Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site

U. S. Nuclear Regulatory Commission
Office of New Reactors
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ABSTRACT

This safety evaluation report[1] (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's technical review of the site safety analysis report (SSAR) and emergency planning information included in the early site permit (ESP) application submitted by Southern Nuclear Operating Company (SNC or the applicant), for the Vogtle Electric Generating Plant (Vogtle or VEGP) site. The SER also documents the NRC staff's technical review of the limited work authorization (LWA) activities for which SNC has requested approval.

By letter dated August 14, 2006, SNC submitted an ESP application for the VEGP site in accordance with Subpart A, "Early Site Permits," of Title 10 of the Code of Federal Regulations (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." The VEGP site is located in Burke County, Georgia, approximately 26 miles southeast of Augusta, Georgia. In its application, SNC seeks an ESP that could support a future application to construct and operate additional nuclear power reactors at the ESP site with a total nuclear generating capacity of up to 6800 megawatts thermal (MWt). The proposed ESP Units 3 and 4 would be built on the VEGP site adjacent to and west of two existing nuclear power reactors operated by SNC.

By letter dated August 16, 2007, SNC also submitted an LWA request in accordance with 10 CFR 52.17(c). The activities that SNC requested under its LWA are limited to placement of engineering backfill, retaining walls, lean concrete backfill, mudmats, and waterproof membrane.

This SER presents the results of the staff's review of information submitted in conjunction with the ESP and LWA 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 (COL) or construction permit (CP) stage, should the applicant desire to construct one or more new nuclear reactors on the VEGP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP or LWA stage and are, for reasons specified in Section 1.7 of the SER, more appropriately addressed at later stages in the licensing process. Appendix A to this SER also identifies the proposed permit conditions, site characteristics, bounding parameters, and inspections, tests, analyses and acceptance criteria (ITAAC) that the staff recommends the Commission impose, should an ESP and an LWA be issued to the applicant.

[1] This SER documents the NRC staff's position on all safety issues associated with the early site permit application and limited work authorization request. This SER has undergone a final review by the Advisory Committee on Reactor Safeguards (ACRS), and the results of the ACRS review are in a final letter report provided by the ACRS. This report is included as Appendix E to this SER.

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 consistent with the format of (1) NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," (2) Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants," and (3) the applicant's site safety analysis report. Numerous sections and chapters in the NUREG-0800 are not within the scope of or addressed in an Early Site Permit (ESP) or Limited Work Authorization (LWA) Request proceeding. The reader will therefore note "missing" chapter and section numbers in this document. The subjects of chapters and section in NUREG-0800 not addressed herein will be addressed, as appropriate and applicable, in other regulatory actions (design certifications, construction permit, or combined license) for a reactor or reactors that might be constructed on the Vogtle ESP site.

APPENDICES

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EXECUTIVE SUMMARY

The regulations at 10 CFR Part 52 contain requirements for licensing new nuclear power plants.[2] These regulations include the NRC's requirements for early site permits (ESP), design certification, and combined license (COL) applications. The ESP process (10 CFR Part 52, Subpart A) is intended to address and resolve site-related issues. The design certification process (10 CFR Part 52, Subpart B, "Standard Design Certifications") provides a means for a vendor to obtain NRC certification of a particular reactor design. Finally, the COL process (10 CFR Part 52, Subpart C, "Combined Licenses") 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. A COL applicant referencing an ESP or certified design must resolve any licensing issues that were not resolved as part of the referenced ESP or design certification proceeding before the NRC issues that COL. In addition, an applicant may request a limited work authorization (LWA) for approval of a limited set of construction activities in accordance with 10 CFR 50.10(d). Pursuant to 10 CFR 50.10(d)(3), an LWA request must contain the design and construction information otherwise required by the Commission's rules and regulations to be submitted for a combined license, but limited to those portions of the facility that are within the scope of the LWA. Pursuant to 10 CFR 50.10(d)(2), this request may come from an ESP applicant, and pursuant to 10 CFR 52.17(c), an ESP applicant may request that an LWA be issued in conjunction with the ESP.

This SER describes the results of a review by the NRC staff of both an ESP application and an associated LWA request submitted by Southern Nuclear Operating Company (SNC, or the applicant) for the Vogtle Electric Generating Plant (VEGP) site. The staff's review was to determine the applicant's compliance with the requirements of Subpart A of 10 CFR Part 52 as well as the applicable LWA requirements under 10 CFR Part 50. The SER serves to identify the staff's conclusions with respect to the ESP and LWA safety review and to identify items that would need to be addressed by a future COL applicant referencing a Vogtle ESP.

The NRC regulations also contain requirements for an applicant to submit an environmental report pursuant to 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." The NRC reviews the environmental report as part of the Agency's responsibilities under the National Environmental Policy Act of 1969, as amended. The NRC presents the results of that review in a final environmental impact statement (FEIS), which is a report separate from this SER. The staff's FEIS, NUREG-1872, "Final Environmental Impact Statement for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant Site," for the ESP application and LWA request was issued in August 2008, and can be accessed through the agencywide documents access and management system (ADAMS) at ML082260190.

By letter dated August 14, 2006, SNC, acting on behalf of itself and Georgia Power Company (GPC), Oglethorpe Power Corporation (an electric membership corporation), Municipal Electric Authority of Georgia, and the City of Dalton, Georgia, an incorporated municipality in the State of Georgia acting by and through its Board of Water, Light and Sinking Fund Commissioners,

2 Applicants may also choose to seek a CP 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.

submitted an ESP application (ADAMS Accession No. ML062290246)[3] for the VEGP site. The VEGP site is located on a coastal plain bluff on the southwest side of the Savannah River in eastern Burke County, Georgia. The site is approximately 26 miles southeast of Augusta, Georgia and 100 miles northwest of Savannah, Georgia. Directly across from the site, on the eastern side of the Savannah River, is the U.S. Department of Energy's (DOE's) Savannah River Site in Barnwell County, South Carolina. The proposed ESP Units 3 and 4 would be built on the VEGP site adjacent to two existing nuclear power reactors, Vogtle, Units 1 and 2, operated by SNC.

By letter dated August 16, 2007, SNC and its affiliates also submitted an LWA request in accordance with 10 CFR 52.17(c). The activities that SNC requested under its LWA are limited to placement of engineering backfill, retaining walls, lean concrete backfill, mudmats, and a waterproof membrane.

In accordance with 10 CFR Part 52, the VEGP application includes: (1) a description of the site and nearby areas that could affect or be affected by a nuclear power plant(s) located at the site; (2) a safety assessment of the site on which the facility would be located, including an analysis and evaluation of the major structures, systems, and components (SSC) of the facility that bear significantly on the acceptability of the site; (3) complete and integrated emergency plans; and (4) a safety assessment of the construction activities requested under the LWA. The application describes how the site, and the requested construction activities under the LWA, complies with the applicable requirements of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," 10 CFR Part 52 and the siting criteria of 10 CFR Part 100, "Reactor Site Criteria."[4]

The SER presents the conclusions of the staff's review of the ESP application and associated LWA request. The staff has reviewed the information provided by the applicant to resolve the open items identified in the SER with open items for the VEGP ESP, issued on August 30, 2007 (ML071581032). In addition, the staff has reviewed the information provided by the applicant in response to requests for additional information (RAI) pertaining to both the ESP application and the LWA request. In Section 1.5 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 are presented in the corresponding sections of this report.

The staff identified, in Appendix A to this SER, the proposed permit conditions that it will recommend the Commission impose, if an ESP is issued to the applicant. Appendix A also

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[3] ADAMS (Agencywide Documents Access and Management System) 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 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-reactors/esp/vogtle.html.

[4] The applicant has 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 SER describes the staff's evaluation of information submitted by the applicant to address GDC 2 with respect to the ESP application. Furthermore, with the applicant's submission of the LWA request, the staff also considered the application's compliance with GDC 1, "Quality Standards and Records," with respect to safety-related structures being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

includes a list of COL action items or certain site-related items that will need to be addressed at the COL or CP stage, if the applicant desires to construct one or more new nuclear reactors on the VEGP site and references the Vogtle ESP in its application. The staff determined that these items are not required for the staff to make its regulatory findings on the ESP or LWA and are, for reasons specified in Section 1.6, more appropriately addressed at a later stage in the licensing process. In addition, Appendix A lists the site characteristics, bounding parameters, and the inspections, tests, analyses, and acceptance criteria (ITAAC) that the staff recommends the Commission impose, should an ESP and an LWA be issued to the applicant.

Inspections conducted by the NRC have verified, where appropriate, the conclusions in this SER. The inspections focused on selected information in the ESP application and its references. The 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 SER, and provided the results of its review to the Commission in an interim report dated November 20, 2007, and in a final report dated December 22, 2008. Appendix E includes a copy of the report by the ACRS on the final safety evaluation report, as required by 10 CFR 52.23, "Referral to the ACRS."

ABBREVIATIONS

ACI	American Concrete Institute
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Management System
ADL	administrative decision line
AF	amplification functions
AFCCC	Air Force Combat Climatology Center
ALARA	as low as reasonably achievable
ALI	annual limits on intake
ANS	American Nuclear Society
ANSI	American National Standards Institute
ANSS	Advanced National Seismic System
ARC	American Red Cross
AREOP	Annual Radiological Environmental Operating Report
ASB	Auxiliary Shield Building
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
ATWS	anticipated transients without scram
BBM	Blue Bluff Marl
bpf	blows per foot
BE	best estimate
Bechtel	Bechtel Power Corporation
BLWM	Bureau of Land and Waste Management
BOP	Behavioral Observation Program
BRH	Bureau of Radiological Health
CADD	computer-aided design and drafting
CAR	Corrective Action Reports
C/D	capacity over demand
CDE	committed dose equivalent
CEUS	Central and Eastern United States
cfps	cubic feet per second
CFR	Code of Federal Regulations
CIS	Containment Internal Structure
COL	Combined Operating License
CP	construction permit
cpm	counts per minute
CPT	(seismic) cone penetration test
CR	condition report
CRR	cyclic resistance ratio
Cs	cesium
CSDRS	Certified Design Response Spectra
CSR	cyclic stress ratio
CU	consolidated undrained
CVSZ	Central Virginia Seismic Zone

D	distance
DAC	derived air concentrations
DBA	design-basis accident
Dbar	mean distance
DC	design certification
DCD	design certification document
DEIS	Draft Environmental Impact Statement
DEM	digital elevation model
DF	design factor
DFCS	Department of Family and Children Services
DG	Draft Regulatory Guide
DHEC	Department of Environmental Control
DHS	Department of Homeland Security
DNR	Department of Natural Resources
DOE	Department of Energy
DOE-SR	Department of Energy, Savannah River Site
DOT	Department of Transportation
DQ	deposition factors
DS	document services
E	elastic modulus
EAB	exclusion area boundary
EAL	emergency action levels
EAS	emergency alert system
ECFS	East Coast Fault System
ECL	emergency classification levels
ECMA	East Coast Magnetic Anomaly
EF	Enhanced Fujita
EIP	emergency implementing procedures
El.	elevation
EMA	Emergency Management Agency
EMS	emergency medical services
ENC	Emergency News Center
ENN	Emergency Notification Network
ENS	emergency notification system
ENS	emergency operations center
EOC	emergency operations facility
EOF	emergency operations facility
EOP	emergency operating procedures
EPA	Environmental Protection Agency
EPC	emergency preparedness coordinator
EPD	Environmental Protection Division
EPIP	emergency plan implementing procedures
EPRI	Electric Power Research Institute
EPZ	emergency planning zones
ER	Environmental Report
ERDS	emergency response data system
ERF	emergency response facility
ERO	emergency response organization
ESBWR	Economic Simplified Boiling Water Reactor
ESF	Emergency Support Function
ESP	Early Site Permit

EST	Earth Science Team
ETE	evacuation time estimate
ETML	elevated temperature material liquid
ETSZ	Eastern Tennessee Seismic Zone
ETV	Educational Television Network
EW	East, West
FA	felt area
FAA	Federal Aviation Administration
FDA	Food and Drug Administration
FEIS	final environmental impact statement
FEMA	Federal Emergency Management Agency
FEOC	Forward Emergency Operations Center
FERC	Federal Emergency Regulatory Commission
FIRS	foundation input response spectra
FNARS	Federal National Alert Radio System
FNF	fixed nuclear facility / facilities
FOSID	frequency of onset of inelastic deformation
fps	feet per second
FRC	Federal Response Center
FRERP	Federal Ragiological Emergency Response Plan
FRMAC	Federal Radiological Monitoring and Assessment Center
FS	factors of safety
FSAR	final safety analysis report
FSER	final safety evaluation report
ft	feet / foot
GA	Georgia
GA REP	Georgia Radiological Emergency Plan
GBU	Global Business Unit
GCSZ	Giles County Seismic Zone
GDC	general design criteria
Ge (Li)	lithium drifted germanium
GEMA	Georgia Emergency Management Agency
GEOP	Georgia Emergency Operations Plan
GET	general employee training
GIS	geographical information system
GL	Generic Letter
GMRS	ground motion response spectra
GPC	Georgia Power Company
h	hour
HEC	Hydrologic Engineering Center
HEC-RAS	Hydrologic Engineering Center River Analysis System
HEPA	high-efficient particulate air
HHS	Department of Health and Human Services
HMR	hydrometeorological Report
HP	health physics
HPN	Health Physics Netowrk
I	Iodine
IBR	incorporated by reference
IC	initiating condition
ICC	Intrastate Coordinating Channel
IEEE	Institute of Electrical and Electronic Engineers

IEM	Innovative Emergency Management, Inc.
in.	inch(es)
INPO	Institute of Nuclear Power Operators
IPCC	Intergovernmental Panel on Climate Change
IPZ	Ingestion Pathway Emergency Planning Zone
ITAAC	inspections, tests, analyses, and acceptance criteria
JFD	joint frequency distribution
JIC	joint information center
KI	potassium iodide
kPa	kilopascals
LB	lower bound
lbf/ft^2	pounds-force per square foot
LGR	local government radio
LLEA	local law enforcement agencies
LLNL	Lawrence Livermore National Laboratory
LOCA	loss-of-coolant accident
LPZ	low population zone
LWA	limited work authorization
LWR	light-water reactor
m	meter
M	moment magnitude
Mbar	mean magnitude
MbLg	body-wave local magnitude
M&TE	measuring and test equipment
m/s	meters per second
MACTEC	MACTEC Engineering and Consulting, Inc.
MAST	Military Assistance to Safety and Traffic
Mbar	mean magnitude
MEI	maximally exposed individual
MGD	million gallons a day
mGy	milliGray
mi	miles
MIDAS	Meteorological Information and Dispersion Assessment System
MLW	mean low water
ML	local magnitude
Mmax	largest maximum magnitude
MM	modified mercalli
MMI	modified mercalli intensity
MOA	Military Operation Area
MOU	memorandum of understanding
MOX	mixed oxide
MPA	methoxypropylamine
MPA	methoxypropylamine
mrad	milliard
mrem	millirem
MRO	Medical Review Officer
m/s	meters per second
MS	surface-wave magnitude
MSE	mechanically stabilized earth
msl	mean sea level
mSv	milliSieverts

MWt	megawatts thermal
mya	million years ago
NaI	sodium iodide
NAWAS	National Warning System
NCDC	National Climatic Data Center
ND	Nuclear Development
NDQAM	Nuclear Development Quality Assurance Manual
NEI	Nuclear Energy Institute
NGDC	National Geophysical Data Center
NHC	National Hurricane Center
NI	nuclear island
NIRMA	Nuclear Information and Records Management Association
NIST	National Institute of Standards and Technology
NMSZ	New Madrid Seismic Zone
NOAA	National Oceanic and Atmospheric Administration
NOAA-CSC	National Oceanic and Atmospheric Administration-Coastal Services Center
NQA	nuclear quality assurance
NQAM	Nuclear Quality Assurance Manual
NRC	Nuclear Regulatory Commission
NREES	Nuclear Response and Emergency Environmental Surveillance Section
NRP	National Response Plan
NS	North, South
NSSL	National Severe Storms Laboratory
NSSS	nuclear steam supply system
NUREG	NRC technical report (Nuclear Regulatory Commission)
NVLAP	National Voluntary Laboratory Accreditation Program
NWR	National Weather Radio
NWS	National Weather Service
NYAL	New York-Alabama Lineament
OBE	operating basis earthquake
OCA	owner-controlled area
OCGA	Official Code of Georgia Annotated
ODCM	Offsite Dose Calculation Manual
OHS	Office of Homeland Security
ORHMC	Oak Ridge Hospital of the Methodist Church
OSC	operational support center
OSID	onset of significant inelastic deformation
OWA	owner-controlled area
PA	protected area
PAG	protective action guideline
PAR	protective action recommendation
PCS	Passive containment cooling system (NRC defines passive containment system)
pcf	per cubic foot
PFT	performance frequency values
PGA	Peak Ground Acceleration
PI	plasticity index
PIO	public information officer
PMF	probable maximum flood
PMH	probable maximum hurricane

PMP	probable maximum precipitation
PMWP	probable maximum water precipitation
PNS	prompt notification system
PO	purchase order
PPM	parts per million
PQAM	Project Quality Assurance Manager
P-S	primary and secondary
psf	pounds per square foot
PSHA	probabilistic seismic hazard analysis
psi	pounds per square inch
PWR	pressurized-water reactor
QA	quality assurance
QAPD	Quality Assurance Program Description
QAPP	Quality Assurance Program Plan
RAI	Request for Additional Information
RAP	Radiological Assistance Program
RASCAL	Radiological Assessment System for Consequence Analysis
RCL	Record Control Log
RCTS	resonant column torsional shear
REI	Risk Engineering, Inc.
ReMi	refraction microtremor
REP	radiological emergency preparedness
RER	radiological emergency response
RERP	radiological emergency response plan
RG	Regulatory Guide
RIS	Regulatory Issue Summary
RMC	Radiation Management Consultants
RQD	Rock Quality Designations
RS	Review Standard
RWP	radiation work permit
SASSI	System for Analysis of Soil-Structure Interaction
SASW	Spectral Analysis of Surface Waves
SCDF	seismic core damage frequencies
SCDOT	South Carolina Department of Transportation
SCEMD	South Carolina Emergency Management Division
SCEOP	South Carolina Emergency Operations Plan
SCETV	South Carolina Educational Television Network
SCOL	Subsequent Combined Operating License
SCORERP	South Carolina Operational Radiological Emergency Response Plan
SCR	stable continental region
SCS	Southern Company Services, Inc.
SCTRERP	South Carolina Technical Radiological Emergency Response Plan
SCV	steel containment vessel
SEI	Structural Engineering Institute
SEN	sensitivity
SEOC	State Emergency Operations Center
SER	safety evaluation report
SERCC	Southeast Regional Climate Center
SERT	State Emergency Response Team
SEUSS	South Eastern United States Seismic Network
SL	severity level

SLED	South Carolina Law Enforcement Division
SMRAP	Southern Agreement for Mutual State Radiation Assistance Activation Procedure
SNC	Southern Nuclear Operating Company
SOC	State Operations Center
SOP	Standard Operating Procedure
SP	light gray sand
SPF	Standard Project Flood
SPT	Standard Penetration Test
SQAP	Software Quality Assurance Plan
Sr	strontium
SR	standard review
SRNL	Savannah River National Laboratory
SRP	Standard Review Plan
SRS	Savannah River Site
SSAR	site safety analysis report
SSC	structures, systems and components
SSE	safe-shutdown earthquake
SSHAC	Senior Seismic Hazard Advisory Committee
SSI	soil-structure-interaction
TAG	Technical Advisory Group
TEDE	total effective dose equivalent
TFI	technical facilitator/integrator
TI	Technical Integrator
TIP	Trial Implementation Project
TLD	thermoluminescent dosimeter
TNT	trinitrotoluene
TSC	technical support center
TtNUS	Tetra Tech, Inc.
TV	threshold value
UB	upper bound
UCSS	Updated Charleston Seismic Source
UFL	Upper Flammability Limit
UFSAR	undated final safety analysis report
UHRS	uniform hazard response spectrum
UHS	ultimate heat sink
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USCB	U. S. Census Bureau
USDA	U. S. Department of Agriculture
USGS	U. S. Geological Survey
UTM	Universal Transverse Mercator
UTS	Universal Transverse Mercator
UU	unconsolidated undrained
V/H	vertical-to-horizontal
VEGP	Vogtle Electric Generating Plant
VHF	very high frequency
VOAD	Voluntary Organizations Active in Disaster
Vs	shear wave velocity
WEC	Westinghouse Electric Company, LLC
WLA	William Lettis & Associates

WMA	Wildlife Management Area
WSRC	Washington Savannah River Company
WUS	Western United States
yd(s)	yard(s)
ZRA	zone of river anomalies

1.0 INTRODUCTION AND GENERAL DESCRIPTION

1.1 Introduction

By letter dated August 14, 2006, SNC, acting on behalf of itself and Georgia Power Company (GPC), Oglethorpe Power Corporation (an electric membership corporation), Municipal Electric Authority of Georgia, and the City of Dalton, Georgia, an incorporated municipality in the State of Georgia acting by and through its Board of Water, Light and Sinking Fund Commissioners, submitted an early site permit (ESP) application (ADAMS Accession No. ML062290246) for the Vogtle Electric Generating Plant (VEGP) site. The proposed site is located in eastern Burke County, GA, approximately 26 miles (mi) southeast of Augusta, GA, and approximately 100 mi northwest of Savannah, GA. The NRC docketed the application on September 19, 2006. Pursuant to Subpart A of 10 CFR Part 52, SNC requested an ESP with a permit duration of 20 years. On August 16, 2007, SNC submitted a limited work authorization (LWA) request for approval of construction activities including the placement of engineered backfill, retaining walls, lean concrete backfill, mudmats, and a waterproof membrane, in accordance with 10 CFR 52.17(c). Pursuant to 10 CFR 50.10(d)(3), an LWA request must contain the design and construction information otherwise required by the Commission's rules and regulations to be submitted for a combined license, but limited to those portions of the facility that are within the scope of the LWA.

