the applicant to justify the use of the alternative source term methodology, in accordance with Regulatory Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants,” issued July 2000, for evaluating ABWR radiological consequences, while the ABWR design is certified with Technical Information Document (TID)-14844, “Calculation of Distance Factors for Power and Test Reactor Sites,” issued March 1962, source term and with the dose criteria in thyroid and whole body doses. The applicant revised Section 3.3.3 in Revision 2 of the application to clarify that the ABWR radiological consequence analyses are based on the TID-14844 source term. Table 3.3-1 in Revision 2 of the application provides the offsite doses in thyroid and whole body doses.

In RAI 3.3-4, the staff noted that Westinghouse has revised its χ/Q values in the AP1000 design control document (DCD) since the applicant submitted the Grand Gulf ESP application and asked whether the applicant planned to use the updated values in revising its application. The applicant responded that it elected not to update the ESP application to incorporate the latest χ/Q values in the AP1000 design certification, stating that the AP1000 certification is still undergoing U.S. Nuclear Regulatory Commission (NRC) review that may result in additional changes in the future. The staff finds that the assumed preliminary χ/Q values used by the applicant in its accident analyses are reasonable and, therefore, adequate for the purpose of demonstrating that a reactor with design characteristics similar to an AP1000 could be sited at the proposed ESP site.

In RAI 3.3-7, the staff asked the applicant to provide, for each DBA, the doses it used for the EAB and the LPZ for the AP1000 and the ABWR, as well as the ratios of site-specific χ/Q values to design certification χ/Qs used. In its response, the applicant stated that it would revise the dose tables in SSAR Section 3.3 to show the χ/Q values and doses from the AP1000 and ABWR DCDs, in addition to the ratios of site-specific χ/Q values to design certification χ/Q values. The applicant provided this information in the SSAR Section 3.3 tables in Revision 2 of its application.

In RAI 3.3-8, the staff noted that SSAR Section 3.3 provides total effective dose equivalent (TEDE) values for the ABWR design, while the ABWR design is certified with the thyroid and whole body doses specified in 10 CFR Part 100. The staff asked the applicant to explain how the doses compare. In its response, the applicant revised the SSAR in Revision 2 of its application to include the thyroid and whole body doses from the ABWR DCD, in addition to the estimated TEDE values. The thyroid and whole body doses met 10 CFR 100.11 dose criteria and its estimated TEDE values met 10 CFR 100.21, respectively. The staff finds the revised tables to be acceptable.

15.2 <u>Regulatory Evaluation</u>

In SSAR Sections 1.4 and 3.3, the applicant identified the following applicable NRC regulations and guidance regarding reactor accident radiological consequence analyses:

- 10 CFR 52.17
- 10 CFR Part 100
- 10 CFR 50.34, "Contents of Applications; Technical Information"
- RG 1.3, Revision 2, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," issued June 1974
- RG 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors," issued March 1972
- RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," issued November 1982
- RG 1.183

- NUREG-0800, Revision 3, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” issued July 1997

- TID-14844

The staff reviewed SSAR Sections 1.4 and 3.3 for conformance with the applicable regulations and considered the corresponding guidance, as identified above. In its evaluation, the staff used the dose consequence evaluation factors found in 10 CFR 50.34(a)(1) that are a factor in determining the acceptability of the site, in accordance with 10 CFR 52.17(a)(1).

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

- An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release would not receive a radiation dose in excess of 25 rem TEDE.

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

Because the applicant has not selected a reactor design to be constructed on the proposed ESP site, the applicant used a PPE approach to demonstrate that it meets these requirements. A PPE is a set of plant design parameters that are expected to bound the characteristics of a reactor(s) that may be constructed at a site, and it serves as a surrogate for actual reactor design information. As discussed in Review Standard (RS)-002, “Processing Applications for Early Site Permits,” and in Chapter 1 of this SER, the staff considers the PPE approach to be an acceptable method for assessing site suitability. For the purposes of this analysis, the applicant proposed a fission product release from the ESP footprint to the environment; the staff reviewed the applicant’s dose evaluation based on this release.

15.3 Technical Evaluation

The applicant evaluated the suitability of the site under the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) using bounding reactor accident source terms and dose consequences as a set of PPE values based on two surrogate designs, as well as site-specific χ/Q values derived from the ESP footprint. The following sections describe the staff’s review of each aspect of this evaluation.

15.3.1 Selection of DBAs

The applicant selected the DBAs listed in Section 3.3.1 of this SER on the basis of the proposed AP1000 reactor design and the certified ABWR reactor design, indicating that it chose these two reactor designs because they have (or are based on) previously certified standard designs and have recognized bases for postulated accident analyses. The staff finds that the applicant selected DBAs that are consistent with the DBAs listed and analyzed in NUREG-0800 and RG 1.183. Therefore, the staff finds that the applicant provided an acceptable DBA selection for evaluating the compliance of the proposed ESP site with the dose consequence evaluation factors specified in 10 CFR 50.34(a)(1). The applicant stated that, because of their greater potential for inherent safety, it expects the DBAs of the other reactors under consideration for the proposed ESP site to be bounded by those DBAs analyzed in the proposed AP1000 and certified ABWR DCDs. While the staff has not reviewed these designs in detail, other than the proposed AP1000 and certified ABWR, it believes that conclusions drawn regarding the site's acceptability based on the AP1000 and ABWR designs are likely to be valid for the other reactor designs the applicant is considering. At the time of any combined license (COL) or construction permit (CP) application that might be filed with respect to construction and operation of a reactor at the Grand Gulf ESP site, the applicant will confirm, and the staff will evaluate, whether the analyses considered here bound the design proposed in the COL or CP application.

15.3.2 Design-Specific (Assumed) χ/Q Values

To support its accident analyses based on the ABWR as a surrogate design, the applicant used the assumed χ/Q values in the certified ABWR DCD. In evaluating the AP1000, the applicant used those χ/Q values in the proposed AP1000 DCD that were under review by the staff at the time the Grand Gulf ESP application was submitted. Westinghouse subsequently revised the χ/Q values in the AP1000 DCD. Consequently, the assumed χ/Q values and the calculated design-specific doses used in the Grand Gulf ESP application may differ from those associated with a certified AP1000 DCD. However, the staff determined that the PPE values for the assumed χ/Q values associated with the AP1000 design used by the applicant in its accident analyses are reasonable and, therefore, are adequate for the purpose of demonstrating that a reactor with design characteristics similar to an AP1000 could be sited at the proposed ESP site. In response to RAI 3.3-7, the applicant provided AP1000 and ABWR χ/Q values it used for the version of the AP1000 and the certified ABWR that it considered. Table 15.3-1 of this SER lists these χ/Q values.:

Table 15.3-1 Design-Specific (Assumed) χ/Q Values in s/m^3

Location and Time Interval	AP1000	ABWR
0 to 2 hour EAB	6.0×10^{-4}	1.37×10^{-3}
0 to 8 hour LPZ	1.35×10^{-4}	1.56×10^{-4}
8 to 24 hour LPZ	1.0×10^{-4}	9.61×10^{-5}
1 to 4 day LPZ	5.4×10^{-5}	3.36×10^{-5}
4 to 30 day LPZ	2.2×10^{-5}	7.42×10^{-6}

15.3.3 Site-Specific χ/Qs

The staff reviewed the applicant's site-specific χ/Q values and performed an independent evaluation of atmospheric dispersion in accordance with the guidance provided in Section 2.3.4 of RS-002. The staff finds the χ/Q values to be acceptable, as described in Section 2.3.4 of this SER. Table 15.3-2 of this SER lists the site-specific χ/Q values used by the applicant and reviewed by the staff. The staff intends to include these site-specific χ/Qs in any ESP that the NRC may issue for the Grand Gulf ESP site.

15.3.4 Source Terms and Radiological Consequence Evaluations

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

The AP1000 source terms are based on the guidance provided in RG 1.183. The methodologies and assumptions that the AP1000 vendor, Westinghouse, used in its radiological consequence analyses are consistent with the guidance provided in RG 1.183. The resulting doses calculated for the AP1000 design using assumed site parameters meet the dose consequence evaluation factors specified in 10 CFR 50.34(a)(1) (i.e., 25 rem TEDE). The methodologies and assumptions that the ABWR vendor, General Electric, used in its radiological consequence analyses for the ABWR design are consistent with the guidance provided in RGs 1.3 and 1.25. The guidance in TID-14844 forms the basis of the ABWR source terms. The resulting doses for the ABWR reactor design using assumed site parameters meet the dose consequence evaluation factors specified in 10 CFR 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance," which are 300 rem to the thyroid and 25 rem to the whole body. While the requirements of 10 CFR 100.11 are not applicable to ESPs, the staff notes that the final rule at Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor," to 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," states the following:

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

Therefore, the staff concludes that the certified ABWR design, in conjunction with assumed site parameters, meets the dose consequence evaluation factors specified in 10 CFR 100.11, as well as those specified in 10 CFR 50.34(a)(1).

In determining the potential radiological consequence doses resulting from DBAs at the proposed site, the applicant used the site-specific atmospheric dispersion factors (χ/Q values), in conjunction with the DBA radiological consequence doses and the postulated χ/Q values provided in the SSAR of the certified ABWR (SSAR/ABWR) and the proposed AP1000 DCD.

The certified ABWR and the proposed AP1000 designs met the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) with their postulated χ/Q values.

The χ/Q values indicate the atmospheric dilution capability. Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. The radiological consequence doses are directly proportional to the χ/Q values. Table 1.9-1 of the SSAR provides the site-specific χ/Q values the applicant used in its radiological consequence analyses, and Section 2.3.4 of this SER discusses the staff's evaluation of these χ/Q values.

The applicant used the atmospheric dispersion computer code (PAVAN) to derive its site-specific χ/Q values. In RAI 2.3.4-2, the staff asked the applicant to provide a copy of the PAVAN computer code input and output files used to generate the EAB and LPZ χ/Q values presented in SSAR Section 2.3.4. The applicant complied with this request in its response to the RAI.

The applicant used the ratios of the site-specific χ/Q values to those postulated in the SSAR/ABWR and AP1000 DCD to determine and demonstrate that the radiological consequence doses at the proposed site meet the requirements of 10 CFR 50.34. The estimated site-specific χ/Q values for the proposed site are lower than those postulated in the SSAR/ABWR and AP1000 DCD. The certified ABWR and the proposed AP1000 designs met the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) with their postulated χ/Q values. Accordingly, the resulting DBA radiological consequence doses at the proposed site are lower than those provided in the SSAR/ABWR and AP1000 DCD and, therefore, meet the requirements of 10 CFR 50.34.

The staff accepts that the radiological consequences of the DBAs at the proposed site based on the AP1000 and ABWR designs are likely to be valid for the other reactor designs the applicant is considering. Whether or not the final reactor design the applicant selects for use at the Grand Gulf ESP site is in fact bounded by the acceptance made here would be subject to review during the staff's consideration of any COL or CP application. In accordance with 10 CFR 52.79(a)(1), at the COL stage, the staff will evaluate whether the design of the facility falls within the parameters specified in an ESP, should the NRC issue one for the Grand Gulf ESP site.

The staff verified the design-specific source terms the applicant provided and finds them to be consistent with those evaluated as part of the design certification reviews. Further, the staff finds that the references provided by the applicant and the methodology it used to determine timing and release rate of fission product source terms to the environment (and consequent dose consequences) from the proposed ESP site are acceptable. Therefore, the staff finds the source terms from the PPE (i.e., the ESP footprint) themselves to be reasonable and acceptable. The staff intends to include the site-specific χ/Q values as site characteristics listed in Appendix A to this SER, for use in any ESP that the NRC might issue for the Grand Gulf site.

Based on its evaluation of the applicant's analysis methodology and inputs to that analysis, the staff finds that the applicant correctly concluded that the dose consequences for the chosen surrogate designs comply with the dose consequence evaluation factors of 10 CFR 50.34(a)(1). Table 15.3-2 of this SER identifies the following site χ/Q values as appropriate for inclusion in any ESP that the NRC might issue for the Grand Gulf ESP site.

Table 15.3-2 Staff's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics (Site-Specific χ/Q Values)

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

RS-002 calls for the staff to perform a confirmatory radiological consequence calculation. However, the design-related inputs to the applicant's dose calculation were directly extracted from design documentation previously submitted to and reviewed by the NRC in connection with design certification applications. Because the applicant simply used the ratio of the site specific a/Q values to the postulated design χ/Q values, the staff did not consider an independent calculation to be useful or necessary and, therefore, did not perform one.

15.4 Conclusions

As set forth above, the applicant submitted its radiological consequence analyses using the site-specific χ/Q values and PPE source term values and concluded that the proposed site meets the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1). Based on the reasons set forth above, the staff finds that the applicant's PPE values for source terms included as inputs to the radiological consequence analyses are reasonable. Further, the staff finds that the applicant's site-specific χ/Q values and dose consequence evaluation methodology are acceptable.

Therefore, the staff concludes that the proposed distances to the EAB and the LPZ outer boundary of the proposed ESP site, in conjunction with the fission product release rates to the environment provided by the applicant as PPE values, are adequate to provide reasonable assurance that the radiological consequences of the DBAs will be within the dose consequence evaluation factors set forth at 10 CFR 50.34(a)(1) for the proposed ESP site. This conclusion is subject to confirmation at the COL or CP stage that the design of the facility specified by the COL or CP applicant falls within the ESP PPE values.

The staff further concludes that (1) the applicant demonstrated that the proposed ESP site is suitable for power reactors with source term characteristics bounded by those of the ABWR and AP1000 without undue risk to the health and safety of the public, and (2) the applicant complies with the requirements of 10 CFR 52.17 and 10 CFR Part 100.

17. EARLY SITE PERMIT QUALITY ASSURANCE MEASURES

17.1 Introduction

System Energy Resources, Inc. (SERI or the applicant), chose not to supply information on the quality assurance (QA) measures it employed for early site permit (ESP) activities in its application for locating an additional plant(s) at the existing Grand Gulf Nuclear Station (GGNS) site. During a preapplication meeting to discuss the ESP inspection process, the applicant submitted information on the QA measures applied by SERI and its principal subcontractors. The staff of the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection of the applicant's QA measures from February 9–13, 2004. Subsequently, the staff performed an in-office technical review to evaluate whether the applicant and its principal subcontractors had applied adequate QA measures. The staff also conducted a review to determine whether SERI adequately applied the guidance in Section 17.1.1 of Review Standard (RS)-002, "Processing Applications for Early Site Permits," to demonstrate the integrity and reliability of the data obtained during ESP activities.

Under Title 10, Section 52.18, "Standards for Review of Applications," of the *Code of Federal Regulations* (10 CFR 52.18), the staff must review ESP applications in accordance with the applicable regulations of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and its appendices, as well as 10 CFR Part 100, "Reactor Site Criteria," as they apply to construction permits. The current regulations do not require ESP holders or applicants to implement a QA program compliant with the requirements of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50. However, the applicant is expected to implement QA measures equivalent in substance to the measures described in Appendix B to 10 CFR Part 50. This will provide reasonable assurance that any information derived from ESP activities which could be used in the design and/or construction of structures, systems, and components (SSCs) important to safety will support satisfactory performance of such SSCs once they are in service. Therefore, the staff evaluated quality measures for those activities associated with the applicant's generation of site-related information that could be used as input to the design of future SSCs to ensure that these measures can provide reasonable assurance of the integrity and reliability of the information, assuming that the applicant's QA measures are equivalent in substance to the criteria of Appendix B to 10 CFR Part 50.

In accordance with 10 CFR 52.79(a)(1), if an application for a combined license (COL) references an ESP, it must contain information sufficient to demonstrate that the design of the facility falls within the site characteristics specified in the ESP. If the COL applicant references a certified design and an ESP and does not request a variance from the ESP in accordance with 10 CFR 52.39(b), the applicant must show that the site parameters postulated for the certified design fall within the characteristics specified in the ESP. Therefore, the ESP applicant must provide reasonable assurance of the reliability and integrity of the data contained in or supporting the ESP application, which in turn supports the COL application.

Conformance to the quality measures described in RS-002, Section 17.1.1, provides reasonable assurance that the applicant used adequate QA measures to support its ESP application. The staff focused its review on whether the applicant's QA measures adequately address the guidance in Section 17.1.1 of RS-002 for each relevant element (as determined by the applicant). The staff performed much of its evaluation during an inspection conducted in February 2004 and documented in Inspection Report 052000009/2004001 (ADAMS Accession No. ML040830045). For any element that the applicant determined not to be relevant, the staff verified that the ESP activities did not rely on QA measures associated with that element. The review focused on the applicant and its primary contractor, Enercon. Inspection Report 052000009/2004001 includes details on additional subcontractors involved in ESP activities. Section 17.7 of this safety evaluation report (SER) discusses the adequacy of the QA measures applied by these subcontractors.

The staff reviewed the document developed by Enercon for SERI that provides general guidance for the quality measures applied to ESP activities. According to the document, Enercon would conduct activities related to the development of the application in accordance with the regulations and applicable portions of its QA program. Most of the subcontractors conducted ESP activities under Enercon's QA program.

17.1.1 Technical Information in the Application (Organization)

SERI did not supply information in its application about organization control. The "Quality Assurance Project Planning Document for Entergy Nuclear Potomac Early Site Permitting Project, Grand Gulf Nuclear Station Site," Project No. ENTO-002, Revision 5, dated October 6, 2003 (hereafter referred to as the QAPPD), describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls used for ESP activities reflect the elements from these criteria, as outlined in the Enercon Services Quality Assurance Program Manual, Revision 8 (hereafter referred to as the QAPM). Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers organization to be one of the criteria having elements associated with the control of ESP activities.

The QAPM describes the Enercon organization for establishing and executing the Enercon QA program. The QAPM specifies the primary responsibilities, authorities, and lines of communication for identifying, reporting, controlling, and resolving quality issues. An organizational chart identifies the Enercon structure responsible for implementing the Enercon QA program. This organizational structure ensures that personnel responsible for implementing the QA program report and/or have direct access to the highest levels of Enercon management and have sufficient independence of cost and schedule when related to safety and/or quality considerations. The QAPM describes the authorities and responsibilities for all management personnel, as well as the independence of personnel performing QA functions.

The QAPM states that any employee of Enercon who is aware of a nonconformance or has a quality concern is encouraged to express that concern to the project manager. If the concern is not resolved to their satisfaction, personnel have access to the company president through the project QA engineer or QA manager.

17.1.2 Regulatory Evaluation (Organization)

While the NRC does not require an organization to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor states that its organization controls will ensure the development of the application in a quality manner and, where appropriate, in accordance with requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.1 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable organization. An acceptable organization should include (1) an organization description and charts of the lines, interrelationships, and areas of responsibility and authority for all organizations performing quality-related activities, including the applicant's organization and principal subcontractors, (2) the relative location of the QA organization, degree of independence from the organization performing ESP activities, and authority of the individuals assigned the responsibility for performing QA functions, and (3) the organizational provisions that exist for ensuring the proper implementation of QA controls.

17.1.3 Technical Evaluation (Organization)

17.1.3.1 Entergy

SERI, a subsidiary of Entergy Corporation, is the applicant for the ESP and authorized Entergy Nuclear Potomac Company to prepare the ESP application. Entergy Nuclear Potomac Company selected Enercon to perform the actual preparation of the ESP application and delegated ESP QA organizational responsibilities, including QA oversight, to Enercon. The Entergy supplier QA organization includes Enercon on its supplier list as a qualified vendor.

The staff noted that Entergy Nuclear Potomac Company assumed responsibility for the procurement of services for seismic and geotechnical ESP evaluations. The staff determined that this organizational structure is equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meets the acceptance criteria contained in Section 17.1.1 of RS-002.

17.1.3.2 Enercon

The staff noted that Enercon's QAPM conforms to the requirements of Appendix B to 10 CFR Part 50. The staff's review of selected portions of Enercon's QAPM identifies several QA organization attributes.

The QAPM states that the QA manager is responsible for the execution of the Enercon QA program (including work performed by other organizations or companies) and that the QA manager has the authority to halt further processing, delivery, or installation of a nonconforming item, deficiency, or unsatisfactory condition until proper disposition has occurred. It also states that the QA manager reports directly to the Chief Operating Officer, Enercon Services, and has access to the President, Enercon Services.

The QAPM states that every Enercon employee has the responsibility to identify conditions adverse to quality and notify the QA manager/project QA engineer of the condition. It also states that any employee may initiate a corrective action report (CAR) for conditions adverse to quality. If a reported condition adverse to quality is determined to be sufficiently significant, the President, Enercon Services, may be called upon to assist in obtaining timely corrective action.

The applicant indicated that the QAPPD was prepared by Enercon and reviewed by Entergy for the purpose of developing an ESP application. The QAPPD includes an organization chart depicting key organizational positions, such as project manager, QA program manager, and project technical/task leads. The QAPPD describes associated position responsibilities and qualification requirements. The staff noted that the Enercon QA manager fulfills the roles and responsibilities of that position. The staff also found that the individuals identified on the project organization chart appear to meet the guidance of Section 17.1.1 of RS-002.

17.1.4 Conclusions (Organization)

As set forth above, the staff reviewed the QA measures employed by the applicant and its primary contractor and concluded that they have implemented an acceptable organization which meets the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.2 Quality Assurance Program

17.2.1 Technical Information in the Application (QA Program)

SERI did not supply information in its application about a QA program. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers the QA program to be one of the criteria having elements associated with the control of ESP activities.

The QAPM states that the QA program is based on the requirements of Appendix B to 10 CFR Part 50. The QA program will be maintained to comply with the requirements of Appendix B to 10 CFR Part 50. The requirements of the American National Standards Institute (ANSI) N45.2-1977, “Quality Assurance Program Requirements for Nuclear Facilities,” applicable “daughter standards,” and ANSI NQA-1-1983, “Quality Assurance Program Requirements for Nuclear Power Plants,” will be used as guidelines for implementing the QA program and were considered during the preparation of this program.

The QAPM states that the QA program will provide for administrative control and verification of the performance of project activities that affect the quality of items supplied or services provided. The scope of work may not require the use of all sections of this program.

In addition, the QAPM states that the QA program will include control mechanisms for each activity depending on the type of activity and the importance of the activity to the achievement and maintenance of quality. These control mechanisms are provided to ensure that (1) prerequisites are identified and met, (2) competent personnel are assigned, and (3) quality is verified by appropriate methods.

The QAPM provides additional guidance on QA program review and approval, distribution and control, periodic appraisal and reporting, and personnel indoctrination and training.

17.2.2 Regulatory Evaluation (QA Program)

While the NRC does not require a QA program to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor stated that its QA program controls will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.2 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of control for ESP activities. The QA program should include (1) a scope of QA controls adequate to ensure that appropriate quality controls are applied to all site characterization data that relate to the design and analysis of SSCs important to safety that might be constructed on the proposed site, (2) provisions to ensure proper definition of QA controls, and (3) provisions to ensure adequacy of personnel qualifications.

17.2.3 Technical Evaluation (QA Program)

This section of the SER evaluates the adequacy of the applicant and its primary contractor's overall QA program description. The SER provides a detailed review and evaluation of each applicable portion of the program under the appropriate sections.

The applicant determined that certain quality controls were not required to be fully implemented. The QAPPD identifies QA requirements only applicable to the ESP project. Specifically, of the 18 elements in the Enercon QAPM, the following elements do not apply to the ESP project:

- Section 8.0, "ID and Control of Material, Parts and Components"
- Section 9.0, "Control of Special Processes"
- Section 10.0, "Inspections"
- Section 11.0, "Test Control"
- Section 14.0, "Inspection, Test and Operating Status"
- Section 15.0, "Nonconforming Materials, Parts or Components"

For Section 12.0, "Control of Measuring and Test Equipment," the applicable ESP procedures address quality standards. The QAPPD includes attachments with specific project instructions tailored to the scope of work.

Enercon determined the applicability of QA policies in accordance with one of its corporate standard procedures (CSPs). The applicable sections of this SER will discuss whether these specific elements of the QAPM should have been applied to the ESP project.

17.2.3.1 *Entergy*

SERI authorized Entergy Nuclear Potomac Company, a subsidiary of Entergy Corporation, to prepare the ESP application. Entergy Nuclear Potomac Company selected Enercon as the lead contractor for development of the ESP application. The procurement documentation specifies that Enercon would implement a QA program in accordance with the criteria of Appendix B to 10 CFR Part 50 to address those ESP application activities that support the design input for future power plant design and construction. Specifically, this includes hydrological and meteorological site characterization activities. In addition, the procurement documentation specifies that Enercon would provide QA oversight of Entergy Nuclear Potomac Company's subcontractor, William Lettis & Associates (WLA), in developing the seismic and geologic input for the ESP application.