The staff has completed its review of the information presented in the VEGP application concerning the site's meteorology, hydrology, geology, and seismology, as well as the potential 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 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 in accordance with the measures discussed in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50. The staff reviewed the complete and integrated emergency plans that SNC would implement if a new reactor(s) is eventually constructed at the ESP site.

In addition, the staff reviewed the technical information presented in the VEGP application pertaining to the LWA activities being requested. Specifically, the staff reviewed the applicant's seismic design, seismic systems, and foundations, as they relate to the LWA activities being requested. The staff also evaluated the applicant's fitness for duty program in accordance with the requirements in 10 CFR Part 26.[5]

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[5] As provided in Part 26, the entities that must comply with Part 26 requirements include "[e]arly site permit holders who have been issued a limited work authorization under § 50.10(e), if the limited work authorization authorizes the early site permit holder to install the foundations, including the placement of concrete, for safety- and security-related SSCs under the limited work authorization." 10 CFR 26.3(c)(5). The statement of considerations for Part 26 indicates that entities authorized by an LWA to perform "only the…placement of backfill" will not be required to comply with Part 26, but that entities who are authorized by an LWA "to perform installation of the foundation" for safety- and security-related SSCs will be required to comply. 73 FR 16966, 16998 (Mar. 31, 2008). The staff has determined that because of its implications for seismic safety, the placement of engineered backfill requested as part of the LWA for the Vogtle site represents an integral part of the foundation; accordingly, the staff considers placement of that backfill pursuant to the LWA to be "installation of the foundation" within the meaning of Part 26. Therefore, consistent with the text of the rule, the staff has determined that the applicant is required to comply with the requirements of Part 26 to establish a fitness for duty program.

The VEGP application includes the SSAR, which describes a safety assessment of the site, as required by 10 CFR 52.17, "Contents of Applications." The public may inspect copies of the ESP application in ADAMS under Accession No. ML081020073. The application is also available for public inspection at the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, MD 20852, and at the Burke County Public Library, 130 Highway 24 South, Waynesboro, GA 30830.

This safety evaluation report (SER)[6] documents the staff's technical evaluation of the suitability of the proposed VEGP site for construction and operation of a nuclear power plant(s) falling within the design parameters that SNC specified in its application. It also documents the results of the staff's technical evaluation of the limited construction activities proposed under SNC's LWA request. The SER delineates the scope of the technical matters that the staff considered in evaluating the suitability of the site and the LWA request. NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," Attachment 2, provides guidance for the staff in conducting its review of the radiological safety and emergency planning aspects of a proposed nuclear power plant site. RS-002, Attachment 2, contains regulatory guidance based on NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (hereafter referred to as the SRP.) In addition to RS-002, the SRP provides the regulatory guidance applied by the staff in its review of the LWA request. The SRP reflects the staff's many years of experience in establishing and promulgating guidance to enhance the safety of nuclear facilities, as well as in performing safety assessments.

The applicant also filed an environmental report for the VEGP 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 VEGP site in a final environmental impact statement (FEIS) issued in August 2008 (ML082260190). The applicant has also provided a site redress plan, in accordance with 10 CFR 52.17(c), in order to perform the LWA activities specifically requested in the application. The FEIS documents the staff's evaluation of the SNC site redress plan.

Appendix A to this SER contains the list of site characteristics, permit conditions, COL action items, and the bounding parameters, and inspections, tests, analyses and acceptance criteria (ITAAC) that the staff recommends the Commission include in any ESP and LWA that might be issued for the proposed site. Appendix B to the SER is a chronology of the principal actions and correspondence related to the staff's review of the ESP and LWA application for the VEGP site. Appendix C lists the references for this SER, Appendix D lists the principal contributors to this report, and Appendix E includes a copy of the report by the ACRS.

1.2 General Site Description

Proposed ESP Units 3 and 4 are planned to be built on the VEGP site. The VEGP site, which spans 3,169 acres, is located on a coastal plain bluff on the southwest side of the Savannah River in eastern Burke County. The site is approximately 15 miles east-northeast of Waynesboro, GA, 26 miles southeast of Augusta, GA, and it is also approximately 100 miles from Savannah, GA. Directly east of the site, across the Savannah River, is the U.S Department of Energy's (DOE) Savannah River Site.

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6 This SER documents the NRC staff's position on all safety issues associated with the early site permit application and limited work authorization request. This SER has undergone a final review by the Advisory Committee on Reactor Safeguards (ACRS), and the results of the ACRS review are in a final letter report provided by the ACRS. This report is included as Appendix E to this SER.

Numerous small towns exist within 50 miles of the site. U.S. Interstate Highway No. I-20 (I-20), a major interstate highway, crosses the northern portion of the 50-mile radius. The site can be accessed through U.S. Route 25; Georgia State Routes 23, 24, 56, and 80; and New River Road. A navigation channel is authorized on the Savannah River from the Port of Savannah to Augusta, GA, and a railroad spur connects the site to the Norfolk Southern Savannah-to-Augusta track. The applicant's SSAR Figures 1-1 and 1-2 show the site location and the area within a 6-mile and 50-mile radius. Section 2.1 of this SER discusses the site location in more detail.

With regard to the existing development of the site, the VEGP site currently has two Westinghouse pressurized water reactors (PWRs), rated at 3,625.6 Mwt. Also on the site are their supporting structures, which include two natural-draft cooling towers (one per unit), associated pumping and discharge structures, water treatment building, switchyard, and training center. Plant Wilson, a six-unit, oil-fueled combustion turbine facility, is also located on the VEGP site, east of Units 1 and 2. The applicant's SSAR Figure 1-3 shows the current VEGP site plan.

With regard to the proposed development of the site, the new plant footprint selected for proposed Units 3 and 4 is adjacent to the west side of the VEGP Units 1 and 2. The footprint is shown on the applicant's SSAR Figure 1-4.

The applicant has referenced the Westinghouse AP1000 certified reactor design for both the ESP application and the LWA request. The applicant's SSAR Section 1.3 identifies the design parameters, site characteristics, and site interface values used in the development of the application. The design parameters are based on the addition of two Westinghouse AP1000 units, to be designated Vogtle Units 3 and 4. The AP1000 has a thermal power rating of 3,400 MWt and a net electrical output of 1,117 megawatts electric. While the staff considered design parameters of the AP1000 certified design in order to make its ESP findings concerning site suitability, issuance of a Vogtle ESP does not constitute approval of future construction of the AP1000 certified design at the Vogtle site. If a CP or COL applicant references a Vogtle ESP in its application, the staff's CP or COL stage review would determine whether the reactor design that is ultimately selected by that applicant falls within the site characteristics and design parameters specified in the ESP. Likewise, while the LWA application references applicable design parameters of the AP1000 certified design, the staff's LWA review addresses only those aspects of the AP1000 design that are within the scope of that request.

1.3 <u>Identification of Agents and Contractors</u>

SNC, acting on behalf of itself and the owners of the VEGP site, is the applicant for the ESP and the LWA and has been the only participant in the review of the suitability of the VEGP site for a nuclear power plant. Bechtel Power Corporation (Bechtel) served as the principal contractor for the development of the SSAR portion of the ESP application and Tetra Tech NUS, Inc. (TtNUS), to assist with preparing the environmental report portion. Both Bechtel and TtNUS supplied personnel, systems, project management, and resources to work on an integrated team with SNC.

Several subcontractors also assisted in the development of SNC's ESP and LWA application. MACTEC Engineering and Consulting, Inc. performed geotechnical field investigations and laboratory testing in support of SSAR Section 2.5, "Geology, Seismology, and Geotechnical

Engineering." William Lettis & Associates, Inc. performed geologic mapping and characterized seismic sources in support of SSAR Section 2.5. Risk Engineering, Inc. performed probabilistic seismic hazard assessments (PSHA) and related sensitivity analyses in support of SSAR Section 2.5.

1.4 Summary of Principal Review Matters

This SER documents the NRC staff's technical evaluation of the VEGP site. The staff's evaluation included a technical review of the information and data the applicant submitted, with emphasis on the following principal matters:

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

- potential hazards of man-made facilities and activities to a nuclear power plant(s) that might be constructed on the ESP site (e.g., mishaps involving storage of hazardous materials (toxic chemicals, explosives), transportation accidents (aircraft, marine traffic, railways, pipelines), and the existing nuclear power facility comprising the nearby VEGP units)

- potential capability of the site to support the construction and operation of a nuclear power plant(s) with design parameters falling within those specified in the application under the requirements of 10 CFR Parts 52 and 100

- suitability of the site for development of adequate physical security plans and measures for a nuclear power plant(s)

- proposed complete and integrated emergency plan, should an applicant for a construction permit (CP) or combined license (COL) referencing a Vogtle ESP decide to seek a license to construct and operate a nuclear power plant(s) on the ESP site; any significant impediments to the development of emergency plans for the VEGP site; and a description of contacts and arrangements made with Federal, State, and local government agencies with emergency planning responsibilities

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

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

This SER also documents the NRC staff's technical evaluation of SNC's LWA request. The staff's evaluation included a technical review of the information and data the applicant submitted, with emphasis on the following principal matters:

- acceptability of the applicant's design properties related to the engineered backfill

- the acceptability of the applicant's mudmat and waterproof membrane design in accordance with 10 CFR 50.10(d)(3)

- quality assurance measures SNC applied to the information submitted in support of the LWA request, and will continue to apply when performing approved LWA activities

- A fitness for duty program developed, with respect to those limited construction activities requested in SNC's LWA application, to meet the applicable requirements contained in 10 CFR Part 26.

During its review, the staff held several meetings with representatives of SNC and its contractors and consultants to discuss various technical matters related to the staff's review of the VEGP site (refer to Appendix B to this SER) and LWA. The staff also visited the site to evaluate safety matters.

Appendix A to this SER includes a list of the site characteristics, bounding parameters, permit conditions, COL action items, and ITAAC that the staff recommends the Commission include in an ESP and LWA for the Vogtle site. The site characteristics are based on site investigation, exploration, analysis, and testing, performed by the applicant and are specific physical attributes of the site, whether natural or man-made. Bounding parameters set forth the postulated design parameters that provide design details to support the NRC staff's review. An explanation of COL action items, permit conditions, and ITAAC is provided below in sections 1.6, 1.7, and 1.8 respectively.

1.5 <u>Summary of Open Items and Confirmatory Items</u>

During its review of SNC's ESP application for the Vogtle site, the staff identified several issues that remained open at the time the SER with open items was issued on August 30, 2007. The staff considered an issue to be open if the applicant did not provide requested information and the staff did not know what would ultimately be included in the applicant's response. For tracking purposes, the staff assigned each of these issues a unique identifying number that indicated the section of this report describing it. The SER with open items was issued with 40 open items. Resolution of each open item is discussed in the SER section in which it appears. For example, Section 2.3 of this report discusses Open Item 2.3-1. As set forth in this report, all open items have been resolved.

During its review of SNC's LWA application for the Vogtle site, the staff also identified several issues for which it needed to obtain further information from the applicant. The staff relied on RAIs and site audits to resolve all outstanding issues. The staff's consideration of these RAIs, the applicant's responses to the RAIs, and the results of site audits are documented throughout this SER.

Previously, in the advanced SER, issued November 12, 2008, the staff identified confirmatory item 1.1-1, to verify that the applicant incorporated all of the necessary changes to which it had committed in RAI and open item responses. 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 staff has completed its review of Revision 5 to the VEGP ESP application and LWA request, submitted December 23, 2008, and has verified that the applicant did incorporate those changes in Revision 5. Therefore, confirmatory item 1.1-1 is closed.

1.6 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 if a COL or CP applicant desires to construct one or more new nuclear reactors on the VEGP site and references a Vogtle ESP. This report refers to these items as COL action items. The COL action items relate to issues that are outside the scope of this SER. The COL action items do not establish requirements; rather, they identify an acceptable 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 Vogtle ESP. An applicant for a COL or CP referencing a Vogtle ESP will need to address each of these items in its application. The applicant may deviate from or omit these items, provided that the COL or CP application identifies and justifies the deviation or omission. The staff determined that the COL action items are not required for the staff to make its regulatory findings on the ESP or LWA and are, for reasons specified in this report for each item, more appropriately addressed at a later stage in the licensing process.

At the time the SER with open items was issued, there were a total of 19 COL action items. As a result of the staff's review of the open item responses, and the supplemental information provided in the LWA request, the staff was able to close out several of the COL action items. In total, there are 5 COL action items remaining. This report highlights the closure of previously identified COL action items. It also highlights the existing and new COL action items proposed by the staff.

Appendix A to this SER includes a list of the COL action items to be addressed by a future COL or CP applicant referencing a Vogtle ESP. The staff identified COL action items in order to ensure that particular significant issues are tracked and considered during the COL or CP stage. The COL action items focus on matters that may be significant in any COL or CP application referencing the ESP and LWA for the Vogtle site, if one is issued. Usually, COL action items are not necessary for issues covered by permit conditions or explicitly covered by the bounding parameters. The list of COL action items is not exhaustive with respect to the information required to meet the requirements for a CP or COL.

1.7 Summary of Permit Conditions

The staff has identified certain permit conditions that it will recommend the Commission impose if an ESP is issued to the applicant. At the time the SER with open items was issued, there were 2 permit conditions identified. As a result of the staff's review of the responses to open items, and the supplemental information provided in the LWA request, the staff identified additional permit conditions and removed one pertaining to hydrology. In total, there are 9 permit conditions identified. This report highlights the closure of the permit condition related to hydrology. It also highlights the existing and new permit conditions proposed by the staff.

Appendix A to this SER summarizes these permit conditions. Each permit condition has been assigned a number based on the order which it appears in this SER. The staff has provided an explanation of each permit condition in the applicable section of this report. These permit conditions, or limitations on the ESP, are based on the provisions of 10 CFR 52.24, "Issuance of Early Site Permit."

1.8 Summary of Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)

For the reasons explained in this report, an ESP application proposing complete and integrated emergency plans for review and approval should propose the inspections, tests, and analyses that the holder of a COL referencing the ESP shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will be operated in conformity with the emergency plans, the provisions of the Atomic Energy Act, and the Commission's rules and regulations.

Likewise, if a request for a limited work authorization (LWA) is to be issued in conjunction with an ESP, it should propose the inspections, tests, and analyses that the ESP holder authorized to conduct LWA activities shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the approved construction activities will have been completed in conformity with the provisions of the Atomic Energy Act and the Commission's rules and regulations.

The staff has identified certain ITAAC that it will recommend the Commission impose with respect to an ESP and LWA issued to the applicant. At the time the SER with open items was issued, the staff had only reviewed and included ITAAC necessary for SNC's Emergency Plans. However, as a result of the staff's review of the supplemental information provided in the LWA request, the staff reviewed and approved additional ITAAC. This report highlights the applicant's proposed ITAAC and the staff's review and approval of them. In addition, Appendix A to this SER summarizes the ITAAC approved by the staff.

2.0 SITE CHARACTERISTICS

2.1 <u>Geography and Demography</u>

2.1.1 Site Location and Description

2.1.1.1 Introduction

This section provides details about the site location and site area description for the VEGP site. The proposed ESP Units 3 and 4 would be built on the VEGP site adjacent to existing VEGP Units 1 and 2. The 3169-acre VEGP site is located on a coastal plain bluff southwest of the Savannah River in eastern Burke County. The site exclusion area boundary (EAB) is bounded by River Road, Hancock Landing Road, and 1.7 miles of the Savannah River. The site is approximately 30 river-miles above the U.S. Highway 301 bridge and directly across the river from the U.S. Department of Energy (DOE) Savannah River Site (SRS), in Barnwell County, South Carolina. The VEGP site is approximately 15 miles northeast of Waynesboro, Georgia, and 26 miles southeast of Augusta, Georgia, which is the nearest population center (with more than 25,000 residents).

2.1.1.2 Regulatory Basis

The acceptance criteria for site location and description are based on meeting the relevant requirements of 10 CFR 52.17, “Contents of applications,” and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the site location and area description:

- 10 CFR 52.17, as it relates to the applicant submitting information needed for evaluating factors involving the characteristics of the site environment, and describing the boundaries of the site and the proposed general location of each facility on the site.

- 10 CFR Part 100, Subpart B, as it relates to site acceptance being based on the consideration of factors relating to the proposed reactor design and the site characteristics.

Review Standard (RS)-002, “Processing Applications for Early Site Permits,” Section 2.1.1, specifies that an applicant has submitted adequate information if it satisfies the following criteria:

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

- The site location, including the exclusion area and the proposed location of a nuclear power plant or plants of specified type that might be constructed on the proposed site, are described in sufficient detail to allow a determination (in Sections 2.1.2, 2.1.3, and 15.0 of RS-002) that 10 CFR Part 100, Subpart B is met.

In addition to identifying specific acceptable criteria to meet the relevant requirements, RS-002 indicates the NRC staff's review of the site location and description typically involves reviewing the following:

- reactor location with respect to (1) latitude and longitude, and the Universal Transverse Mercator (UTM) coordinates, (2) political subdivisions (i.e., counties, cities, states, or their respective agencies), and (3) prominent natural and manmade features of the area for use in independent evaluations of the exclusion area authority and control, the surrounding population, and nearby manmade hazards

- the site area map containing the reactor and associated principal plant structures to determine (1) the distance from the reactor to the boundary lines of the EAB and (2) the location, distance, and orientation of plant structures with respect to highways, railroads, and waterways that traverse or lie adjacent to the exclusion area to ensure that they are adequately described to permit analyses of the possible effects of plant accidents on these transportation routes.

2.1.1.3 Technical Evaluation

Following the procedures described in RS-002, Section 2.1.1, the NRC staff reviewed Section 2.1.1 of the SSAR in the VEGP application regarding the site location and site area description, as well as the information the applicant provided in response to the NRC staff's RAI 2.1.1-2 and 2.1.1-3.

The applicant provided the following information regarding the site location and site area description:

- the site boundary for the proposed VEGP Units 3 and 4 to be built on the proposed ESP site with respect to the existing VEGP Units 1 and 2

- the site layout for the proposed VEGP Units 3 and 4 to be built on the proposed ESP site

- the site location with respect to political subdivisions and prominent natural and manmade features of the area within the 6-mile LPZ and the 50-mile population zone

- the topography and characteristics of the land surrounding the proposed ESP site

- the commercial, industrial, institutional, recreational, and residential structures located within the site area

- the distance from the proposed ESP site to the nearest EAB, including the direction and distance

- the potential radioactive release points and their locations for the proposed units

- the distance of the proposed Units 3 and 4 to be built on the proposed ESP site from regional U.S. and State highways

The proposed Units 3 and 4 would be located within the existing VEGP site adjacent to existing Units 1 and 2. The ESP site boundary, as shown in Figure 1-4 of the SSAR, is the same as the site boundary for the existing VEGP Units 1 and 2. This figure depicts both the existing units and the proposed units in addition to the site boundary, exclusion area boundary (EAB), protected area (PA) for the proposed units, visitor's center, and Plant Wilson, a six-unit oil-fueled combustion turbine facility owned by Georgia Power Company (GPC), which is also located on the VEGP site.