17.2.3.2 *Enercon*

The staff noted that the ESP agreement contract documents the selection of Enercon as the primary contractor responsible for developing the ESP application. The contract states that all services that could affect design input for safety-related SSCs in support of the ESP application must be performed under the auspices of the QAPM and the QAPPD developed by Enercon. It further states that, for work designated as safety related, the primary contractor must comply with the provisions of 10 CFR Part 21, "Reporting of Defects and Noncompliance."

Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. Enercon developed the QAPPD to provide guidance for implementing the QA program for the SERI application.

The staff reviewed the Enercon QAPPD, which Enercon developed to implement its QA program for specific activities related to the ESP application. Enercon intended the QAPPD to provide a detailed description of the total scope of work and tasks necessary to produce the ESP application. The QAPPD identifies hydrological and meteorological activities that fall within the Enercon QA program, as well as oversight of seismic and geotechnical work performed by WLA. The staff verified that calculations associated with the determination of atmospheric dispersion factors were performed with QA program controls within the scope of meteorological activities. In addition, the staff confirmed calculations to determine that population projections were developed with adequate quality measures.

Activities performed by WLA and other Enercon subcontractors, as well as WLA subcontractors, were governed by Enercon's QAPM through a purchase order or the QAPPD. Eustis Engineering Company, Inc. (Eustis), is one exception; the SER discusses this in Section 17.7.3.

17.2.3.3 *William Lettis & Associates*

WLA provided services for seismic and geotechnical evaluation of the site under a separate contract with Entergy Nuclear Potomac Company. WLA employees and its subcontractors were required to perform work in accordance with the Enercon QAPM. As detailed in Inspection Report 052000009/2004001, the staff reviewed selected project instructions prepared by WLA and reviewed by Enercon to provide guidelines for conducting seismic and geotechnical activities. The staff verified that the project instructions require that work be performed under Enercon's QAPM.

The staff determined that WLA personnel appear to have extensive education and experience in seismic analyses. Furthermore, WLA adequately provided and documented training for its employees.

17.2.4 Conclusions (QA Program)

As set forth above, the staff reviewed the QA measures implemented by the applicant and its primary contractor. The staff concludes that they have implemented an acceptable QA program which meets the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.3 Design Control

17.3.1 Technical Information in the Application (Design Control)

SERI did not supply information in its application about design control. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in its QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers design control to be one of the criteria having elements associated with the control of ESP activities.

The QAPM states that those applicable design inputs, such as design bases, regulatory requirements, codes, standards, and quality requirements, must be identified and documented in the QAPPD, individual calculations, or design reports, as appropriate. Changes to specified design inputs, as well as the reasons for these changes, must be identified, approved, documented, and controlled.

The QAPM states that design activities must be identified in the QAPPD and accomplished in accordance with procedures of a type sufficient to assure the achievement of the applicable design controls specified in this section. Design activities must be documented in sufficient detail to permit verification and auditing.

The QAPM notes that procedures must govern the preparation and control of drawings, specifications, and other design documents, such as installation instructions and test procedures. The QAPPD must specify the identification of design documents and the applicable procedures for their preparation and control.

The QAPM indicates that the project manager is responsible for all external or internal communications. Communications related to quality concerns of a design must be brought to the attention of the QA manager or project QA engineer.

In addition, the QAPM states that measures must be applied to verify the adequacy of design. A change in design requires that, when feasible, the same individual, group, or organization that reviewed and approved the original documents must also review and approve documents reflecting the change. When not feasible, the reviewing individual, group, or organization must have qualifications commensurate to those who prepared the original document.

In Request for Additional Information (RAI) 17.1-1, the staff asked the applicant to describe the QA measures it used to authenticate and verify any data important to safety retrieved from Internet Web sites that support information in the site safety analysis report (SSAR) that could affect the design, construction, or operation of SSCs important to safety. In its response, the applicant stated that Project Instruction (PI) ENTO-002-PI-02 describes the controls applied to the collection of data in support of the development of the SSAR for the ESP application. The applicant developed the PI for use during collection and review of data supporting those aspects of the SSAR dealing with the safety assessment of the ESP site, specifically hydrological and meteorological data. The PI also indicates the option of its use for other data collection and review, such as demographic data. The PI is applicable to published data and raw data (e.g., data collected from Internet Web site databases). Attachment 1 to the PI documents these sources, as required.

17.3.2 Regulatory Evaluation (Design Control)

While the NRC does not require design control to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor stated that its design controls will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.3 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of design control. Acceptable design controls should include (1) the scope of activities that could affect design and construction activities for SSCs important to safety that might be constructed on the site, (2) definition of the organizational structure, activity, and responsibility of the positions or groups responsible for design activities important to safety (if any), (3) provisions to carry out design activities important to safety in a planned, controlled, and orderly manner, (4) provisions for interface control between functional units of the applicant's organization, (5) provisions to verify the technical adequacy of design documents applicable to ESP activities that could affect SSCs important to safety, and (6) provisions to control design changes applicable to ESP activities that could affect SSCs important to safety.

17.3.3 Technical Evaluation (Design Control)

Enercon is the primary contractor for the ESP project, providing personnel, systems, project management, and resources. Entergy Nuclear Potomac Company procured engineering services and support for specific design control activities from its subcontractor, WLA. WLA in turn subcontracted some of these activities to Eustis, GEOVision Physical Services, Pacific Engineering, Inc., the University of Texas (UT), and Jack Benjamin & Associates. Subcontractors, with the exception of Eustis, were subject to Enercon's QA program and the QAPPD.

The staff evaluated the applicant's response to RAI 17.1-1 concerning the QA measures used to authenticate and verify data that were retrieved from Internet Web sites and which support information in the SSAR affecting the design, construction, or operation of SSCs important to safety. In its response to the RAI, the applicant described the method it used to authenticate or verify the data. The staff found this method of authenticating Internet Web site data to be acceptable.

The staff determined, through review of the applicant's response to RAI 17.1-1, that it had provided adequate QA measures to authenticate and verify data retrieved from Internet Web sites that support information in the SSAR that could affect the design, construction, or operation of SSCs important to safety. Specifically, PI ENTO-002-PI-02, describes the administrative controls applied to the collection of data in support of the development of the SSAR for the ESP application. The PI states that data obtained from Internet Web site sources must be documented as to the source, date of receipt, date or revision level of the data, and title. The data must be retained in the project file. Finally, the data gatherer/user will ensure that data collected are appropriate for the task (based on the knowledge and experience of the individual), can be traced to their source, and support the intended use.

17.3.3.1 Enercon

Entergy Nuclear Potomac Company selected Enercon as the primary vendor to establish a QA program for the ESP. Enercon prepared the QAPPD that was used for applicable portions of the ESP application and established the overall quality framework for the ESP project. Enercon wrote its QAPM to comply with the requirements of Appendix B to 10 CFR Part 50.

The staff reviewed the ESP design control instructions attached to the QAPPD. Additionally, the staff reviewed the design control procedures referenced in the QAPPD. Inspection Report 052000009/2004001 details the staff's review of specific instructions and procedures.

The staff noted that the QAPM provides guidelines for QA controls in the areas of design input, verification, change control, and corrective actions. Additionally, the QAPM provides the guidelines for design process, interface control, and document control and references other Enercon QA procedures for document control and corrective actions. The staff found that the QA design control measures described in Enercon's QAPPD and other Enercon procedures and documents are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and the guidance contained in Section 17.1.1 of RS-002 regarding ESP design control activities.

17.3.3.2 William Lettis & Associates

Entergy Nuclear Potomac Company contracted with WLA to perform various aspects of the work associated with the ESP permit project. WLA managed and directed field activities associated with the geological, geotechnical, and geophysical work involved with the ESP project. WLA and its subcontractors performed the work according to the guidance provided in

Enercon project instructions (noted previously in this section), portions of the Enercon QAPM, and American Society for Testing and Materials (ASTM) standards.

WLA compiled and evaluated the geosciences database and developed the seismic source model for input into the probabilistic seismic hazard assessment. Additionally, WLA performed the technical review of the data compilation and seismic source characterization activities. As discussed in Inspection Report 052000009/2004001, the staff reviewed documents related to the work performed, supervised, or reviewed by WLA, including (1) site boring summary sheets, (2) cone penetrometer test (CPT) summary logs, (3) static laboratory testing summaries for site borings, (4) borehole logging reports, and (5) WLA daily reports.

The staff noted that the documents independently verify the validity of stated assumptions, inputs, and references cited in engineering reports. The independent technical review determined that WLA and its subcontractors collected and analyzed the input data according to the standard-of-practice methodologies outlined in ASTM standards.

As detailed in Inspection Report 052000009/2004001, the staff also reviewed the engineering reports. These reports verify the validity of the assumptions, inputs, outputs, and references used for calculations. However, the staff noted that the independent reviews for these calculations, which conclude that no substantive discrepancies exist, were completed subsequent to the submission of the ESP application.

The staff concluded that the QA design control measures for the work performed by WLA in support of the ESP project are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and the design control acceptance criteria contained in Section 17.1.1 of RS-002.

17.3.4 Conclusions (Design Control)

As set forth above, the staff reviewed the QA control measures employed by the primary contractor and its subcontractors and concluded that they implemented acceptable design controls which meet the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.4 Procurement Document Control

17.4.1 Technical Information in the Application (Procurement Document Control)

SERI did not supply information in its application about procurement document control. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers procurement document control to be one of the criteria having elements associated with the control of ESP activities.

The QAPM requires procurement document control for the purchase of all safety-related items and services. Procurement documents must be controlled to ensure that requirements, including the basis for acceptance of items or services, are fully and correctly specified. Either the procurement document or other referenced documents must detail technical and QA requirements.

The QAPM states that procurement documents must incorporate (1) inspections and tests to be performed by the subcontractor, including acceptance criteria, (2) source activities to be performed for Enercon (or the client), (3) designated hold points for Enercon or client personnel to perform QA functions, (4) access to records, and (5) QA programs to be documented and applied by the subcontractor that cover the relevant requirements of the Enercon QA program, including those mandated by 10 CFR Part 21, as applicable.

The QAPM notes that the project manager is responsible for all procurement documents. The QA manager must review procurement documents for safety-related items or services.

The QAPM also states that proposed revisions to safety-related procurement documents must be prepared and reviewed in the same manner as the original documents. Procurement documents developed as part of a project must be retained with the project files and must be controlled and maintained as specified in Section 17.0 of the QAPM.

17.4.2 Regulatory Evaluation (Procurement Document Control)

While the NRC does not require procurement document control to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor stated that its procurement document controls will ensure development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.4 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of procurement document controls. Acceptable procurement document controls should include (1) provisions to ensure that procurement documents related to ESP activities that could affect SSCs important to safety include or reference the applicable technical requirements and QA controls, and (2) provisions for the review and approval of procurement documents for ESP activities that could affect SSCs important to safety.

17.4.3 Technical Evaluation (Procurement Document Control)

The contract between Entergy Operations, Inc., and Enercon assigns the primary responsibility for project control and preparation of the ESP application to Enercon. Under the contract, Enercon developed the QAPPD. The QAPPD identifies Entergy Nuclear Potomac Company as the client organization, Enercon as the primary contractor for preparation of the ESP application, and WLA as the primary subcontractor for ESP site characterization.

The contract with WLA assigns that organization the responsibility for regional and site investigations, geological hazards investigation, seismic source characterization, and updating the probabilistic seismic hazards analysis developed by the Electric Power Research Institute (EPRI). Entergy Nuclear Potomac Company issued a contract to EPRI, under the auspices of an existing service agreement, for control of information exchanged between EPRI and WLA.

Enercon issued contracts to two principal subcontractors. One contract authorizes Omega to prepare calculations and analyses to determine radiological dose consequences. A second contract authorizes Black Diamond Consultants to update an evacuation time estimate (ETE).

WLA issued contracts in two general areas of activity. One area covers subsurface investigations and characterization of the site. The second area includes the preparation of seismic calculations and independent technical reviews under what are essentially personnel service contracts.

17.4.3.1 Enercon

Enercon is on the Entergy Nuclear Potomac Company's qualified supplier list to provide energy design, general engineering services, and computer software engineering services. The Nuclear Procurement Issues Committee (NUPIC) audited Enercon's QA program to ensure conformance with the technical requirements of Appendix B to 10 CFR Part 50 and the reporting requirements of 10 CFR Part 21. The Enercon QA program follows the guidelines of ANSI N45.2-1977 and ANSI/American Society of Mechanical Engineers (ASME) NQA-1.

Enercon accepted the primary contract from Entergy Nuclear Potomac Company for preparation of the ESP application. The contract sets forth the terms and conditions under which Enercon would provide consulting, professional, or technical services. The contract states that individual task orders would define specific work activities and schedules. The contract identifies the individuals responsible for technical administration, project performance, and contract management.

As detailed in Inspection Report 052000009/2004001, the staff reviewed the contract's QA and reporting requirements for the conduct of project-related activities. The contract states that Enercon would follow its QA program and the QAPPD, as approved by the Entergy Nuclear Potomac Company regulatory compliance/QA manager, in performing all services that are provided in preparation of the ESP application and that could affect the design input for the safety-related SSCs. Further, for work designated as safety related, the contractor would comply with the provisions of 10 CFR Part 21.

Under the contract, Enercon provides engineering, technical, and project management support to prepare an ESP application in accordance with 10 CFR Part 52. The key elements of an ESP application include (1) administrative information, (2) the SSAR, (3) the site environmental report, and (4) emergency planning information. As detailed in Inspection Report 052000009/2004001, the staff's review included contract-related letters issued by Enercon documenting acceptance of the contract, development of an infrastructure for the ESP, and other contract-related matters.

The staff found that the procurement document controls, with respect to Enercon, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.4.3.2 William Lettis & Associates

An Entergy contract authorizes WLA to perform regional and site investigations. The contract's quality requirements state that all services provided which could affect the safety-related functions of SSCs associated with the ESP plant parameter envelope must be performed under the auspices of the Enercon QA program, supplemented by the Entergy QAPPD.

Enercon's QA program incorporates a mandate imposed on subcontractors to implement the reporting requirements of 10 CFR Part 21. Therefore, a subcontractor's acceptance of a task under the Enercon QA program also imposes the requirements of 10 CFR Part 21.

The contract provides for access rights by representatives of Entergy to observe contract-related activities and review for acceptance all services provided under the contract. The work orders generally invoke the quality requirements of the service agreement described above.

The staff found that the procurement document controls, with respect to WLA, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.4.4 Conclusions (Procurement Document Control)

As set forth above, the staff reviewed the QA measures employed by the primary contractor and its subcontractors and concluded that they have implemented an acceptable level of procurement document control which meets the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support the satisfactory performance of such SSCs once they are in service.

17.5 Instructions, Procedures, and Drawings

17.5.1 Technical Information in the Application (Instructions, Procedures, and Drawings)

SERI did not supply information in its application about the control of instructions, procedures, and drawings. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers the control of instructions, procedures, and drawings to be one of the criteria having elements associated with the control of ESP activities.

The QAPM states that documented procedures, instructions, and drawings that include appropriate quantitative and qualitative criteria for determining satisfactory work performance and quality compliance must prescribe activities affecting quality. An appropriate level of management must review the instructions, procedures, and drawings for adequacy and approve them for use.

According to the QAPM, the QAPPD identifies applicable QA requirements for an individual project. The QAPPD may be used to provide and/or identify project-specific instructions in cases in which the issuance or revision of a CSP would be inappropriate or unnecessary.

17.5.2 Regulatory Evaluation (Instructions, Procedures, and Drawings)

While the NRC does not require control of instructions, procedures, and drawings to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor stated that its control of instructions, procedures, and drawings will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.5 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of control for instructions, procedures, and drawings. Acceptable controls for instructions, procedures, and drawings should include (1) provisions for ensuring that ESP activities that could affect SSCs important to safety are prescribed by and accomplished in accordance with instructions, procedures, and drawings, and (2) provisions for incorporating quantitative and qualitative acceptance criteria in instructions, procedures, and drawings related to ESP activities that could affect SSCs important to safety.

17.5.3 Technical Evaluation (Instructions, Procedures, and Drawings)

Section 17.3.3 of this SER provides a detailed discussion of instructions, procedures, and drawings implemented by the primary subcontractor. The staff considered the scope of controls for instructions, procedures, and drawings to be adequate for ensuring that the primary subcontractor properly conducted ESP activities for the applicant and primary contractor. The staff also reviewed the adequacy of activities conducted by additional subcontractors. The following discusses the staff's review of the ESP activities conducted by the additional subcontractors to ensure that controls for instructions, procedures, and drawings are adequate for their scopes of work.

17.5.3.1 University of Texas

WLA subcontracted with the UT Soil Dynamics Laboratory to perform boring sample dynamic laboratory analyses for the ESP project. The QA program policies contained in the UT report comply with the Soil Dynamics Laboratory QA program, which the U.S. Department of Energy previously approved for the Yucca Mountain project dynamic soil and rock tests. Documentation from UT describes technical and test procedures for the resonant column and torsional shear testing performed in the Soil Dynamics Laboratory.

As discussed in Inspection Report 052000009/2004001, the staff noted that UT designed the dynamic test results, reports, and validation procedures to meet the standards of ASTM D3740, "Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction." The staff also found that the UT engineering personnel involved in performing the tests and writing the reports appear to be adequately trained for the work they performed on the ESP project.

The staff concluded that the instruction, procedure, and drawing controls applied to the work performed by UT in support of the ESP project are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002 regarding ESP design control activities.

17.5.3.2 Eustis

WLA subcontracted with Eustis to perform CPTs and laboratory analysis in support of seismic studies for the ESP project. Eustis carried out the CPT sounding under the requirements of a QAPPD instruction, as specified in its subcontract with WLA. Eustis performed the laboratory analysis in accordance with the Eustis QA procedure, which was reviewed and approved by the Enercon QA manager.

The staff determined that the Eustis QA manual specifies that qualified, trained individuals use approved procedures in accordance with ASTM or other industry standards to complete the laboratory analysis.

The staff concluded that the instruction, procedure, and drawing controls applied to the work performed by Eustis in support of the ESP project are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and the guidance contained in Section 17.1.1 of RS-002 regarding ESP design control activities.

17.5.3.3 GEOVision

WLA subcontracted with GEOVision to perform geophysical surveying for the ESP project. GEOVision performed its work in accordance with Enercon's QAPM, as specified in Entergy Nuclear Potomac Company's contract with WLA.

The staff noted that GEOVision implemented procedures for the validation of the software output calculations and similar calculations performed by hand.

The staff concluded that the instruction, procedure, and drawing controls applied to the work performed by GEOVision in support of the ESP project are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002 regarding ESP design control activities.

17.5.3.4 Pacific Engineering

WLA subcontracted with Pacific Engineering to complete work for the ESP project under the guidance contained in the Enercon QAPM. Pacific Engineering (1) provided technical advice for the detailed site investigation and laboratory testing program, (2) evaluated preliminary and final analysis of safe-shutdown earthquake (SSE) site response effects, and (3) developed SSE site amplification factors and a calculation package to document the results.

Pacific Engineering worked with Jack Benjamin & Associates to conduct SSE ground motion analyses for the proposed ESP site. All calculations and software used in the development of SSE ground motions were certified for use in accordance with applicable Enercon CSPs.

The staff concluded that the instruction, procedure, and drawing controls applied to the work performed by Pacific Engineering in support of the ESP project are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002 regarding ESP design control activities.

17.5.3.5 Jack Benjamin & Associates

WLA subcontracted with Jack Benjamin & Associates to perform work for the ESP project in accordance with Enercon's QAPM. Jack Benjamin & Associates (1) developed SSE ground motion based on site response amplification factors, (2) provided an updated EPRI probabilistic seismic hazard assessment for the proposed site, (3) updated seismicity parameters for EPRI source zones, as required, and (4) prepared a calculation package documenting any analysis.

The staff concluded that the instruction, procedure, and drawing controls applied to the work performed by Jack Benjamin & Associates in support of the ESP project are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002 regarding ESP design control activities.

17.5.3.6 Omega Technical Services

Omega performed the assessment for radiological dose consequences in support of the ESP project. The scope of work performed by Omega includes both nuclear and nonnuclear safety-related activities. The activities that Omega and Enercon determined to be nuclear safety related were subject to the requirements of Enercon's QAPM and CSPs. The staff noted that Omega personnel involved in the ESP project (1) drafted calculations used to develop the normal dose calculation estimates for radiological consequence evaluations, (2) performed dose calculations for various accidents associated with the advanced boiling-water reactor, Westinghouse Advanced Plant 1000 (AP1000), and Advanced CANDU Reactor-700 plants, (3) performed calculations for normal atmospheric dispersion factors required to determine maximum offsite dose, and (4) evaluated the proposed methodology for the preparation of calculations and analyses.

The staff found that the instruction, procedure, and drawing controls applied to the work performed by Omega in support of the ESP project are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and the guidance contained in Section 17.1.1 of RS-002 regarding ESP design control activities.

17.5.4 Conclusions (Instructions, Procedures, and Drawings)

As set forth above, the staff reviewed the QA measures employed by the primary subcontractors and concluded that they have implemented an acceptable level of control for instructions, procedures, and drawings which meets the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support the satisfactory performance of such SSCs once they are in service.

17.6 <u>Document Control</u>

17.6.1 Technical Information in the Application (Document Control)

SERI did not supply information in its application about document control. The QAPPD describes the QA measures for ESP activities and identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect these elements, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers document control to be one of the criteria having elements associated with the control of ESP activities.

The QAPM states that all safety-related documents associated with a specific project are subject to the following three procedural requirements:

(1) responsibility and methodology are established for preparing, reviewing, approving, and issuing documents and their revisions

(2) unique identification is provided by assignment of document numbers

(3) distribution is controlled by recording document number, date of issue, and all document recipients

The QAPM states that, before approval, the new or revised document will be reviewed to ensure that regulatory, technical, and QA requirements have been appropriately and adequately addressed. A designated person will approve the document after review comments have been resolved. A copy of the latest approved revision will be retained as a QA record.

The QAPM states that revision of any document associated with a quality-related activity will receive the same level of review and approval as the original document. Unless provided for by contractual agreement, only the latest revision of a document will be used.

The QAPM states that transmittal of revised documents will normally be in accordance with the revised document's current distribution list.

17.6.2 Regulatory Evaluation (Document Control)

While the NRC does not require document control to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, Enercon stated that its document controls will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.6 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of document control. Acceptable document controls should include provisions to ensure that documents related to ESP activities that could affect SSCs important to safety, including changes, are reviewed for adequacy, approved for release by authorized personnel, and distributed and used at the location where the prescribed activity is performed.

17.6.3 Technical Evaluation (Document Control)

Section 17.5 of this SER discusses the document controls applied by the subcontractors. In addition, Inspection Report 052000009/2004001 details the specific documents reviewed and any relevant discussions of their adequacy. The staff considers the scope of document control to be adequate for the ESP activities that were conducted. The staff evaluated documents that were reviewed and approved for issuance to ensure that the document control process was followed. The staff determined that the applicant and its primary contractor had adequate document controls in place for ESP activities.

17.6.3.1 Enercon

The staff found that the primary contractor adequately controlled the distribution of the copies of the QAPM and CSPs. Enercon identified controlled copies of the QAPM and CSPs. The QA manager maintained a record of distribution and properly incorporated revisions into applicable documents. Enercon identified authorized users of the procedures. The staff determined that Enercon adequately controlled documents used for ESP activities.

17.6.4 Conclusions (Document Control)

As set forth above, the staff reviewed the QA measures employed by the primary contractor and concluded that it implemented acceptable document controls which meet the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support the satisfactory performance of such SSCs once they are in service.

17.7 Control of Purchased Material, Equipment, and Services

17.7.1 Technical Information in the Application (Control of Purchased Material, Equipment, and Services)

SERI did not supply information in its application about the control of purchased material, equipment, and services. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers control of purchased material, equipment, and services to be one of the criteria having elements associated with the control of ESP activities.

The QAPM notes that the project manager is responsible for incorporating the technical and QA requirements in procurement documents. The project manager must control communication with subcontractors, assuring that changes and other contractual matters are referred to the manager of projects or division manager for action. The QA manager or designee is responsible for review and concurrence of specified QA requirements in the procurement documents, as well as scheduling and performance of source QA activities. The project manager or QA engineer is responsible for quality verification of items or services received.

The QAPM states that procurement activity controls must ensure that procured items and services affecting the quality of safety-related items conform to the requirements of the procurement documents.

The QAPM states that, if the procured item or service is to be delivered under a QA program that is not Enercon's or the client's, a review and source audit(s) of the subcontractor's QA program must be completed and documented. Enercon or the client may conduct this review and audit, as contractually agreed upon. If the subcontractor is on the client's approved vendor list, this review and audit(s) is not required, provided that client approval is obtained.