The NRC staff has verified the following latitude and longitude and UTM coordinates of the proposed units, as provided in the SSAR:

UTM Coordinates	Latitude/Longitude Deg/Min/Sec
Unit 3: Zone 17 3,667,170 m N; 428,320 m E	33 08 27 N; 81 46 07 W
Unit 4: Zone 17 3,667,170 m N; 428,070 m E	33 08 27 N; 81 46 16 W

The EAB for the VEGP, Units 1 and 2 will also apply to the proposed ESP VEGP Units 3 and 4. There are no residents in this exclusion area. The site EAB is bounded by River Road, Hancock Landing Road, and 1.7 miles of the Savannah River. The property boundary encompasses the entire EAB and extends beyond River Road in some areas. The nearest point to the EAB is located approximately 3400 feet southwest of the proposed VEGP Units 3 and 4 power block area. The applicant established this EAB to meet the siting and evaluation factors in Subpart B of 10 CFR Part 100, as well as the radiation exposure criterion "as low as is reasonably achievable," defined in 10 CFR Part 50.

The 3,169-acre proposed ESP site is located on a coastal plain bluff southeast of the Savannah River in eastern Burke County. The VEGP site is situated within three major resource areas: (1) the Southern Piedmont, (2) Carolina and Georgia Sand Hills, and (3) the Coastal Plain. These characteristics are typical of land forms that resulted from historical marine sediment deposits in central and eastern Georgia. There are no mountains in the general area.

The proposed ESP site is approximately 15 miles east-northeast of Waynesboro, Georgia, and 26 miles southeast of Augusta, Georgia, the nearest population center having more than 25,000 residents. It is also about 100 miles from Savannah, Georgia, and 150 river-miles from the mouth of the Savannah River. Burke County includes five incorporated towns (1) Waynesboro, (2) Girard, (3) Keysville, (4) Midville, and (5) Sardis. Of these five towns, only the town of Girard is within 10 miles of the ESP site. Girard has a population of 227 residents, according to the 2000 census.

Based on the NRC staff's review of the general site area and the information collected from the local officials during the site visit, the applicant's information with regard to the site location and area description is adequate and acceptable because it satisfies the acceptance criteria specified in RS-002, Section 2.1.1.

First, although the site is accessible by River Road via U.S. Highway 25 and Georgia Routes 56, 80, 24, and 23, and a railroad spur connects the site to the Norfolk Southern Savannah-to-Augusta track, there are no highways, railroads, or waterways that traverse the proposed ESP site EAB. Accordingly, because there are no highways, railroads, and waterways that traverse the exclusion area, routine use of these routes is not likely to interfere with normal plant operations.

Second, based on the NRC staff's review of the general site area and the information collected from the local officials during the site visit, the applicant's information with regard to the site location and area description is adequate and acceptable to allow the NRC to evaluate whether the applicant met the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff has verified that the EAB distance is consistent with the distance the applicant used in its radiological consequence analyses described in Chapter 15 and in Chapter 13.3 of the SSAR. The applicant stated that all areas outside the EAB will be unrestricted in the context of 10 CFR Part 20, "Standards for Protection Against Radiation," and the gaseous effluent release limits, per guidelines provided in 10 CFR Part 50, for the proposed ESP units, would apply to the EAB. Further information regarding the site location and site description is provided in Sections 2.1.2, 2.1.3, and 11 of this SER.

2.1.1.4 Conclusion

As set forth above, the applicant provided and substantiated information concerning the site location and description of site area. The NRC staff has reviewed the information provided and, for the reasons given above, concludes that the applicant established site characteristics that meet the requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff further concludes that the applicant provided sufficient details about the site location and description of the site area to allow the NRC staff to evaluate, as documented in Sections 2.1.2, 2.1.3, 11, 13.3, and 15 of this SER, whether the applicant met the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Introduction

This section addresses the information concerning the legal authority to regulate any and all access and activity within the entire plant exclusion area for the proposed VEGP Units 3 and 4. Part 1, Chapter 3, of the SSAR provides general information pertaining to the owners/co-owners group. The applicant stated that GPC, for itself and as an agent for the other co-owners, has delegated complete authority to SNC to determine and regulate all activities within the designated exclusion area. "No Trespassing" signs are posted on the perimeter of the VEGP EAB on land and along the Savannah River, and indicate the actions to be taken in the event of emergency conditions at the plant.

2.1.2.2 Regulatory Basis

The acceptance criteria for exclusion area authority and control are based on meeting the relevant requirements of 10 CFR Part 100 with respect to the applicant's authority over the designated exclusion area.

- 10 CFR 100.3 states: 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. Residence within the exclusion area shall normally be prohibited. In any event, residents shall be subject to ready removal in case of necessity. 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.

As stated in RS-002, Section 2.1.2, specifies that an applicant has submitted adequate information if it satisfies the following criteria:

- The applicant demonstrates, prior to issuance of an ESP, that it has the authority within the exclusion area, as required by 10 CFR 100.3, or provides reasonable assurance that it will have such authority prior to start of construction of a proposed nuclear unit that might be located on the proposed ESP site.

- Activities unrelated to operation of a nuclear power plant or plants of specified type that might be constructed on the proposed site within the exclusion area are acceptable provided: (a) such activities, including accidents associated with such activities, represent no significant hazard to a nuclear power plant or plants of specified type that might be constructed on the proposed site, or are to be accommodated as part of the plant design basis at the COL stage. (See Section 2.2.3 of RS-002); (b) the applicant is aware of such activities and has made appropriate arrangements to evacuate persons engaged in such activities, in the event of an accident; and (c) there is reasonable assurance that persons engaged in such activities can be evacuated without receiving radiation doses in excess of the reference values of 10 CFR 50.34(a)(1).

RS-002, Section 2.1.2 also addresses review procedures that allow the NRC staff to determine whether the relevant requirements are met. This typically involves the NRC staff reviewing (1) the applicant's legal authority to determine all activities within the designated exclusion area, (2) the applicant's authority and control in excluding or removing personnel and property in the event of an emergency, and (3) proposed or permitted activities in the exclusion area which are unrelated to operation of the reactor to ensure that they do not result in a significant hazard to public health and safety.

2.1.2.3 Technical Evaluation

Following the procedures described in RS-002, Section 2.1.2, the NRC staff reviewed SSAR Chapter 2.1.2 of the VEGP ESP application regarding exclusion area authority and control, in addition to the applicant's responses to RAIs 2.1.2-1, 2.1.2-2, and 2.1.2-3.

In the SSAR Chapter 2.1.2, the applicant presented information concerning the following:

- complete legal authority to regulate any and all access and activity within the entire plant exclusion area

- identification of two facilities (the visitor's center and the GPC combustion turbine plant, Plant Wilson) within the EAB that have authorized activities unrelated to nuclear plant operations

- emergency planning, including arrangements for traffic control

Figure 1-4 of the SSAR depicts the boundary lines of the exclusion area for the proposed ESP site, which is the same as the EAB for the existing VEGP Units 1 and 2. The EAB is bounded by River Road, Hancock Landing Road, and 1.7 miles of the Savannah River. No state or county roads, railroads, or waterways traverse the VEGP exclusion area. The nearest point to the EAB is located approximately 3400 feet southwest of the proposed VEGP Units 3 and 4 ESP power block area.

The applicant stated that pursuant to the VEGP owner's agreement, GPC, for itself and as agent for the co-owners, has delegated to SNC (the applicant) complete authority to regulate any and all access and activity within the entire plant exclusion area. The applicant also stated that the perimeter of the VEGP EAB is adequately posted with "No Trespassing" signs on land and along the Savannah River, which indicate the actions to be taken in the event of emergency conditions at the plant. The applicant stated that it has complete authority to regulate any and all access and activity within the ESP EAB.

The NRC staff verified the applicant's description of exclusion area, the authority under which all activities within the exclusion area can be controlled, and the methods by which access and occupancy of the exclusion area can be controlled during normal operation and in the event of an emergency situation and concluded that the applicant has the required authority to control activities within the designated exclusion area.

The NRC staff verified for consistency the EAB the applicant considered for the radiological consequence evaluations in Chapters 15 and 13.3 of the SSAR.

The applicant stated that two facilities within the EAB have authorized activities unrelated to nuclear plant operations. These are the visitor's center and the GPC combustion turbine plant, Plant Wilson. The applicant also stated that the exclusion area outside the controlled area fence, including along the Savannah River, will be posted and closed to persons who have not received permission to enter the property.

The applicant stated that access to the visitor's center is controlled by security at the pavilion on the entrance road to the plant. Normally, only a few administrative personnel are located at the visitor's center, and the number of visitors at the center is minimal. In the event of emergency conditions at the plant, the emergency plan for the proposed Units 3 and 4 provides for notification of visitors to the center concerning the proper actions to be taken and evacuation instructions.

The applicant also stated that the VEGP staff control Plant Wilson, and locked gates limit access to the facility from New River Road. The emergency plan for the proposed Units 3 and 4 also provides for notification and evacuation of VEGP personnel at Plant Wilson. In addition, the applicant stated that SNC normally will not control passage or use of the Savannah River along the EAB. "No Trespassing" signs are posted near the river indicating the actions to be taken in the event of emergency conditions at the plant.

The NRC staff has evaluated and verified in Section 13.3 of this SER, the emergency plans and detailed information on the activities in the EAB as described above and in SSAR Chapter 13.3 to ensure that proper plans and procedures are in place. The NRC staff concludes that the specified activities unrelated to operation of a nuclear plant or plants that might be constructed on the proposed site within the exclusion area are acceptable.

2.1.2.4 Conclusion

As set forth above, the applicant appropriately described the exclusion area, the authority under which all activities within the exclusion area can be controlled, and the methods by which access and occupancy of the exclusion area can be controlled during normal operation and in the event of an emergency situation. In addition, the applicant has the required authority to control activities within the designated exclusion area, including the exclusion and removal of persons and property, and has established acceptable methods for control of the designated exclusion area. Therefore, the NRC staff concludes that the applicant's exclusion area is acceptable and meets the requirements of 10 CFR Part 100.

2.1.3 Population Distribution

2.1.3.1 Introduction

This section addresses the information provided by the applicant concerning the estimated population distribution surrounding the proposed ESP site up to a 50-mile radius, based on the year 2000 census. Data concerning the resident population distribution within the LPZ, the nearest population center, and population densities up to a 20-mile radius from the proposed site are provided by the applicant. The estimated transient population data out to 50 miles is also provided by the applicant. The cumulative population, including both the resident and transient population in 2000 within the LPZ, within 10 miles of the site, and within 50 miles from the center of the proposed ESP site is presented. The estimated population projections based on a 20-year (1980-2000) growth rate are also presented for the years 2010, 2020, 2030, 2040, and 2070. The established LPZ for the proposed Units 3 and 4 is the same as the LPZ for the existing VEGP, Units 1 and 2, falling within a 2-mile radius of the midpoint between the Units 1 and 2 containment buildings.

2.1.3.2 Regulatory Basis

The acceptance criteria for population distribution are based on the relevant requirements of 10 CFR 50.34, "Contents of Applications: Technical Information;" 10 CFR 52.17; and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the site location and area description:

- 10 CFR 52.17(a)(1)(ix) , insofar as it establishes the dose limits at the EAB and LPZ resulting from potential reactor accidents, as it relates to the requirements of 10 CFR 100.21(c).

- 10 CFR 52.17, insofar as it requires each applicant to provide a description of the existing and projected future population profile of the area surrounding the site.

- 10 CFR Part 100, insofar as it establishes the following requirements with respect to population.

    - 10 CFR 100.20(a), as it relates to population distribution and population density.

    - 10 CFR 100.21(a), which states that every site must have an exclusion area and an LPZ, as defined in 10 CFR 100.3.

- 10 CFR 100.21(b), which states that the population center distance, as defined in 10 CFR 100.3, must be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ.

- 10 CFR 100.3, which defines exclusion area, LPZ, and population center distance.

RS-002, Section 2.1.3, specifies that an applicant has submitted adequate information if it satisfies the following criteria:

- Either there are no residents in the exclusion area, or if so, such residents 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 (as defined in 10 CFR 100.3) is at least one and one third times the distance from the reactor to the outer boundary of the LPZ.

- The population center distance is acceptable if there are no likely concentrations of greater than 25,000 people over the lifetime of a nuclear power plant or plants of specified type that might be constructed on the proposed site (plus the term of the ESP) closer than the distance designated by the applicant as the population center distance.

- The boundary of the population center shall 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 (a) they contain population data for the latest census, projected year(s) of startup of a nuclear power plant or plants of specified type 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; (b) they describe the methodology and sources used to obtain the population data, including the projections; (c) they include information on transient populations in the site vicinity; and (d) the population data in the site vicinity, including projections, are verified to be reasonable by other means such as U.S. Census publications, publications from State and local governments, and other independent projections.

- If the population density at the ESP stage exceeds the guidelines given in Position C.4 of Regulatory Guide (RG) 4.7 “General Site Suitability Criteria for Nuclear Power Stations,” Revision 2, issued April 1998, special attention to the consideration of alternative sites with lower population densities is necessary. A site that exceeds the population density guidelines of 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.

Position C.4 of RG 4.7 states that, preferably, a reactor would be located so that, at the time of initial site approval and within about 5 years thereafter, the population density, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), does not exceed 500 persons per square mile.

In addition to identifying specific acceptance criteria to meet the relevant requirements, RS-002 also indicates the NRC staff review of population distribution typically involves reviewing the following:

- data about the population in the site vicinity
- the population in the exclusion area
- the LPZ to determine whether appropriate protective measures could be taken on behalf of the populace in that zone in the event of a serious accident
- the nearest boundary of the closest population center containing 25,000 or more residents to determine whether this boundary is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ
- the population density in the site vicinity, including weighted transient population at the time of initial site approval and within 5 years thereafter, to determine whether it exceeds 500 persons per square mile averaged over any radial distance out to 20 miles

2.1.3.3 Technical Evaluation

Following the procedures described in RS-002, Section 2.1.3, the NRC staff reviewed SSAR Chapter 2.1.3 regarding population distribution, as well as the applicant's responses to RAIs 2.1.3-1 through 2.1.3-6.

The NRC staff notes that there are no residents in the exclusion area.

In SSAR Chapter 2.1.3, the applicant estimated and provided the population distribution surrounding the ESP site, up to a 50-mile radius, based on the 2000 census. In this section, the applicant provided the resident population distribution within the LPZ, the nearest population center, and population densities up to a 20-mile radius from the site.

The NRC staff reviewed the population data presented by the applicant in the 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 described in Section 2.1.3.2 of this SER. The NRC 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 NRC staff also reviewed whether appropriate protective measures could be taken on behalf of the enclosed populace within the EPZ, which encompasses the LPZ, in the event of a serious accident.

The NRC staff obtained the 1980 and 2000 U.S. Census Bureau (USCB) population data for the 16 counties in Georgia and the 12 counties in South Carolina that are within a 50-mile radius of the center of the ESP site. By accounting the percentage of each county falling within the 50-mile radius, the NRC staff was able to estimate the 2000 population within the 50-mile radius. The NRC staff also estimated the 1980 population within a 50-mile radius using the same approach. As a confirmatory check, the NRC staff compared the applicant's

2000 population data against the NRC staff's estimated 2000 population data. The NRC staff found that the staff's estimate was within 2 percent of the data that the applicant presented in the SSAR.

The NRC staff also reviewed the projected population data provided by the applicant. The NRC staff reviewed information pertaining to the cumulative populations, including the weighted transient populations, for the years 2010, 2020, 2030, 2040, and 2070. The population projections have been verified for consistency with the population projections presented in Section 13.3 of this SER as part of emergency planning and preparedness. The NRC staff also made confirmatory population projection estimates using annualized growth rates calculated for each county within 50 miles of the site based on data from the USCB Web site. The NRC staff-estimated population projections are slightly higher than the applicant's estimated projections, which may be because of the NRC staff's application of growth rate on a county basis, rather than on a census-block basis within each county. Therefore, the NRC staff deems the applicant's methodology for estimating population projections appropriate, reasonable, and acceptable. If the NRC staff were to approve and issue an ESP in 2010 (assuming a combined operating license (COL) application is submitted at the end of the ESP-approved period of 20 years), with a projected startup of new units in 2030 and an operational period of 40 years, the projected year for end of plant life is 2070. Accordingly, the NRC staff finds that the applicant's projected population data set covers an appropriate number of years and is reasonable.

The NRC staff reviewed the applicant's transient population data. The transient population within a 10-mile radius includes 200 hunters and fishermen at recreational areas along the Savannah River. The transient population between 10 and 50 miles from the VEGP site includes workers at and occupants of colleges, schools, hospitals, a military base, and the SRS. In addition, the thousands of people who visit Augusta and the surrounding area annually during the week of the Masters Tournament and for other annual events are included. Based on this information, the NRC staff finds that the applicant's estimate of the transient population to be reasonable.

The applicant estimated and provided the cumulative population, including a transient population of 50 hunters and fishermen, in the LPZ. No towns, recreational facilities, hospitals, schools, prisons, or beaches are within the LPZ, and River Road is the only road within the LPZ. The applicant evaluated representative design-basis accidents (DBAs) in Chapter 15 of the SSAR, and the NRC staff independently verified the applicant's evaluation in Chapter 15 of this SER to demonstrate that the radiological consequences of design-basis reactor accidents at the proposed ESP site are within the dose limits set forth in 10 CFR 52.17(a)(1)(ix).

The distance to Augusta, Georgia, the nearest population center, is about 26 miles and is well in excess of 2.67 miles (one and one third times the distance of 2 miles from the reactor to the outer boundary of the LPZ). In addition, the applicant, as well as the NRC staff, did not identify any other population center closer than the population center distance, as identified above. Therefore, the NRC staff concludes that the proposed site meets the population center distance requirement, as defined in 10 CFR Part 100, Subpart B. The NRC staff has also determined and concluded, based on the projected cumulative resident and transient population within 10 miles of the site, during the lifetime of plant, that there is no likelihood of a future population center of 25,000 people or more within 2.7 miles of the ESP site.

The NRC staff evaluated the site against the criterion in Regulatory Position C.4 of RG 4.7, Revision 2, regarding whether it is necessary to consider alternative sites with lower population densities. The evaluation included the review and verification of whether the population densities in the vicinity of the proposed site, including the weighted transient population, projected at the time of initial site approval and 5 years thereafter, would exceed the criteria of 500 persons per square mile averaged over a radial distance of 20 miles (cumulative population at a distance divided by the area at that distance). The NRC staff has independently determined population density for the lifetime of the plant based on the NRC staff's confirmatory population projection estimates discussed earlier, and has found that the population densities for the proposed site would be well below this criterion. Therefore, the NRC staff concludes that the site conforms to Regulatory Position C.4 in RG 4.7, Revision 2. Based on the applicant's projected population data and population densities, assuming initial approval of the ESP in 2010, construction beginning at the end of the term of 20 years of the ESP approval, and a plant operating life of 40 years, the NRC staff finds that the site also meets the guidance of RS-002 regarding population densities over the lifetime of facilities that might be constructed on the site. Specifically, the population density over that period is not expected to exceed 500 persons per square mile averaged out to 20 miles from the site.

Based on the information provided by the applicant in SSAR Chapter 13.3, the applicant's response to RAI 2.1.3-3, and the NRC staff's conclusions discussed in Section 13.3 of this SER, the NRC staff finds that appropriate protective measures could be taken on behalf of the populace in the LPZ in the event of a serious accident. Therefore, the NRC staff finds the applicant's response to be satisfactory.

2.1.3.4 Conclusion

As set forth above, the applicant provided an acceptable description of current and projected population densities in and around the site. The NRC staff concludes that the population data provided are acceptable and meet the applicable requirements of 10 CFR Part 52 and 10 CFR Part 100, Subpart B. This conclusion is based on the applicant having provided an acceptable description and safety assessment of the site, which contain present and projected population densities that are within the guidelines of Regulatory Position C.4 of RG 4.7. In addition, the applicant properly specified the LPZ and population center distance. The NRC staff has reviewed and confirmed, by comparison with independently obtained population data, the applicant's estimates of the present and projected populations surrounding the site, including transients. The applicant also evaluated the radiological consequences of DBAs at the proposed site in SSAR Chapter 15 and provided reasonable assurance that appropriate protective measures can be taken within the LPZ to protect the population in the event of a radiological emergency.

2.2 Nearby Industrial, Transportation, and Military Facilities and Descriptions

2.2.1-2.2.2 Identification of Potential Hazards in Site Vicinity

2.2.1.1-2.2.2.1 Introduction

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 in its vicinity. Such facilities and routes include air, ground, and water traffic; pipelines; and fixed manufacturing, processing; and storage facilities. The purpose of the review is to verify that the applicant has submitted sufficient information concerning the presence and magnitude of potential external hazards, so that the reviews and evaluations described in Sections 2.2.3 and 3.5.1.6 can be performed. Section 2.2 of the SSAR covers information concerning the industrial, transportation, and military facilities in the vicinity of the proposed ESP site. The NRC staff prepared Sections 2.2.3 and 3.5.1.6 of this SER using information presented in SSAR, Section 2.2, in accordance with the procedures described in RS-002.