The QAPM states that Enercon will verify that procured items and services conform to the requirements of procurement documents. For these items, Enercon must verify that all characteristics required by the procurement document have been completed and documented, that the results of tests and examinations are in accordance with the acceptance criteria specified in the procurement document, and that the qualifications and certifications of personnel are in accordance with the procurement document requirements. For services procured by Enercon, acceptance will be accomplished by the review of documents produced and may require verification of conformance to specifications by surveillance or audit of the activity. The importance to safety, complexity, and the subcontractor's quality performance will determine, at least in part, the methods selected for verification. Verification activities, including data and results, will be documented. Provisions will be made so that the supplier, the client, or Enercon maintain documentary evidence of conformance to procurement documents for purchased material before and during the use of such material and equipment at the client's facility. Enercon's verification will not relieve the subcontractor of its responsibility for quality or quality verification.

17.7.2 Regulatory Evaluation (Control of Purchased Material, Equipment, and Services)

While the NRC does not require control of purchased material, equipment, and services to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, Enercon stated that its control of purchased material, equipment, and services will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.7 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of control of purchased material, equipment, and services. Acceptable controls should include (1) provisions for the control of purchased material, equipment, and services related to ESP activities that could affect SSCs important to safety that apply to selecting suppliers, as well as to assessing the adequacy of quality, and (2) provisions to ensure that documented evidence of the conformance to procurement specifications of material and equipment related to ESP activities that could affect SSCs important to safety are available at the site before installation or use.

17.7.3 Technical Evaluation (Control of Purchased Material, Equipment, and Services)

Section 17.4.3 of the SER discusses the controls of purchased material, equipment, and services applied by SERI to the primary contractor. This section of the SER focuses on the additional subcontractors that were engaged in activities for the ESP project. The following sections discuss the scope of activities and the QA measures applied to those activities.

17.7.3.1 Omega

Enercon's service agreement authorizes Omega to conduct an assessment of a radiological dose consequence approach in support of the ESP application. The associated work order authorized calculation of the accident atmospheric dispersion factors for the exclusion boundary and low-population zone. For these safety-related activities, the contract specified that Omega complete calculations under the applicable CSPs. Inspection Report 052000009/2004001 further discusses the staff's review of the procurement controls.

The staff found that the procurement controls, with respect to Omega, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.7.3.2 Black Diamond Consultants

Enercon's contract authorizes Black Diamond Consultants to review the ESP project's site emergency plan and update the associated ETE. The scope of work entails a field evaluation of roadway conditions and relevant changes (since the original update estimate was completed in 1986) and interviews with appropriate State and local officials. Enercon specified the work to be performed in accordance with NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" (NUREG-0654 FEMA-REP-1, Revision 1 Addenda), Section II, and the requirements of 10 CFR 52.17(b)(2)(i). The contract specified that the documentation of the analyses should include methods, contacts, assumptions, and results, as appropriate, to support conclusions reached. The contract authorized a specific individual to perform the work.

The staff found that the procurement controls, with respect to Black Diamond Consultants, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.7.3.3 Eustis

Under a work order, WLA subcontracted with Eustis to provide CPTs and laboratory test services in support of WLA seismic investigations at the ESP site. The ESP site work involved the completion of four CPT soundings at the ESP site, estimated to require borings approximately 80 to 120 feet deep. Eustis carried out the CPT soundings under Enercon's QA program and in accordance with applicable project requirements, specified in the QAPPD instructions. The contract reserved the right of access for Enercon representatives to observe and inspect CPT operations for compliance with the company's QA requirements. Additionally, the contract required that all Eustis personnel involved in data acquisition processing receive training in the Enercon QA program.

The work order specified that Eustis carry out laboratory analysis in accordance with its quality procedures. Enercon conducted a qualification audit of the Eustis laboratory, which concluded that, although Eustis did not have a QA program that met the requirements of Enercon's QA program, adequate controls were in place to support adding Eustis to the Enercon qualified supplier list for material testing in support of the ESP project.

Eustis contract deliverables included maintenance of a scientific notebook and daily field reports for the CPT investigations. Upon project completion, Eustis must provide copies of the scientific notebook, calibration records, or documentation of CPT logs or laboratory results. Eustis must provide a report documenting the scope of work, methodology, data, and results of investigations. The staff reviewed a summary of the results in the ESP application.

The staff found that the procurement document controls, with respect to Eustis, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002. However, the contract did not impose the reporting requirements of 10 CFR Part 21. Additionally, SERI did not require the work performed by this subcontractor to meet the criteria of 10 CFR Part 21. Since the results of the laboratory testing may be used for support of load-bearing structures and equipment, an RAI focused on the lack of documentation regarding 10 CFR Part 21 requirements. Inspection Report Open Item 052000009/2004001-02 discusses this omission.

Subsequently, in RAI 17.1-4, the staff asked the applicant to describe the actions it took to ensure the work performed by Eustis for the ESP project complied with the requirements of 10 CFR Part 21. In its response, the applicant stated that the Enercon QA program qualified, by source audit, the Eustis QA program to perform static soil testing. Eustis does not maintain a 10 CFR Part 21 reporting process. Project records document the adequacy of the work that Eustis provided. Eustis completed all testing in accordance with the applicable ASTM standards, as prescribed in the Enercon QA procedures. In addition, before performing ESP work, the U.S. Army Corps of Engineers (USACE) certified Eustis for similar work.

The applicant noted that, during the ESP phase, static soil data provided by Eustis will be used in a qualitative, rather than quantitative manner for soil classification, general evaluation of geologic hazards and comparative evaluation with the data in the updated final safety analysis report. During the second phase (i.e., the COL phase), the data may be used to supplement additional information required to be collected during this phase (additional boreholes and testing will be required at the COL phase). This COL data will be used to evaluate liquefaction potential, foundation-bearing capacities, foundation settlements, and excavation design. The work performed for the COL phase, which will serve to further validate the original Eustis work, will require 10 CFR Part 21 requirements to be applied.

The staff found that the procurement controls, with respect to Eustis, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002. In addition, the staff found the alternative method that the applicant proposed to address a lack of 10 CFR Part 21 requirements, specifically as applied to Eustis, to be acceptable.

17.7.3.4 GEOVision

WLA contracted with GEOVision to conduct ESP site activities related to geophysical surveys and pressure and shear wave suspension logging. GEOVision performed its work in accordance with Enercon's QAPM and applicable project requirements, as specified in the QAPPD.

GEOVision identified the pressure and shear wave surveys that were conducted within the scope of the contract as safety related and, as such, required calibration of equipment and documentation of all work in a scientific notebook. The staff reviewed the GEOVision activities associated with this contract in the applicable site-boring logs and classification logs. The staff found that GEOVision appropriately documented the required calibrations and work.

The staff found that the procurement controls, with respect to GEOVision, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.7.3.5 University of Texas

WLA contracted with Dr. Ken Stokey of UT to conduct laboratory testing services in support of the WLA seismic investigations. Testing included six dynamic triaxial tests and resonant column and torsional shear tests. Dr. Stokey and UT performed the work in accordance with Enercon's QA program and the applicable project requirements, as specified in Enercon's QAPPD. The contract specified that the work be carried out under existing UT procedures, which the Enercon QA manager reviewed and approved for the project. The applicant included the approved procedure as an attachment in the QAPPD (PI ENTO-002-PI-05).

The staff found that the procurement controls, with respect to UT, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.7.3.6 Jack Benjamin & Associates

WLA subcontracted with Jack Benjamin & Associates for a designated individual to provide technical services, including a technical review of ground motion sensitivity analysis and development of rock ground motions. A subsequent work order authorized (1) additional technical reviews to update the seismicity parameters for EPRI source zones and the EPRI probabilistic seismic hazard assessment and median ground rock ground motion for site response analysis, (2) preparation of calculation packages documenting these reviews, and (3) preparation of ESP SSAR Sections 2.5.2.3 and 2.5.2.5. Although the contract did not impose any specific QA requirements, on the basis of a discussion between the NRC staff and the project managers, such contracts are common within the industry, functioning like a staff augmentation program with the independent subcontractor working under the QA program of the contracting organization. In this case, Jack Benjamin & Associates performed subcontractor work under Enercon's QA program, as stipulated in the Entergy contract with WLA. The calculations performed under this subcontract were not available for review.

The staff found that the procurement controls, with respect to Jack Benjamin & Associates, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.7.3.7 Pacific Engineering

Pacific Engineering personnel performed technical services under this contract. Pacific Engineering provided technical advice for detailed site investigation and laboratory testing. The individual designated in the above Jack Benjamin & Associates contract was responsible for ground motion sensitivity analysis. The contract also authorized work for the performance of the final site response analysis, development of SSE site amplification factors, and preparation of a calculation package in SSAR Section 2.5.2.4. The same QA requirements as noted in the Jack Benjamin & Associates contract applied to the work performed by Pacific Engineering.

The staff found that the procurement document controls, with respect to Pacific Engineering, are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.7.4 Conclusions (Control of Purchased Material, Equipment, and Services)

As set forth above, the staff reviewed the QA measures employed by the primary subcontractors and concluded that they have implemented acceptable controls for purchased material, equipment, and services which meet the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support the satisfactory performance of such SSCs once they are in service.

17.8 Identification and Control of Materials, Parts, and Components

17.8.1 Technical Information in the Application (Identification and Control of Materials, Parts, and Components)

SERI did not supply information in its application about the identification and control of materials, parts, and components. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan does not consider identification and control of materials, parts, and components to be one of the criteria having elements associated with the control of ESP activities.

The QAPPD does not provide justification as to why the identification and control of materials, parts, and components does not apply to ESP activities. However, in its QAPM, the primary contractor describes the requirements for identifying safety-related items.

The QAPM states that item specification or procurement documents will state identification requirements for items. Identification will be keyed to some unique feature, such as lot, heat, part, or serial number.

The QAPM states that, when direct identification is impractical or insufficient, physical separation or procedural controls will be added or substituted to ensure that each item can be positively identified. Markings on tags and labels, when required, will be applied in a manner that is not detrimental to the item or its use. Markings on items, tags, and labels will be legible, unambiguous, and durable. Coding may be used, provided that the code is explained in records traceable to the items. All documents intended to provide a record of the necessary characteristics (quality) or performance of required processes or activities on an item will include the identification of the item. The catalog number or standard identification marked on the container may identify standard shelf or catalog items, which are procured in quantity and which do not have specific material, test, or inspection requirements.

The QAPM states that the identification of items will be maintained at all times. Item and item record identification will be verified before installation of the material, part, or component.

In RAI 17.1-3, the staff asked the applicant to explain why the identification and control of materials, parts, and components does not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures used for the ESP application. In its response, SERI stated that the development of the ESP application does not require procurement, fabrication, receipt, or erection of safety-related materials, parts, components, or partially fabricated assemblies for installation into a nuclear power plant. A QAPPD instruction specifies the applicable quality controls, governing codes, and national consensus standards for control of all equipment used in the laboratory testing of samples. This criterion is therefore not applicable to the ESP project.

17.8.2 Regulatory Evaluation (Identification and Control of Materials, Parts, and Components)

While the NRC does not require the identification and control of materials, parts, and components to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor states that its identification and control of materials, parts, and components does not apply to ESP activities. However, the QAPM does have the requisite controls.

Paragraph 17.1.1.8 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of identification and control of materials, parts, and components. An acceptable level should include (1) provisions to identify and control materials, parts, and components related to ESP activities that could affect SSCs important to safety, and (2) provisions to ensure that incorrect or defective items are not used in ESP activities that could affect SSCs important to safety.

17.8.3 Technical Evaluation (Identification and Control of Materials, Parts, and Components)

Neither the applicant nor its primary contractor invoked QA measures for the identification and control of materials, parts, and components. The staff concluded, based on its review of the applicant's response to RAI 17.1-3 and its observations during the inspection, that the applicant and Enercon did not conduct activities important to safety that require the identification and control of materials, parts, and components.

17.8.4 Conclusions (Identification and Control of Materials, Parts, and Components)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that the scope of work for the ESP project does not require the identification and control of materials, parts, and components.

17.9 <u>Control of Special Processes</u>

17.9.1 Technical Information in the Application (Control of Special Processes)

SERI did not supply information in its application about control of special processes. The QAPPD describes the QA measures for ESP activities and identifies certain criteria of Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan does not consider control of special processes to be one of the criteria having elements associated with the control of ESP activities.

The QAPPD does not provide justification as to why the identification and control of special processes does not apply to ESP activities. However, in its QAPM, Enercon describes that this criterion of Appendix B to 10 CFR Part 50 addresses the necessity of establishing controls to assure that those special processes, such as welding and heat treating, are correctly performed by properly qualified and certified personnel.

The QAPM states this criterion is not within the scope of services currently provided by Enercon. Should events dictate, Enercon would add this criterion to the program and obtain separate client approval before beginning any activity that requires it to control special processes.

In RAI 17.1-3, the staff asked the applicant to explain why the control of special processes does not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures used for the ESP application. In its response, the applicant stated that the development of the ESP application does not involve any special processes, including welding, heat treating, or nondestructive examination. No requirements are in place for use of personnel qualified in accordance with specific codes and standards governing nondestructive examination activities. Therefore, this criterion does not apply to the ESP project.

17.9.2 Regulatory Evaluation (Control of Special Processes)

While the NRC does not require the control of special processes to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1of RS-002 contains guidance for the staff to use in evaluating an ESP applicant’s control of special processes. In the Enercon QAPM, the primary contractor stated that the development of the ESP application will not involve the use of special processes.

Paragraph 17.1.1.9 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of control of special processes. Acceptable control of special processes should include (1) provisions to ensure the acceptability of special processes used for ESP activities that could affect SSCs important to safety, and (2) provisions to ensure that special processes related to ESP activities that could affect SSCs important to safety are performed by qualified personnel using qualified procedures and equipment.

17.9.3 Technical Evaluation (Control of Special Processes)

Neither the applicant nor its primary contractor invoked QA measures for the control of special processes. The staff concluded, based on its review of the applicant's response to RAI 17.1-3 and its observations during the inspection, that the applicant and Enercon did not conduct activities important to safety that require control of special processes.

17.9.4 Conclusions (Control of Special Processes)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that, based on the scope of work for the ESP project, control of special processes is not required.

17.10 Inspection

17.10.1 Technical Information in the Application (Inspection)

SERI did not supply information in its application about controls for inspection. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls used for ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan does not consider controls for inspection to be one of the criteria having elements associated with the control of ESP activities.

The QAPPD does not provide justification as to why inspection controls do not apply to ESP activities. However, in its QAPM, Enercon describes that this criterion addresses the establishment of a program for performing inspections for work activities important to safety.

The QAPM states that this criterion is not within the scope of services currently provided by Enercon. However, Enercon or its subsidiaries provide qualified personnel for certification to client inspection programs. Enercon's involvement is limited to providing personnel who, by virtue of review of resumes, certificates, and other such documentation, provide reasonable assurance of meeting the minimum qualification requirements of ANSI N45.2.6, "Qualifications of Inspection, Examination, and Testing Personnel for Nuclear Power Plants," or American Society for Nondestructive Testing (ASNT)-TC-1A, "Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing," where applicable. In cases in which such evidence is weak or questionable, Enercon will verify the individual's qualifications with previous employers. Enercon will provide personnel certified in specific disciplines in accordance with the client's certification program.

In RAI 17.1-3, the staff asked the applicant to explain why inspection does not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures used for the ESP application. In its response, the applicant stated that the development of the ESP application does not involve inspection process monitoring activities. In addition, no hold or witness points were required to be established for any of the activities performed under the ESP project. The applicant and its primary contractor performed quality surveillances and audits under the QAPPD. Therefore, this criterion does not apply to the ESP project.

17.10.2 Regulatory Evaluation (Inspection)

While the NRC does not require inspection controls to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating an ESP applicant's control for inspections. In its QAPM, the primary contractor states that development of the ESP application will not involve the use of controls for inspection.

Paragraph 17.1.1.10 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of inspection control, including (1) provisions for the inspection of activities affecting the quality of ESP activities that could affect SSCs important to safety, in addition to the items and activities to be covered, (2) establishment of organizational responsibilities and qualifications for individuals or groups performing inspection of ESP activities that could affect SSCs important to safety, and (3) provisions for inspection personnel to be independent of the performance of the activity being inspected.

17.10.3 Technical Evaluation (Inspection)

Neither the applicant nor its primary contractor invoked QA measures for inspection. The staff concluded, based on its review of the applicant's response to RAI 17.1-3 and its observations during the inspection, that the applicant and Enercon did not conduct activities important to safety that require inspection.

17.10.4 Conclusions (Inspection)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that, based on the scope of work for the ESP project, inspection is not required.

17.11 <u>Test Control</u>

17.11.1 Technical Information in the Application (Test Control)

SERI did not supply information in its application about test control. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls used for ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers test control to be one of the criteria having elements associated with the control of ESP activities.

The QAPPD does not provide justification as to why test control does not apply to ESP activities. However, in its QAPM, Enercon describes requirements for test control.

The QAPM provides the roles and responsibilities of Enercon personnel for test control. It also states that independent tests or a test program will be planned, as required by the contract, and documented to identify the testing required and the test schedule for the ESP project. Enercon will submit test planning documents to the client for review and approval, as required by the contract. The QAPPD addresses the specific requirements for test planning. For each test or system of tests, the test planning documents will include the schedule for the development of test procedures, performance of the tests, and qualification of test personnel, when applicable.

The QAPM states that test procedures will identify the item to be tested and the purpose of the test. Test procedures will specify, as applicable, (1) preparations and inspections that must be accomplished before testing, (2) special environments, (3) prerequisites, (4) calibrated instrumentation, (5) instructions, (6) hold points, (7) acceptance criteria based on applicable design documents, and (8) methods for documenting or recording test data and results.

The QAPM notes that, when test results or an evaluation reveals a nonconformance, the test documentation will clearly state the degree, cause, and disposition of nonacceptability.

In RAI 17.1-3, the staff asked the applicant to explain why test control does not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures used for the ESP application. In its response, the applicant stated that the development of the ESP application does not require a test program to demonstrate that the SSCs would perform satisfactorily in service. The applicant and its primary contractor did not perform any testing under the ESP project that relates to proof testing, preoperational testing, or operational testing.

This criterion addresses testing differently than the laboratory testing performed on samples taken for seismological data collection activities and field geophysical testing. This criterion specifies and implements the appropriate quality controls for laboratory and geophysical testing and analysis in accordance with the requirements of design control. A QAPPD instruction specifies the applicable quality controls, governing codes, and national consensus standards for testing of these samples. Therefore, this criterion does not apply to the ESP project.

17.11.2 Regulatory Evaluation (Test Control)

While the NRC does not require test control to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant’s primary contractor stated that its test controls do not apply to ESP activities. However, the QAPM does have the requisite controls.

Paragraph 17.1.1.11 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of test control. Acceptable test controls should include (1) provisions ensuring that tests related to ESP activities that could affect SSCs important to safety are appropriately controlled to provide confidence that these SSCs would perform adequately in service, and (2) provisions ensuring that prerequisites are provided in written test procedures and that test results are documented and evaluated for activities related to ESP activities that could affect SSCs important to safety.

17.11.3 Technical Evaluation (Test Control)

The staff indicated that observations made by QA personnel meet quality measures for test control. This section uses the term "surveillance" as a set of observations of limited scope performed by an individual. The staff considered the surveillances that QA personnel conducted an appropriate indicator of acceptable test controls in place for ESP activities. A surveillance would cover such areas as properly completed tests, completed prerequisites in the test procedure, and properly documented results.

The staff reviewed the Enercon QA manager's performance of two surveillances at the ESP site and one surveillance at UT, where Enercon conducted dynamic material testing. Instead of Enercon overseeing surveillances, an independent subcontractor with QA experience performed surveillances at the WLA offices in San Rafael and Walnut Creek, California. The following discusses the staff's review of these surveillance results.

17.11.3.1 Site Evaluation Activities

The Enercon QA manager conducted two surveillances while site activities were in progress. In the first surveillance, the QA manager observed mud rotary drilling at Borehole No. 1. This surveillance verified that SERI recorded the core barrel dimension and condition of bits and steel, as required. Based on this observation, the QA manager concluded that the equipment complies with ASTM D1586-84, "Standard Test Method for Penetration Test and Split-barrel Sampling of Soils." The QA manager also checked equipment for thin-wall sampling, determining that it complies with ASTM D1587-94, "Standard Practice for Thin-walled Geotechnical Sampling of Soils." Two deficiencies, involving handling of soil samples, were dispositioned and closed during the surveillance.

The second surveillance verified that observed attributes met the requirements of ASTM D5778-95, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils." One deficiency, involving field calibration of equipment, was dispositioned and closed during the surveillance.

The staff found that the test controls for the ESP site evaluation activities are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.11.3.2 Material Testing Laboratories

The Enercon QA manager conducted a surveillance of activities associated with resonant column and torsional shear testing at UT. The surveillance examined test apparatus and configuration and calibration documentation. Based on observation of equipment setup and testing activities, the QA manager concluded that SERI performed the testing in accordance with the applicable QAPPD instruction. The QA manager identified three deficiencies associated with calibration dates on test equipment. Two were attributed to typographical errors; the third was attributed to an out-of-date calibration sticker. All deficiencies were dispositioned and closed during the surveillance.

The staff found that the test controls for material testing activities are performed and controlled in a manner equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.11.3.3 William Lettis & Associates

The staff reviewed three internal surveillance reports documenting surveillances conducted at the WLA offices in San Rafael and Walnut Creek, California.

WLA conducted the first surveillance before any calculations had been performed. The WLA staff used a checklist to verify that project requirements, such as a project file, resumes for project personnel, and project instructions, were in place.

WLA conducted a second surveillance to verify that the records required by QAPPD instructions were complete. This surveillance followed the completion of site activities, and the report identified a number of needed actions.

WLA conducted the third surveillance to verify completeness of project deliverables, the preparation of which was controlled by QAPPD instructions. In addition, the surveillance reviewed project documentation for compliance with the applicable Enercon CSP for issuance of project deliverables.

With the exception of six findings and two recommendations identified in the three surveillances, the staff concluded that WLA satisfied the applicable requirements of the QAPPD instructions. The staff documented the actions taken to close the findings and recommendations in an email to the primary contractor. The primary contractor documented closure of the findings and recommendations in a letter.

The staff found that the test controls for activities conducted by WLA are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1of RS-002.

17.11.4 Conclusions (Test Control)

As set forth above, the staff reviewed the QA measures employed by the applicant and the primary contractor and its subcontractors, concluding that they have implemented acceptable test controls which meet the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.12 <u>Control of Measuring and Test Equipment (M&TE)</u>

17.12.1 Technical Information in the Application (Control of M&TE)

SERI did not supply information in its application about the control of M&TE. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers the control of M&TE to be one of the criteria having elements associated with the control of ESP activities.

The QAPM states that, to ensure accuracy, M&TE will be controlled, calibrated, adjusted, and maintained at prescribed intervals or before use against certified equipment having known valid relationships to nationally recognized standards. If no national standards exist, the basis for calibration will be documented. Special calibration will be performed when the accuracy of the equipment is suspect. When M&TE is found to be out of calibration, an evaluation will document the validity of previous inspection or test results and the acceptability of the items previously inspected or tested. If any M&TE is consistently found to be out of calibration, it will be repaired or replaced.

17.12.2 Regulatory Evaluation (Control of M&TE)

While the NRC does not require the control of M&TE to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor stated that its control of M&TE will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.12 in Section 17.1.1 of RS-002 provides the QA measures constituting an acceptable level of control of M&TE. Acceptable control of M&TE should include (1) provisions to ensure that tools, gauges, instruments, and other measuring and testing devices are properly identified and controlled, and (2) provisions to ensure that those tools and devices are calibrated and adjusted at specified intervals.

17.12.3 Technical Evaluation (Control of M&TE)

17.12.3.1 William Lettis & Associates

WLA managed and directed the field activities. WLA used various specialty subcontractors for exploratory drilling and sampling, geophysical surveying, and laboratory testing. The WLA project manager provided overall direction for the work and supervised a staff of senior and staff geologists. WLA conducted its work in accordance with a QAPPD instruction for geologic and geophysical field exploration and laboratory testing. The QAPPD instruction provided guidelines to ensure that WLA performed the field and laboratory studies in a manner consistent with applicable regulations and nuclear industry standards. WLA conducted testing in accordance with ASTM standards. The staff reviewed the completed M&TE calibration data sheets attached to the instruction and found no deficiencies. WLA also enclosed pertinent calibration methodology procedures, which meet ASTM standards.

17.12.3.2 University of Texas

The UT performed boring sample dynamic laboratory analysis. The staff reviewed the testing report, which details procedures that UT designed for the control of M&TE to meet ASTM D3740. The staff considered the procedures adequate for the scope of work conducted by UT.

The UT conducted linear and nonlinear dynamic soil property measurements determined by combined resonant and torsional shear tests. The staff reviewed engineering report results that document the work conducted at UT. The report contains all documentation associated with (1) the testing and calibration procedures, (2) the QA program, and (3) the overall system checks conducted before and after UT performed dynamic testing. The staff also ensured that the calibration standards used are traceable to the National Institute of Standards and Technology (NIST).

17.12.3.3 Eustis

Eustis conducted four CPTs at the site using an electronic piezocone penetrometer. The sleeve friction is measured directly using a subtraction load cell. Eustis completed the testing in accordance with methods and procedures outlined in ASTM D5778-95. During the CPTs, Eustis recorded CPT parameters (tip resistance and friction resistance) and pore pressure measurements. Eustis made pore pressure measurements using a pore pressure element located behind the tip. The staff reviewed the instrumentation calibration report and found that it is traceable to NIST.

17.12.3.4 GEOVision

GEOVision conducted suspension soil velocity measurements. The staff noted that GEOVision performed the velocity measurements using industry-standard or better methods for both measurements and analyses. GEOVision completed all work under its QA procedures, which include (1) use of before and after NIST-traceable calibrations, where applicable, for field and laboratory instrumentation, (2) use of standard field data logs, (3) use of independent verification of data by comparison of receiver-to-receiver and source-to-receiver velocities, and (4) independent review of calculations and results by a registered professional engineer, geologist, or geophysicist. The staff found that the GEOVision controls for M&TE appear adequate for the work performed.

17.12.4 Conclusions (Control of M&TE)

As set forth above, the staff reviewed the QA measures employed by the primary subcontractors and concluded that they implemented acceptable controls for M&TE that meet the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.13 Handling, Storage, and Shipping

17.13.1 Technical Information in the Application (Handling, Storage, and Shipping)

SERI did not supply information in its application on handling, storage, and shipping controls. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers the handling, storage, and shipping controls to be one of the criteria having elements associated with the control of ESP activities.

The QAPM states that, when necessary, particular items, special coverings, special equipment, and special protective environments (i.e., inert gas, temperature levels, and moisture content) will be specified, provided, and their existence verified. For critical, sensitive, perishable, or high-valued articles, specific written procedures for handling, storage, packaging, shipping, and preservation will be used. Special handling tools and equipment will be provided, as necessary, to ensure safe and adequate handling. Markings will be adequate to identify, maintain, and preserve the shipment, including indication of the presence of a special environment or the need for special control.

17.13.2 Regulatory Evaluation (Handling, Storage, and Shipping)

While the NRC does not require handling, storage, and shipping controls to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary subcontractor states that its handling, storage, and shipping controls will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.13 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of handling, storage, and shipping control. Acceptable controls should include provisions to control the handling, storage, shipping, cleaning, and preservation of items related to ESP activities that could affect SSCs important to safety in accordance with work and inspection instructions to prevent damage, loss, and deterioration by environmental conditions, such as temperature or humidity.

17.13.3 Technical Evaluation (Handling, Storage, and Shipping)

17.13.3.1 Enercon

The staff did observe a specific example of Enercon's controls for handling, storage, and shipping, which it details in a site visit report (ADAMS Accession No. ML022320222). Enercon conducted exploratory borings and CPTs during the staff visit. This enabled the staff to observe the performance of two CPTs and the partial drilling of a test hole with the collection of soil samples. The exploratory boring characterized subsurface geologic conditions, performed in-situ testing, conducted borehole geophysical surveys, and obtained soil samples for laboratory testing. The staff saw several wood boxes of soil samples from a boring that were stored in a shaded area, awaiting shipment to UT for dynamic soil testing. Each box contained several plastic tubes of soil samples. Enercon marked and sealed each tube with wax at both ends to prevent the escape of moisture from the soil. The soil samples appeared to be properly sealed and packed.

A QAPPD instruction describes field techniques for controlling field samples. The instruction states that control-numbered field notebooks will be used to record data and field observations and measurements. The recording geologist will number and sign notebook pages. In addition, samples collected will be numbered and labeled in a manner consistent with the outcrops identified in the field notebooks. The QAPPD instruction also covers (1) field techniques for controlling field samples, (2) sample storage, (3) labeling and identification of samples, (4) recording samples, (5) sample storage, and (6) the sample retention period.

Another QAPPD instruction describes the handling and storage of various soil and rock samples. Specific instructions apply to various types of samples from different sampling methods, such as mud rotary drilling, diamond wireline rock coring, rock sampling, and borehole logging. The ASTM Standards D4220-95, “Standard Practices for Preserving and Transporting Soil Samples,” and D5079-90, “Standard Practices for Preserving and Transporting Rock Core Samples,” outline the guidelines for collecting and transporting samples for lab testing or future analysis.

17.13.4 Conclusions (Handling, Storage, and Shipping)

As set forth above, the staff reviewed the QA measures employed by the primary contractor and concluded that it implemented acceptable controls for handling, storage, and shipping which meet the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.14 Inspection, Test, and Operating Status

17.14.1 Technical Information in the Application (Inspection, Test, and Operating Status)

SERI did not supply information in its application about controls for inspection, test, and operating status. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan does not consider controls for inspection, test, and operating status to be one of the criteria having elements associated with the control of ESP activities.

The QAPPD does not provide justification as to why identification and controls inspection, test, and operating status do not apply to ESP activities. However, in its QAPM, the primary contractor states that this criterion addresses the necessity of identifying the status of inspections, tests, and/or operability of safety-related SSCs. The QAPM further states that this criterion is not within the scope of services currently provided by Enercon. Should events dictate, Enercon will add this criterion to the program and obtain separate client approval.

In RAI 17.1-3, the staff asked the applicant to explain why inspection, test, and operating status do not apply to the development of the ESP application. Alternatively, if this QA measure were to apply, the staff asked the applicant to describe the QA measures used for the ESP application. In its response, the applicant stated that the development of the ESP application does not entail the design, fabrication, or installation of any safety-related SSCs. No measures were required to indicate whether components have passed inspections or tests. Similarly, no SSCs are presumed to operate where tagging or operational controls would be required to indicate status. A QAPPD instruction specifies the applicable quality controls and the governing codes and standards for control of all equipment used in laboratory testing of samples. Therefore, this criterion does not apply to the ESP project.

17.14.2 Regulatory Evaluation (Inspection, Test, and Operating Status)

While the NRC does not require controls for inspection, test, and operating status to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating an ESP applicant's control of special processes. In its QAPM, Enercon states that controls for inspection, test, and operating status are not within the scope of services it currently provides. Should events dictate, Enercon will add this criterion to the program and obtain separate client approval.

Paragraph 17.1.1.14 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of controls for inspection, test, and operating status. Acceptable controls should include provisions to indicate the inspection, test, and operating status of items related to ESP activities that could affect SSCs important to safety in order to prevent inadvertent use or bypassing of inspection and tests.

17.14.3 Technical Evaluation (Inspection, Test, and Operating Status)

Neither the applicant nor its primary contractor invoked QA measures for inspection, test, and operating status. The staff concluded, based on its review of the applicant's response to RAI 17.1-3 and its observations during the inspection, that the applicant and Enercon did not conduct activities important to safety that require control of inspection, test, and operating status.

17.14.4 Conclusions (Inspection, Test, and Operating Status)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that, based on the scope of work for the ESP project, inspection, test, and operating status is not required.

17.15 <u>Nonconforming Materials, Parts, or Components</u>

17.15.1 Technical Information in the Application (Nonconforming Materials, Parts, or Components)

SERI did not supply information in its application about control of nonconforming materials, parts, or components. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan does not consider control of nonconforming materials, parts, or components to be one of the criteria having elements associated with the control of ESP activities.

The QAPPD does not provide justification as to why control of nonconforming materials, parts, or components does not apply to ESP activities. However, in its QAPM, Enercon describes requirements for the control of nonconforming materials, parts, or components. According to the QAPM, the QAPPD will include, if applicable to the project scope, requirements in procedures for identification, documentation, segregation, disposition, and notification to affected organizations of nonconforming items.

The QAPM states that nonconforming items will be reviewed and accepted, rejected, repaired, or reworked in accordance with documented procedures. Repaired or reworked items will be reinspected based on applicable procedures. Measures that control further processing, delivery, or installation of a nonconforming or defective item pending a decision on its disposition will be established and maintained. Nonconforming items may be disposed of by acceptance as is, by scrapping or repairing the defective item, or by reworking to complete or correct to a drawing or specification. The measures will require documentation verifying the acceptability of nonconforming items that have the disposition of “repair” or “use as is.” As a guideline, control of nonconforming items by tagging, marking, or other means of identification is acceptable when physical segregation is not practical, although physical segregation and markings are preferred.

17.15.2 Regulatory Evaluation (Nonconforming Materials, Parts, or Components)

While the NRC does not require control of nonconforming materials, parts, or components to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant’s primary subcontractor states that its control of nonconforming materials, parts, or components will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.15 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of nonconforming materials, parts, or components control. Acceptable controls should include provisions to control the use or disposition of nonconforming materials, parts, or components related to ESP activities that could affect SSCs important to safety.

17.15.3 Technical Evaluation (Nonconforming Materials, Parts, or Components)

Neither the applicant nor its primary contractor invoked QA measures for control of nonconforming materials, parts, or components. The staff concluded, based on its review of the applicant's response to RAI 17.1-3 and its observations during the inspection, that the applicant and Enercon did not conduct activities important to safety that require identification and control of nonconforming materials, parts, or components.

17.15.4 Conclusions (Nonconforming Materials, Parts, or Components)

As set forth above, the staff reviewed the need for QA measures by the applicant and its primary contractor and concluded that the scope of work for the ESP project does not require the identification and control of materials, parts, or components.

17.16 Corrective Action

17.16.1 Technical Information in the Application (Corrective Action)

SERI did not supply information in its application about corrective action. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers corrective action to be one of the criteria having elements associated with the control of ESP activities.

In the QAPM, the scope of corrective action includes provisions for response to significant conditions adverse to quality or that require action by Enercon to comply with the requirements of 10 CFR Part 21. The QAPM also provides for the initiation of "stop work" action.

The QAPM states that every Enercon employee must identify conditions adverse to quality and notify the QA manager or designee of the condition. This responsibility for notification is not limited to known conditions but may also include conditions suspected to be adverse to quality. The QA manager and project manager are both responsible for identifying any CARs that could represent a condition requiring evaluation and reporting based on the requirements of 10 CFR Part 21. For project problems, the project manager is responsible for resolving the corrective action request and for initiating actions to correct the condition. The project manager will describe these actions on a corrective action resolution form, which will be sent to the QA manager for acceptance.

According to the QAPM, the QA manager, project QA engineer, or lead auditor is responsible for verifying the adequacy and completion of corrective action and, upon such verification, for closeout and documentation of the CARs. Documentation of corrective action includes (1) a description of the identified problem, (2) a root cause analysis of the problem, (3) immediate actions taken to correct a specific problem, and (4) the actions taken to prevent recurrence of the problem (if evaluated as necessary).

According to the QAPM, the project manager will notify subcontractors of conditions adverse to quality within the subcontractor's facility or of conditions adverse to quality that could impact work being performed by the subcontractor.

The QAPM states that, once a verification that immediate actions and actions taken to prevent recurrence is complete, the CAR will be closed out. An original of the closeout report, including any correspondence related to the report, will be retained in the project files as quality records. The QA manager will retain a copy of the report and associated correspondence.

17.16.2 Regulatory Evaluation (Corrective Action)

While the NRC does not require corrective action to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor states that its corrective action will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.16 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of control of corrective action. An acceptable corrective action program should include provisions to ensure that conditions adverse to quality are promptly identified and corrected. For significant conditions adverse to quality, such provisions should preclude recurrence.

17.16.3 Technical Evaluation (Corrective Action)

17.16.3.1 Enercon

Enercon's QAPM provides for controls on the identification and correction of conditions adverse to quality. The primary contractor used a CAR to document conditions adverse to quality. The staff determined that the applicable CSP on corrective action provides adequate guidance for the conduct of a corrective action program. However, the staff identified that neither the QAPM nor the CSP define a condition adverse to quality. As discussed below, the staff found that the threshold at which the primary contractor documented CARs and took corrective action was appropriate for ESP activities. The Enercon QA manager generated a CAR to document the staff's finding. Inspection Report 052000009/2004001 further details the staff's review of the corrective action program.

The staff reviewed a CAR which documents that Enercon did not use a reference summary form for population data sources, as required by the QAPPD instructions. Initially, the population data were not considered safety related. The applicant used the population data in at least one safety-related calculation for the projected dose to the public resulting from normal plant releases via the liquid or gaseous pathways, based on a worst-case release. The staff found that the corrective actions resulted in the addition of appropriate information to the reference summary form.

The staff reviewed a CAR that documents that Omega prepared the design verification checklists' reviewer and verification sheets for calculations that were not properly numbered, in accordance with the applicable CSP. The staff considered this CAR to be administrative in nature.

The staff reviewed a CAR that documents that the project manager did not review a purchase order for a Eustis laboratory analysis, as required by Enercon's QAPM. Resolution of the CAR determined that the project manager was aware of the purchase order. However, this purchase order had unique arrangements for completion of the work by WLA. Entergy Nuclear Potomac Company contracted with WLA directly to perform the seismic and geotechnical work required for the ESP application. The staff determined that, although Eustis worked under the Enercon QAPM, the subcontractor was contractually obligated to WLA, who was actually responsible for the work.

The staff noted the low number of CARs generated during the ESP project and that only the Enercon QA manager had documented deficiencies, which the QA manager noted in a CAR.

The staff found that the Enercon corrective action program is equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meets the guidance contained in Section 17.1.1 of RS-002.

17.16.3.2 William Lettis & Associates

WLA conducted an internal surveillance to ensure its compliance with applicable QA requirements contained in the relevant QAPPD instructions. The individual who conducted the surveillance identified 15 items and did not include those items in the Enercon corrective action process. The same individual conducted a followup surveillance, which reviewed these items. From this surveillance, six items remained. WLA responded in an email to the individual who conducted the surveillance that it had addressed the items. The staff conducted a followup of some items to ensure that WLA had adequately addressed and closed the items. Three of the items pertained to revising procedures. Two items involved WLA needing verification that the subcontractors completed the tasks. One item involved WLA documenting review of field logs. Although WLA did not formally place the items in Enercon's corrective action program, the items had been adequately addressed. The Enercon QA manager documented the staff's observation that the discrepancies noted in the surveillances were not entered into Enercon's corrective action process on a CAR.

17.16.4 Conclusions (Corrective Action)

As set forth above, the staff reviewed the QA measures employed by the primary contractor and its subcontractors and concluded that they have implemented an acceptable corrective action program that meets the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.17 <u>Quality Assurance Records</u>

17.17.1 Technical Information in the Application (Quality Assurance Records)

SERI did not supply information in its application about QA records. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers QA records to be one of the criteria having elements associated with the control of ESP activities.

The QAPM states that Enercon and the client, as agreed upon, will determine and dispose of requirements for project-specific QA records. The QAPPD will document these requirements. The project manager or QA engineer will establish the QA record files specified before beginning work on a project.

The QAPM states that QA records will be legible, accurate, and complete, as appropriate. QA records generated on a project will be controlled to ensure retrievability, prevent loss, and provide for accountability upon project completion. The project manager will transmit all project records involving lifetime storage retention, as specified in ANSI N45.2.9-1979, "Requirements for Collection, Storage, and Maintenance of Quality Assurance Records for Nuclear Power Plants," to the client at the completion of a project. Records specified as corporate QA records, and any project record not transmitted to the client as stated above, will be maintained for a period consistent with the recommendations of ANSI N45.2.9-1979. QA records will be stored neatly, maintained in files, logbook, or otherwise organized to protect the records from damage or deterioration.

The QAPM states that the QA manager must establish and maintain files for (1) copies of superceded sections of the Enercon QAPM and CSPs, (2) distribution logs for the Enercon QAPM and CSPs, (3) annual and periodic reports to management on QAPM effectiveness, (4) notification records of 10 CFR Part 21 problems, (5) reports of internal and client audits and associated documentation of corrective actions, (6) records of auditor training and qualification and lead auditor certifications, (7) CARs and logs, and (8) reports of project audits, subcontractor audits, and preaward surveys.

The QAPM states that the project manager or designee must establish and maintain a QA document file consisting of applicable project-related documents, including (1) controlled copies of current and superceded revisions of the QAPPD, (2) records of training administered, (3) reports of project audits, (4) CARs related to the project and documentation of actions taken, (5) quality records related to design, (6) procurement documents, (7) instructions, procedures, and drawings which prescribe quality activities, (8) document control logs or resisters, (9) evidence of verification of procured items or services, (10) records of qualifications of project personnel, and (11) other records specified in the QAPPD or CSPs.

17.17.2 Regulatory Evaluation (Quality Assurance Records)

While the NRC does not require QA records to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor states that its QA records will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.17 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of QA records control. Acceptable control of QA records should include provisions for the identification, retention, retrieval, and maintenance of quality records.

17.17.3 Technical Evaluation (Quality Assurance Records)

17.17.3.1 Enercon

According to Enercon's QAPM, the elements of the QA program (as identified above) must be used to ensure the quality of the ESP project. The QAPM states that the CSP documents the requirements and responsibilities for records transmittal, retention, and maintenance.

In its review of test records produced by WLA and Eustis, audits and surveillances of the Enercon subcontractors, and surveillances performed at WLA, the staff noted that the subcontractors maintained all of the records in accordance with the QAPM.

17.17.4 Conclusions (Quality Assurance Records)

As set forth above, the staff reviewed the QA measures employed by the primary contractors and concluded that they have implemented an acceptable level of control for QA records which meets the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.18 Audits

17.18.1 Technical Information in the Application (Audits)

SERI did not supply information in its application about audits. The QAPPD describes the QA measures for ESP activities and identifies certain criteria in Appendix B to 10 CFR Part 50 that contain elements associated with the control of ESP activities. Enercon applied elements from these criteria or verified that the controls applied to ESP activities reflect the elements from these criteria, as outlined in the Enercon QAPM. Enercon wrote the QAPM to comply with the requirements of Appendix B to 10 CFR Part 50; as such, it contains QA policies corresponding to each of the Appendix B criteria. The plan considers audits to be one of the criteria having elements associated with the control of ESP activities.

According to the QAPM, the QA manager must schedule audits; select, train, and certify audit personnel; verify completed corrective actions resulting from audits; and maintain audit files.

The lead auditor must plan audits, perform audits, report findings and recommendations, notify appropriate personnel of conditions noted that are adverse to quality, and follow up and close out audit reports.

The QAPM states that the QA manager will determine the required frequency of audits for a specific project and assign personnel to perform the audit. When scheduling audits, consideration will be given to the nature and complexity of the activity. The QAPPD will identify the audit schedule. At its discretion, the QA manager may supplement the regularly scheduled audits with additional ones.

According to the QAPM, personnel selected to perform as auditors will have a working knowledge of the Enercon QA program and will have experience or training commensurate with the scope, complexity, or any special attributes of the activity to be audited. Audit personnel should be familiar with the requirements of ANSI N45.2.12, "Requirements for Auditing of Quality Assurance Programs for Nuclear Power Plants." The qualifications will be certified and documentation will be placed in the individual's audit records maintained by the QA manager.

The QAPM states that personnel selected for auditing will not have any direct responsibility for performance of the activity they will audit. Before the audit, audit personnel will prepare an audit plan describing the audit to be performed, including appropriate checklists.

According to the QAPM, an audit report will be prepared upon completion of the audit detailing those results. The audit report will include any CARs written as a result of the audit. The audited organization will respond to CARs within 30 days following receipt of the audit report, unless an alternate schedule has been established.

17.18.2 Regulatory Evaluation (Audits)

While the NRC does not require audits to comply with the criteria of Appendix B to 10 CFR Part 50, Section 17.1.1 of RS-002 contains guidance for the staff to use in evaluating the measures employed by an ESP applicant. In the QAPPD, the applicant's primary contractor stated that its audits will ensure the development of the application in a quality manner and, where appropriate, in accordance with the requirements of Appendix B to 10 CFR Part 50.

Paragraph 17.1.1.18 in Section 17.1.1 of RS-002 provides the QA measures that constitute an acceptable level of audit control. Acceptable audits should include (1) provisions for audits to verify compliance with all aspects of QA controls and to determine the effectiveness of the QA controls, and (2) detailed responsibilities and procedures for conducting, documenting, and reviewing the results of audits, including the designation of management levels to review and assess audit results.

17.18.3 Technical Evaluation (Audits)

17.18.3.1 Enercon

The Enercon QAPM outlines the conduct of audits, but includes no specific procedures. The QAPM describes auditor qualifications, audit planning, performance, reporting, and followup action. Enercon conducted the audits using applicable portions of its QA checklist, which was modeled on the NUPIC audit checklist. The same Enercon individual conducted two audits that were related to ESP activities. The staff reviewed the resume, qualifications, and training records of the individual. The individual appeared to be adequately qualified and trained to conduct audits.

The first audit verified the implementation of applicable QA controls at Eustis for the ESP project work. Eustis conducted the retrieval of soil samples for testing and then tested the soil samples at its materials testing laboratory. The audit established a basis for placing Eustis on the Enercon qualified supplier list. Eustis was conditionally approved for ESP geotechnical testing. The audit determined that, although Eustis did not implement a QA program that meets all the requirements of Appendix B to 10 CFR Part 50, the company did have sufficient controls in place to warrant its conditional approval as a supplier of materials testing for the ESP project. This conclusion was primarily based on the evidence of existing controls, as reviewed by the staff in the Enercon QA checklist document, that Enercon judged to be adequate for the work Eustis conducted. The results of recent accreditation evaluations conducted by the USACE and the American Association of State Highway and Transportation Officials supplemented Enercon's conclusion. The evaluations measured compliance by Eustis to applicable ASTM standards.

No audit findings or CARs were issued as a result of the audit. The staff found that the audit provided evidence that Eustis implemented adequate controls for work conducted on the ESP project.

The second audit verified the implementation of applicable QA controls by the Enercon Atlanta and Oklahoma City offices, as applicable to the ESP project. The auditor applied portions of the Enercon QA checklist. The audit determined that, with the exception of three CARs issued for minor infractions, Enercon completed all work performed on the ESP project in accordance with its QA requirements.

The three CARs detailed (1) a failure to use reference forms for demographic data determined by the auditor to be safety related, (2) a failure to properly number the pages for calculation design verification checklists, and (3) a failure to obtain explicit approval by the project manager for a purchase order issued by a subcontractor. Section 17.16 of this SER details the staff's determination of adequate corrective actions for the CARs.

In the QAPPD, the staff noted that Enercon will conduct audits and inspections of project activities as directed by the Enercon QA manager. This may include surveillance of field activities that are done in accordance with the QAPPD, surveillance of laboratory testing activities and activities conducted at the various offices, and detailed audits of project activities at the Enercon and WLA offices. Instead of, or in addition to, scheduled audits, a lead auditor may inspect project output documents requiring the implementation of a QA program to comply with the QAPPD requirements. An inspection report will document audits and inspections.

The staff noted that Enercon did not conduct an audit or an inspection of WLA. A representative of Entergy Nuclear Potomac Company stated that it would conduct an audit of WLA in the future.

The staff reviewed a recent NUPIC audit conducted to requalify Enercon on the Entergy Nuclear Potomac Company's qualified supplier list as a provider of safety-related design engineering services. Enercon performed and reported the audit in accordance with applicable Entergy Nuclear Potomac Company procedures using the NUPIC audit checklist. Enercon did not identify any findings during the audit, and no followup actions were required. The scope of the NUPIC audit was not specific to the ESP project. However, the NUPIC audit satisfactorily covered the general scope of technical services provided by Enercon to the ESP project.

The staff found that Enercon performed audits that are equivalent in substance to the requirements of Appendix B to 10 CFR Part 50 and meet the guidance contained in Section 17.1.1 of RS-002.

17.18.4 Conclusions (Audits)

As set forth above, the staff reviewed the QA measures employed by the primary contractor and concluded that it implemented acceptable audit controls that meet the guidance in Section 17.1.1 of RS-002. This provides reasonable assurance that any information derived from ESP activities that could be used in the design and/or construction of SSCs important to safety will support satisfactory performance of such SSCs once they are in service.

17.19 Conclusions

Based on its review and evaluation of the QA measures contained or referenced in the SSAR, as set forth above, the staff concludes the following:

- The organizations and persons performing QA functions have the independence and authority necessary to effectively carry out QA measures without undue influence from those directly responsible for costs and schedules.

- The QA procedures and measures, when properly implemented, are equivalent in substance to the criteria of Appendix B to 10 CFR Part 50 and conform to the guidance in RS-002, Section 17.1.1.