2.2.1.2- 2.2.2.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17, with respect to the requirement that the application contain information on the location and description of any nearby industrial, military, or transportation facilities and routes.

- 10 CFR 100.20(b), which requires that the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, military and chemical facilities) be evaluated to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.

- 10 CFR 100.21(e), which requires that the potential hazards associated with nearby transportation routes, industrial, and military facilities be evaluated and site parameters established such that potential hazards from such routes and facilities will not pose undue risk to the type of facility proposed to be located at the site.

RS-002, Section 2.2.1-2.2.2, specifies that an applicant has submitted adequate information to meet the above requirements, if the submitted information satisfies the following criteria:

- data in the site safety assessment adequately describes the locations and distances of industrial, military, and transportation facilities in the vicinity of the plant, a nuclear power plant or plants of specified type that might be constructed on the proposed site, and are in agreement with data obtained from other sources, when available.
- descriptions of the nature and extent of activities conducted at the site and nearby facilities, including the products and materials likely to be processed, stored, used, or transported, are adequate to permit identification of possible hazards.

- sufficient statistical data with respect to hazardous materials are provided to establish a basis for evaluating the potential hazard to a nuclear power plant or plants of specified type that may be constructed on the proposed site.

2.2.1.3-2.2.2.3 Technical Evaluation

Following the procedures detailed in RS-002, Sections 2.2.1-2.2.2, the NRC staff evaluated the potential for man-made hazards in the vicinity of the proposed ESP site by reviewing

- information the applicant provided in Section 2.2.1-2.2.2 of the SSAR,
- information the NRC staff obtained during a visit to the proposed ESP site and its surrounding vicinity,
- other publicly available reference material, such as U.S. Geological Survey (USGS) topographic maps, geographic information system (GIS) information, road and railroad maps, and electric transmission lines and natural gas pipeline maps, and
- information the NRC staff collected independently from such sources as state and local authorities.

In SSAR Chapters 2.2.1 and 2.2.2, the applicant identified and described the following facilities and routes, within a 5-mile radius of the existing VEGP site, which may generate potential hazards or which may engage in potentially hazardous activities:

- Georgia State Highway 23,
- the CSX Railroad,
- Plant Wilson, a combustion turbine electrical plant owned by the GPC,
- the SRS,
- a coal-fired steam electrical plant operated by Washington Savannah River Company in the D-Area of the SRS,
- VEGP Units 1 and 2,
- the Chem-Nuclear Systems radioactive disposal site (18 miles east of the proposed site) in South Carolina, and
- the Unitech Service Group Nuclear Laundry Facility (21 miles east of the proposed site) in South Carolina.

The applicant included maps that show the locations of these facilities and routes (along with airways and military operations) in comparison to the proposed ESP site (SSAR Figures 2.2.2 and 2.2.3). The applicant presented descriptions of these facilities and routes in SSAR Chapter 2.2.2.

In SSAR Chapter 2.2.2.3, the applicant described the roads within a 5-mile radius of the site. Segments of Georgia State Highways 23, 80, and 56 Spur are located within a 5-mile radius. The nearest highway with commercial traffic is Georgia State Highway 23. State Highway 23 serves as a major link between Augusta and Savannah. The heaviest truck traffic along State Highway 23, near the proposed site, consists primarily of timber and wood products and materials. In SSAR Table 2.2-3, the applicant provided available statistical data on personal injury accidents on these roads between 1999 and 2003.

SSAR Chapter 2.2.2.4 states that the CSX Railroad in South Carolina is the nearest railroad with commercial traffic and is approximately 4.5 miles northeast of the VEGP site. The CSX Railroad runs through and services the SRS. The railroad carries a number of major chemical substances, including cyclohexane, anhydrous ammonia, carbon monoxide, molten sulfur, and elevated temperature material liquids (ETMLs).

(Two local Norfolk Southern rail lines exist in Burke County, operated by Norfolk Southern, one through Waynesboro and one through Midville. These rail lines are approximately 12 miles west of the VEGP site.)

Plant Wilson is located approximately 6000 feet east-southeast from the proposed VEGP, Units 3 and 4. This combustion turbine plant is a GPC electrical peaking power station. The plant consists of six combustion turbines with a total rated capacity of 351.6 MW. The storage capacity of the fuel oil storage tanks at Plant Wilson is 9,000,000 gallons.

The SRS borders the Savannah River for approximately 17 miles opposite the VEGP site. It occupies an approximately circular area 310 square miles (198, 344 acres), encompassing parts of Aiken, Barnwell, and Allendale Counties in South Carolina. The SRS is owned by DOE and operated by an integrated team led by the Washington Savannah River Company. The site is a closed Government reservation except for through traffic on South Carolina Highway 125 and the CSX railroad. The current and near-term operating SRS facilities are engaged in various activities. The SRS processes and stores nuclear materials in support of the national defense and the U.S. non-proliferation efforts. This site also develops and deploys technologies to improve the environment and treat nuclear and hazardous wastes left from the Cold War. Because the SRS facilities are distant (i.e., more than 17 miles) from the proposed units, they are not considered to pose a viable threat to the safe operation of the proposed units.

Washington Savannah River Company operates the 70 megawatt coal-fired steam and electrical plant in the D-Area of SRS. This plant has been in operation since 1952 and supplies steam and electricity to several facilities throughout the SRS.

Chem-Nuclear Systems developed, constructed, and currently operates the largest radioactive waste disposal site in the country, near Barnwell, South Carolina. In addition, Unitech Services Nuclear laundry facility is located in the Barnwell County Industrial Park and provides radiological laundry and respirator services. However, these facilities are not considered to be an external hazard to the proposed nuclear units because of their distance (18 and 21 miles, respectively) from the VEGP site.

The existing VEGP Units 1 and 2, are located about 3600 feet and 3900 feet respectively, west of the Savannah River. Besides the activities at Plant Wilson, the only other activities unrelated to plant operations that may occur within the exclusion area are those associated with the operation of the visitor’s center. VEGP has made arrangements to control and, if necessary, evacuate the exclusion area in the event of an emergency.

In SSAR Chapter 2.2.2.1, the applicant referenced the “Burke County Comprehensive Plan: 2010, Part 1,” which forecasts a relatively slow, stable population growth pattern for Burke County, indicative of the fact that nearby industries have not significantly grown. The applicant stated that currently no major development of industrial, military, or transportation facilities is projected to occur within a 25-mile radius of the VEGP site, except for the development of proposed VEGP Units 3 and 4.

The applicant also identified and described in SSAR, Chapter 2.2.2, the nature, extent, and location of any:

- mining activities,
- commercially-traversable waterways,
- airports,
- airways,
- military-operation areas and routes,
- natural gas or petroleum pipelines,
- military facilities, and
- storage tanks and chemicals found on the current VEGP site.

In SSAR Chapter 2.2.2.2, the applicant stated that no mining activities occur within 5 miles of the VEGP site.

SSAR Chapter 2.2.2.5 states that the footprint of the proposed VEGP Units 3 and 4 is located about 4850 feet southwest of the Savannah River. The small amount of water traffic on the Savannah River that does exist is primarily composed of barge-tug tows moving up and down the river channel out of the Port of Savannah. There are no locks or dams in the vicinity of the proposed plant site. In 2004, only 13 commercial vessels were recorded on the Savannah River below Augusta. Within this section of the river, a total of less than 500 tons of nonexplosive residual fuel oil was transported near or past the VEGP site. Except for the residual fuel oil, there were no flammable or potentially explosive materials transported on this portion of the Savannah River. However, in its response to the NRC staff’s RAI dated March 16, 2007, the applicant stated that fuel oil is no longer transported by barge past the VEGP site, and the barge hazard has been eliminated from additional consideration. The proposed intake structure is located approximately 1800 feet upstream of the existing VEGP Units 1 and 2 intake structures.

In SSAR Chapter 2.2.2.6.1, the applicant addressed nearby airports. There are no airports within 10 miles of the VEGP site. The closest airport, Burke County Airport, is approximately 16 miles west-southwest of the site. The average number of operations (landings and takeoffs) is about 57 per week. The closest commercial airport is the Augusta Regional Airport at Bush Field, which is located approximately 17 miles north-northwest of the VEGP site. Based on Federal Aviation Administration (FAA) information, 17 aircraft are based on the field, of which 10 are single-engine airplanes, 4 are multi-engine airplanes, and 3 are jet-engine airplanes. The average number of operations is about 91 per day. Approach and departure paths at Bush Field are not aligned with the VEGP site, and no regular air traffic patterns for Bush Field extend into the airspace over the VEGP site.

A small, un-improved grass airstrip is located immediately north of the VEGP site (north of Hancock Landing Road and west of the Savannah River). At its closest point, the airstrip is about 1.4 miles from the power block of the proposed new units. This privately owned and operated airstrip has a 1650-foot runway oriented east-west. Therefore, the takeoffs and landings are tangential to the site and oriented away from the plant. No FAA information is available for this airstrip. Informal communication with the owner and operator revealed that the airstrip is for personal use, and the associated traffic consists only of small single-engine aircraft. In addition, there is a small helicopter landing pad on the VEGP site. This facility exists for corporate use and for use in case of an emergency. The traffic associated with both of these facilities is characterized as sporadic.

In Section 2.2.2.6.2 of the SSAR, the applicant addresses airways. The applicant stated that the centerline of Airway V185 is approximately 1.5 miles west of the VEGP site. Additionally, Airway V417 is about 12 miles northeast of the VEGP site, and Airway V70 is approximately 20 miles south of the VEGP site. Because of its close proximity to the VEGP site, SSAR Chapter 3.5.1.6 evaluates hazards from air traffic along the V185 airway.

Section 2.2.2.6.3 of the SSAR describes military air training routes. The west edge of the Pointsett Military Operation Area (MOA) is about 75 miles east-northeast of the VEGP site. The east edge of the Bulldog MOAs is about 11 miles west of the VEGP site. Military aircraft in the Bulldog MOA come mainly from Shaw Air Force Base (about 32 miles east of Columbia, South Carolina) and McEntire Air National Guard Station (about 13 miles east-southeast of Columbia). Among the military training air routes, VR97-1059 is located closest to the VEGP site. The distance between the centerline of VR97-1059 and the VEGP site is about 18 miles. The maximum route width of VR97-1059 is 20 nautical miles; therefore, the width on either side of the route centerline is assumed to be 10 nautical miles (11.5 miles). The VEGP site is located more than 6 miles from the edge of this training route. The total number of military aircraft using route VR97-1059 is approximately 833 per year.

In Section 2.2.2.7 of the SSAR, the applicant addressed the existence of natural gas and petroleum pipelines nearby the VEGP site. The applicant stated that there are three natural gas pipelines within 25 miles of the VEGP site (However, none are located within 10 miles of the VEGP site):

- Pipeline 1 is located approximately 21 miles northeast of the VEGP site.
- Pipeline 2 is located approximately 19 miles southwest of the VEGP site.
- Pipeline 3 is located approximately 20 miles northwest of the VEGP site.

Section 2.2.2.8 of the SSAR describes any existing nearby military facilities. The applicant stated that no military facilities are within 5 miles of the VEGP site.

Section 2.2.2.9 of the SSAR addresses the existence of any storage tanks and chemicals currently held on the VEGP site. The list of such chemicals can be found in the SSAR on Table 2.2.5.

Based on its review of the information provided by the applicant in SSAR Chapter 2.2.1-2.2.2, as supplemented by responses to the NRC staff's RAI 2.2.2-1 and 2.2.2-2, and the information discussed above, the NRC staff did not identify any potential source of additional hazards beyond those that the applicant has identified and described.

2.2.1.4-2.2.2.4 Conclusion

As set forth above, the applicant provided information in the SSAR regarding potential site hazards in accordance with RS-002, such that compliance with the requirements of 10 CFR 52.17, 10 CFR 100.20(b) and 10 CFR 100.21(e) can be evaluated. In the SSAR, the applicant identified the facilities and reviewed the nature and extent of activities involving potentially hazardous materials on or in the vicinity of the site and identified hazards that might pose undue risk to the proposed nuclear facility. Based on the information presented in the SSAR, as well as information the NRC staff obtained independently, the NRC concludes that all potential hazards and potentially hazardous activities on and in the vicinity of the site have been identified. These potential hazards and potentially hazardous activities have been reviewed and are discussed in Sections 2.2.3 and 3.5.1.6 of this safety evaluation report (SER).

2.2.3 Evaluation of Potential Accidents

2.2.3.1 Introduction

In this section of the SER, Section 2.2.3, the NRC staff documents its review and evaluation of potential accident sequences on and in the vicinity of the proposed ESP site, such as an explosion of a flammable substance or a release of a toxic chemical. The NRC staff reviews the applicant's probability analyses of potential accident sequences involving hazardous materials or activities on the proposed ESP site and its vicinity to determine that appropriate data and analytical models have been utilized and to ensure that the calculated risks associated with potential accident sequences are sufficiently low.

2.2.3.2 Regulatory Basis

The acceptance criteria for the evaluation of potential accidents are based on meeting the relevant requirements of 10 CFR 52.17, 10 CFR 100.20 and 10 CFR 100.21, as they relate to factors considered in site evaluation. These requirements stipulate that individual and societal risk of potential plant accident sequences must be low. The NRC staff considered the following regulatory requirements in evaluating the potentiality and consequences of accident sequences:

- 10 CFR 52.17, with respect to the requirement that the application contain information on the location and description of any nearby industrial, military, or transportation facilities and routes.

- 10 CFR 100.20(b), which states that the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, military and chemical facilities) be evaluated to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.

- 10 CFR 100.21(e), which requires that the potential hazards associated with nearby transportation routes, industrial, and military facilities be evaluated and site parameters established such that potential hazards from such routes and facilities will not pose undue risk to the type of facility proposed to be located at the site.

RS-002, Section 2.2.3 specifies that an application meets the above requirements, if the application satisfies the following criteria:

- None of the identified potential accidents are design basis events. A design basis event is defined as an accident that has a probability of occurrence on the order of 10^{-7} per year (or greater) and the expected rate of radiological exposure, as a postulated consequence of the accident, is in excess of 10 CFR 100.21 exposure standards.

If any of the identified potential accidents are considered design basis events, a detailed analysis is required, for each of the accidents so categorized, of the effects of the accident on the plant's safety-related structured and components. Because of the difficulty of assigning accurate numerical values to the expected rate of unprecedented potential hazards, on the probabilistic order of 10^{-7}, the NRC staff employed its judgment as to the acceptability of the overall risk calculated for a potential accident.

To evaluate the information provided in SSAR 2.2.1-2.2.2 per the above acceptance criteria, applicant applied the NRC-endorsed analytical methodologies found in the following:

- RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 3, issued November 1978, which defines design basis events external to the nuclear plant as those accidents that have a probability of occurrence on the order of about 10^{-7} per year or greater.

- RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," issued December 2001.

- RG 1.91, "Evaluation of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plant Sites," Revision 1, issued February 1978.

When independently assessing the applicant's analysis in SSAR Chapter 2.2.3, the NRC staff applied the same above-cited analytical methodologies.

2.2.3.3 Technical Evaluation

The NRC staff reviewed the information presented in SSAR Chapter 2.2.3 of the VEGP ESP application pertaining to potential accidents, as well as the applicant's responses to RAIs 2.2.3-1 through 2.2.3-16.

The applicant analyzed postulated accidents for various types, sources and locations:

- explosions and flammable vapor clouds
- release of hazardous chemicals
- fires
- radiological hazards

The applicant reviewed the existing analysis of potential hazards to VEGP Units 1 and 2 to determine its applicability to the proposed VEGP Units 3 and 4, in evaluating the postulated releases of flammable materials and toxic gases from transportation accidents or materials stored at industrial facilities within a 5-mile radius of the VEGP site. In addition, the applicant evaluated new chemicals identified for either VEGP Units 1 and 2, or VEGP Units 3 and 4, to determine their impact on the proposed VEGP Units 3 and 4. The NRC staff has reviewed the applicant's analyses and has made independent confirmatory checks and calculations to determine the applicant's conformance to the requirements and the applicant's reasonableness and approach in assessing these potential hazards.

2.2.3.3.1 Explosions and Flammable Vapor Clouds

Truck Traffic

The applicant analyzed the potential consequences of explosions postulated to occur on transportation routes near the proposed ESP site using the methodology given in RG 1.91. RG 1.91 details a method for determining distances from critical plant structures to a railway, highway, or navigable waterway beyond which any explosion that might occur on these transportation routes is not likely to have an adverse effect on plant operation or to prevent a safe shutdown. Under those conditions, a detailed review of the transport of explosives on those transportation routes would not be required. The RG 1.91 methodology is based on a level of peak positive incident over-pressure, below which no significant damage would be expected to plant structures. The NRC staff, in RG 1.91, conservatively chose 1 psi for this level. The calculation to determine the minimum safe distance at the chosen peak positive incident over-pressure (1 psi) is as follows:

R > kW 1/3, whereas R is the distance in feet from an exploding charge of W pounds of trinitrotoluene (TNT). When R is in feet and W is in pounds, k = 45. When R is in meters and W is in kilograms, k = 18.

The concept of TNT equivalence (i.e, finding the mass of substance in question that will produce the same blast effect as a unit mass of TNT) has long been used in establishing safe separation distances for solid explosives.

Based on the previous analysis done for VEGP Units 1 and 2, the applicant identified six chemicals as potential hazards when transported by truck. The applicant used the U.S. Environmental Protection Agency (EPA) Tier II reports for Burke and Richmond Counties in Georgia, along with the EPA Landview database to confirm and/or update the list of chemicals for the analysis. The applicant also performed a traffic corridor evaluation, which showed that even fewer chemicals pass by the site now than was previously assumed in the analysis for Units 1 and 2. The applicant concluded that the only hazardous chemicals likely transported by truck in the vicinity of the site are gasoline and diesel/fuel oil.

Georgia State Highway 23 is the closest ground route to the VEGP site, by which the previously-identified chemicals are being transported by truck. The nearest point from State Highway 23 to the center of VEGP Units 1 and 2, is 4.7 miles and to the center of VEGP, Units 3 and 4, 4.2 miles. The applicant concluded that, due to the distance between Highway 23 and the proposed ESP site, any explosions induced by flammable clouds of these chemicals will not adversely affect the safe operation of the proposed units. The NRC staff independently confirmed these findings using the methodology described in RG 1.91. For an explosion from a flammable cloud, the maximum distance that would result in a peak incident blast pressure of 1 psi is conservatively determined to be 2479 feet from the road.

For an 8500-gallon gasoline truck carrying a TNT equivalent of 56,165 pounds, the critical distance would be 1723 feet from the explosion point. Since the above calculated critical distances of 2479 feet and 1723 feet for the two types of explosions discussed, are much less than 4.2 miles, the distance between Highway 23 (at its closest point) and proposed

Units 3 and 4, the NRC staff concludes that the potential explosion of a gasoline truck would not adversely impact the safe operation of the plant.

In addition to the above-discussed highway transit, gasoline is delivered to the site by tank wagon containing a maximum volume of 4000 gallons. For an explosion from a 4000 gallon truck, the NRC staff calculated the critical distance (beyond which the blast pressure would be less than 1 psi) to be 1340 feet. For an explosion from a flammable cloud in the equivalent circumstances, the critical distance is 1658 feet. The closest distance from the site delivery route to the power block circle is approximately 2000 feet. That distance is greater than the above calculated critical distances. Therefore, the NRC staff concludes that the potential explosion of a gasoline delivery tank truck would not have an adverse impact on the safety of the plant operation. Because of its higher quantity and TNT equivalent and because it is more volatile than diesel fuel, gasoline impacts are considered bounding for the truck-borne hazards evaluation.

Pipelines and Mining Facilities

No natural gas pipeline or mining facilities are located within 10 miles of the VEGP site. Based on RG 1.70, because there are no pipelines or mining activities within 5 miles of the VEGP site, the applicant did not evaluate potential hazards from this source.

Waterway Traffic

The potential impact of barge traffic was analyzed for VEGP, Units 1 and 2. However, the current use of the Savannah River and the lack of commercial facilities and barge slips/docks upstream of the plant indicate that there is no current or projected barge traffic on the Savannah River past the VEGP site. Because the Savannah River is not being used to transport chemicals by barge, a hazard evaluation was not required.

Railroad Traffic

The nearest railroad to the VEGP site is the CSX Railroad, which is approximately 4.5 miles northeast of the center point of VEGP, Units 1 and 2. Based on the information obtained from CSX, the top four U.S. Department of Transportation (DOT) qualified hazardous chemicals are cyclohexane (64 percent), anhydrous ammonia (9 percent), carbon monoxide (3 percent), and ETML (3 percent). Because cyclohexane is both flammable and toxic, it was analyzed in detail to evaluate the potential for an explosion hazard from a railcar and from a flammable vapor cloud.