- The applicant applied QA measures to all ESP activities that established information regarding (1) the design and construction of SSCs important to safety which might be constructed on the proposed site, or (2) the establishment of site characteristics for comparison to the values of site parameters postulated in a certified design or to serve as design inputs for a custom design. The measures provide adequate confidence that information provided in the ESP application and accepted by the NRC is reliable and, when used as input for the design or construction of SSCs important to safety, would not adversely impact their ability to perform satisfactorily in service. Therefore, the staff concludes that the applicant implement acceptable QA measures fore the ESP activities.

18. REVIEW BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The Advisory Committee on Reactor Safeguards (ACRS) completed its review of the application from System Energy Resources, Inc. (SERI), for an early site permit (ESP) for the Grand Gulf ESP site, as well as the U.S. Nuclear Regulatory Commission (NRC) staff's draft safety evaluation report (DSER) for this application. The ACRS ESP subcommittee began a detailed review of the Grand Gulf ESP application and the staff's DSER in April 2005. The ACRS ESP subcommittee met with representatives from SERI and the NRC staff on May 16, 2005.

The ACRS held its full committee meeting on the Grand Gulf ESP DSER on June 2, 2005. The discussions during these meetings focused on the open items identified in the DSER. On the basis of its review, the ACRS issued an interim letter report, dated June 14, 2005, which addresses the portions of the Grand Gulf ESP application that concern safety. The staff responded to the interim letter report in its letter dated August 12, 2005 (ADAMS Accession No. ML052210235). This final safety evaluation report (SER) documents the actions the staff took in response to the comments and recommendations the ACRS identified in its interim report of June 14, 2005, as described in the staff's response letter of August 15, 2005. The staff issued its final SER after the resolution of open items discussed in the DSER and after receiving the ACRS interim letter report to the Commission related to its review.

During its meeting with the ACRS on December 8, 2005, the staff discussed the resolution of open items and responses to ACRS comments on the major elements of the ESP review. At the 528th meeting of the ACRS, the full committee considered the staff's FSER, as well as the SERI Grand Gulf ESP application, and issued its final letter report to the NRC Executive Director for Operations (EDO) on December 23, 2005. In this letter, ACRS concluded that the safety evaluation report should be issued once the staff has made more explicit its analysis of the hazards posed to the proposed site by explosions in transportation accidents on the Mississippi River. By memorandum dated March 27, 2006, the staff addressed the ACRS' comments, the changes of which are reflected within this report. Both the ACRS' letter report and the NRC staff's memorandum are included as Appendix E to this report. The NRC staff's initial response dated February 1, 2006, to the ACRS is also included in Appendix E.

19. CONCLUSIONS

In accordance with Subpart A, “Early Site Permits,” of Title 10, Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants,” of the *Code of Federal Regulations* (10 CFR Part 52), the U.S. Nuclear Regulatory Commission (NRC) staff reviewed the site safety analysis report and emergency planning information included in the early site permit (ESP) application submitted by Systems Energy Resources, Inc., for the Grand Gulf ESP site. On the basis of its evaluation and independent analyses, as discussed in this safety evaluation report (SER), the staff concludes that the Grand Gulf ESP site characteristics comply with the requirements of 10 CFR Part 100, “Reactor Site Criteria,” with the limitations and conditions proposed by the staff in this SER for inclusion in any ESP that might be issued. Further, for the reasons set forth in this SER, the staff concludes that, taking into consideration the site criteria contained in 10 CFR Part 100, a reactor(s) having characteristics that fall within the parameters for the site, and which meets the terms and conditions proposed by the staff in this SER, can be constructed and operated without undue risk to the health and safety of the public. For the same reasons, the staff also concludes that issuance of the requested ESP will not be inimical to the common defense and security or to the health and safety of the public. If issued, the Grand Gulf ESP may be referenced in an application to construct and/or operate a nuclear power reactor(s) with a total generating capacity of up to 8600 megawatts (thermal) at the ESP site, subject to the terms and conditions of the permit.

APPENDIX A

PERMIT CONDITIONS, COL ACTION ITEMS, SITE CHARACTERISTICS, AND BOUNDING PARAMETERS

Figures

A.1 Permit Conditions

Permit Condition: The Commission's regulation in 10 CFR § 52.24 authorizes the inclusion of limitations and conditions in an ESP. A permit condition is not needed when an existing NRC regulation requires a future regulatory review of a matter to ensure adequate safety during design, construction, or inspection activities for a new plant. The staff is proposing that the Commission include eight permit conditions, which are set forth below, to control various safety matters.

Permit Condition No.	SER Section	Description
2.1 - Geography and Demography		
1	2.1.2	The NRC staff proposes to include a condition in any ESP that might be issued to govern exclusion area control. This permit condition would require that an applicant for a COL referencing this ESP to demonstrate that they have been granted the right to exercise sufficient control within the exclusion area identified in the ESP, including the authority to maintain ingress to and egress from the exclusion area and to evacuate individuals from the exclusion area in the event of an emergency. The permit condition also requires a COL applicant referencing this ESP to secure any necessary arrangements to provide, in the event of a declared emergency, for the control of traffic on county roads and the evacuation of individuals within the ESP exclusion area. The condition requires that these arrangements be obtained and executed before the construction of a nuclear plant begins under a constuction permit or COL referencing the ESP.
2.4 - Hydrology		
2	2.4.13	The NRC staff proposes to include a condition in any ESP that might be issued in connection with this application requiring that an applicant referencing such an ESP design any new unit's radwaste systems with features to preclude any and all accidental releases of radionuclides into any potential liquid pathway.

Permit Condition No.	SER Section	Description
2.5 - Geology, Seismology, and Geotechnical Engineering		
3	2.5.1	The NRC staff proposes to include a condition in any ESP that might be issued in connection with this application requiring that the ESP holder and/or an applicant referencing such an ESP perform geologic mapping of future excavations for safety-related structures, evaluate any unforseen geologic features that are encountered, and notify the NRC no later than 30 days before any excavations for safety-related structures are open for NRC's examination and evaluation.

A.2 COL Action Items

<u>COL Action Items</u>: The combined license (COL) action items set forth in the SER and incorporated herein identify certain matters that shall be addressed in the final safety analysis report (FSAR) by an applicant who submits an application referencing the North Anna ESP. These items constitute information requirements but do not form the only acceptable set of information in the FSAR. An applicant may depart from or omit these items, provided that the departure or omission is identified and justified in the FSAR. In addition, these items do not relieve an applicant from any requirement in 10 CFR Parts 50 and 52 that govern the application. After issuance of a construction permit (CP) or COL, these items are not controlled by NRC requirements unless such items are restated in the preliminary safety analysis report or FSAR, respectively.

The staff identified the following COL action items with respect to individual site characteristics in order to ensure that particular significant issues are tracked and considered during the review of a later application referencing any ESP that might be issued for the North Anna ESP site.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.2 - Nearby Industrial, Transportation, and Military Facilities			
2.2-1	2.2.3	A COL or CP applicant should perform an evaluation of industrial hazards associated with site, and should assess design-specific interactions between the existing and new unit(s) and, if necessary, propose measures to account for such interactions.	New unit design and specific location not known at ESP stage
2.3 - Meteorology			
2.3-1	2.3.3	A COL or CP applicant should evaluate interaction between the existing meteorological tower and the proposed facility's cooling towers.	Design and specific location of cooling tower units are not known at ESP stage.
2.3-2	2.3.4	A COL or CP applicant should evaluate dispersion of airborne radioactive materials to the control room.	Control room location and design not known at ESP stage.
2.3-3	2.3.5	A COL or CP application should confirm specific release point characteristics and locations of potential receptors for routine release dose computations.	Exact release points and receptor locations not known at ESP stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.4 - Hydrology			
2.4-1	2.4.1.3	A COL or CP application should demonstrate that sufficient separation between the new ESP intake and the combined effluent outfall is provided so that the effluent recirculating back to the new ESP intake will not adversely affect the intake.	Design of ESP facility intake and outfall will be completed only at the COL stage after a reactor design is chosen at the COL stage.
2.4-2	2.4.1.3	A COL or CP applicant should demonstrate that if dewatering is necessary for the operation of the ESP facility, it will be considered a safety-related facility and must be designed, operated, and maintained as such.	Detailed design of the facility is not known at ESP stage.
2.4-3	2.4.1.3	A COL or CP applicant should design the site grading to provide flooding protection to safety-related structures at the ESP site based on a comprehensive flood water routing analysis for a local PMP event on the ESP site.	Detailed design of the facility, including the site grade are beyond the scope of an ESP review.
2.4-4	2.4.1.3	A COL or CP applicant should design the ESP facility with a maximum withdrawal of 85,000 gpm from the Mississippi River for makeup water requirement for the ESP facility	Detailed design of the facility, including its makeup water requirements are not available at the ESP stage.
2.4-5	2.4.2.3	A COL or CP applicant should demonstrate that the ESP plant grade is safe from the flooding effects of maximum water surface elevation during local intense precipitation without relying on any active surface drainage systems that may be blocked during this event.	Certain locations within the ESP site area can be at the flood elevation of the site in response to local intense precipitation. It is not feasible to determine flooding protection needs at the ESP stage in response to local intense precipitation because final site grade and drainage patterns are not yet known.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.4-6	2.4.8.3	A COL or CP applicant should demonstrate that 30-day cooling water supply for the ESP facility UHS will be available as liquid water in any dedicated water storage basin(s) accounting for any losses including, but not limited to, those resulting from evaporation, seepage, icing, and a margin of safety.	Detailed engineering design of underground UHS reservoirs, should they be needed, to ensure adequate capacity is not within the scope of ESP review.
2.4-7	2.4.8.3	A COL or CP applicant should demonstrate that the ESP facility UHS will not be used frequently for non emergency operation of the ESP facility.	The ESP water budget analysis relies on independent UHS reservoirs only, but need for a UHS is not known at the ESP stage.
2.4-8	2.4.12.3	A COL or CP applicant should demonstrate that an adequately designed ground water well system capable of withdrawing a maximum of 3570 gpm is provided for the ESP facility.	Detailed design of the facility is not known at the ESP stage.
2.4-9	2.4.12.3	A COL or CP applicant should provide detailed ground water information including location and depth of perched aquifers	Additional ground water characterization is not known at the ESP stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.5 - Geology, Seismology, and Geotechnical Information			
2.5-1	2.5.4	A COL or CP applicant should use excavation walls (or a combination of ground improvement with tied-back walls) and control the ground water during the excavations at the COL stage.	Exact unit locations not known at ESP stage.
2.5-2	2.5.4	A COL or CP applicant should conduct detailed studies on the fill material and the required treatment to the fill material.	Exact unit locations and design not known at ESP stage.
2.5-3	2.5.4	A COL or CP applicant should perform additional borings, laboratory testing, and a geophysical survey to confirm the current base case material properties and their variabilities throughout the site during the COL stage. If the investigations to be performed during the COL stage indicate differences in material properties which may have significantly impact to design ground motions, the applicant should evaluate the need to perform additional site response analyses with the updated properties to develop updated design ground motions.	Exact unit locations and design not known at ESP stage.
2.5-4	2.5.4	A COL or CP applicant should perform geotechnical investigations during the COL stage to provide additional verification regarding the soil properties of the zone with rise and fall of P-wave velocity, indicated in the SSAR.	Exact unit locations and design not known at ESP stage.
2.5-5	2.5.4	A COL or CP applicant should provide information to correlate plot plans and profiles of each seismic Category I facility with subsurface profiles and material properties to ascertain the sufficiency of selected borings to represent soil variations under each structure.	Exact unit locations not known at ESP stage.
2.5-6	2.5.4	A COL or CP applicant should evaluate potential excavation procedures that may be used, as well as the impact of the adjacent bluff on temporary support conditions and on standoff distance in the ESP area.	Exact unit locations and design not known at ESP stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason for Deferral
2.5-7	2.5.4	A COL or CP applicant should provide a detailed dewatering plan for evaluating the ground water conditions (procedure for dewatering during construction, and ground water control throughout the life of the plant) regarding their effects on the foundation stability.	Exact unit locations and design not known at ESP stage.
2.5-8	2.5.4	A COL or CP applicant should perform additional site investigations during the COL stage, including deep borings in the footprint of the powerblock structures to evaluate the potential for karst formation.	Exact unit locations and design not known at ESP stage.
2.5-9	2.5-4	A COL or CP applicant should develop specific design criteria (such as potential wall rotations, facility sliding, and overturning) during the COL stage when the specific characteristics of the operating system are known.	Site average shear-wave velocity of the Zone III-IV bedrock slightly less than design value provided at ESP stage.
2.5-10	2.5.5	A COL or CP applicant should incorporate the effects resulting from the local topography or possible changes in topography in the future SSI analyses	Locations of safety-related structures relative to the existing or new slopes not known at ESP stage.
2.5-11	2.5.6	A COL or CP applicant should evaluate the effect of potential flooding of the Mississippi River and possible future erosion of the bluff, including their impacts on SSI effects of the plant.	Locations of safety-related structures relative to the existing or new slopes not known at ESP stage.
11.1 - Radioactive Effluent Dose Consequences from Normal Operations			
11.1-1	11.1.4	A COL or CP applicant should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for any facility to be built on the Grand Gulf site are bounded by the radiological doses included in the ESP application and reviewed by the NRC.	Specific details of how the new facility will control, monitor, and maintain radioactive gaseous and liquid effluents not known at ESP stage.
13.6 - Industrial Security			
13.6-1	13.6.3	A COL or CP applicant should provide specific designs for protected area barriers.	Exact locations and design of barriers not known at ESP stage.

A.3 Site Characteristics

Site Characteristics: Based on site investigation, exploration, analysis and testing, the applicant initially proposes a set of site characteristics. These site characteristics are specific physical attributes of the site, whether natural or man-made. Site characteristics, if reviewed and approved by the staff, are specified in the ESP. The staff proposes to include the following site characteristics in any ESP that might be issued for the Grand Gulf site.

Site Characteristic	Value	Definition
2.1 - Geography and Demography		
Exclusion Area Boundary	The perimeter of a 2760 ft radius circle from the circumference of a 630 ft circle encompassing the proposed power block housing the reactor containment structure for new unit	The area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area
Low Population Zone	2 mile radius circle from the circumference of a 630 ft circle encompassing the proposed power block housing the reactor containment structure for new unit	The area immediately surrounding the exclusion area which contains residents
Population Center Distance	2.7 miles	The minimum allowable distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents
2.2 - Nearby Industrial, Transportation, and Military Facilities		
Minimum separation distance from GGNS onsite storage of liquid hydrogen.	737 ft	Minimum distance between GGNS onsite storage of 20,000 gallons of liquid hydrogen and safety related systems of a new plant at the proposed ESPsite.

Site Characteristic		Value	Definition
2.3 - Meteorology			
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2% annual exceedance	92 EF	The ambient dry-bulb temperature that will be exceeded 2% of the time annually
	0.4% annual exceedance	95 EF	The ambient dry-bulb temperature that will be exceeded 0.4% of the time annually
	average annual highest	98 EF	The average of the maximum temperatures recorded each year
	100-year return period	108 EF	The ambient dry-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Minimum Dry-Bulb Temperature	99% annual exceedance	25 EF	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 1% of the time annually
	99.6% annual exceedance	21 EF	The ambient dry-bulb temperature below which dry-bulb temperature will fall 0.4% of the time annually
	average annual lowest	14 EF	The average of the minimum temperatures recorded each year
	100-year return period	!6 EF	The ambient dry-bulb temperature for which a 1% annual probability of a lower dry-bulb temperature exists (100-year mean recurrence interval)

Site Characteristic		Value	Definition
Maximum Wet-Bulb Temperature	2% annual exceedance	78 EF	The ambient wet-bulb temperature that will be exceeded 2% of the time annually
	0.4% annual exceedance	80 EF	The ambient wet-bulb temperature that will be exceeded 0.4% of the time annually
Basic Wind Speed			
Fastest-mile		83 mi/h	The fastest-mile wind speed to be used in determining wind loads, defined as the fastest-mile wind speed at 33 feet above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
3-Second Gust		96 mi/h	The 3-second gust wind speed to be used in determining wind loads, defined as the 3-second gust wind speed at 33 feet above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Tornado			
Maximum Wind Speed		300 mi/h	Maximum wind speed resulting from passage of a tornado having a probability of occurrence of 10^{-7} per year
Translational Speed		60 mi/h	Translation component of the maximum tornado wind speed
Maximum Rotational Speed		240 mi/h	Rotation component of the maximum tornado wind speed
Radius of Maximum Rotational Speed		150 feet	Distance from the center of the tornado at which the maximum rotational wind speed occurs
Pressure Drop		2.0 $lbf/in.^2$	Decrease in ambient pressure from normal atmospheric pressure resulting from passage of the tornado

Site Characteristic	Value	Definition
Rate of Pressure Drop	1.2 $lbf/in.^2/s$	Rate of pressure drop resulting from the passage of the tornado
Winter Precipitation		
100-Year Snowpack	6.1 lbf/ft^2	Weight of the 100-year return period snowpack (to be used in determining normal precipitation loads for roofs)
48-Hour Probable Maximum Winter Precipitation	35 inches of water	Probable maximum precipitation during the winter months (to be used in conjunction with the 100-year snowpack in determining extreme winter precipitation loads for roofs)
Ultimate Heat Sink		
Meteorological Conditions Resulting in the Minimum Water Cooling during Any 1 Day	81.0 EF wet-bulb temperature with coincident 86.3 EF dry-bulb temperature	Historic worst 1-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in the Minimum Water Cooling during Any Consecutive 5 Days	80.2 EF wet-bulb temperature with coincident 86.2 EF dry-bulb temperature	Historic worst 5-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in the Maximum Evaporation and Drift Loss during Any Consecutive 30 Days	78.5 EF wet-bulb temperature with coincident 83.1 EF dry-bulb temperature	Historic worst 30-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in Maximum Water Freezing in the UHS Water Storage Facility	98 EF degree days below freezing	Historic maximum cumulative degree days below freezing
Short-Term (Accident Release) Atmospheric Dispersion		
0–2-H χ/Q Value @ EAB	5.95×10^{-4} s/m^3	The 0–2-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the EAB

Site Characteristic	Value	Definition
0–8-H χ/Q Value @ LPZ	8.83×10^{-5} s/m^3	The 0–8-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
8–24-H χ/Q Value @ LPZ	6.16×10^{-5} s/m^3	The 8–24-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
1–4-Day χ/Q Value @ LPZ	2.82×10^{-5} s/m^3	The 1–4-day-atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
4–30-Day χ/Q Value @ LPZ	9.15×10^{-6} s/m^3	The 4–30-day atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
Long-Term (Routine Release) Atmospheric Dispersion		
Annual Average Undepleted/No Decay χ/Q Value @ Site Boundary	8.8×10^{-6} s/m^3	The maximum annual average site boundary undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Site Boundary	7.8×10^{-6} s/m^3	The maximum annual average site boundary depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Site Boundary	1.2×10^{-8} 1/m^2	The maximum annual average site boundary D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Home	2.2×10^{-6} s/m^3	The maximum annual average home undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual

Site Characteristic	Value	Definition
Annual Average Depleted/No Decay χ/Q Value @ Nearest Home	1.9×10^{-6} s/m^3	The maximum annual average home depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Home	7.0×10^{-9} 1/m^2	The maximum annual average home D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Garden	2.0×10^{-6} s/m^3	The maximum annual average garden undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Garden	1.7×10^{-6} s/m^3	The maximum annual average garden depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Garden	5.4×10^{-9} 1/m^2	The maximum annual average garden D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Milk Cow	7.0×10^{-8} s/m^3	The maximum annual average milk cow undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Milk Cow	4.7×10^{-8} s/m^3	The maximum annual average milk cow depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Milk Cow	8.7×10^{-11} 1/m^2	The maximum annual average milk cow D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

Site Characteristic	Value	Definition
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Meat Cow	1.4×10^{-7} s/m^3	The maximum annual average meat cow undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/No Decay χ/Q Value @ Nearest Meat Cow	1.1×10^{-7} s/m^3	The maximum annual average meat cow depleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Meat Cow	4.0×10^{-10} 1/m^2	The maximum annual average meat cow D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

Site Characteristic	Value	Definition
2.4 - Hydrology		
Hydrology		
Proposed Facility Boundaries	UFSAR Figure 2.4-1 shows the areal extent of proposed facility boundaries. This figure is reproduced below as Figure 1, bounding coordinates of the ESP site are a site characteristic. During construction, the ESP site could be disturbed up to a depth ranging from 35 to 140 feet plus some additional excavation.	ESP site boundary map
Site Grade	132.5 feet above MSL	Finished plant grade of the ESP site
Highest Ground Water Elevation	70 feet below grade; 62.5 feet above MSL; perched water may be present between the site grade at 132.5 feet above MSL and the water table at 62.5 feet above MSL.	The maximum elevation of ground water at the ESP site
Flood Elevation	Flood water elevation at the ESP site caused by local intense precipitation will be established by the COL applicant using local intense precipitation values established in Section 2.4.2.3 of this SER. Local intense precipitation itself is a site characteristic, listed below.	Maximum flood level at the ESP site resulting from local intense precipitation
Local Intense Precipitation	19.2 in./h, of which 6.2 in. falls during the first 5 minutes.	Maximum potential rainfall at the immediate ESP site
Frazil and Anchor Ice	The ESP site does not have the potential for the formation of frazil and anchor ice.	Accumulated ice formation in a turbulent flow condition
Maximum Cumulative Degree Days Below Freezing	98 EF	A measure of severity of winter weather conditions conducive to ice formation (computed using observed air temperature data)

Site Characteristic	Value	Definition
Distance to the Closest Surface Water	Stream B is the closest surface water feature; 1017 ft.	Distance to closest surface water body from center of ESP powerblock
Location of Aquifers Used by Large Population for Domestic, Municipal, Industrial, or Irrigation Water Supplies	2760 ft.	Distance of nearest public water supply well located just outside the exclusion area boundary from center of ESP powerblock
2.5 - Geology, Seismology, and Geotechnical Engineering		
Basic Geologic and Seismic Information		
Capable Tectonic Structures	-----	No fault displacement potential within the Site Area
Vibratory Ground Motion		
Design Response Spectra	Appendix A. Figure 2 (SSER Figure 2.5-68)	Site Specific response spectra
Stability of Subsurface Materials and Foundations		
Minimum shear wave velocity of soil at the proposed plant foundation Level	1000 feet per second (fsp)	Current reactor designs require the minimum shear wave velocity at the foundation level be at least 1000 fsp.

A.4 Bounding Parameters

A plant parameter envelope (PPE) sets forth postulated values of design parameters that provide design details to support the staff's review of an ESP application. A controlling PPE value, or bounding parameter value, is one that necessarily depends on a site characteristic. As the PPE is intended to bound multiple reactor designs, the staff would review the actual design selected in a COL or CP application referencing an ESP to ensure that the design fits within the bounding parameter values. Otherwise, the COL or CP applicant would need to demonstrate that the design, given the site characteristics in the ESP, complies with NRC regulations. Should an applicant reference an ESP for a design that is not certified, the applicant would need to demonstrate that the design's characteristics fall within the bounding parameter values.