For the explosion from a railcar, the equivalent TNT mass of 117.5 pounds, based on an Upper Flammability Limit (UFL) of 8.34 percent of cyclohexane at the point of release, would produce a peak overpressure of 1 psi at a distance of 220 feet from the railroad. For an explosion from a flammable vapor cloud, the TNT-equivalent maximum distance beyond which the blast pressure would be less than 1 psi is calculated to be 1026 feet from the railcar. The separation distance between the railroad and the proposed units is 4.5 miles, which is far greater than the above calculated critical distances. Even for a maximum railcar load of 132,000 pounds, the critical distance that could cause a peak overpressure of 1 psi to safety-related structures from an explosion or flammable vapor-cloud-induced explosion is calculated to be 2293 ft. Since the amounts of chemicals transported are much lower than the maximum railcar load, and that the actual distance (approximately 4.5 miles) between the railroad and the VEGP site is greater than the critical distance of 2293 ft, the NRC staff has determined that if such an explosion were to occur, it would not pose a hazard to safety-related structures at the plant.

2.2.3.3.2 Release of Hazardous Chemicals

Using the methodology found in RG 1.78, the applicant analyzed the potential impacts of hazardous chemical releases on control room habitability. RG 1.78 provides guidance on the detailed evaluation of such release events and describes assumptions and criteria for screening out release events that need not be considered in the evaluation of control room habitability. RG 1.78 provides that chemicals stored or situated at distances greater than 5 miles from the plant need not be considered because, if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that either toxic limits will never be reached or there would be sufficient time for the control room operators to take appropriate action. In addition, the probability of a plume remaining within a given sector for a long period of time is small. Likewise, if hazardous chemicals are known or projected to be shipped by rail, water, or road routes outside a 5-mile radius of nuclear power plant, the shipments need not be considered further for evaluation.

As another screening criteria, for stationary sources of hazardous chemicals within the 5-mile radius of a nuclear power plant, a detailed analysis need only be performed if the hazardous chemicals are in quantities greater than the limits provided in RG 1.78 for a toxicity limit and stable meteorological conditions. Mobile sources, within the 5-mile radius, need not be considered further if the total shipment frequency for all hazardous chemicals (i.e., all hazardous chemicals considered as a singular cargo category without further distinction of the nature of those chemicals) does not exceed the specified number by traffic type (10 shipments per year for truck traffic, 30 per year rail traffic, or 50 per year for barge traffic - these frequencies are based on transportation accident statistics, conditional spill probability given an accident, and a limiting criterion for the number of spills or releases). Frequent shipments (i.e., shipments exceeding the specified number by traffic type) do not need to be considered in detailed analysis if the quantity of hazardous chemicals is less than the quantity provided in RG 1.78 (as adjusted for the appropriate toxicity limit, meteorology, and control room air exchange rate).

Since there are no manufacturing plants, chemical plants, storage facilities, or oil or gas pipelines are located within 5 miles of the VEGP site, only the following potential scenarios were evaluated:

<u>Release of Hazardous Chemicals from a Transportation Accident</u>

The applicant concluded that the only hazardous chemicals likely to be transported by truck in the vicinity of the VEGP site are gasoline and diesel/fuel oil. Therefore, the control room habitability analysis conducted by the applicant only included those two chemicals. Because gasoline is more volatile than diesel/fuel oil, the applicant applied the flammable properties of gasoline for the purposes of the analysis. Per the analytical methodology in RG 1.78, the calculated toxic vapor concentration of gasoline at the control room resulting from a release of gasoline from a 8500 gallon truck on Georgia State Highway 23 (4.2 miles from VEGP, Units 3 and 4) is 34.9 parts per million, and from a 4000 gallon tank wagon during delivery (2000 feet from the center of the power block for Units 3 and 4) is 95.1 parts per million. The calculated vapor concentrations are much smaller than the toxicity limit of 300 parts per million (American Conference of Governmental Industrial Hygienists Threshold Limit Value) and, therefore, the applicant asserted that no adverse impact on control room habitability from the accidental release of gasoline or diesel/fuel oil is expected. The NRC staff has reviewed and verified the applicant's information through independent analysis. The NRC staff has found the applicant's methodology to be acceptable and the results and conclusions to be reasonable. Based on the above information, the NRC staff concludes that the accidental release of gasoline or diesel/fuel oil by truck transportation would not cause concentrations of these chemicals to affect control room habitability at or above the corresponding toxicity limits.

The information obtained by the applicant from CSX revealed that the railroad carried four major hazardous chemicals in 2005: cyclohexane, anhydrous ammonia, carbon monoxide, and ETMLs. Accidental spills of carbon monoxide or ETMLs are not expected to create a vapor hazard for the site, as they are molten nonhazardous materials. Therefore, evaluations were performed for cyclohexane and anhydrous ammonia. Assuming a railcar capacity of 67 tons of cyclohexane (based on RG 1.91 limit of 132,000 pounds for a railcar load) and 26 tons of anhydrous ammonia (analyzed previously for VEGP Units 1 and 2), the vapor concentrations at the control room, which is approximately 4.5 miles from railroad, were estimated based on stable atmospheric conditions using a windspeed of 1 meter per second (m/s). The calculated vapor concentration of 34.3 parts per million for cyclohexane is much less than the toxicity limit of 1300 parts per million, and the calculated concentration of 112 parts per million for anhydrous ammonia is also less than the toxicity limit of 300 parts per million. The NRC staff reviewed the applicant's calculations of the concentrations of these chemicals and conducted independent confirmatory analyses using the methodology provided in RG 1.78. In light of the above evaluation and analyses, the NRC staff finds that the applicant's approach and calculations are reasonable and its conclusions acceptable. Based on these estimated toxic vapor concentrations for these chemicals, the NRC staff has determined that the potential hazard from these chemicals is minimal and will not affect the safe operation of the proposed units.

Potential Hazard from Major Depots or Storage Areas

The applicant stated that the only chemical storage areas within 5 miles of the VEGP site are located at the SRS and the Plant Wilson combustion turbine plant. The original analysis performed for VEGP, Units 1 and 2 discussed the storage at SRS "D-Area" (which is 4.5 miles from the center of Units 1 and 2) and of the chemicals chlorine and ammonia. Since these chemicals (or any others) are no longer used at D-Area, the analysis for VEGP Units 3 and 4 considered only the chemicals stored at Plant Wilson.

The chemicals stored at Plant Wilson (approximately 5500 feet from the new power block of Units 3 and 4) consist of three 3-million gallon tanks of fuel oil, sulfuric acid, and several other chemicals in small quantities. Because the sulfuric acid and the other chemicals are present in small quantities and have low volatility and toxicity, the applicant stated that they do not pose a potential hazard to control room habitability. Therefore, the applicant only analyzed one of the 3-million gallon fuel oil tanks, as a bounding case, for the toxic vapor concentration from potential accidental release. The applicant estimated the vapor concentration of fuel oil to be less than 50 parts per million at 5500 feet from the storage tank. Since the calculated concentration is much less than the toxicity limit of 300 parts per million, the applicant concluded that the Plant Wilson fuel oil storage tanks do not present a hazard to VEGP Units 3 and 4. The NRC staff conducted a confirmatory analysis and found that the calculated concentration is much less than the toxicity limit of 300 parts per million.

Potential Hazard from Onsite Storage Tanks

SSAR, Table 2.2-5 lists the chemicals that are stored at VEGP. Of the many chemicals listed that are stored and used on the site, only three chemicals, hydrazine, phosphoric acid, and methoxypropylamine (MPA), were evaluated by the applicant for potential hazard effects that would be bounding. Phosphoric acid and MPA are new chemicals that are being used at VEGP, Units 1 and 2. The applicant stated that the other listed chemicals were not considered for evaluation based on low volatility, low toxicity, or the relatively small quantities stored. In evaluating the control room habitability conditions, the applicant used the guidelines of NUREG-0570, "Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release," to determine the toxic concentrations of these chemicals at the control room intake.

Hydrazine is stored northeast of the VEGP Unit 1 reactor and is separated by a minimum distance of 1800 feet from Units 3 and 4. The applicant's analysis of the hydrazine for Units 1 and 2 showed that at least 2 minutes would be available between detection and the time the short-term toxicity limit (as defined in RG 1.78) would be reached. Since hydrazine storage is separated by 1800 feet for Units 3 and 4, the impact on the new units from an accidental release of hydrazine would be less than the impact on the existing VEGP Units 1 and 2. Due to the impact on control room habitability, these calculations will be evaluated at the time of the COL application. This is **COL Action Item 2.2-1**. When addressing this COL action item, Section 6.4 of the FSAR should also be taken into consideration.

Phosphoric acid is stored in a 5050-gallon tank at a distance of approximately 3200 feet from the air intake for the Unit 3 control room. The applicant calculated phosphoric acid concentration outside the control room intake under stable conditions (F stability) with 1 m/s windspeed to be 94 microgram/m^3, much lower than the 8-hour threshold limit value of 1 milligram/m^3 and the short-term exposure limit of 3 milligram/m^3.

The applicant had previously evaluated MPA for VEGP Units 1 and 2. The applicant calculated the MPA release concentration based on a 400-gallon release at 59 meters from the control room intake under atmospheric conditions of 2.5 m/s wind speed and G stability. Using these parameters, the applicant calculated the MPA concentration for VEGP Units 1 and 2 to be 1.5 parts per million, which is much lower than the short term exposure limit of 15 parts per million. Since VEGP Units 3 and 4 would be farther away from the MPA release point than VEGP Units 1 and 2, the MPA concentration at the new control room intake is expected to be lower than that calculated for VEGP Units 1 and 2.

SSAR Table 2.2-6 lists the chemicals that will be used at Units 3 and 4. However, the applicant did not provide the quantity of chemicals. Potential toxic concentrations of these chemicals based on their volatility, toxicity, and quantity, including their impact on control room habitability, will be evaluated at the time of the COL application. This is **COL Action Item 2.2-2**. When addressing this COL action item, Section 6.4 of the FSAR should also be taken into consideration.

The NRC staff used screening models (ALOHA, 2007; HPAC, 2005) to perform confirmatory analyses to independently determine the toxic concentrations of the above discussed chemicals. The NRC staff's estimated concentrations are comparable to those calculated by the applicant. Based on the NRC staff's confirmatory checks, the staff concludes that the applicant's assumptions, and its approach in determining the toxic concentrations of these chemicals at the control room intake, are reasonable and acceptable. Therefore, the NRC staff agrees with the applicant's conclusion that the control room will remain habitable for most release scenarios without any operator action. Furthermore, the applicant demonstrated that in the hydrazine release scenario, control room operators will have sufficient time to take emergency action (e.g., donning emergency breathing apparatus).

2.2.3.3.3 Fires

The preceding sections addressed the potential fire hazards associated with transportation accidents, industrial storage facilities, and onsite storage. The applicant considered the fire hazard from a forest fire resulting in release of potentially toxic chemicals CO, NO2, and CH4, and determined that such a scenario would produce only negligible concentrations outside the control room air intakes. In addition, because of the long distances separating the tree line from the control room, the NRC staff finds that there would be no adverse heat impact in the form of heat flux from the forest fire.

2.2.3.4 Radiological Hazards

Radiation monitoring of the main control room environment is provided by the radiation monitoring system. The habitability systems are capable of maintaining the main control room environment suitable for prolonged occupancy throughout the duration of postulated accidents that require protection from external fire, smoke, and airborne activity. In addition, safety related SSCs have been designed to withstand the efforts of radiological events and consequential releases. However, this site-specific information would be reviewed in Chapters 11 and 15 of a COL application.

2.2.3.5 Conclusion

The NRC staff has reviewed the applicant's potential accidents analysis using the procedures set forth in RS-002, Section 2.2.3. As discussed, the NRC staff has made confirmatory checks and calculations and has verified the applicant's evaluation of potential accidents by using screening models with conservative assumptions and comparing and verifying pertinent data available in the literature.

Based on these considerations, the NRC staff concludes that the potential accidents considered by the applicant would allow for a determination of whether a plant design is adequate to accommodate potential hazards in the site vicinity. Therefore, the NRC staff finds that, with respect to the hazards associated with evaluated potential accidents, the proposed site is acceptable for the planned units and the site meets the relevant requirements of 10 CFR 52.17, 10 CFR 100.20(b), and 10 CFR 100.21(e).

2.3 <u>Meteorology</u>

To ensure that a nuclear power plant or plants can 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 on 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 Section 2.3 of the SSAR, responses to staff requests for additional information (RAIs), and generally available reference materials (as cited in applicable sections of RS-002).

2.3.1 Regional Climatology

2.3.1.1 Introduction

In Section 2.3.1 of the SSAR, the applicant presented information on the climatic conditions and regional meteorological phenomena (both the averages and extremes thereof) that could affect the design and operating bases of safety- and/or nonsafety-related SSCs for the proposed nuclear power plant. Specifically, the applicant provided the following information:

- data sources used to characterize the regional climatological conditions pertinent to the proposed site.
- a description of the general climate of the region with respect to types of air masses, synoptic features (high- and low-pressure systems), general airflow patterns (wind direction and speed), temperature and humidity, and precipitation (rain, snow, and sleet).
- frequencies and descriptions of severe weather phenomena that have affected the proposed site, including extreme wind, tornadoes, tropical cyclones, precipitation extremes, winter precipitation (hail, snowstorms, and ice storms), and thunderstorms (including lightning).
- a justification as to why the identification of meteorological conditions associated with the ultimate heat sink (UHS) maximum evaporation and drift loss of water and minimum water cooling is not necessary for a description of design-basis dry- and wet-bulb temperatures for the proposed site.
- a description of design-basis dry- and wet-bulb temperatures for the proposed site.
- the potentiality for restrictive air dispersion conditions and high air pollution at the proposed site.

Based on the above information, the applicant provided a table, SSAR Table 1-1, of proposed site characteristics. Site characteristics are the actual physical, environmental, and demographic features of a site and are used to verify the suitability of a proposed plant design for a site. The following are climatic site characteristics the applicant proposed to define the site:

- the maximum winter precipitation load (i.e., 100-year snowpack and 48-hour probable maximum winter precipitation (PMWP)) on the roofs of safety-related structures.

- tornado parameters, including maximum wind speed, maximum rotational and translational wind speed, the radius of maximum rotational wind speed, the maximum pressure drop, and the maximum rate of pressure drop.

- the 100-year return period straight-line (basic) wind speed.

- ambient air temperature and humidity extremes, including maximum dry-bulb (2-percent and 0.4-percent annual exceedance with concurrent mean wet-bulb temperatures; 100-year return period); minimum dry-bulb (99-percent and 99.6-percent annual exceedance; 100-year return period); and maximum wet-bulb (0.4-percent annual exceedance; 100-year return period).

- The site temperature basis for the AP1000, including the maximum safety dry-bulb temperature and coincident wet-bulb temperature; maximum safety noncoincident wet-bulb temperature; maximum normal dry-bulb temperature and coincident wet-bulb temperature; and maximum normal noncoincident wet-bulb temperature.

2.3.1.2 Regulatory Basis

The acceptance criteria for identifying regional climatological and meteorological information are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The staff considered the following regulatory requirements in reviewing the applicant's identification of regional climatological and meteorological information:

- 10 CFR 52.17(a), which requires that the application contain a description of the seismic, meteorological, hydrological, and geological characteristics of the proposed site.

- 10 CFR 100.20(c), which requires that the meteorological characteristics of the site, necessary for safety analysis or that may have an impact on plant design, be identified and characterized as part of the NRC's review of the acceptability of a site.

- 10 CFR 100.21(d), which requires that the physical characteristics of the site, including meteorology, geology, seismology, and hydrology be evaluated and site parameters established, such that the potential threats from such physical characteristics will pose no undue risk to the type of facility proposed to be located at the site.

The climatological and meteorological information assembled in compliance with the above regulatory requirements would be necessary to determine, at the COL stage, a proposed facility's compliance with the following requirements in Appendix A of 10 CFR Part 50:

- GDC 2, which requires that structures, systems and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

- GDC 4, "Environmental and Dynamic Effects Design Bases," which requires that SSCs important to safety be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, included loss-of-coolant accidents.

An ESP applicant, though, need not demonstrate compliance with the above GDC, with respect to regional climatology.

RS-002, Section 2.3.1 specifies that an application meets the above requirements, if the application satisfies the following criteria:

- The description of the general climate of the regions should be based on standard climatic summaries compiled by the National Oceanic and Atmospheric Administration (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 the standard meteorological records from nearby representative National Weather Service (NWS), military, or other stations recognized as standard installations which have long periods on record. The applicability of these data to represent site conditions during the expected period of reactor operation should be substantiated.

- Design basis straight-line wind velocity should be based on appropriate standards, with suitable corrections for local conditions.

- UHS meteorological data, as stated in RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," should be based on long-period regional records which represent site conditions.

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

- High air pollution potential information should be based on U.S. EPA studies.

- All other meteorological and air quality data used for safety-related plant design and operating bases should be documented and substantiated.

To the extent applicable to the above-outlined acceptance criteria, the applicant applied the NRC-endorsed meteorological information selection methodologies and techniques found in the following:

- RG 1.23, "Onsite Meteorological Programs," which provides criteria for an acceptable onsite meteorological measurements program, which can be used to monitor regional meteorology site characteristics.

- RG 1.70, which describes the type of regional meteorological data that should be presented in SSAR Section 2.3.1.

- RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," which provides criteria for selecting the design-basis tornado parameters.

When independently assessing the veracity of the information presented by the applicant in SSAR Chapter 2.3.1, the NRC staff applied the same above-cited methodologies and techniques.

2.3.1.3 Technical Evaluation

The NRC staff reviewed the application, as supplemented by letters dated January 30, 2007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML070330054);

March 26, 2007 (ADAMS Accession No. ML070880685); and March 30 2007 (ADAMS Accession No. ML070940221) to verify the accuracy, completeness, and sufficiency of the information presented by the applicant regarding regional climatology. In reviewing and evaluating this information, the staff used (or relied on) none of the applicant's proposed design parameters and site interface values presented in SSAR Section 1.3.

2.3.1.3.1 Data Sources

The applicant characterized the regional climatology of the proposed VEGP site's area using data from the National Climatic Data Center (NCDC), including the NWS station in Augusta, Georgia, and from nine other nearby cooperative observer stations. Five of these cooperative observer stations are located in Georgia counties, including Burke, Jefferson, Jenkins, Richmond, and Screven. The other four stations are located in the South Carolina counties, including Aiken, Bamberg, Barnwell, and Orangeburg. The regional climatic observation stations used by the applicant are included in the list presented in SER Table 2.3.1-1.

The applicant also obtained information on mean and extreme regional climatological phenomena from a variety of sources, such as publications by the NCDC, the Air Force Combat Climatology Center (AFCCC), the American Society of Civil Engineers (ASCE), the National Oceanic and Atmospheric Administration—Coastal Services Center (NOAA-CSC), and the Southeast Regional Climate Center (SERCC).

In RAI 2.3.1-1, the NRC staff asked the applicant to explain how it selected the observation stations it used to characterize regional climatology in SSAR Section 2.3.1. The applicant responded by revising its SSAR to enumerate the following selection criteria:

- The applicant chose stations in "proximity" to the site (i.e., within the general site area, less than or equal to 50 kilometers).

- The applicant attempted to select stations surrounding the site equally in all directions, to the greatest extent possible.

- Where more than one station exists in the same general direction from the site, the applicant selected the station that recorded a more extreme value for one or more meteorological conditions or phenomena (e.g., rainfall, snowfall, temperatures).

In addition to the ten climatic stations identified by the applicant, the NRC staff reviewed data from an additional seven climatic stations. Generally, the staff used data from stations within 50 miles (80 kilometers) and with a period of record greater than 10 years. SER Table 2.3.1-1 lists the observation stations used by the staff, in addition to those used by the applicant, to evaluate the regional climatology characteristics of the site.

During a site audit conducted on December 6, 2006, the staff asked the applicant to include all applicable stations which recorded the most extreme value for a particular meteorological condition or phenomena. The applicant responded by revising its SSAR to include data from the Louisville and Bamberg observation stations.

The NRC staff also used information reported by the NWS, NCDC, NOAA-CSC, Storm Prediction Center, National Severe Storms Laboratory (NSSL), National Hurricane Center (NHC), SERCC, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Structural Engineering Institute (SEI), AFCCC, and ASCE.

2.3.1.3.2 General Climate

The applicant described the proposed VEGP site's general climate as mild with short winters. The region often experiences long periods of mild weather in the autumn and spring, coupled with long hot summers. The predominant air mass over the region is maritime tropical. In the winter, continental polar air, associated with high-pressure systems that move southeastward out of Canada, periodically affects the region. However, in general, down sloping and land modification warm the cold air that reaches the proposed site.

The regional climate is primarily influenced by the Azores high-pressure system. During the summer, the Bermuda High and the Gulf High have the strongest influence on Georgia's precipitation and temperature patterns. These circulation patterns are less defined in the transitional seasons and winter months, because of the passage of synoptic and meso-scale weather systems.

The applicant stated that monthly precipitation exhibits a cyclical pattern, with one maximum during the winter into early spring and a second maximum during late spring into summer. These two precipitation maxima are related to eastward moving low-pressure systems and thunderstorm activity, respectively. During the summer and early autumn, heavy precipitation can also be associated with tropical cyclones.

The staff agrees with the applicant's description of the general climate of the region, which is consistent with the NCDC narrative, "Annual Summary with Comparative Data for Augusta, Georgia;" the NCDC climatic data summary for Augusta shows an annual mean wind speed of 6.1 miles per hour (mi/h) and an annual prevailing wind direction from the west-southwest.

2.3.1.3.3 Severe Weather

2.3.1.3.3.1 Extreme Wind

Estimating wind loading on plant structures involves identifying the site's "basic" wind speed, which is defined by ASCE/SEI 7-02, "Minimum Design Loads for Buildings and Other Structures," as the "3-second gust speed at 33 feet (10 meters) above the ground in Exposure Category C".[6] Using linear interpolation on a plot of basic wind speeds presented in ASCE/SEI 7-02 for the portion of the United States that includes the proposed VEGP site, the applicant defined the basic wind speed for the proposed site as 97 mi/h. This value is associated with a mean recurrence interval of 50 years. Using a conversion factor listed in ASCE/SEI 7-02, the applicant derived a 100-year return period 3-second gust wind speed site characteristic value of 104 mi/h, as presented in SER Table 2.3.1-4.

Based on Section C6.0 of ASCE/SEI 7-02, 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 97 mi/h corresponds to a 100-year return period basic wind speed value of 104 mi/h. Therefore, the staff concludes that a site characteristic 3-second gust basic wind speed value of 104 mi/h is acceptable.

2.3.1.3.3.2 Tornadoes

The applicant used an approximate 55-year period of tornado reports (January 1950 through April 2005) from the NCDC to calculate the probability of a tornado strike near the proposed VEGP site. The applicant stated that 348 tornadoes have been reported to have touched down in the vicinity (i.e., within a 2-degree latitude and longitude area) of the proposed ESP site. Following the methodology presented in WASH-1300, "Technical Basis for Interim Regional Tornado Criteria," issued May 1974, the applicant used the following formula to calculate the probability that a tornado will strike a particular location during any one year period:

$$Ps = n(a/A)$$

where:

Ps = mean tornado strike probability per year
n = average number of tornadoes per year in the area being considered
a = average individual tornado area
A = total area being considered

The applicant calculated the probability of a tornado strike in the vicinity of the proposed ESP site of 774×10^{-7} per year, or, put differently, a recurrence interval of once every 12,920 years. The staff verified the applicant's probabilistic calculation, using the same tornado database, "Storm Events for Georgia and South Carolina, Tornado Event Summaries," from NCDC.

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[7] Exposure Category C is defined as open terrain with scattered obstructions, having heights generally less than 30 feet (9.1 meters). This category includes flat open country, grasslands, and all water surfaces in hurricane-prone regions.

The applicant chose the tornado site characteristics based on the proposed Revision 1 to RG 1.76 (Draft Regulatory Guide DG-1143). DG-1143 provides design basis tornado characteristics for three tornado intensity regions throughout the United States, each with a 10‑7 probability of occurrence. The proposed VEGP site is adjacent to both tornado intensity regions I and II. The applicant chose to use the more conservative design-basis tornado region (region I) and, correspondingly, proposed the following tornado site characteristics:

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

In March, 2007, revision 1 to RG 1.76 was issued. Revision 1 reconfirmed that the design-basis tornado wind speeds for new reactors should correspond to the exceedance frequency of 10‑7 per year. The design-basis tornado wind speeds presented in Revision 1 to RG 1.76 are based on the Enhanced-Fujita (EF) scale, which relates the degree of damage from a tornado to the tornado's maximum wind speed. The original versions of RG 1.76 and DG-1143 were based on the original Fujita scale. The applicant's design-basis tornado site characteristics conservatively bound those presented in Revision 1 to RG 1.76. For example, Revision 1 to RG 1.76 suggests a design-basis tornado wind speed of 230 mi/h for the proposed VEGP site, whereas the applicant chose a site characteristic design-basis wind speed of 300 mi/h.

Because the applicant's design-basis tornado site characteristics conservatively bound those presented in Revision 1 to RG 1.76, the staff concludes that the applicant has chosen acceptable tornado site characteristics. SER Table 2.3.1-4 presents the tornado site characteristics for the proposed VEGP site in the list of regional climatic site characteristics.

2.3.1.3.3.3 Tropical Cyclones

According to information presented by the applicant, during the period of time between 1851 and 2004, 102 tropical cyclones centers passed within a 100-nautical mile (185-kilometer) radius of the proposed VEGP site. The applicant used the NOAA-CSC historical tropical database to derive these results. Using the same database, the staff was able to verify the statistics presented by the applicant. SER Table 2.3.1-3 presents the storm classifications and respective frequencies of tropical cyclones passing within 100 nautical miles of the site during the 154-year period tracked by the NOAA-CSC database.

Since 1850, only nine hurricanes of category 2 strength or greater, which had sustained (i.e., 1-minute average) winds greater than 96 mi/h, have impacted the 100-nautical mile area surrounding the proposed VEGP site. This translates to a recurrence interval of 0.06 years, or one hurricane of category 2 strength or greater every 17.1 years. Six of these category 2 and 3 storms that affected the 100-nautical mile area surrounding proposed site did so before 1900. No category 2 or 3 storms have affected the region since 1959.

The strongest recorded hurricane to pass within 100 nautical miles of the site was hurricane Gracie on September 29, 1959. Hurricane Gracie had sustained wind speeds of 120 mi/h as it crossed the Atlantic coastline approximately 100 nautical miles southeast of the proposed VEGP site. The forward speed of the storm, as it crossed the coastline, was about 12 mi/h, as reported by the NHC. Based on its forward speed, hurricane Gracie would have needed to travel approximately 7 hours overland to reach the proposed VEGP site, approximately 88 miles (142 kilometers) from the coast. The storm's sustained wind speeds had weakened to 70 mi/h within 6 hours after it crossed the coastline. Assuming the storm took a direct track over the proposed VEGP site, the maximum projected sustained winds at the site would have been 70 mi/h. The Hurricane Research Division, a specialized division of NOAA, recommends multiplying sustained winds by a factor of 1.3 to obtain 3-second gust estimates. This would have resulted in a 3-second gust wind speed of approximately 91 mi/h, well below the chosen 3-second gust basic wind speed site characteristic of 104 mi/h.

Although tropical systems generally weaken significantly before impacting the proposed VEGP site, they still can cause significant amounts of rainfall. The applicant reported that tropical cyclones produced at least 12 separate 24-hour and monthly rainfall records at eight NWS cooperative observer network stations in the vicinity of the proposed site's area. The staff has independently confirmed these statistics.

2.3.1.3.3.4 Precipitation Extremes

The applicant used historical climate data from 10 nearby observing stations, as listed in SER Table 2.3.1-1, to identify precipitation extremes (rainfall and snowfall) observed near the proposed VEGP site. Based on the similarity of precipitation extremes and a real distribution of the observing stations around the site, these data can be used to adequately represent precipitation extremes that might be expected to occur at the site.

In SSAR Table 2.3-3, the applicant provided a climatic summary for each of the utilized observation stations, including the ones with the maximum 24-hour rainfall and maximum monthly rainfall. The staff independently verified each of these rainfall records, using the NCDC "Cooperative Summary of the Day—Daily Surface Data (TD 3200/3210)" and confirmed that the statistics provided by the applicant are correct.

During a site audit conducted on December 6, 2006, the staff asked why the applicant did not use as input to SSAR Table 2.3-3 the monthly rainfall value of 22.16 inches at Louisville in October 1990, as reported in the NCDC "Climatology of the United States No. 20." The applicant responded in a letter dated January 30, 2007, that this value is suspect and most likely an error. The applicant used the NCDC "Cooperative Summary of the Day" and climate summaries from SERCC to show that the actual value should be 14.34 inches. The staff agrees with the applicant that the 22.16 inches is an error and accepts the overall highest monthly total of 17.32 inches, which occurred at Springfield.

Although most of the recorded precipitation extremes were associated with the occurrence of tropical cyclones, the overall highest 24-hour rainfall total and overall highest monthly rainfall total were not. On April 16, 1969, the 24-hour rainfall record in the area surrounding the proposed site was set at the Aiken 4NE Station, when 9.68 inches fell. The overall highest monthly total of 17.32 inches occurred during June 1973 in Springfield.

According to the applicant, the disruptive effects of any winter storm accompanied by frozen precipitation in the proposed VEGP site area can be significant. However, storms that produce significant amounts of snow are infrequent. With one exception, all of the 24-hour and monthly record snowfall totals around the proposed site were associated with a storm that occurred early in February 1973. The applicant originally reported that the highest daily and monthly snowfall totals were both 17.0 inches and occurred at the Blackville station in South Carolina (Most other surrounding stations recorded similar amounts, ranging from 14.0 to 16.0 inches). The staff found larger values of 19.0 inches and 22.0 inches for the daily and monthly snowfall records near the site--these occurred in

February 1973 at Bamberg, South Carolina. During a site audit conducted on December 6, 2006, the staff asked the applicant to justify not including Bamberg as one of the cooperative observation stations considered in the SSAR. The applicant responded by adding climatic data from Bamberg to the SSAR and using data recorded by the Bamberg station to help characterize the regional climatology of the proposed VEGP site.

The staff notes that large snowfalls are very rare in the vicinity of the proposed site. At Waynesboro, the climatic observation station closest to the proposed site, maximum monthly snowfall totals from 1940 through 2006 (except for 1973) annually have ranged between 2 and 4 inches; only 5 years in the 66-year period have had months with snowfall greater than 2 inches at the Waynesboro cooperative observation site.

The staff concludes that the applicant has adequately identified precipitation extremes that might be expected to occur at or around the site. SER Table 2.3.1-2 lists the highest precipitation extremes that have occurred in the vicinity of the site.

2.3.1.3.3.5 Winter Precipitation Loads

The methodology for assessing the potential winter precipitation load on the roofs of safety-related structures considers two climate-related components, the weight of the 100-year return period ground-level snowpack, and the weight of the 48-hour PMWP. Consistent with the staff's branch position on winter precipitation loads (NRC memorandum dated March 24, 1975, from Harold R. Denton to R.R. Maccary), the winter precipitation loads included in the combination of normal live loads considered in the design of a nuclear power plant that might be constructed on a proposed ESP site 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 included in the combination of extreme live loads considered in the design of a nuclear power plant that might be constructed on a proposed ESP site 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 to justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on top of the snowpack and/or building roofs.

The applicant identified a 100-year return period ground-level snowpack value of 10-pounds-force per square foot (lbf/ft^2) for the proposed VEGP site, which was determined in accordance with ASCE/SEI 7-02. The applicant estimated the 48-hour PMWP as 28.3 inches (water equivalent) of precipitation. The applicant derived this PMWP estimate by using the guidance provided in the NOAA Hydrometeorological Report No. 53 (HMR 53), "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates—United States East of the 105th Meridian."

Between February 9 and 11, 1973, heavy snowfall impacted the proposed VEGP site. Snowfall totals recorded at most of the surrounding climatic data stations ranged from 14.0 to 17.0 inches, with the highest recorded snowfall of 22.0 inches occurring at Bamberg. The storm produced the most snowfall in the climatic period of record for the region. Precipitation records from SERCC, "Period of Record Daily Climate Summary for Bamberg, SC," indicate the amount of liquid equivalent (i.e., liquid depth if all the snow melted) was 7.79 inches for this event. An inch of liquid water is equivalent to 5.2 lbf/ft^2, and, correspondingly, 7.79 inches of liquid water yields a snowpack of 40.5 lbf/ft^2.

In RAI 2.3.1-2, the staff asked the applicant to justify the adequacy of the proposed snowpack site characteristic, 10 lbf/ft^2, in consideration of the effects of the previously-discussed February 1973 storm. The applicant responded that the liquid equivalent value from SERCC is most likely bad datum and should have been removed. The applicant also stated that Section C7, Table C7-1, of the ASCE standard specifically lists the Augusta NWS location as having a maximum observed ground snow load of 8 lbf/ft^2 over a period of 40 years. The NRC staff accepts the applicant's response, and the applicant's proposed snowpack site characteristic of 10 lbf/ft^2, because other liquid equivalent estimates from other stations for the February 9–11, 1973 event are much smaller (less than 2.40 inches for most stations). The following is a list of the total snowfall and liquid equivalent, as recorded by NCDC in its Summary of the Day publications, for several surrounding climatic stations for the February 1973 storm:

STATION	SNOWFALL	LIQUID EQUIVALENT
Augusta	14.0 inches	2.13 inches
Louisville	14.8 inches	1.55 inches
Midville	10.0 inches	1.97 inches
Millen	14.0 inches	2.30 inches
Waynesboro	14.0 inches	2.39 inches

The staff, thus, agrees with the applicant that the 7.79 inches liquid equivalent value from SERCC is most likely incorrect.

The applicant has identified the 48-hour PMWP site characteristic of 28.3 inches using data from HMR-53. The applicant determined its 48-hour PMWP site characteristic value by using linear interpolation between the 24- and 72-hour probable maximum precipitation (PMP) values for December (Figures 35 and 45 of HMR-53), which had the largest values among the winter months December–February. The value of 28.3 inches converts to an estimated weight of the 48-hour PMWP of 147 lbf/ft^2, assuming that 1 inch of liquid water is equivalent to 5.2 lbf/ft^2. Using the same data from HMR-53, the staff found that the applicant has adequately identified an appropriate estimate of the 48-hour PMWP.

SER Table 2.3.1-4 presents the staff-accepted winter precipitation site characteristics for the proposed VEGP site as part of the list of regional climatic site characteristics.

2.3.1.3.3.6 Hail, Freezing Rain, and Sleet

The following discussion on hail, freezing rain, and sleet is intended to provide 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 bases.

Hail can accompany severe thunderstorms and can be a major weather hazard, causing significant damage to crops and property. The applicant used the NOAA "Climate Atlas of the United States" to estimate that around the proposed VEGP site area, specifically to the northwest of the site, the annual mean number of days with hail of 0.75 inches or greater in diameter is approximately 1 to 2 per year. The applicant also stated that an extreme hailstorm event (i.e., hail with a diameter greater than 2.75 inches) was observed only once, on May 21, 1964, about 43 miles southeast of the proposed site.

The NCDC Storm Event Database, "Storm Events for Georgia, Query Results, Hail Event(s) Reported in Burke County, Georgia Between 01/01/1950 and 07/31/2006," reports that a total of 28 hail events with hail 0.75 inches or greater occurred in Burke County from January 1971 through May 2006. In four of those events, the hail had a diameter of 1.75 inches or greater.

The NRC staff notes that hailstorm events are point observations, which are often dependent on population density. Estimates of hail size can range widely based on the surrounding area population density and years considered. The applicant stated that Burke County can expect, on average, hail with a diameter of 0.75 inches or greater about 1 day per year and hail with a diameter of 1.0 inches or greater less than 1 day per year. The applicant also stated that the annual mean number of days reported with hail equal to or greater than 0.75 inches ranges from 1 to 2 days per year in the nearby, more populated counties of Richmond, Columbia, Aiken, and Edgefield. The annual mean number of days reported with hail equal to or greater than 1.0 inches ranges up to 1 day per year in those same counties. The staff verified the hail frequencies presented by the applicant from "The Climate Atlas of the United States." Based on the NSSL "Severe Thunderstorm Climatology, Total Threat," the staff finds that, considering data from 1980 through 1999, the total number of days per year with hail greater than 0.75 inches ranges from 2 to 4.

The applicant estimated that the highest average frequency of ice storms (i.e., sleet and freezing rain) occurs to the northeast, east, and southeast of the proposed VEGP site in South Carolina. These areas can expect an average of 3 to 5 days of freezing precipitation per year. Ice accumulations typically have a thickness of less than 1 inch.

The staff has independently confirmed and accepts the hail and ice storm frequencies provided by the applicant. The NCDC Storm Event Database, "Storm Events for Georgia, Query Results, Snow & Ice Event(s) Reported in Burke County, Georgia, Between 01/01/1950 and 07/31/2006," lists four ice events for Burke County in the period January 2002 through January 2005. "The Climate Atlas of the United States" estimates 3 to 5 days per year with freezing rain around the proposed VEGP site area. The staff notes that cold air damming events can bring cold air and an increased probability of ice storms during the winter months. In Jones, et al. (2002), the NCDC reports a 50-year return period uniform radial ice thickness of 0.75 inches because of freezing rain, with a concurrent 3-second gust wind speed of 30 mi/h for the proposed site area.

2.3.1.3.3.7 Thunderstorms

The following discussion on thunderstorms is intended to provide 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 bases.

The applicant estimated that, on average, approximately 52 days with thunderstorm occurrences happen per year in the site area. This frequency is taken from the NCDC local climatological data, annual summary with comparative data, for Augusta. The majority of thunderstorms recorded (60 percent) occurred between late spring and midsummer (i.e., from June through August). The applicant estimated that approximately 16 flashes to earth per square mile (6.2 flashes to earth per square kilometer) per year occur around the site. The staff finds this number appropriate based on similar values from "The Climate Atlas of the United States" (4.8–6 flashes to earth per square kilometer), a 5-year flash density map from Vaisala (4–8 flashes to earth per square kilometer), and a 1999 paper by G. Huffines and R.E. Orville, titled "Lightning Ground Flash Density and Thunderstorm Duration in the Continental United States: 1989-96" (3–7 flashes to earth per square kilometer). Assuming the size of the potential reactor area for the proposed Vogtle units is bounded by an area of 0.068 square miles (0.176 square kilometers), an approximate average of 1 lightning strike per year will occur in the reactor area.

2.3.1.3.4 Ultimate Heat Sink

The applicant has chosen a reactor design that does not use a cooling tower to release heat to the atmosphere following a loss-of-coolant accident. Instead, a passive containment cooling system (PCS) would provide the safety-related UHS. The applicant stated that the PCS is not significantly influenced by local weather conditions. If, at the COL or CP stage, the applicant chooses an alternative plant design that requires the use of a UHS cooling tower, the applicant will need to identify the appropriate meteorological site characteristics (i.e., maximum evaporation and drift loss and minimum water cooling conditions) used to evaluate the design of the chosen UHS cooling tower. At the time of the COL or CP, the staff will verify the design type and characteristics of the UHS. This is COL Action Item 2.3-1.

2.3.1.3.5 Temperatures

The applicant based its ambient air temperature and humidity site characteristics (e.g., the 0.4-percent, 2-percent, 99-percent, and 99.6-percent annual exceedance dry-bulb temperatures[8] and 0.4-percent annual exceedance wet-bulb temperature) on 1973–1996 Augusta data published by AFCCC in its 1999 long-term, engineering-related climatological data summaries. The values for the 0.4-percent, 2-percent, 99-percent, and 99.6-percent annual exceedance dry-bulb temperatures are 97 °F, 92 °F, 25 °F, and 21 °F, respectively. The staff performed an independent analysis for a longer period of record (1961–2006) using hourly data from Augusta, obtained from the NCDC "Integrated Surface Hourly Observations" data compilation. The staff calculated the same values as the applicant. Consequently, the staff finds the proposed site characteristics for ambient air temperature and humidity appropriate.

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8 The data presented by the applicant as minimum 1-percent and 0.4-percent annual exceedance values are referred to by the staff as 99-percent and 99.6-percent annual exceedance values throughout the SE.

The applicant based the mean coincident wet-bulb temperatures associated with the annual 2-percent and 0.4-percent exceedance dry-bulb temperatures on data in the AFCCC report "Engineering Weather Data." The staff has confirmed that the mean coincident wet-bulb temperatures of 75 °F and 76 °F associated with the 2-percent and 0.4-percent exceedance probabilities are appropriate based on values presented in the AFCCC report.

To determine the site characteristic 0.4-percent annual exceedance maximum wet-bulb temperature value, the applicant selected a value of 79 °F from the AFCCC report for Augusta based on data from 1973 through 1996. The staff evaluated Augusta wet-bulb data from 1961 through 2006 and produced the same exceedance value. Thus, the staff finds the applicant's value of 79 °F appropriate for the 0.4-percent annual exceedance maximum wet-bulb temperature site characteristic.