Bounding Parameters	Value	Definition
2.4 - Hydrology		
Makeup water flow (max)	78,000 gpm	Maximum flow required to replenish evaporation and blowdown losses from normal heat sink cooling towers.
Potable Water/Sanitary Waste System (max)	240 gpm	Maximum flow of water for plant housekeeping
Demineralized Water System (max)	1,440 gpm	Maximum water flow for demineralization of blowdown discharge
Fire Protection System (max)	1,890 gpm	Maximum water flow for fire fighting system

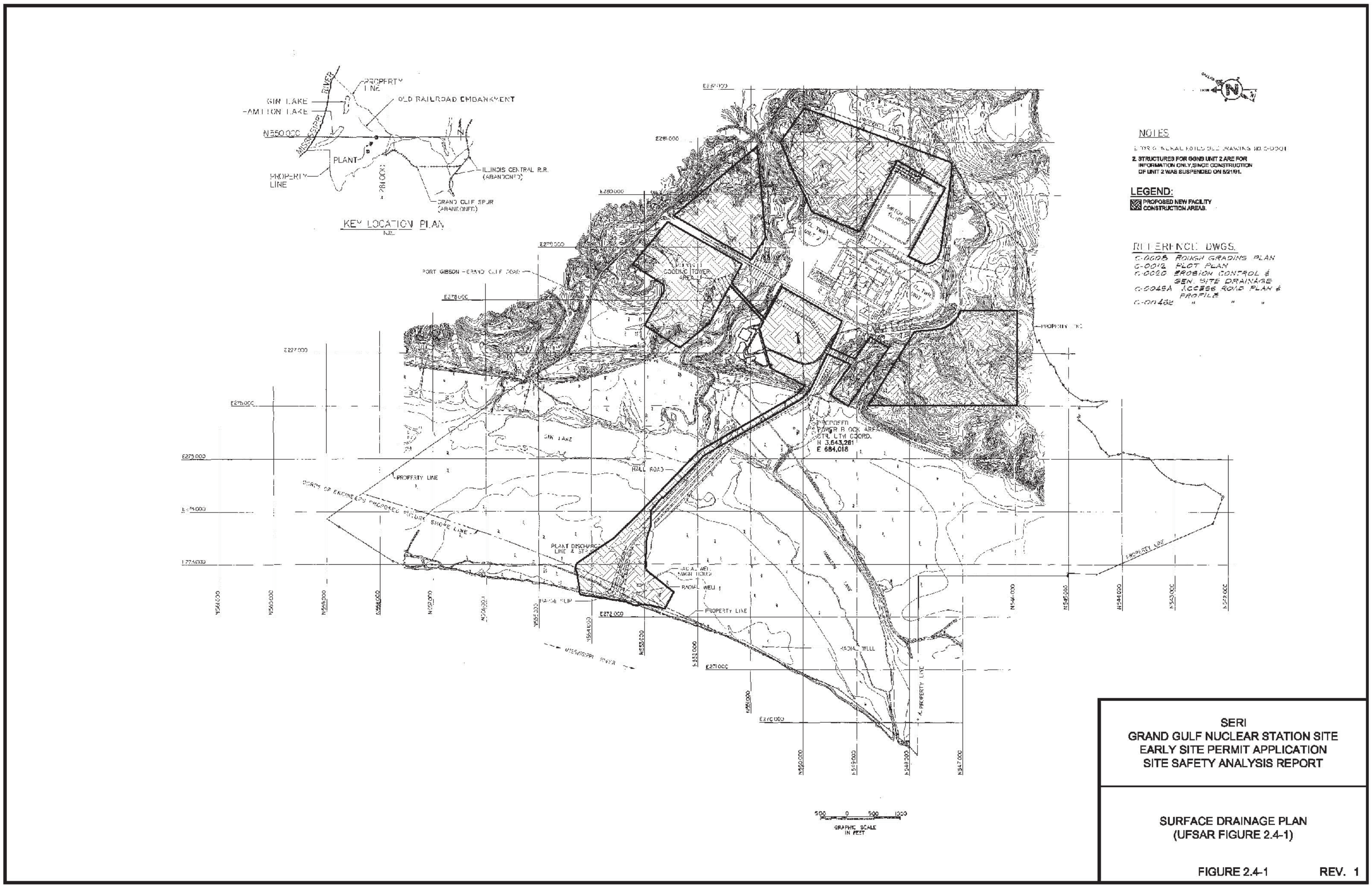


Figure 1- The proposed facility boundary of the ESP site

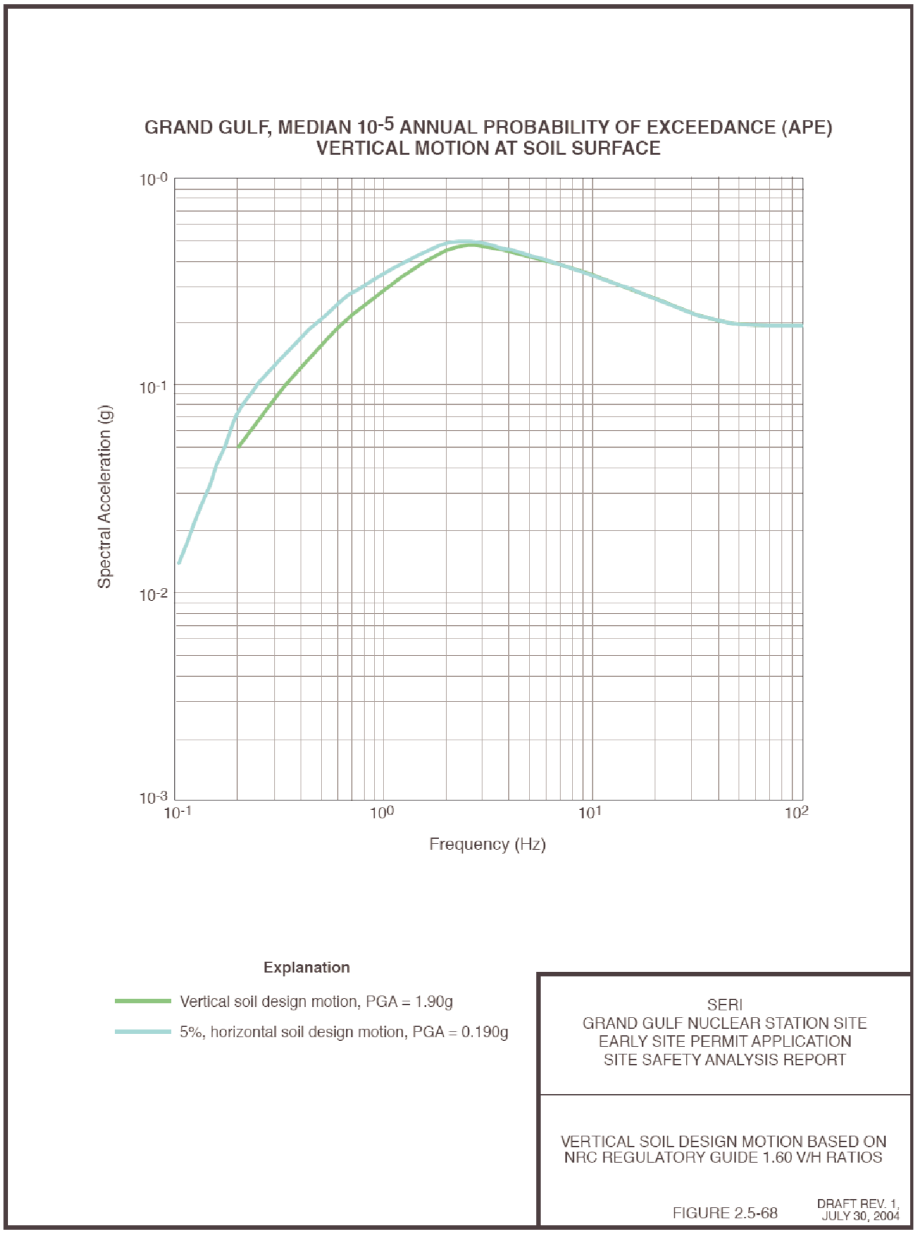


Figure 2-Horizontal and vertical response spectra for the Safe Shutdown Earthquake at the ESP site

APPENDIX B

CHRONOLOGY

This appendix contains a chronological listing of routine licensing correspondence between the staff of the U.S. Nuclear Regulatory Commission and System Energy Resources, Inc., regarding the review of the Grand Gulf early site permit application under Project No. 720 and Docket No. 52-009.

Revisions to the Grand Gulf Early Site Permit Application

Rev.	**Date**	**Accession Number**
0	10-16-2003	ML032960315
1	07-04-2005	ML052420635
2	10-03-2005	ML052780449
3	03-08-2006	ML060830203

Chronology of Early Site Permit Application for Grand Gulf

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
8/15/2002	ML031540413	Letter from G. A. Zinke, Entergy re: Quality Processes for Preparing the Entergy ESP Application.. 3 Page(s)	Letter	Entergy Nuclear Potomac Co	NRC/Document Control Desk	05000416, 05000417, PROJ0720
5/6/2003	ML030980029	Letter to G. Zinke, Entergy to provide NRC guidance on how security measures should be addressed in application for early site permit (ESP) at Grand Gulf site.. 6 Page(s)	Letter	NRC/NRR/ NRLPO	Entergy Nuclear Generation Co	05000416, PROJ0720
5/9/2003	ML031350581	Schedule for Entergy Early Site Permit Application.. 2 Page(s)	Letter	Entergy Nuclear, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
6/2/2003	ML031480443	Letter to G. Zinke, re: Alternative Energy Sources.. 8 Page(s)	Letter	NRC/NRR/ NRLPO	Entergy Nuclear Generation Co	PROJ0720
6/23/2003	ML031280718	Letter to K. Hughey - USNRC Responses to Entergy Nuclear Comments on Draft RS-002, “Processing Applications for Early Site Permits.”. 6 Page(s)	Letter	NRC/NRR/ NRLPO	Entergy Nuclear Operations, Inc	PROJ0720
8/1/2003	ML032250068	Schedule for Entergy Early Site Permit Application.. 2 Page(s)	Letter	Entergy Nuclear, Inc	NRC/Document Control Desk	PROJ0720
10/16/2003	ML032960373	Grand Gulf Early Site Permit Application Submittal.. 3 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960291	Grand Gulf Early Site Permit Application, Part 1, Cover and Table of Contents.. 30 Page(s)	License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960294	Grand Gulf Early Site Permit Application, Part 2, Site Safety Analysis Report, Table of Contents.. 28 Page(s)	License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960313	Grand Gulf Early Site Permit Application, Part 2, Chapter 1, Introduction and General Description.. 18 Page(s)	License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960320	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Site Characteristics, Pages 2.2-2 - 2.5-97.. 192 Page(s)	License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960323	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Tables, 2.1-1 through 2.5-25.. 366 Page(s)	License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960331	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.1-2 through 2.3-21.. 35 Page(s)	Drawing, License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960334	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.4-1 through 2.4-55.. 69 Page(s)	Drawing, License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960335	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figure 2.5-1.. 1 Page(s)	License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960338	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-2 through 2.5-3.. 2 Page(s)	License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960343	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figure 2-5.4a.. 1 Page(s)	License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960347	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures, 2.5-4b through 2.5-8.. 5 Page(s)	Drawing, License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960348	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figure 2.5-9a.. 1 Page(s)	License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960350	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figure 2.5-9b.. 1 Page(s)	License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960364	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-10 through 2.5-14.. 5 Page(s)	Drawing, License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960367	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figure 2.5-15.. 1 Page(s)	Drawing, License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960370	Grand Gulf Early Site Permit Application.. 2 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960372	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-16a through 2.5-19.. 5 Page(s)	Drawing, License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960376	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-20 through 2.5-24.. 5 Page(s)	Drawing, License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960379	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figure 2.5-25.. 1 Page(s)	License-Application for Construction Permit DKT 50, Photograph	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960388	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-26 through 2.5-28.. 3 Page(s)	Drawing, License-Application for Construction Permit DKT 50, Map	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960390	Grand Gulf Early Site Permit Application, Part 3, Chapter 2, Environmental Description.. 84 Page(s)	Environmental Report	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960393	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figure 2.5-29.. 1 Page(s)	Drawing	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960396	Grand Gulf Early Site Permit Application, Part 3, Chapter 2, Tables 2.2-1 through 2.7-120.. 249 Page(s)	Environmental Report	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960398	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-30 through 2.5-37.. 8 Page(s)	Drawing	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960399	Grand Gulf Early Site Permit Application, Part 3, Chapter 2, Figures 2.1-1 through 2.4-4.. 52 Page(s)	Drawing	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960402	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-38 through 2.5-68. 31 Page(s)	Drawing	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960404	Grand Gulf Early Site Permit Application, Part 3, Chapter 2, Figures 2.5-1 through 2.8-2.. 31 Page(s)	Drawing	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960406	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-69 through 2.5-80.. 12 Page(s)	Drawing	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960410	Grand Gulf Early Site Permit Application, Part 3, Chapter 3, Plant Description.. 56 Page(s)	Environmental Report	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960411	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-81 through 2.5-86.. 6 Page(s)	Drawing, Graphics incl Charts and Tables	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960414	Grand Gulf Early Site Permit Application, Part 3, Chapter 4, Environmental Effects of Construction.. 70 Page(s)	Environmental Report	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960417	Grand Gulf Early Site Permit Application, Part 2, Chapter 2, Figures 2.5-87 through 2.5-94.. 8 Page(s)	Graphics incl Charts and Tables	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960418	Grand Gulf Early Site Permit Application, Part 3, Chapter 5, Environmental Effects of Station Operations.. 133 Page(s)	Environmental Report	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960419	Grand Gulf Early Site Permit Application, Part 2, Chapter 3, Site Safety Assessment.. 61 Page(s)	- No Document Type Applies	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960421	Grand Gulf Early Site Permit Application, Part 3, Chapter 6, Environmental Measurement and Monitoring Programs.. 38 Page(s)	Environmental Report	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960422	Grand Gulf Early Site Permit Application, Part 3, Environmental Report, Table of Contents.. 31 Page(s)	Environmental Report	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960425	Grand Gulf Early Site Permit Application, Part 3, Chapter 7, Environmental Impacts of Postulated Accidents Involving Radioactive Materials.. 48 Page(s)	Environmental Report, License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960426	Grand Gulf Early Site Permit Application, Part 3, Chapter 1, Introduction.. 9 Page(s)	Environmental Report	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960427	Grand Gulf Early Site Permit Application, Part 3, Chapter 8, Need for Power.. 1 Page(s)	Environmental Report, License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960429	Grand Gulf Early Site Permit Application, Part 3, Chapter 9, Alternatives to Proposed Action.. 43 Page(s)	Environmental Report, License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/22/2003	ML032960430	Grand Gulf Early Site Permit Application, Part 3, Chapter 10, Environmental Consequences of Proposed Action.. 11 Page(s)	Environmental Report, License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960432	Grand Gulf Early Site Permit Application, Part 4, Emergency Planning Information.. 100 Page(s)	License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
10/22/2003	ML032960435	Grand Gulf Early Site Permit Application, Part 5, Programs and Plans.. 4 Page(s)	License-Application for Construction Permit DKT 50	System Energy Resources, Inc	NRC/Document Control Desk	PROJ0720
11/7/2003	ML033020043	Letter to W. A. Eaton re: Notice of Receipt and Availability of Application for Early Site Permit for the Grand Gulf ESP Site.. 8 Page(s)	Letter	NRC/NRR/DRIP	System Energy Resources, Inc	PROJ0720

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
11/24/2003	ML033180651	Letter to W.A. Eaton Announcing Acceptance and Docketing of the Grand Gulf ESP.. 7 Page(s)	Letter	NRC/NRR/ DRIP	Entergy Operations, Inc, System Energy Resources, Inc	05200009
12/23/2003	ML033630515	Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Related to Early Site Permit for Grand Gulf (TAC NO. MC1379).. 9 Page(s)	Letter	NRC/NRR/ DRIP/RLEP	Entergy Operations, Inc, System Energy Resources, Inc	05000417, 05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
1/13/2004	ML033530010	Letter to Multiple Addresses re: Grand Gulf ESP Application.. 13 Page(s)	Letter	NRC/NRR/ DRIP	Atomic Energy of Canada, Ltd, Dominion Generation, Enercon Services, Inc, Entergy Nuclear South, Entergy Nuclear, Inc, Entergy Operations, Inc, Exelon Generation Co, LLC, Framatome ANP, Inc, Greenpeace, Nuclear Control Institute, Nuclear Energy Institute (NEI), Nuclear Information & Resource Service (NIRS), PBMR Pty, Ltd, Public Citizen's Critical Mass	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
1/29/2004	ML040440048	01/29/04-System Energy Resources, Inc.'s Answer to Notice of Hearing. 4 Page(s)	Legal-Notice of Hearing	System Energy Resources, Inc, Winston & Strawn, LLP	NRC/OCM	05200009
2/18/2004	ML040510279	01/21/2004 Summary of Public Meeting to Discuss the Environmental Scoping Process for the Grand Gulf Early Site Permit (ESP) Application (Tac No. MC1379).. 7 Page(s)	Meeting Summary	NRC/NRR/ DRIP/RLEP	System Energy Resources, Inc	05200009
2/21/2004	ML040360176	01/21/2004 Attachment 1: (Corrected Transcripts with Copy of NRC Slides, Written Statements); Attachment 2: (List of Meeting Attendees).. 173 Page(s)	Meeting Transcript, Slides and Viewgraphs	NRC	System Energy Resources, Inc	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
3/19/2004	ML040830045	IR 05200009-04-001 on 02/13/2004 for System Energy Resources, Inc., - NRC Inspection of Applicant and Contractor Quality Assurance Activities Involved with Preparation of the Application for an Early Site Permit.. 40 Page(s)	Inspection Report, Letter	NRC/RGN-III/DRS	System Energy Resources, Inc	05200009
5/11/2004	ML041330230	Issuance of Environmental Scoping Summary Report Associated with the Staff's Review of the Application by System Energy Resources, Inc. (SERI) Entergy for an Early Site Permit for the Grand Gulf ESP Site.. 71 Page(s)	Environmental Impact Statement, Letter, Report, Technical	NRC/NRR/DRIP/RLEP	Entergy Operations, Inc, System Energy Resources, Inc	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
5/19/2004	ML041420530	Request for Additional Information Related to the Staff's Review of the Environmental Report for the Grand Gulf Early Site Permit (ESP) Application.. 25 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/ DRIP	Entergy Operations, Inc	05200009
5/19/2004	ML041470464	Followup to Early Site Permit Application Environmental Audit - Response 2.. 5 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	05200009
5/19/2004	ML041890361	Followup to Early Site Permit Application Environmental Audit - Response 1.. 17 Page(s)	Letter	Entergy Operations, Inc, System Energy Resources, Inc	NRC/Document Control Desk	05200009
5/28/2004	ML041560142	05/28/04-Answer by System Energy Resources. Inc. To Proposed Contentions. 57 Page(s)	Legal-Intervention Petition, Responses and Contentions	System Energy Resources, Inc, Winston & Strawn, LLP	NRC/ASLBP	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
6/1/2004	ML041400113	Request For Additional Information Letter No. 1 - System Energy Resources, Inc. Early Site Permit (ESP) Application for the Grand Gulf ESP Site Safety Analysis Report Sections 2.3.1 and 2.3.2.. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/ DRIP/RNRP	System Energy Resources, Inc	05200009
6/14/2004	ML041740691	SERI ESP Application - EQHAZARD PSHA Calculation.. 3 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	05200009
6/22/2004	ML041400221	06/22/04-Letter to W. Eaton, Entergy Operations, re: ESP Template.. 6 Page(s)	Letter	NRC/NRR/ DRIP/RNRP	Entergy Nuclear Operations, Inc	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
7/15/2004	ML041610345	Grand Gulf, Request For Additional Information Letter No. 2, Early Site Permit Application for the Grand Gulf ESP Site.. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/ DRIP/RNRP	Entergy Nuclear, Inc, System Energy Resources, Inc	05200009
7/15/2004	ML041610345	Grand Gulf, Request For Additional Information Letter No. 2, Early Site Permit Application for the Grand Gulf ESP Site.. 9 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/ DRIP/RNRP	Entergy Nuclear, Inc, System Energy Resources, Inc	05200009
8/10/2004	ML042290395	Response to Request for Additional Environmental Information Related to Early Site Permit Application (Partial Response No. 4).. 22 Page(s)	Letter	Entergy Nuclear, Inc, System Energy Resources, Inc	NRC/Document Control Desk	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
8/11/2004	ML042330035	08/11/04-Answer by System Energy Resources, Inc. To Request for Extension of Time. 4 Page(s)	Legal-Motion	System Energy Resources, Inc, Winston & Strawn, LLP	NRC/OCM	05200009
8/13/2004	ML042100194	Request For Additional Information Letter No 4 - Grand Gulf ESP Application.. 15 Page(s)	Request for Additional Information (RAI)	NRC/NRR/ DRIP/RNRP	Entergy Nuclear, Inc	05200009
8/16/2004	ML042400269	Response to Request for Additional Environmental Information Related to Early Site Permit Application (Partial Response No. 5).. 5 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
8/26/2004	ML042390512	Supplemental Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application by System Energy Resources, Inc. (SERI) for the Grand Gulf ESP Site (TAC No. MC1379).. 5 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/ DRIP	Entergy Operations, Inc, System Energy Resources, Inc	05200009
9/2/2004	ML042450046	Grand Gulf Request For Additional Information - System Energy Resources, Inc. Early Site Permit Application.. 7 Page(s)	Request for Additional Information (RAI)	NRC/NRR/ DRIP/RNRP	Entergy Nuclear Operations, Inc	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
9/7/2004	ML042580204	09/07/04-Brief of System Energy Resources, Inc. In Opposition to Appeal by NAACP-Claiborne County, Mississippi Branch, Nuclear Information and Resource Service, Public Citizen, and Mississippi Chapter of the Sierra Club from LBP-04-19. 27 Page(s)	Legal-Brief	System Energy Resources, Inc, Winston & Strawn, LLP	NRC/OCM	05200009
9/7/2004	ML042600179	09/07/04-Joint Filing of System Energy Resources, Inc. And the Nuclear Regulatory Commission Staff Regarding Mandatory Hearing. 8 Page(s)	Legal-Report	System Energy Resources, Inc, Winston & Strawn, LLP	NRC/ASLBP	05200009
9/17/2004	ML042250232	Request For Additional Information Letter No. 5 - Concerning Grand Gulf ESP Application.. 16 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/ DRIP/RNRP	Entergy Nuclear Operations, Inc	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
9/17/2004	ML042590004	09/09/04 - Summary of Meeting with Dominion, SERI and Exelon Regarding Reviews of EP Aspects of Their Respective ESP Applications.. 10 Page(s)	Meeting Summary	NRC/NRR/ DRIP/RNRP	Dominion Nuclear North Anna, LLC, Exelon Generation Co, LLC, Exelon Nuclear, System Energy Resources, Inc	05200007, 05200008, 05200009
9/21/2004	ML042720365	Early Site Permit - Request for Additional Information Letter No. 4.. 1 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	05200009
9/30/2004	ML042810129	Early Site Permit Application - Update of Referenced Mississippi Radiological Emergency Preparedness Plan.. 2 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
9/30/2004	ML042810132	Response to Supplemental Request for Additional Information Regarding the Environmental Portion of the Early Site Permit Application by System Energy Resources, Inc., for the Grand Gulf ESP Site.. 7 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	05200009
10/19/2004	ML043010065	Response to RAI Letter No. 4	Letter	System Energy Resources, Inc.	NRC/Document Control Desk	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
10/28/2004	ML043020633	Second Supplemental Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application by System Energy Resources, Inc. (SERI) for the Grand Gulf ESP SiteTAC NO. MC1379).. 5 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/ DRIP/RLEP	Entergy Operations, Inc, System Energy Resources, Inc	05200009
10/28/2004	ML043020633	Second Supplemental Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application by System Energy Resources, Inc. (SERI) for the Grand Gulf ESP SiteTAC NO. MC1379).. 5 Page(s)	Letter, Request for Additional Information (RAI)	NRC/NRR/ DRIP/RLEP	Entergy Operations, Inc, System Energy Resources, Inc	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
11/12/2004	ML043090132	Revised Dates For Conducting the Environmental Review of the Application by SERI For An ESP For The Grand Gulf ESP Site.. 7 Page(s)	Letter	NRC/NRR/ DRIP/RNRP	System Energy Resources, Inc	05200009
12/08/2004	ML043350120	Request For Additional Information Letter No. 6 - Concerning Grand Gulf Early Site Permit Application. 15 Page(s)	Letter	NRC/NRR/ DRIP/RNRP	Entergy Nuclear, Inc	05200009
12/10/2004	ML043520051	Response to Request for RAIs Letter No.5 70 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	05200009
01/25/2005	ML050250250	Response to Request for RAIs Letter No.6 42 Page(s)	Letter	System Energy Resources, Inc	NRC/Document Control Desk	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
02/03/2005	ML050380489	Response to Second Supplemental Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application by System Energy Resources, Inc. (SERI) for the Grand Gulf ESP Site. 3 Page(s)	Letter	Entergy Operations, Inc, System Energy Resources, Inc	NRC/Document Control Desk	05200009
03/24/2005	ML050740064	Potential Open Items for the Draft Safety Evaluation Report for the Grand Gulf Early Site Permit Application	Letter	NRC/NRR/ DRIP/RNRP	System Energy Resources, Inc.	05200009
04/07/2005	ML050910208	Draft Safety Evaluation Report for the Grand Gulf Early Site Permit Application	Letter	NRC/NRR/ DRIP/RNRP	System Energy Resources, Inc.	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
04/19/2005	ML051020313	Draft Safety Evaluation Report for the Grand Gulf Early Site Permit Application.. 7 Page(s)	Letter	NRC/NRR/ DRIP/RNRP	- No Known Affiliation, Advanced Technologies & Labs International, Inc, AECL Technologies, Inc, Claiborne County, MS, Dominion Generation, Enercon Services, Inc, Entergy Nuclear South, Entergy Nuclear, Inc, Entergy Operations, Inc, Exelon Generation Co, LLC, Framatome ANP, Inc, Greenpeace, Morgan, Lewis & Bockius, LLP, Nuclear Control	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
06/21/2005	ML051750058	Response to RAIs to Resolve the Grand Gulf Early Site Permit Draft Safety Evaluation Report Open Items 78 Page(s)	Letter	System Energy Resources, Inc.	NRC/Document Control Desk	05200009
06/28/2005	ML051860175	Response to Grand Gulf Early Site Permit Draft Safety Evaluation Report Open Items 13.3-2 and 13.3-4 Discussion Grand Gulf Nuclear Station, Unit 1. 3 Page(s)	Letter	Entergy Operations, Inc	NRC/Document Control Desk	05000416, 05200009
06/24/2005	ML051950260	G20050470/LTR-05-0338 - C. Randy Hutchinson Ltr re Potential Delays in the NRC Review of the Grand Gulf Early Site Permit Application. 5 Page(s)	Letter	Entergy Nuclear, Inc	NRC/NRR	05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
07/26/2005	ML052070247	07/26/2005 - E-Mail re: Grand Gulf ESP Open Item 2.5-3-Case Study of Alternative Treatment of PA=0.5 Source Hazard.. 20 Page(s)	E-Mail, Technical Paper	NRC/NRR/ DRIP/RNRP	Entergy Nuclear, Inc	05200009
07/28/2005	ML043350120	Undated Letter Request For Additional Information Letter No. 6 - Concerning Grand Gulf Early Site Permit Application. 15 Page(s)	Letter	NRC/NRR/ DRIP/RNRP	Entergy Nuclear, Inc	05200009
09/15/2005	ML052620081	GNRO-2005/00055 - Grand Gulf Emergency Plan Clarification Related to Early Site Permit Review 6 Page(s)	Letter	Entergy Operations, Inc.	NRC/Document Control Desk	05000416, 05200009

Document Date	Accession Number	Title/Description Includes Est. Page Count	Document Type	Author Affiliation(s)	Addressee Affiliation(s)	Docket Number
09/16/2005	ML052630371	CNRO-2005/00054- Grand Gulf Early Site Permit Application Revision 1 Corrections (TAC No. MC1378) 18 Page(s)	Letter	System Energy Resources, Inc.	NRC/Document Control Desk	05200009

APPENDIX C
REFERENCES

American National Standards Institute (ANSI)

— — — — —, ANSI A58.1-1982, “Minimum Design Loads for Buildings and Other Structures.” March 10, 1982.