To calculate 100-year return maximum and minimum dry-bulb temperatures, the applicant performed linear regression using daily maximum and minimum dry-bulb temperatures from Augusta from the 30-year period between 1966 and 1995. The staff used a methodology presented in the 2001 ASHRAE Handbook ("Fundamentals") to check the applicant's 100-year return values. The ASHRAE methodology is based on the assumption that the annual maxima and minima are distributed according to the Gumbel (Type 1 Extreme Value) distribution. Based on techniques presented in Chapter 27 of the Handbook, the staff calculated 100-year return values of maximum dry-bulb temperature for Waynesboro, Augusta, and Louisville; and 100-year return values of minimum dry-bulb temperature for Waynesboro, Augusta, and Aiken. The staff included Aiken and Louisville in its analysis because those are the two observation stations where the all-time maximum (112 °F) and minimum (−4 °F) temperatures occurred in the vicinity of the proposed VEGP site. Louisville data are available for the past 77 years, and Aiken data are available for the past 94 years; thus, a reasonably extensive record exists on which to base climate records. Based on techniques in the ASHRAE handbook, the staff calculated 100-year return maximum and minimum dry-bulb temperature values which are bounded by the applicant's proposed 100-year return period maximum and minimum dry-bulb temperature site characteristic values of 115 °F and −8 °F, respectively. The applicant's proposed 100-year return period maximum and minimum dry-bulb temperature site characteristic values also bound the all-time maximum and minimum temperatures observed in the area surrounding the proposed VEGP site (i.e., 112 °F at Aiken, and −4 °F at Louisville). Therefore, the staff finds that the applicant's values of 115 °F and −8 °F are appropriate for the 100-year return period maximum and minimum dry-bulb temperature site characteristics.

The applicant used a linear regression technique on 1966–1995 data from Augusta to estimate the 100-year return period maximum wet-bulb temperature of 88 °F. The staff conducted a similar linear regression technique, and, in addition, used the technique presented in the ASHRAE handbook, as previously discussed above, to calculate a similar 100-year return value using 1961–2006 data from the Augusta NWS site. The maximum hourly wet-bulb temperature recorded at Augusta from 1961 through 2006 was 86 °F. Based on these results, the staff believes that the applicant's 100-year return maximum wet-bulb temperature site characteristic value of 88 °F is appropriate.

The applicant based many of the proposed site characteristics on data from Augusta. The staff accepts this approach because meteorological conditions at Augusta tend to be representative of the proposed VEGP site. In SER Section 2.3.3, the staff shows a comparison between onsite meteorological data and corresponding Augusta data. Temperature, dew point, wind speed, and wind direction measurements are very similar between the two observation stations.

At the time of any COL application, the applicant would have to compare site characteristics presented in the ESP against the corresponding site parameters listed in the design certification document (DCD).

The site characteristics discussed above are meant to encompass many potential designs and corresponding site parameters. Since the applicant has expressed an interest in using the AP1000 design in any future COL application, the applicant has identified additional site characteristics that directly correspond to temperature site parameters in the AP1000 DCD. The applicant provided the following definitions for the AP1000 DCD temperature site parameters:

- Maximum Safety Dry-Bulb Temperature and Coincident Wet-Bulb Temperature: These site parameter values represent a maximum dry-bulb temperature that exists for 2 hours or more, combined with the maximum wet-bulb temperature that exists in that population of dry-bulb temperatures.

- Maximum Safety Noncoincident Wet-Bulb Temperature: This site parameter value represents a maximum wet-bulb temperature that exists within a set of hourly data for a duration of 2 hours or more.

- Maximum Normal Dry-Bulb Temperature and Coincident Wet-Bulb Temperature: The dry-bulb temperature component of this site parameter pair is represented by a maximum dry-bulb temperature that exists for 2 hours or more, excluding the highest 1 percent of the values in an hourly data set. The wet-bulb temperature component is similarly represented by the highest wet-bulb temperature excluding the highest 1 percent of the data, although there is no minimum 2-hour persistence criterion associated with this wet-bulb temperature.

- Maximum Normal Noncoincident Wet-Bulb Temperature: This site parameter value represents a maximum wet-bulb temperature, excluding the highest 1 percent of the values in an hourly data set (i.e., a 1 percent exceedance), that exists for 2 hours or more.

The applicant identified the following AP1000 specific temperature site characteristics:

- a maximum safety dry-bulb temperature of 115 °F with a coincident wet-bulb temperature of 77.7 °F.

- a maximum safety noncoincident wet-bulb temperature of 83.9 °F.

- a maximum normal dry-bulb temperature of 94 °F with a coincident wet-bulb temperature of 78 °F.

- a maximum normal noncoincident wet-bulb temperature of 78 °F.

Initially, the applicant used a 30-year period of record, 1966 through 1995, from Augusta to define these site characteristics. In Open Item 2.3-1, the staff asked the applicant to base the AP1000 specific maximum safety dry-bulb and maximum safety wet-bulb temperatures on a more conservative 100-year return period. The applicant responded to Open Item 2.3-1 by providing a 100-year return period maximum safety dry-bulb temperature with a coincident wet-bulb temperature and maximum safety noncoincident wet-bulb temperature.

As previously discussed above, the staff has independently confirmed and accepts the applicant's 100-year dry-bulb temperature site characteristic of 115 °F. Since this value is based on a linear regression technique, there is no discrete measurement of the coincident wet-bulb temperature. The applicant estimated the safety coincident wet-bulb temperature based on the relationship between concurrent dry- and wet-bulb temperatures at Augusta from 1949 through 1995. The staff performed a similar analysis using hourly data from Augusta from 1961 through 2006 and believes the applicant's estimate is accurate.

The applicant calculated the 100-year return period maximum safety noncoincident wet-bulb temperature based on a linear regression technique. The staff used the technique presented in the ASHRAE handbook, as previously discussed above, to calculate a similar 100-year return value (i.e., ± 1°F) using 1961–2006 hourly data from the Augusta NWS site. Thus, the staff believes the applicant's maximum safety noncoincident wet-bulb temperature estimate is appropriate for the site.

The maximum safety noncoincident wet-bulb temperature of 83.9 °F is lower than the previously discussed 100-year return period maximum wet-bulb temperature of 88 °F because, as defined above, it is based on a two hour persistence criteria; whereas, the 88 °F wet-bulb temperature is based on a one hour persistence criteria.

Since the applicant has determined a maximum safety dry-bulb temperature with a coincident wet-bulb temperature and a maximum safety noncoincident wet-bulb temperature based on a 100-year return period, the staff considers Open Item 2.3-1 closed.

As previously discussed above, the staff finds the applicant's estimates of 2-percent and 0.4-percent exceedance dry-bulb temperature and coincident wet-bulb temperature and 0.4-percent exceedance non-coincident wet-bulb temperature appropriate. The AP1000 specific maximum normal dry-bulb and wet-bulb temperatures are based on a 1-percent exceedance. The values are consistent with those previously discussed and thus acceptable to the staff.

2.3.1.3.6 Stagnation Potential

Large-scale episodes of atmospheric stagnation are not common in the region of the proposed site. Based on the 50-year period from 1948 through 1998, high-pressure stagnation conditions, usually accompanied by light and variable wind conditions, can be expected at the proposed VEGP site about 20 days per year, or about four cases per year with the mean duration of each case being about 5 days (Wang and Angell). Stagnation conditions usually occur during the months from May through October, with a peak in September. Winds are usually weakest in September due to influence from the Bermuda High pressure system.

The applicant also noted that, from a climatological standpoint, the lowest morning mixing heights occur in the autumn and are the highest during the winter. Conversely, afternoon mixing heights reach a seasonal minimum in the winter and a maximum during the summer, which is expected because of more intense summer heating. The applicant presented mixing height data from Athens, Georgia, which the applicant claims is reasonably representative of conditions at the proposed VEGP site.

The staff confirmed the information presented by the applicant regarding restrictive dispersion conditions as correct. Section 2.3.2 of this SER discusses the proposed VEGP site air quality conditions for design- and operating-basis considerations. Sections 2.3.4 and 2.3.5 of this SER discuss atmospheric dispersion site characteristics used to evaluate short-term post-accident airborne releases and long-term routine airborne releases, respectively.

2.3.1.3.7 Climate Change

As specified in RS-002, the applicability of data used to discuss severe weather phenomena that may impact the proposed ESP site during the expected period of reactor operation should be substantiated.

Long-term environmental changes and changes to the region resulting from human or natural causes may affect the applicability of the historical data for describing the site's climate characteristics. Although there is no scientific consensus regarding the issue of climate change, the staff believes current climate trends should be analyzed for the potential for ongoing environmental changes.

During a site audit conducted on December 6, 2006, the staff asked the applicant to evaluate trends in temperature and precipitation extremes in the proposed VEGP site vicinity and discuss whether such trends may be indicative of climatic change. In a letter dated January 30, 2007, the applicant stated that initial investigations showed no consistent long-term climate change in the proposed site area. The applicant also revised its SSAR to include a discussion of long-term climatic changes.

The applicant analyzed trends in temperature and rainfall normals / standard deviations over a 70-year period for successive 30-year intervals based on the NCDC "Climatography of the United States." The applicant stated that average temperature has increased only slightly (i.e., 0.2 to 0.3 °F) over the latest 30-year period and rainfall, on average, has increased by 1.5 inches over the same period.

The staff has confirmed and accepts the numbers provided by the applicant. The staff analyzed 1-year, 10-year, and 20-year trends in annual average daily maximum and minimum temperatures, annual extreme maximum and minimum temperatures, annual average precipitation, and annual extreme daily precipitation at Waynesboro and Augusta for potential indications of climate change using data from 1951 through 2004. The trends over 20 years show that annual extreme minimum temperatures have increased 2 °F and average annual precipitation has increased about 1.5 to 2.5 inches over the period of record. All other meteorological parameters showed no discernible signs of climate change.

The Intergovernmental Panel on Climate Change (IPCC) issued its Fourth Assessment Report on Climate Change in February 2007. The staff considered Chapter 11 in "Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the 4th Assessment Report of the Intergovernmental Panel on Climate Change," regarding the southeastern portion of the United States. The IPCC models projecting potential future climate change depend on human activity and land use. To account for this, the IPCC uses different global scenarios as input to the models. Chapter 11 of the IPCC report discusses the following three scenarios:

- (A2) "A more divided world with self-reliant, independently operating nations"
- (A1B) "A more integrated world with an emphasis on all energy sources"
- (B1) "A world more integrated and ecologically friendly" (i.e., less energy consumption and more cooperating nations)

During the 100-year period under the A1B scenario (i.e., 1980–1999 as compared to 2080–2099), the IPCC projection estimates that the proposed VEGP site may see an increase in average annual temperature of 3 °C and an increase in precipitation of 0 to 5 percent. Under the more and less extreme scenarios, increases in annual average temperature may range from 2 °C to 7.5 °C. The projection also shows a general decrease in snow depth as a result of delayed autumn snowfall and earlier spring snow melt.

The staff also analyzed climate-change-induced hurricane trends within 100 nautical miles of the site and found no discernible trends in hurricane frequency or intensity. The "Summary for Policymakers" based on the February 2007 IPCC report makes the following statement concerning tropical cyclones:

> Based on a range of models, it is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures. (IPCC Sections 3.8, 9.5, and 10.3)

However, the question of whether hurricanes are becoming more destructive because of global warming is a contested issue in the scientific debate over climate change. A number of academic papers have been published either supporting or debunking the idea that warmer temperatures linked to human activity have created more intense storms, and the issue is currently unresolved (Dean; Eilperin; Kerr; Witze). Based on the current amount of scientific uncertainty regarding this subject, the staff believes the applicant has adequately addressed the issue of hurricanes and provided conservative site characteristics.

The applicant stated that the number of recorded tornado events has increased, in general, since detailed records were routinely kept beginning around 1950. However, some of this increase is attributable to a growing population, greater public awareness and interest, and technological advances in detection. These changes are superimposed on normal year-to-year variations. Consequently, the number of observations recorded within a 2-degree latitude and longitude square centered on the VEGP site reflects these effects. The staff has confirmed and accepts the applicant's statements regarding tornadoes. The "Summary for Policymakers" based on the February 2007 IPCC report states, "there is insufficient evidence to determine whether trends exist in small scale phenomena such as tornadoes, hail, lightning, and dust storms." (IPCC Sections 3.8 and 5.3).

In conclusion, 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."

2.3.1.4 Conclusion

The NRC staff has evaluated the relevant sections of the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007, pursuant to the acceptance criteria described RS-002, Section 2.3.1 and applicable regulatory requirements of 10 CFR Part 52 and 10 CFR Part 100. The applicant has presented and substantiated information relative to the regional meteorological conditions. The staff has reviewed the information presented by the applicant and concludes that the identification and consideration of the regional and site meteorological characteristics meet the requirements of 10 CFR 52.17(a)(1), 10 CFR 100.20(c), and 10 CFR 100.21(d).

Table 2.3.1-1 - Regional Climatic Observation Stations

STATION NAME	COUNTY	STATE CLIMATIC DIVISION	DISTANCE FROM ESP SITE (km)	DIRECTION FROM ESP SITE	STATION ELEV. (m)	DIFF. FROM ESP SITE ELEV. (m)	YEARS OF DATA
Appling 2NW 1	Columbia	GA-6	69	NW	113	46	46
Augusta Bush Field 2	Richmond	GA-6	32	NW	40	-27	57
Augusta 1	Richmond	GA-6	41	NW	40	-27	13
Louisville 1 E 2	Jefferson	GA-6	59	SW	98	31	77
Midville Exp. Station 2	Burke	GA-6	51	SW	85	18	50
Millen 4 N 2	Jenkins	GA-6	36	SSW	59	-8	68
Newington 2	Screven	GA-6	65	SSE	64	-3	43
Sylvania 2 SSE 1	Screven	GA-6	47	SE	76	9	13
Waynesboro 2 S 2	Burke	GA-6	25	WSW	82	15	67
Allendale 2 NW 1	Allendale	SC-7	44	ESE	55	-12	26
Bamberg 2	Bamberg	SC-7	70	ENE	50	-17	57
Blackville 3W 2	Barnwell	SC-7	47	NE	99	32	93
Hampton 1 S 1	Hampton	SC-7	68	SSE	29	38	55
Aiken 5 SE 2	Aiken	SC-5	41	N	150	83	94
Clarks Hill 1 W 1	McCormick	SC-5	71	NW	116	49	56
Trenton 1 NNE 1	Edgefield	SC-5	68	NNE	189	122	47
Springfield 2	Orangeburg	SC-5	60	NNE	91	24	58

1 Climatic stations used by the staff only
2 Climatic stations used by both the staff and applicant

Data Reference: NCDC, "Local Weather Observation Station Record," October 2006.

Table 2.3.1-2 Climatic Precipitation Extremes within 50 Miles of the ESP Site

PARAMETER	SITE EXTREMES	STATION
Maximum 24-hr Rainfall	9.68 in.	Aiken 5SE
Maximum Monthly Rainfall	17.32 in.	Springfield
Minimum Monthly Rainfall	0 in.	Multiple
Maximum 24-hr Snowfall	19 in.	Bamberg
Maximum Monthly Snowfall	22 in.	Bamberg
Maximum Daily Snow Depth	19 in.	Bamberg

Table 2.3.1-3 - Tropical Cyclone Frequency within a 100-Nautical Mile Radius of the Proposed VEGP Site between 1851 and 2004

CLASSIFICATION	NUMBER OF OCCURRENCES	MAXIMUM SUSTAINED (1-MIN AVG) WIND SPEED RANGE
Saffir-Simpson Category 5 Hurricanes	0	>155 mi/h
Saffir-Simpson Category 4 Hurricanes	0	131–155 mi/h
Saffir-Simpson Category 3 Hurricanes	5	111–130 mi/h
Saffir-Simpson Category 2 Hurricanes	4	96–110 mi/h
Saffir-Simpson Category 1 Hurricanes	16	74–95 mi/h
Tropical Storms	46	39–73 mi/h
Tropical Depressions	23	<39 mi/h
Subtropical Storms	1	<74 mi/h
Subtropical Depressions	2	<39 mi/h
Extra-Tropical Storms	5	N/A

Table 2.3.1-4 - Regional Climatology Site Characteristics

SITE CHARACTERISTIC	VALUE		DESCRIPTION
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2 percent annual exceedance	92 ºF / 75 ºF	The ambient dry-bulb temperature (and mean coincident wet-bulb temperature) that will be exceeded 2 percent of the time annually
	0.4 percent annual Exceedance	97 ºF / 76 ºF	The ambient dry-bulb temperature (and mean coincident wet-bulb temperature) that will be exceeded 0.4 percent of the time annually
	100-year return Period	115 ºF	The ambient dry-bulb temperature that has a 1 percent annual probability of being exceeded (100-year mean recurrence interval)
Minimum Dry-Bulb Temperature	99 percent annual exceedance	25 ºF	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 1 percent of the time annually
	99.6 percent annual exceedance	21 ºF	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 0.4% of the time annually
	100-year return period	-8 ºF	The ambient dry-bulb temperature for which a 1 percent annual probability of a lower dry-bulb temperature exists (100-year mean recurrence interval)
Maximum Wet-Bulb Temperature	0.4 percent annual exceedance	79 ºF	The ambient wet-bulb temperature that will be exceeded 0.4 percent of the time annually
	100-year return period	88 ºF	The ambient wet-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Site Temperature Basis for AP1000			
Maximum Safety Dry-Bulb and Coincident Wet-Bulb	115 ºF / 77.7 ºF		These AP1000 specific site characteristics values represent a maximum dry-bulb temperature that exists for 2 hours or more, combined with the maximum wet-bulb temperature that exists in that population of dry-bulb temperatures.

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Maximum Safety Wet-Bulb (Non-Coincident)	83.9 ºF	This AP1000 specific site characteristic value represents a maximum wet-bulb temperature that exists within a set of hourly data for a duration of 2 hours or more.
Maximum Normal Dry-Bulb and Coincident Wet-Bulb	94 ºF / 78 ºF	The dry-bulb temperature component of this AP1000 specific site characteristics pair is represented by a maximum dry-bulb temperature that exists for 2 hours or more, excluding the highest 1 percent of the values in an hourly data set. The wet-bulb temperature component is similarly represented by the highest wet-bulb temperature excluding the highest 1 percent of the data, although there is no minimum 2-hour persistence criterion associated with this wet-bulb temperature.
Maximum Normal Wet-Bulb (Non-Coincident)	78 ºF	This AP1000 specific site characteristic value represents a maximum wet-bulb temperature, excluding the highest 1 percent of the values in an hourly data set (i.e., a 1 percent exceedance), that exists for 2 hours or more.
Basic Wind Speed		
3-Second Gust	104 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 percent 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
Maximum Translational Speed	60 mi/h	Translation component of the maximum tornado wind speed

SITE CHARACTERISTIC	VALUE	DESCRIPTION
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	10 lb/sq ft	Weight of the 100-year return period snowpack (to be used in determining normal precipitation loads for roofs)
48-Hour Probable Maximum Winter Precipitation	28.3 inches of water	PMP during the winter months (to be used in conjunction with the 100-year snowpack in determining extreme winter precipitation loads for roofs)

2.3.2 Local Meteorology

2.3.2.1 Introduction

In Section 2.3.2 of the SSAR, the applicant presented information on local (site) meteorological parameters. Specifically, the applicant provided the following information:

- a description of the local (site) meteorology in terms of airflow, atmospheric stability, temperature, water vapor, precipitation, fog, and air quality.
- an assessment of the influence on the local meteorology of construction and operation of the nuclear power plant that is planned to 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 the nuclear power plant that is planned to be built on the proposed site.

This section verifies that the applicant has identified and considered the meteorological and topographical characteristics of the site and the surrounding area, as well as changes that may result to those characteristics because of the construction and operation of the proposed facility.

2.3.2.2 Regulatory Basis

The acceptance criteria for identifying local meteorological parameters are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The staff considered the following regulatory requirements in reviewing the applicant's identification of local meteorological parameters:

- 10 CFR 52.17(a), which requires that the application contain a description of the seismic, meteorological, hydrological, and geological characteristics of the proposed site.
- 10 CFR 100.20(c), which requires that the meteorological characteristics of the site, necessary for safety analysis or that may have an impact on plant design, be identified and characterized as part of the NRC's review of the acceptability of a site.
- 10 CFR 100.21(c), which requires that site atmospheric dispersion characteristics be evaluated and dispersion parameters established such that (1) radiological effluent release limits associated with normal operation from the type of facility to be located at the site can be met for any individual located offsite; and (2) radiological dose consequences of postulated accidents shall meet the criteria set forth in 10 CFR 50.34(a)(1) for the type of facility proposed to be located at the site.
- 10 CFR 100.21(d), which requires that the physical characteristics of the site, including meteorology, geology, seismology, and hydrology be evaluated and site parameters established, such that the potential threats from such physical characteristics will pose no undue risk to the type of facility proposed to be located at the site.