— — — — —, ANSI N45.2-1977, “Quality Assurance Program Requirements for Nuclear Facilities.” 1977.

— — — — —, ANSI N45.2.6, “Qualifications of Inspection, Examination, and Testing Personnel for Nuclear Power Plants.” 1973.

— — — — —, ANSI N45.2.9-1979, “Requirements for Collection, Storage, and Maintenance of Quality Assurance Records for Nuclear Power Plants.” 1979.

— — — — —, ANSI N45.2.12, “Requirements for Auditing of Quality Assurance Programs for Nuclear Power Plants.” 1977.

— — — — —, ANSI NQA-1-1983, “Quality Assurance Program Requirements for Nuclear Power Plants.” 1983.

American National Standards Institute and American Nuclear Society (ANSI/ANS)

— — — — —, ANSI/ANS-2.8-1992, “Determining Design Basis Flooding at Power Reactor Sites.” 1992.

American Society of Civil Engineers and Structural Engineering Institute (SEI/ASCE)

— — — — —, SEI/ASCE 7-02, “Minimum Design Loads for Buildings and Other Structures.” 2002.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

— — — — —, “2001 ASHRAE Handbook—Fundamentals.” July 2001.

American Society for Nondestructive Testing (ASNT)

— — — — —, ASNT-TC-1A, “Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing.” January 1, 2001.

American Society for Testing and Standards (ASTM)

— — — — —, ASTM D1586-84, “Standard Test Method for Penetration Test and Split-barrel Sampling of Soils.” 1992.

— — — — —, ASTM D1587-94, "Standard Practice for Thin-walled Geotechnical Sampling of Soils." March 2000.

— — — — —, ASTM D2487, "Test Method for Classification of Soils for Engineering Purposes," March 10, 2000.

— — — — —, ASTM D2488, "Practice for Description and Identification of Soils (Visual-Manual Procedure)." February 10, 2000.

— — — — —ASTM D3740, "Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction."

— — — — —, ASTM D4220-95, "Standard Practices for Preserving and Transporting Soil Samples." January 1, 2000.

— — — — —, ASTM D5079-90, "Standard Practices for Preserving and Transporting Rock Core Samples." May 1, 1990.

— — — — —, ASTM D-5778-95, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils." January 1, 2000.

Electric Power Research Institute (EPRI)

— — — — —, "Seismic Hazard Methodology for the Central and Eastern United States." Volumes 5–10. EPRI: Palo Alto, California. July 1986.

— — — — —, 1008910, Revision 1, "CEUS Ground Motion Project - Model Development and Results." EPRI: Palo Alto, California. August 2003.

— — — — —, Coppersmith, K.J., Johnston, A.C., Metzeger, A.G., and Abrabasz, W.J. Research Project 2556-12, "Methods for Assessing Maximum Earthquakes in the Central and Easter United States." EPRI: Palo Alto, California. 1987.

— — — — —, Johnston, A.C., et al. TR-102261-VI, "The Earthquakes of Stable Continental Regions." EPRI: Palo Alto, California. 1994.

— — — — —, TR-102261, "Engineering Characterization of Earthquake Strong Ground Motion Recorded at Rock Sites." Palo Alto, California. 1994.

— — — — —, TR-102293, "Guidelines for Determining Design-Basis Ground Motions." EPRI: Palo Alto, California. 1993.

Mississippi Code

— — — — —, *Title 33, Chapter 15,* Mississippi Code of 1972.

— — — — —, *Title 33, Chapter 15, Emergency Management Law of 1980*, Mississippi Code 1972, Annotated. 1980.

— — — — —, *Title 45, Section 14, Radiation Protection Law of 1978*, Mississippi Code 1972, Annotated. 1978.

National Climatic Data Center (NCDC)

— — — — —, "Cooperative Summary of the Day TD 3200 POR—2001 Data CDROM, Eastern United States, Puerto Rico, and Virgin Islands." NCDC: Asheville, North Carolina. November 2002.

— — — — —, "Cooperative Summary of the Day TD 3200 POR—2001 Data CDROM, Central United States." NCDC: Asheville, North Carolina. November 2002.

— — — — —, "Jackson, Mississippi, 2003 Local Climatological Data, Annual Summary with Comparative Data." NCDC: Asheville, North Carolina. 2004.

— — — — —, "Solar and Meteorological Surface Observational Network (SAMSON) for Eastern U.S. CDROM." NCDC: Asheville, North Carolina. September 1993.

— — — — —, Storm Event Database, "Storm Events for Mississippi, Query Results, Hail Event(s) Reported in Claiborne County, Mississippi Between 01/01/1950 and 09/30/2004." <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms> (December 20, 2004). (ADAMS Accession No. ML050130527).

— — — — —, Storm Event Database, "Storm Events for Mississippi, Query Results, Snow & Ice Event(s) Reported in Claiborne County, Mississippi Between 01/01/1950 and 09/30/2004." <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms> (December 20, 2004). (ADAMS Accession No. ML050130524).

— — — — —, "Southeast Mississippi Divisional Normals—Precipitation, Period 1971–2000." *Climatography of the United States.* No. 85. NCDC: Asheville, North Carolina. June 15, 2002.

— — — — —, "Southeast Mississippi Divisional Normals—Temperature, Period 1971–2000." *Climatography of the United States.* No. 85. NCDC: Asheville, North Carolina. June 15, 2002.

National Oceanic and Atmospheric Administration (NOAA)

— — — — —, Hydrometeorological Report No. 33, "Seasonal Variation of the Probable Maximum Precipitation East of 105th Meridian for Areas from 10 to 100 Square Miles and Durations of 6, 12, 24, and 48 Hours." U.S. Weather Bureau: Washington, DC. April 1956.

— — — — —, Hydrometeorological Report No. 52, "Application of Probable Maximum Precipitation Estimates—United States East of the 105th Meridian." NOAA: Washington, DC. August 1982.

— — — — —, Hydrometeorological Report No. 53, "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates. United States East of the 105th Meridian." NOAA: Washington, DC. April 1980.

— — — — — —, Technical Paper 16, “Maximum 24-Hour Precipitation in the United States.” U.S. Weather Bureau: Washington, DC. January 1952.

— — — — — —, “Tsunami, The Great Waves.” <http://www.prh.noaa.gov/itic/library/pubs/greatwaves/tsunami_great_waves.html> (December 17, 2004).

National Severe Storms Laboratory (NSSL)

— — — — — —, “Severe Thunderstorm Climatology, Total Threat.” National Severe Storms Laboratory. August 29, 2003. <http://www.nssl.noaa.gov/hazard/totalthreat.html> (January 16, 2005). (ADAMS Accession No. ML050180187).

National Weather Service (NWS)

— — — — — —, “Hydrometeorological Design Studies Center.” <http://www.nws.noaa.gov/oh/hdsc/max_precip/pmp.html> (December 16, 2004).

— — — — — —, “NWS Jackson, MS Climate Zone.” <http://www.srh.noaa.gov/jan/temp_hi_lo_.html> (December 16, 2004). (ADAMS Accession No. ML043520084).

— — — — — —, “NWS Jackson, MS—St. Joseph 3N Climate.” <http://www.srh.noaa.gov/jan/climate/climate_saintjoseph3n.htm> (January 12, 2005). (ADAMS Accession No. ML050130513).

Southern Regional Climate Center (SRCC)

— — — — — —, “Monthly Total Snowfall, Jackson WSFO Airport, Mississippi.” <http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMONtsnf.pl?ms4472> (January 16, 2005). (ADAMS Accession No. ML051950526).

— — — — — —, “Climate Synopsis for Mississippi.” <http://www.srcc.lsu.edu/southernClimate/atlas/msdescription> (December 16, 2004). (ADAMS Accession No. ML043520091).

— — — — — —, “Monthly Precipitation, Port Gibson 1 NW, Mississippi.” <http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?ms7132> (January 12, 2005). (ADAMS Accession No. ML050130516).

— — — — — —, “Monthly Total Snowfall, Jackson 4 NW, Mississippi.” <http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?ms4467> (January 16, 2005). (ADAMS Accession No. ML050180180).

— — — — — —, “Monthly Total Snowfall, Port Gibson 1 NW, Mississippi.” <http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?ms7132> (January 12, 2005). (ADAMS Accession No. ML050130509).

— — — — — —, "Vicksburg Military Park, Mississippi Period of Record General Climate Summary—Temperature." <http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?ms9216> (January 11, 2005). (ADAMS Accession No. ML050130520).

State of Louisiana

— — — — — —, "Emergency Operations Plan (LEOP)." State of Louisiana, Office of Emergency Preparedness: Baton Rouge, Louisiana. March 2002.

— — — — — —, *Executive Reorganization Act*, LA. R.S. 36:358(E) and 408(F). 1975.

— — — — — —, *Louisiana Disaster Act of 1974*, LA. R.S. 29:701 et seq. 1974.

— — — — — —, *Louisiana Environmental Affairs Act*, LA. R.S. 30:1051 et seq. 1979.

— — — — — —, Louisiana Environmental Quality Act, Acts 1983, No. 97. (L.R.S. 30:2001 et seq.). Effective. February 1, 1984.

— — — — — —, "Louisiana Peacetime Radiological Response Plan." Revision 9. State of Louisiana, Radiological Emergency Planning & Response: Baton Rouge, Louisiana. December 2000.

— — — — — —, Radiological Emergency Response Operational Procedure 1, "Radiation Exposure Control." Louisiana Department of Environmental Quality: Baton Rouge, Louisiana.

— — — — — —, Radiological Emergency Response Operational Procedure 2, "Notification and Headquarters Activation." Louisiana Department of Environmental Quality: Baton Rouge, Louisiana.

— — — — — —, Radiological Emergency Response Operational Procedure 4, "Radiation Exposure Control. Louisiana Department of Environmental Quality: Baton Rouge, Louisiana.

State of Mississippi

— — — — — —, *The Constitution of the State of Mississippi*. 1890.

— — — — — —, *Executive Order 653.* November 16, 1990.

— — — — — —, Mississippi Comprehensive Emergency Management Plan, Volume III, Revision 6, "Mississippi Radiological Emergency Preparedness Plan." Mississippi Emergency Management Agency, Radiological Emergency Preparedness Section: Jackson, Mississippi. July 2001.

System Energy Resources, Inc. (SERI)

— — — — — —, Early Site Permit for the Grand Gulf Nuclear Station Site—Part 1, Revision 0, "Administrative Information." SERI: Jackson, Mississippi. October 2003.

— — — — —, Early Site Permit for the Grand Gulf Nuclear Station Site Part 2, Revision 0, "Site Safety Analysis Report." SERI: Jackson, Mississippi. October 2003.

— — — — —, Early Site Permit for the Grand Gulf Nuclear Station Site—Part 3, Revision 0, "Environmental Report." SERI: Jackson, Mississippi. October 2003.

— — — — —, Early Site Permit for the Grand Gulf Nuclear Station Site—Part 4, Revision 0, "Emergency Planning Information." SERI: Jackson, Mississippi. October 2003.

— — — — —, Early Site Permit for the Grand Gulf Nuclear Station Site—Part 4, Revision 1, "Emergency Planning Information." SERI: Jackson, Mississippi. July 2005.

— — — — —, Early Site Permit for the Grand Gulf Nuclear Station Site—Part 4, Revision 2, "Emergency Planning Information." SERI: Jackson, Mississippi. October 3, 2005.

— — — — —, Early Site Permit Application for the Grand Gulf Nuclear Station Site—Revision 3. SERI: Jackson, Mississippi. March, 2006.

— — — — —, December 10, 2004, Letter from George A. Zinke, System Energy Resources, Inc., to NRC. Subject: Response to Request for Additional Information Letter No. 5 - System Energy Resources, Inc., Early Site Permit Application for Grand Gulf ESP Site. (ADAMS Accession No. ML05038174).

— — — — —, February 22, 2006, Letter from George A. Zinke, System Energy Resources, Inc., to NRC. Subject: Response to Request for Additional Information Regarding the Grand Gulf Early Site Permit Final Safety Evaluation Report - System Energy Resources, Inc., Early Site Permit Application for Grand Gulf ESP Site.

— — — — —, March 7, 2006, Letter from George A. Zinke, System Energy Resources, Inc., to NRC. Subject: Supplemental Information, Response to Request for Additional Information Regarding the Grand Gulf Early Site Permit Final Safety Evaluation Report - System Energy Resources, Inc., Early Site Permit Application for Grand Gulf ESP Site.

U.S. Army Corps of Engineers (USACE)

— — — — —, 1994 Flood Control and Navigation Maps—Mississippi River. USACE, Mississippi Valley Division: Vicksburg, Mississippi. 1994.

— — — — —, EM-1110-2-1100 (Revision 1), "Coastal Engineering Manual." Department of the Army: Washington, DC. July, 2003.

— — — — —, EM-1110-2-1411, "Standard Project Flood Determinations." Department of the Army: Washington, DC. 1965

— — — — —, "Geological Investigation of the Alluvial Valley of the Lower Mississippi River." Mississippi River Comm. Vicksburg, Mississippi, 1944.

— — — — —, "Geomorphology and Quaternary Geologic History of the Lower Mississippi Valley," U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., 1994.

— — — — —, "HEC-1 Download." U.S. Army Corps of Engineers Hydrologic Engineering Center. 1998. <http://www.hec.usace.army.mil/software/legacysoftware/hec1/hec1-download.htm>

— — — — —, "Ice Jam Database." <http://www.crrel.usace.army.mil/ierd/ijdb/> (December 28, 2004).

— — — — —, "National Inventory of Dams." <http://crunch.tec.army.mil/nid/webpages/nid.cfm> (January 4, 2005).

— — — — —, Navigation Bulletin No. 1, "Special Notice: Mississippi River." Department of the Army: Vicksburg, Mississippi. 2004. <http://www.mvk.usace.army.mil/offices/od/odr/navigation/msriver/msrdikes.pdf>

— — — — —, Annex C, Project Design Flood Study, "Comprehensive Review of the Mississippi River and Tributaries Project." Mississippi River Commission: Vicksburg, Mississippi. December 1969.

— — — — —, "Shore Protection Manual." U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. U.S. Government Printing Office: Washington, DC. 1973.

— — — — —, "Technical Memorandum No. 3-311, "Geological Investigation of Faulting in the Lower Mississippi Valley. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 1950.

— — — — —, "Vicksburg District River Operations Branch." <http://www.mvk.usace.army.mil/offices/od/odr/main.asp> (December 28, 2004).

— — — — —, "Stages and Discharges of the Mississippi River and Tributaries in the Vicksburg District, Annual Report of the District Engineers." Department of the Army: Vicksburg, Mississippi. 1990.

— — — — —, Technical Manual 5-1300, "Structures to Resist the Effects of Accidental Explosions." Department of the Army: Washington, DC. November 19, 1990.

U.S. Atomic Energy Commission (AEC)

— — — — —, TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites." AEC: Washington, DC. March 1962. (ADAMS Accession No. ML021750625).

U.S. Census Bureau

— — — — —, "Census 2000 Data." <http://www.census.gov/census2000/>

U. S. Code

National Environmental Policy Act of 1969, 42 U.S.C. 4321-4347 (1970), P.L. 91-190, 83 Stat. 852.

U.S. Code of Federal Regulations

——————, *Title 10, Energy*, Part 20, "Standards for Protection Against Radiation."

——————, *Title 10, Energy*, Part 21, "Reporting of Defects and Noncompliance."

——————, *Title 10, Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

——————, *Title 10, Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

——————, *Title 10, Energy*, Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

——————, *Title 10, Energy*, Part 71, "Packaging and Transportation of Radioactive Material."

——————, *Title 10, Energy*, Part 73, "Physical Protection of Plants and Materials."

——————, *Title 10, Energy*, Part 100, "Reactor Site Criteria."

——————, 49 CFR Part 173, "Shippers—General Requirements for Shipments and Packagings."

U.S. Environmental Protection Agency (EPA)

——————, EPA 400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents." EPA: Washington, DC. May 1992.

U.S. Geological Survey

——————, "Ground Water Atlas of the United States." Ed. J.A. Miller. U.S. Geological Survey: Reston, Virginia. 2004.

— — — — — —, “National Stream Water Quality Accounting Network.” <http://water.usgs.gov/nasqan/progdocs/statables.html> (January 4, 2005).

— — — — — —, “National Water Information System.” <http://nwis.waterdata.usgs.gov/nwis/>.

— — — — — —, “National Water Information System.” <http://nwis.waterdata.usgs.gov/nwis/discharge/?site_no=07289000&agencycd=USGS&set_logscale_y=1&format=rdb&date_format=YYYY-MM-DD&rdb_compression=value&submitted_form=brief_list> (January 4, 2005).

— — — — — —, “Peak Streamflow for the Nation—USGS 07289000 Mississippi River at Vicksburg, Mississippi.” <http://nwis.waterdata.usgs.gov/nwis/peak?site_no=07289000&agency_cd=USGS&format=html> (November 15, 2004.)

— — — — — —, Water Supply Paper 1870-D, “Summary of Floods in the United States during 1966.” U.S. Geological Survey: Reston, Virginia. 1971.

— — — — — —, Water Supply Paper 2030, “Summary of Floods in the United States during 1969.” U.S. Geological Survey: Reston, Virginia. 1975.

— — — — — —, Final Technical Report No. 01HQGR0052. Cox, R.T. “Investigation of Seismically-Induced Liquefaction in the Southern Mississippi Embayment.” National Earthquake Hazards Reduction Program. Reston, Virginia. 2002

U.S. Nuclear Regulatory Commission (NRC)

NUREG-Series Reports

— — — — — —, NUREG/CR-4461, Revision 1, “Tornado Climatology of the Contiguous United States.” NRC: Washington, DC April 2005.

— — — — — —, NUREG-0654/FEMA-REP-1, Revision 1, “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants.” Washington, DC. November 1980.

— — — — — —, NUREG-0654/FEMA-REP-1, Revision 1, Supplement 2, “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants—Criteria for Emergency Planning in an Early Site Permit Application—Draft Report for Comment.” NRC: Washington, DC. April 1996.

— — — — — —, NUREG-0654/FEMA-REP-1, Revision 1, Supplement 3, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants—Criteria for Protective Action Recommendations for Severe Accidents—Draft Report for Interim Use and Comment." NRC: Washington, DC. July 1996.

— — — — — —, NUREG-0696, "Functional Criteria for Emergency Response Facilities—Final Report." NRC: Washington, DC. February 1981.

— — — — — —, NUREG-0800, Revision 3, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants." NRC: Washington, DC. July 1997.

— — — — — —, NUREG-0831, "Safety Evaluation Report Related to the Operation of Grand Gulf Nuclear Station." NRC: Washington, DC. September 1981.

— — — — — —, NUREG-0917, "Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data." NRC: Washington, DC. July 1982.

— — — — — —, NUREG-1488, "Revised Livermore Seismic Hazard Estimates for Sixty-Nine Nuclear Power Plant sites East of the Rocky Mountains." NRC: Washington, DC. 1994.

— — — — — —, NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations." NRC: Washington, DC. November 1982.

— — — — — —, NUREG/CR-2919, "XOQDOQ Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations." NRC: Washington, DC. September 1977.

— — — — — —-, NUREG/CR-3759, "Lightning Strike Density for the Contiguous United States from Thunderstorm Duration Records." NRC: Washington, DC. May 1984.

— — — — — —, NUREG/CR-4013," LADTAP II—Technical Reference and User Guide." NRC: Washington, DC. April 1986.

— — — — — —, NUREG/CR-4653, "GASPAR II—Technical Reference and User Guide." NRC: Washington, DC. March 1987

— — — — — —, NUREG/CR-4831, "State of the Art Methods for Development of Evacuation Time Estimate Studies for Nuclear Power Plants." NRC: Washington, DC. March 1992.

———————, NUREG/CR-6372, “Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts.” NRC: Washington, DC. November 1997.

———————, NUREG/CR-6728, “Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard and Risk-Consistent Motions Spectra Guidelines.” NRC: Washington, DC. 2001.

Regulatory Guides

———————, Draft Guide DG-1101, "Site Investigations for Foundations of Nuclear Power Plants.” NRC..Washington, DC. February 2001. (ADAMS Accession No. ML010510162).

———————, Draft Guide DG-1109, "Laboratory Investigations of Soils and Rocks for Engineering Analyses and Design of Nuclear Power Plants.” NRC Washington, DC. August 2001. (ADAMS Accession No. ML012420328).

———————, Regulatory Guide 1.3, Revision 2, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors.” NRC: Washington, DC. June 1974. (ADAMS Accession No. ML003739601).

———————, Safety Guide 23, Proposed Revision 1, “Onsite Meteorological Programs.” NRC: Washington, DC. September 1980.

———————, Safety Guide 25, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors.” NRC: Washington, DC. March 1972. (ADAMS Accession No. ML003769781).

———————, Regulatory Guide 1.27, “Ultimate Heat Sink for Nuclear Power Plants.” NRC: Washington, DC. January 1976. (ADAMS Accession No. ML003739969).

———————, Regulatory Guide 1.29, Revision 3, “Seismic Design Classification.” NRC: Washington, DC. September 1978. (ADAMS Accession No. ML003739983).

———————, Regulatory Guide 1.59, Revision 2, “Design Basis Floods for Nuclear Power Plants.” NRC: Washington, DC. August 1977. (ADAMS Accession No. ML003740388).

———————, Regulatory Guide 1.60, Revision 1, "Design Response Spectra for Seismic Design of Nuclear Power Plants," December 1973.

———————, Regulatory Guide 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition." NRC: Washington, DC. November 1978. (ADAMS Accession Nos. ML003740072, ML003740108, and ML003740116).

———————, Regulatory Guide 1.78, Revision 1, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release." NRC: Washington, DC. December 2001. (ADAMS Accession No. ML013100014).

———————, Regulatory Guide 1.91, Revision 1, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants." NRC: Washington, DC. February 1978. (ADAMS Accession No. ML003740286).

———————, Regulatory Guide 1.101, Revision 4, "Emergency Planning and Preparedness for Nuclear Power Reactors." NRC: Washington, DC. July 2003.

———————, Regulatory Guide 1.102, Revision 1, "Flood Protection for Nuclear Power Plants." NRC: Washington, DC. September 1976. (ADAMS Accession No. ML003740308).

———————, Regulatory Guide 1.109, Revision 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I." NRC: Washington, DC. October 1977. (ADAMS Accession No. ML003740384).

———————, Regulatory Guide 1.111, Revision 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors." NRC: Washington, DC. July 1977. (ADAMS Accession No. ML003740354).

———————, Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors." NRC: Washington, DC. May 1977. (ADAMS Accession No. ML003740361).

———————, Regulatory Guide 1.113, Revision 1, "Estimating Aquatic Dispersions of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I." NRC: Washington, DC. April 1977. (ADAMS Accession No. ML003740390).

———————, Regulatory Guide 1.125, Revision 1, "Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants." NRC: Washington, DC. October 1978. (ADAMS Accession No. ML003739388).

——————, Regulatory Guide 1.132, Revision 1, "Site Investigations for Foundations of Nuclear Power Plants." NRC: Washington, DC. March 1979. (ADAMS Accession No. ML003740350).

——————, Regulatory Guide 1.138, "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants." NRC: Washington, DC. April 30, 1978. (ADAMS Accession No. ML003740184).

——————, Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants." NRC: Washington, DC. November 1982.

——————, Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion." NRC: Washington, DC. March 1997. (ADAMS Accession No. ML003740084).

——————, Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors." NRC: Washington, DC. July 2000. (ADAMS Accession No. ML003716792).

——————, Regulatory Guide 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites." November 2003.

——————, Regulatory Guide 4.4, "Reporting Procedure for Mathematical Models Select to Predict Heated Effluent Dispersion in Natural Water Bodies." NRC: Washington, DC. May 1974. (ADAMS Accession No. ML003739535).

——————, Regulatory Guide 4.7, Revision 2, "General Site Suitability Criteria for Nuclear Power Stations." NRC: Washington, DC. April 1998. (ADAMS Accession No. ML003739894).

NRC Letters

——————, March 25, 1988, Letter from L.S. Rubinstein, USNRC to E.E. Kintner, ALWR Utility Steering Committee, Subject: ALWR Design Basis Tornado. (ADAMS Accession No. ML031270370).

Other NRC Documents

——————, NRR Review Standard, RS-002, "Processing Applications for Early Site Permits." NRC: Washington, DC. May 3, 2004. (ADAMS Accession No. ML040700236).

— — — — —, “Pre-application Site Visit to Grand Gulf Nuclear Station for Familiarization with Geotechnical Data Gathering Processes for Early Site Permit.” NRC Memorandum from C.J. Paulk to J.E. Lyons. August 19, 2002. (ADAMS Accession No. ML022320222).

— — — — —, “Site Analysis Branch Position—Winter Precipitation Loads.” NRC Memorandum from H.R. Denton to R.R. Maccary. March 24, 1975. (ADAMS Accession No. ML050630277).

— — — — —, “System Energy Resources, Inc.,—NRC Inspection of Applicant and Contractor Quality Assurance Activities Involved with Preparation of the Application for an Early Site Permit, NRC Inspection Report 052000009/2004001.” March 19, 2004. (ADAMS Accession No. ML040830045).

Other References

Corporate Authors

Enercon Services, Inc., Project No. ENTO-002, Revision 5, “Quality Assurance Project Planning Document for Entergy Nuclear Potomac Early Site Permitting Project, Grand Gulf Nuclear Station Site.” Enercon Services, Inc. October 6, 2003.

Mississippi Power & Light Company. “Evacuation Time Estimates for the Grand Gulf Nuclear Station Plume Exposure Pathway Emergency Planning Zone.” Grand Gulf Nuclear Station Emergency Plan, Appendix E. Mississippi Power & Light Company: Jackson, Mississippi. March 1986.

Port Gibson/Claiborne County Civil Defense. “Port Gibson/Claiborne County Radiological Emergency Preparedness Plan.” Revision 5. PGCCD: Port Gibson, Mississippi. August 2003.

Individual Authors

Atkinson, G.M. and Boone, D.M. “Ground-Motion Relations for Eastern North America.” *Bulletin of Seismological Society of America*. Vol. 85, No. 1, pp. 17-30. 1995.

Ambraseys, N.N. “Engineering Seismology: Earthquake Engineering and Structural Dynamics.” *Elsevier Science*. Vol. 17, pp. 1-105. 1988.

Anderson, J.G. and S.E. Hough, "A Model for the Shape of the Fourier Amplitude Spectrum of Acceleration at High Frequencies," *Bulletin of the Seismological Society of America*. 1984.

Bakun, W.H. And M.G. Hopper, “Magnitude and Locations of the 1811–1812 New Madrid, Missouri, and the 1886 Charleston, South Carolina Earthquake.” *Bulletin of Seismological Society of America.* Vol. 94, No. 1. 2004.

Chow, V.T., Bulletin 462, “Hydrologic Determination of Waterway Areas for the Design of Drainage Structures in Small Drainage Basins.” University of Illinois, Experimental Station: Urbana, Illinois. 1962.

Chow, V.T. *Open Channel Hydraulics*. McGraw-Hill: New York. 1959.

Cox, R.T., Larsen, D., Forman, S.L., Woods, J., Morat, J., and Galluzzi, J. “Preliminary Assessment of Sand Blows in the Southern Mississippi Embayment.” *Bulletin of the Seismological Society of America*. Vol. 94, No. 3, pp. 1125-1142. 2004.

Dockery, D.T. III, and Marble, J.C. “Seismic Stratigraphy of the Jackson Dome.” Mississippi Geology. Vol. 19, No. 3, pp. 29-43. 1998

Feddes, R.G., R.A. Clark, and R.C. Runnels. Technical Report 28, “A Hydrometeorological Study Related to the Distribution of Precipitation and Runoff over Small Drainage Basins–Urban Versus Rural Areas.” Texas A&M University Water Resources Institute: College Station, Texas. 1970.

Fujita, T.T. SMRP Research Paper 162, “Areal Survey of Grand Gulf Plant and Vicinity After the April 17, 1978 Tornado.” Department of the Geophysical Sciences, The University of Chicago: Chicago, Illinois. May 1978.

Hudlow, M.D. Technical Report 3, “Techniques for Hydrograph Synthesis Based on Analysis of Data from Small Drainage Basins in Texas.” Texas A&M University, Water Resources Institute: College Station, Texas. 1966.

Jarrell, J.D., et al., NOAA Technical Memorandum NWS TPC-1, “The Deadliest, Costliest, and Most Intense United States Hurricanes from 1900 to 2000 (And Other Frequently Requested Hurricane Facts).” NOAA Atlantic Oceanographic and Meteorological Laboratory Hurricane Research Division: Miami, Florida, October 2001. (ADAMS Accession No. ML050130530).

Johnston, A.C. “Seismic Moment Assessment of Earthquakes in Stable Continental Regions: III. New Madrid 1811-1812, Charleston 1886 and Lisbon 1755.” *Geophysical Journal International*. Vol. 126, pp. 314-344. 1996.

Jones, K., et al., Technical Report 2002-01, “The Development of a U.S. Climatology of Extreme Ice Loads.” National Climatic Data Center: Asheville, North Carolina. December 2002.

Korshover, J., NOAA Technical Memorandum ERL ARL-55, “Climatology of Stagnating Anticyclones East of the Rocky Mountains, 1936–1975.” NOAA Environmental Research Laboratories: Silver Spring, Maryland. March 1976.

Kulwahy, F.H. and P.W. Mayne. Electric Power Research Institute Report EL 6800, Research Project 1493-6, “Manual on Estimating Soil Properties for Foundation Design.” EPRI: Palo Alto, California. 1990.

Lockridge, P.A., L.S. Whiteside and J.F. Lander. “Tsunamis and Tsunami-Like Waves of the Eastern United States.” *The International Journal of the Tsunami Society.* Vol. 20, No. 3. 2002. <http://epubs.lanl.gov/tsunami/ts203.pdf>

McDonald, J.R. “Assessment of Tornado Damage to the Grand Gulf Nuclear Generating Station.” Institute for Disaster Research, Texas Tech University: Lubbock, Texas. June 1978. (ADAMS Accession No. 7811210046).

Ramsdell, Jr., V.A. “Technical Evaluation Report on Design Basis Tornadoes for the Grand Gulf ESP Site.” Pacific Northwest National Laboratories: Richland, Washington. November 9, 2004. (ADAMS Accession No. ML050050234).

Schweig, E.S., R.B. VanArsdale, and R.K. Burroughs. “Subsurface Structure in the Vicinity of an Intraplate Earthquake Swarm.” 1991.

Silva, W.J., Technical Report NCEER-97-0010. “Characteristics of Vertical Strong Ground Motions for Applications to Engineering Design.” 1997.

Silva, W.J., N. Abrahamson, G. Toro, and C. Costantino. “Description and Validation of the Stochastic Ground Motion Model.” Report Submitted to Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York. 1997.

Silva, W.J. N. Gregor, and R. Darragh. “Development of Regional Hard Rock Attenuation Relations for Central and Eastern North American, Pacific Engineering and Analysis.” 2002.

Simpson, R.H., et al. “The Atlantic Hurricane Season of 1969.” *Monthly Weather Review*. pp. 293–306. April 1970.

Savy, J.B. et al. UCRL-ID-115111, “Eastern Seismic Hazard Characterization Update.” Lawrence Livermore National Laboratory: Livermore, California. June 1993.

Temple, J.M. “Evaluation of Existing Evacuation Time Estimates and Analysis of Potential Impediments to Protective Actions, Grand Gulf Nuclear Station.” Black Diamond Consultants, Inc. May 2003.

Temple, J.M. “Evaluation of Existing Evacuation Time Estimates and Analysis of Potential Impediments to Protective Actions, Grand Gulf Nuclear Station.” Revision 1. Black Diamond Consultants, Inc. January 2005.

Abkowitz M. and Galarraga J. “Tanker Accident Rates and Expected Consequences in U.S. Ports and High Seas Regions.” State-of-the-Art Report 3. 1986

APPENDIX D

PRINCIPAL CONTRIBUTORS

Name	Responsibility
Anand, Raj	Project Management
Anderson, Joseph	Emergency Planning
Araguas, Christian	Project Management
Bagchi, Goutam	Hydrology
Campe, Kazimieras	Site Hazards
Mark Blumberg	Site Hazards
Bret Tegeler	Site Hazards
John Mckirgan	Site Hazards
Cheng, Thomas	Geotechnical Engineering
Harvey, Robert B.	Meteorology
Klementowicz, Stephen	Normal Radiological Dose Analyses
Lee, Jay	Accident Analyses
Li, Yong	Geology and Seismology
Prescott, Paul	Quality Assurance
Segala, John	Project Management
Tardiff, Albert	Security

Contractors	Technical Area
Federal Emergency Management Agency	Emergency Planning
Pacific Northwest Laboratory	Emergency Planning, Hydrology, Meteorology, and Site Hazards
U.S. Geologic Survey	Geology and Seismology
Brookhaven National Laboratory	Geology and Seismology

APPENDIX E

REPORT BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

December 23, 2005

Luis A. Reyes
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT: EARLY SITE PERMIT APPLICATION FOR THE GRAND GULF SITE AND THE ASSOCIATED FINAL SAFETY EVALUATION REPORT

Dear Mr. Reyes:

During the 528th meeting of the Advisory Committee on Reactor Safeguards, December 7-10, 2005, we met with representatives of the NRC staff and System Energy Resources, Inc. (SERI), the applicant for an early site permit (ESP) for the Grand Gulf site, and discussed the application and the NRC staff's final Safety Evaluation Report (FSER). We provided an interim report on this application and the draft Safety Evaluation Report on June 14, 2005. We reviewed this application to fulfill the requirement of 10 CFR 52.23 that the ACRS report on those portions of an ESP application that concern safety. We also had the benefit of the documents referenced.

CONCLUSIONS AND RECOMMENDATIONS

- The NRC staff has written a very readable and comprehensive Safety Evaluation Report. The three permit conditions the staff proposes for the early site permit and the 26 action items for the combined license phase are appropriate.
- This Safety Evaluation Report should be issued once the staff has made more explicit its analyses of the hazards posed to the proposed site by explosions in transportation accidents on the Mississippi River.
- The staff needs to provide additional guidance to applicants concerning the discussion in an application of "Major Features" of the emergency planning for a proposed site.

DISCUSSION

SERI seeks an early site permit for a reactor or a set of reactor modules of total power up to 4300 MW_{th} on a site adjacent to the current Grand Gulf Nuclear Power Station, a BWR/6 with a Mark III containment. With the additional unit or modules, the total nuclear generating capacity at the Grand Gulf site could be as high as 8600 MW_{th}. The Grand Gulf site had previously been approved for two units, but the second unit was never completed.

EDO --G20050882

The SERI application for an early site permit does not specify a particular power plant technology for the new reactor or reactor modules to be placed on the site. The early site permit application, instead, uses a "plant parameter envelope" of power plant characteristics that is intended to bound the reactor technology that could eventually be selected.

- Nature of the Proposed Site

The proposed site is located on the eastern side of the Mississippi River about 25 miles south of Vicksburg, Mississippi. The site is rural in nature. There is little industrial activity and no military base near the site. There is a natural gas pipeline somewhat more than 4 miles from the site.

The nearest major airport is at Jackson, Mississippi, about 65 miles from the proposed site. The staff has determined that the air traffic corridors near the site pose no undue risk. There is a highway 4½ miles from the site. The principal ground transportation hazard is thought to be the delivery of hydrogen to the site for use in the currently operating boiling water reactor. The staff has found that the delivery and storage of this hydrogen would pose no undue risk to the proposed new power plant site.

The most important transportation route near the site is the Mississippi River. The nearest bank of this river is about 1.1 miles from the proposed site. Explosions and releases of toxic gases and vapors could pose threats to the proposed site. The staff and the applicant have agreed to defer consideration of the threats posed by the accidental releases of toxic vapors and gases until a specific plant for the site has been chosen and the habitability of the control room can be evaluated.

The staff has concluded that the detonation of 5000 tons TNT-equivalent bounds the explosion threat to the proposed site. According to staff-approved methods of analysis, such a detonation would require a standoff distance of about 2.1 miles from the facility. The staff concludes, however, that because the site is located behind a 65-foot bluff, the 1.1 mile standoff is adequate. The technical basis for this conclusion needs to be made clear in the Safety Evaluation Report prior to its issuance. This clarification should include a description of the reliability of the calculational method adopted by the staff.

The staff has concluded also that the detonation bounds the explosive hazard posed by vapor explosions such as might occur in the release of liquefied natural gas during a transportation accident on the river. The technical basis for this conclusion should also be made clear in the Safety Evaluation Report. The clarification should include a discussion of whether the staff used the TNT-equivalent method to analyze vapor explosions and the conservatisms associated with such an approximation if it was adopted.

- Population in the Vicinity of the Site

The permanent population around the site is low. The nearest town, Port Gibson, Mississippi, is about 6 miles from the proposed site and has a population of about 1750. The nearest population center, Vicksburg, Mississippi, is 25 miles to the north and has a current population of about 27,000. The projected population growth in the area to the year 2070 is expected to be small, perhaps less than 20%.

- Geology and Seismicity of the Site

The proposed site is located on consolidated river sediments. Geological investigations show no evidence of significant ground deformation for at least the last 500,000 years and perhaps for the last 5 million years. Salt domes in the area are 6 and 8 miles from the proposed site.

The site is in an area of little seismic activity. The nearest historical seismic event occurred more than 25 miles away. The limiting earthquake source is the New Madrid seismic zone over 200 miles away. SERI has performed a probabilistic seismic hazard analysis that takes into account recent revisions made by the U.S. Geological Survey to the frequencies and intensities of events in the New Madrid seismic center. The analysis also considers the possibility of seismic activity along the suspected faults on the Saline River which may not be capable faults. The proposed site is a deep soil site (bedrock is at a depth of about 10,000 feet). SERI has done sufficient characterization of the site to produce analyses of the soil amplification factors. The probabilistic seismic hazard curve developed for the site is bounded by the design safe shutdown earthquake curves adopted in the plant parameter envelope.

- Meteorology

Vigorous storms such as hurricanes and tornados are the principal weather threats to a reactor located on the proposed site. SERI and the staff have used historical information to characterize these and other weather features of the site. In our review of the Safety Evaluation Report, we examined the applicability of hurricane frequency data on the prediction of future storm activity. There is evidence that storm activity is increasing in the Gulf of Mexico due to known weather cycles. The staff and the applicant have used historical data over a sufficient period to capture data from previous weather cycles. We find no definitive evidence that storm intensities in excess of the bounds established by the applicant and accepted by the staff will develop. These bounds may not be especially conservative. Representatives of SERI informed us that inland wind gusts produced by the recent hurricane Katrina at the latitude of the proposed site were somewhat less than 92 mph which can be compared to the 96 mph maximum three-second wind gust adopted for the site characterization. The staff has stated that should future weather evidence indicate site characteristics accepted in the Safety Evaluation Report are not adequate, these characteristics will be amended as needed.

The proposed site is located on a bluff about 65 feet above the normal river level. Land on the opposite bank of the river is more easily flooded than the proposed site. Consequently, major river flooding is not a threat to the site. Local, onsite flooding will have to be addressed if the permit is granted and a decision is made to construct a power plant on the site.

- Emergency Plans

The applicant has elected to submit for review just the "major features" of emergency planning for the proposed site, as is allowed by the regulations. The staff has concluded that these major features are largely adequate. The applicant has stated that the remaining information would be submitted with a combined license application. The applicant and the staff encountered challenges in defining the limitations that should exist on descriptions of major features of emergency planning, especially for a site where reactors currently exist. These challenges could be avoided in the future by providing additional guidance to the applicants.

Sincerely,

Graham B. Wallis
Chairman

References:

1. U.S. Nuclear Regulatory Commission, Final Safety Evaluation Report, "Safety Evaluation of Early Site Permit Application in the Matter of System Energy Resources, Inc., a Subsidiary of Entergy Corporation, for the Grand Gulf Early Site Permit Site," October 21, 2005.

2. System Energy Resources, Inc., Grand Gulf Early Site Permit Application, Revision 0, October 2003.

3. Letter dated June 14, 2005, from G. B. Wallis, Chairman, ACRS, to L. A. Reyes, Executive Director for Operations, NRC, Subject: Interim Letter: Draft Safety Evaluation Report on Grand Gulf Early Site Permit Application.

RESPONSES TO THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

February 1, 2006

Dr. Graham B. Wallis, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: EARLY SITE PERMIT APPLICATION FOR THE GRAND GULF SITE AND THE ASSOCIATED FINAL SAFETY EVALUATION REPORT

Dear Chairman Wallis:

Thank you for your letter dated December 23, 2005, regarding the final safety evaluation report (FSER) of the System Energy Resources, Inc. (SERI), application for the Grand Gulf early site permit (ESP). The staff of the U.S. Nuclear Regulatory Commission (NRC) will reproduce your letter as Appendix E to the FSER for the Grand Gulf ESP which will be issued as a final NRC technical report in an upcoming NUREG. In your letter, the Advisory Committee on Reactor Safeguards (ACRS) agreed with the staff's proposed permit conditions, but expressed concern over some of the staff's conclusions associated with the nature of the proposed site.

Specifically, your letter stated that the technical basis for the staff's conclusion on its analyses of the hazards posed to the proposed site by explosions in transportation accidents on the Mississippi River needed to be more explicit. The staff has noted the ACRS concern and has asked the applicant to provide additional information to demonstrate how it meets Regulatory Guide (RG) 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants." The staff's evaluation of this information will be documented in the NUREG. Prior to issuance of the NUREG, the staff plans to inform the ACRS of the proposed changes.

Lastly, ACRS recommended that the staff provide additional guidance to applicants concerning "Major Features" of emergency planning for a proposed site. The staff agrees with the ACRS recommendation and is working to establish additional guidance, which will be included in a revision of Supplement 2 to NUREG-0654/FEMA-REP-1. It is the staff's understanding that industry does not plan to submit a "Major Features" ESP application in the near future and therefore the priority for this work is considered low. Currently, the staff's focus is on activities related to updating the emergency planning sections of the standard review plan and creation of guidance for future combined license applicants.

The NRC staff appreciates the insights that the ACRS has provided concerning the safety review of the Grand Gulf ESP. These insights are a valuable contribution to the NRC staff's review and development of the FSER.

Sincerely,

/RA/

Luis A. Reyes
Executive Director
for Operations

cc: Chairman Diaz
Commissioner McGaffigan
Commissioner Merrifield
Commissioner Jaczko
Commissioner Lyons
SECY

March 27, 2006

MEMORANDUM TO: John Larkins, Executive Director
Advisory Committee on Reactor Safeguards

FROM: David A. Matthews, Division Director
Division of New Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: ACRS REVIEW OF THE GRAND GULF EARLY SITE PERMIT APPLICATION - FINAL SAFETY EVALUATION REPORT CHANGED PAGES

On December 23, 2005, the Advisory Committee on Reactor Safeguards (ACRS) sent the NRC staff a letter regarding the final safety evaluation report (FSER) on the System Energy Resources, Inc. (SERI), application for the Grand Gulf early site permit (ESP). In this letter, the ACRS expressed concern about the staff's conclusions regarding the nature of the proposed site. The ACRS stated that the technical basis for the staff's conclusion on the hazards to the proposed site by explosions in transportation accidents on the Mississippi River needed to be more explicit.

The staff agreed with the ACRS's concern and asked the applicant to provide additional information to demonstrate compliance with 10 CFR Part 100. In a February 22, 2006, response, the applicant stated that it had decided not to follow Regulatory Guide (RG) 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants." The applicant also abandoned its initial argument for taking credit for an existing 60-foot bluff as a shield against any potential blasts along the Mississippi River. Instead, the applicant proposed an alternate methodology.

Using data provided by the US Army Corps of Engineers (USACE), Waterborne Commerce Statistics Center, the applicant performed an initial screening of commodities shipped on the Mississippi River past the ESP site. As a result of this initial screening, the applicant identified materials that could potentially create an explosion resulting in a blast overpressure on the order of 1 psi or greater at the western edge of the ESP site power block area. The applicant did an analysis for each of these commodities to determine the overpressure at 1.1 miles, taking into account the chemical and physical properties, the state of the material shipped, the assumed progression of events following the incident that releases the material, the reaction kinetics, and the release rates.

The analysis considered three different types of explosions: a confined space detonation, a local vapor cloud explosion, and vapor cloud formation and dispersion downwind toward the ESP site with a delayed detonation. For the commodities that resulted in a potential overpressure greater than 1 psi or with predicted concentrations at the site above the lower explosive limit as determined by version 5.4 of the ALOHA (Areal Locations of Hazardous Atmospheres) computer program, the applicant performed a risk assessment to determine if the probability of occurrence of the event was acceptably low.

The staff reviewed SERI's February 22, 2006, submittal and determined that the proposed alternate methodology is acceptable and demonstrates compliance with the regulations. The staff will capture its evaluation and the minor changes that resulted from SERI's submittal of Revision 3 to the Grand Gulf ESP application, in the NUREG. The staff plans to publish the FSER as a NUREG by April 14, 2006. If you have any questions about the attached changes to the Grand Gulf FSER please contact Christian Araguas, the project manager for the Grand Gulf ESP application, at (301)-415-3637.

Enclosure: Grand Gulf Early Site Permit FSER Changed Pages

NRC FORM 335 U.S. NUCLEAR REGULATORY COMMISSION
(9-2004)
NRCMD 3.7

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER
(Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG - 1840

2. TITLE AND SUBTITLE

Safety Evaluation Report for an
Early Site Permit (ESP) at the
Grand Gulf ESP Site

3. DATE REPORT PUBLISHED

MONTH	YEAR
April	2006

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

6. TYPE OF REPORT

Techinal Report

7. PERIOD COVERED *(Inclusive Dates)*

8. PERFORMING ORGANIZATION - NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

Division of New Reactor Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Division of New Reactor Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

10. SUPPLEMENTARY NOTES

Docket No. 52-009, Project No. 720

11. ABSTRACT *(200 words or less)*

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission staff's technical review of the site safety analysis report and emergency planning information included with the early site permit (ESP) application submitted by System Energy Resources, Inc. (SERIor the applicant), a subsidiary of Entergy Corporation, for the Grand Gulf ESP site. Byletter dated October16, 2003, SERI submitted the application for the Grand Gulf ESP site in accordance with SubpartA, "Early Site Permits," of Title10, Part52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," of the Codeof Federal Regulations (10CFR Part52). The Grand Gulf ESP site is in Claiborne County in southwestern Mississippi. The ESP site identified in the application is collocated with the Grand Gulf Nuclear Station, Unit1, near Port Gibson, Mississippi. In its application, SERI seeks approval of an ESP that could support a future application to construct and operate additional nuclear unit(s) at the ESP site, with total nuclear generating capacity of up to 8600megawatts thermal (MWt), with a maximum 4300 MWt per unit.

This SER presents the results of the staff's review of information submitted in conjunction with the ESP application. The staff has identified, in Appendix A to this SER, certain site-related items that will need to be addressed at the combined license or construction permit stage, should an applicant desire to construct one or more new nuclear reactors on the Grand Gulf ESP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Section 1.7 of this SER, more appropriately addressed at later stages in the licensing process. Appendix A to this SER also identifies the proposed permit conditions that the staff recommends the Commission impose, should an ESP be issued to the applicant

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

Early Site Permit (ESP)
Combined License (COL)
Permit Conditions
COL Action Items
Site Characteristics
Bounding Parameters
Grand Gulf ESP Site

13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

(This Page)

unclassified

(This Report)

unclassified

15. NUMBER OF PAGES

16. PRICE