The local meteorological information assembled in compliance with the above regulatory requirements would be necessary to determine, at the COL stage, a proposed facility's compliance with the following requirements in Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR Part 50:

- GDC 2, which requires that structures, systems and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions; and further requires that consideration be given to the most severe local weather phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

An ESP applicant, though, need not demonstrate compliance with the above GDC, with respect to local meteorology.

RS-002, Section 2.3.2 specifies that an application meets the above requirements, if the application satisfies the following criteria:

- 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 RG 1.70.

- A complete topographical description of the site and environs set out to a distance of 50 miles from the site should be provided.

- A discussion and evaluation of the influence of a nuclear power plant of the type proposed to be constructed on the site on local meteorological and air quality conditions should be provided.

To the extent applicable to the above-outlined acceptance criteria, the applicant applied the NRC-endorsed meteorological information selection methodologies and techniques found in the following:

- RG 1.23, which provides criteria for an acceptable onsite meteorological measurements program to be used to monitor local (onsite) meteorology site characteristics.

- RG 1.70, which describes the type of local meteorological data that should be presented in SSAR Section 2.3.2.

When independently assessing the veracity of the information presented by the applicant in SSAR Chapter 2.3.2, the NRC staff applied the same above-cited methodologies and techniques.

2.3.2.3 Technical Evaluation

Using the approaches and methodologies described in RS-002 Section 2.3.2, the NRC staff reviewed the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007. In reviewing and evaluating the applicant's site meteorology, the staff used (or relied on) none of the applicant's proposed design parameters and site interface values presented in SSAR Section 1.3.

2.3.2.3.1 Local Meteorology Description

The applicant used data from the existing Vogtle meteorological monitoring program and 10 surrounding NWS observation stations (as listed in SSAR Section Table 2.3.1-2 and repeated in

SER Section 2.3.1) to describe local meteorology. The applicant used data from the onsite meteorological monitoring program to describe wind speed, wind direction, and atmospheric stability conditions; surrounding offsite observation stations were data sources for temperature, atmospheric moisture, precipitation, and fog conditions.

The applicant presented means and historical extremes of temperature, rainfall, and snowfall data from the 10 offsite observation stations listed in SSAR Section 2.3.1. SER Table 2.3.2-1 summarizes the overall extremes from those stations, as compiled by the applicant.

The staff evaluated the information regarding local meteorological conditions submitted by the applicant using data from the Vogtle onsite meteorological monitoring system, as well as climatic data reported in "Monthly Station Climate Summaries," "U.S. Monthly Climate Normals," and "Daily Surface Data" (all from NCDC) and "Period of Record Daily Climate Summaries for Georgia and South Carolina" from SERCC. The staff has confirmed the normal and extreme values presented by the applicant in SSAR Tables 2.3-3 and 2.3-5, respectively.

2.3.2.3.1.1 <u>Airflow</u>

The applicant presented hourly wind data from the Vogtle onsite meteorological monitoring program, as described in SSAR Section 2.3.3, from 1998 through 2002. The applicant also provided annual and seasonal wind roses based on 10-meter and 60-meter observation heights. The NRC staff confirmed that the wind directions from both levels are fairly similar. The prevailing annual wind direction for the site is generally from the southwest. Winds from the southwest predominate during the spring and summer, westerly winds predominate during the winter, and northeasterly winds predominate during the autumn months.

The applicant stated that annual average wind speeds at the 10- and 60-meter observation levels are 2.5 m/s and 4.6 m/s, respectively. This is consistent with the 6.1-meter measurement height annual average wind speed at Augusta, Georgia, of 2.7 m/s. The annual frequencies of calm wind conditions are 0.44 and 0.07 percent of the time for the 10-meter and 60-meter observation levels at the proposed VEGP site.

The staff reviewed the Vogtle onsite meteorological wind data from 1998 through 2002 for completeness and consistency. The wind measurements provided by the applicant had at least 95-percent data recovery. Initially, the staff did have concerns about the consistency of the data. The staff, having compared the 1998–2002 annual data used by the applicant to the 1972–1973, 1977-1978, 1978–1979, and 1980–1981 meteorological data presented in the original final safety analysis report (FSAR) for Vogtle Units 1 and 2, discovered that there were discrepancies between the two sets of data. During a site audit conducted on December 6, 2006, the staff asked the applicant to explain the differences in wind direction frequency at 60 meters and 10 meters during the spring, summer, and winter seasons, when comparing the submitted VEGP wind data to the original FSAR data for Vogtle Units 1 and 2. In its letter dated January 30, 2007, the applicant explained that while the winds are somewhat uniform (in that the overall peak sector for both the original FSAR data and the 1998–2002 data is the same (west)), there is some variability among the annual data due to the relatively low wind speeds at the site. The staff has confirmed that the wind speeds are typically light at the site and thus some degree of variability can be expected. When winds are light they are typically not produced by a large-scale pressure gradient (e.g., synoptic scale), rather by smaller, more random and turbulent motions (e.g., meso-scale).

During the December 2006 site audit, the staff also asked the applicant to explain the amount of variability in summer wind direction frequency between the two onsite observation heights of 10 and

60 meters. The applicant stated in its letter dated January 30, 2007 that it was revising the wind roses for the summer season to correct an error and would include the corrected wind roses in the next revision of the SSAR. In a letter dated March 26, 2007, the applicant also provided a revised onsite 1998–2002 database, in which periods of bad data were removed and coded as such. Based on an independent review of the revised onsite meteorological data, the staff accepts the changes and concludes that the onsite meteorological wind data from 1998 through 2002 are both complete and consistent.

The staff agrees with the applicant that the winds for the proposed VEGP site are predominately from the southwest through west sectors. The staff also agrees with the annual average wind speeds of 2.5 m/s and 4.6 m/s at 10 and 60 meters as presented by the applicant. The staff's conclusions are based on a comparison between the Vogtle onsite meteorological wind data and nearby Augusta climatological data, as presented in the NCDC 2004 "Local Climatological Data."

2.3.2.3.1.2 Atmospheric Stability

The applicant classified atmospheric stability in accordance with the guidance provided in the proposed Revision 1 to RG 1.23. Atmospheric stability is a critical parameter for estimating dispersion characteristics in SSAR Sections 2.3.4 and 2.3.5. Dispersion of effluents is greatest for extremely unstable atmospheric conditions (i.e., Pasquill stability class A) and decreases progressively through extremely stable conditions (i.e., Pasquill stability class G). The applicant primarily based its stability classification on temperature change with height (i.e., delta-temperature or $\Delta T/\Delta Z$) between the 60-meter and 10-meter height, as measured by the Vogtle onsite meteorological monitoring program between 1998 and 2002.

The applicant provided seasonal and annual frequencies of atmospheric stability classes for the 5-year period of record for the onsite data from 1998–2002. According to the applicant, there is a predominance of slightly stable (Pasquill stability class E) and neutral stability (Pasquill stability class D) conditions at the proposed VEGP site, ranging from 50 to 60 percent of the time, on a seasonal and annual basis. Extremely unstable conditions (Pasquill stability class A) occur most frequently during spring and summer, and extremely stable conditions (Pasquill stability class G) occur most frequently during the fall and winter months. Based on past experience with stability data at various sites, a predominance of slightly stable (Pasquill stability class E) and neutral (Pasquill stability class D) conditions at the proposed site is generally consistent with expected meteorological conditions.

During a site audit conducted on December 6, 2006, the staff asked the applicant to explain the decrease in frequency of extremely unstable conditions (Pasquill stability class A) from 1998-2000 to 2001–2002, and the increase in frequency of slightly stable conditions (Pasquill stability class E) from 2000 to 2001. The staff also asked the applicant to explain a decrease in the number of occurrences of unstable conditions (Pasquill stability classes A–C) in 2001 and 2002, as compared to 1998 through 2000. The applicant responded, in its letter dated January 30, 2007, that there has been a slight decreasing trend in stability class A over the past 5 years; however, when individual stability classes are combined into the following three basic stability categories, (1) unstable (A-C), (2) neutral (D-E), and (3) stable (F-G) the decreasing trend is not as significant. The applicant stated that the increase in stability class E frequency was due to a data error. This error was corrected in the revised meteorological database. The staff reviewed the revised meteorological database and has concluded that its concerns regarding stability class frequencies have been resolved.

As a qualitative check of the hourly stability data provided by the applicant, the staff created plots of stability class as a function of time of day for each individual year, and, additionally, the 5 years together. SER Figure 2.3.2-1 is a plot of the proposed VEGP site 1998–2002 hourly stability class data as a function of time of day. Unstable conditions (Pasquill stability classes A–C) generally occurred during the day, and stable conditions (Pasquill stability classes F–G) generally occurred during the night, as expected due to daytime heating and nighttime cooling.

During a site audit conducted on December 6, 2006, the staff asked the applicant to explain a daytime increase in the number of occurrences of stable conditions (Pasquill stability classes F and G) in 2001, which is not seen in the other years. The applicant responded, in its letter dated January 30, 2007, that this could be attributed to a data error. This error was corrected in the revised meteorological database. The staff has confirmed that this problem has been fixed.

Frequency of occurrence for each stability class is one of the inputs to the dispersion models used in SSAR Sections 2.3.4 and 2.3.5. The applicant included these data in the form of a joint frequency distribution (JFD) of wind speed and direction data as a function of stability class. A comparison of a JFD developed by the staff from the hourly data submitted by the applicant with the JFD developed by the applicant showed reasonable agreement.

The staff accepts the 5 years of stability data presented by the applicant in SSAR Section 2.3.2 as complete and adequate. The staff believes that these data are appropriate to use as input to the dispersion models discussed in SER Sections 2.3.4 and 2.3.5.

2.3.2.3.1.3 Temperature

The applicant characterized normal and extreme temperatures for the site based on the 10 surrounding observation stations listed in SSAR Section 2.3.1.1. The extreme maximum temperature recorded near the site is 112 °F, and the extreme minimum temperature recorded near the site is −4 °F. Annual average temperatures for the 10 surrounding observation stations in the site vicinity (which are based on the average of the daily mean maximum and minimum temperatures) range from 63.1 °F to 65.0 °F. The applicant stated that the annual average diurnal (day-to-night) temperature differences in the site vicinity range from 21.9 °F to 26.3 °F.

Using data from NCDC and SERCC, the staff reviewed the daily mean temperatures, the extreme temperatures, and the diurnal temperature ranges presented by the applicant. The staff confirmed the temperature characterizations, as presented in SSAR Section 2.3.2, and accepts them as correct.

2.3.2.3.1.4 Water Vapor

The applicant presented wet-bulb temperature, dew point temperature, and relative humidity data summaries from the Augusta NWS observation station to characterize the typical atmospheric moisture conditions near the proposed VEGP site.

Based on a 49-year period of record, the applicant indicated that the mean annual wet-bulb temperature is 56.7 °F. The highest monthly mean wet-bulb temperature is 72.7 °F during July, and the lowest monthly mean wet-bulb temperature is 40.3 °F during January. According to the applicant, the mean annual dew point temperature at Augusta is 51.9 °F, which also reaches its maximum during summer and minimum during winter. The applicant gives the highest monthly mean dew point temperature as 69.7 °F during July, and the lowest monthly mean dew point temperature as 34.4 °F during January.

Based on a 30-year period of record, the applicant indicates that relative humidity averages 72 percent on an annual basis. The average early morning relative humidity levels exceed 90 percent during August, September, and October. Typically, the relative humidity values reach their diurnal maximum in the early morning and diurnal minimum during the early afternoon.

The staff has verified and accepts as correct and appropriate the wet-bulb temperature, dew point temperature, and relative humidity data presented by the applicant. The staff reviewed the data listed in the NCDC "Augusta, Georgia, 2004 Local Climatological Data, Annual Summary with Comparative Data." Because of the proximity of Augusta to the proposed VEGP site and because of the similarity of topographic features at both locations (i.e., gently rolling terrain, adjacent to the Savannah River, and location within the broad river valley), the Augusta atmospheric moisture data should be typical of the atmospheric moisture conditions in the proposed site region. SER Section 2.3.1 discusses the wet-bulb site characteristics more quantitatively.

2.3.2.3.1.5 Precipitation

Based on data from the 10 surrounding observation stations, the applicant provided that the average annual precipitation (water equivalent) totals generally range from 43.85 to 48.57 inches. The highest average annual precipitation is 52.43 inches, which occurs at the Aiken 4NE Station.

According to the applicant, snowfall is infrequent, with normal annual totals ranging from 0.1 to 1.4 inches. SER Section 2.3.1 discusses in greater detail snowfall in the vicinity of the proposed VEGP site.

Using daily snowfall and rainfall data from NCDC and SERCC, the staff has independently verified the precipitation statistics presented in SSAR Section 2.3.2 and accepts them as accurate.

2.3.2.3.1.6 Fog

Augusta is the closest station to the proposed VEGP site that makes fog observations. The applicant stated that, based on a 54-year period of record, Augusta averages about 35.1 days per year of heavy fog conditions (e.g., visibility is reduced to one-quarter mile or less).

According to the applicant, the frequency of typical fog conditions at Augusta is expected to be similar to that at the proposed VEGP site because of the proximity and similarity of topographic features between the two locations. Both sites are located in gently rolling terrain, adjacent to the Savannah River, and are situated in a broad river valley.

The staff confirmed the applicant's assertion that the Augusta NWS station reports 35.1 days per year with heavy fog observations. The staff agrees that the frequency of fog conditions at Augusta is expected to be similar to that at the proposed VEGP site because of the proximity and similarity of topographic features at both locations.

2.3.2.3.1.7 Air Quality

The applicant provided that the proposed VEGP site is located in the Augusta—Aiken Interstate Air Quality Control Region. The counties within this region, including Burke County, have been designated as being in attainment or unclassified for all EPA criteria air pollutants (i.e., ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead) (40 CFR 81.311, "Georgia," and 40 CFR 81.34, "Metropolitan Dayton Intrastate Air Quality Control Region").

According to the applicant, the proposed nuclear steam supply system (NSSS) and other radiological systems related to the proposed facility will not be sources of criteria pollutants or other hazardous air pollutants. Other proposed supporting equipment such as diesel generators, fire pump engines, auxiliary boilers, emergency station-blackout generators, and other nonradiological emission-generating sources are not expected to be, in the aggregate, a significant source of criteria pollutant emissions. The staff agrees with this assessment because these systems will be used on an infrequent basis.

Because the EPA has designated the proposed VEGP site area as being in attainment or unclassified for all criteria air pollutants and the new facility is not expected to be a significant source of air pollutants, the staff finds that the VEGP site air quality conditions should not be a significant factor in the design and operating bases for the facility.

2.3.2.3.2 Impacts on Local Meteorology

The applicant stated that the associated paved, concrete, or other improved surfaces resulting from the construction of the proposed nuclear facility are insufficient to generate discernible, long-term effects to local- or micro-scale meteorological conditions. Wind flow may be altered immediately adjacent to and downwind of larger site structures, but these effects will likely dissipate within 10 structure heights downwind. SER Section 2.3.3 discusses the effects of these larger structures on wind flow.

Although temperature may increase above altered surfaces, the effects will be too limited in their vertical profile and horizontal extent to alter local- or regional-scale ambient temperature changes. Any water vapor releases from the proposed 600-foot-high natural draft cooling towers will have insignificant effects on local meteorology because of the high release height of thermal/water vapor plumes.

Because of the limited and localized nature of the expected modifications associated with the proposed plant structures and the associated improved surfaces, the staff agrees with the applicant that the proposed facility will not have significant impact on local meteorological conditions to affect plant design and operation.

The use of natural draft cooling towers could create visible plumes under certain atmospheric conditions, which could cause shadowing of nearby lands and salt deposition. Ground-level icing would be insignificant, though, because of the low probabilities of ground-level plumes and freezing conditions. The staff finds that these projected atmospheric impacts will not have significant impact on local meteorological conditions to affect plant design and operation.

During a site audit conducted on December 6, 2006, the staff asked the applicant to clarify whether any terrain modifications are expected to result from construction of the proposed facility and how they may affect the local meteorological characteristics of the site. The applicant responded in its letter dated January 30, 2007, that although there will be excavation, landscaping, site leveling, and clearing associated with the construction of the new units, these alterations to the site terrain would be localized and would not represent a significant alteration to the flat-to-gently-rolling topographic character of the area and region around the site. Therefore, the overall meteorological characteristics of the site will not be affected. The staff agrees that these activities are too small-scale to impact the local meteorological characteristics of the site.

2.3.2.3.3 Topographic Description of the Site

The proposed VEGP site is located in Burke County, Georgia, west of the Savannah River on approximately 3169 acres of land. The applicant provided maps of topographic features within a 5-mile radius of the site. The applicant also provided terrain elevation profiles along each of the 16 standard 22.5-degree compass radials out to a distance of 50 miles. Based on these profiles, the applicant characterized the proposed site terrain as flat to gently rolling. The only significant nearby topographic feature mentioned by the applicant is the broad Savannah River valley. The staff agrees with this terrain characterization based on topography data from the USGS and a site visit. The staff concludes that the applicant provided all the necessary topographic information.

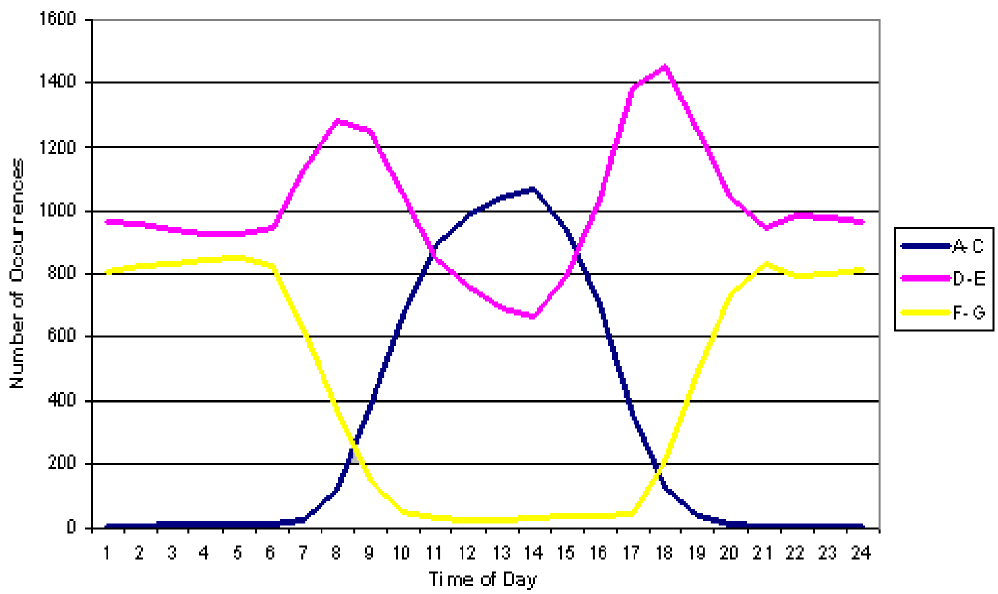
2.3.2.4 Conclusion

The NRC staff has evaluated the relevant sections of the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007, pursuant to the acceptance criteria of RS-002 Section 2.3.2 and applicable regulatory requirements of 10 CFR Part 52 and 10 CFR Part 100. As discussed above, the applicant has identified and provided acceptable consideration of the meteorological and topographical characteristics of the site and the surrounding area, including the potential impact on plant design and operation due to changes in local meteorology caused by plant construction and operation. Therefore, the staff finds that the applicant has provided the information required to address 10 CFR 52.17(a), 10 CFR 100.20(c), 10 CFR 100.21(c), and 10 CFR 100.21(d).

Table 2.3.2-1 - Offsite Temperature and Precipitation Extremes

PARAMETER	VALUE (DATE)	LOCATION
Maximum Temperature	112 °F (7/24/52)	Louisville 1E
Minimum Temperature	−4 °F (1/21/85)	Aiken 4NE
Maximum 24-hr Rainfall	9.68 in. (4/16/69)	Aiken 4NE
Maximum Monthly Rainfall	17.32 in. (6/73)	Springfield
Maximum 24-hr Snowfall	19.0 in. (2/10/73)	Bamberg
Maximum Monthly Snowfall	22.0 in. (2/73)	Bamberg

Figure 2.3.2-1 Vogtle 1998-2002 Hourly Stability Class Frequency



2.3.3 Onsite Meteorological Measurements Program

2.3.3.1 Introduction

In Section 2.3.3 of the SSAR, the applicant presented information concerning the onsite meteorological measurements program in support of its ESP application. 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 QA program for sensors and recorders, and data acquisition and reduction procedures.

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

This section verifies that the applicant successfully implemented an appropriate onsite meteorological measurements program and that data from this program provide an acceptable basis for estimating atmospheric dispersion for DBA and routine releases from a nuclear power plant of the type specified by the applicant.

2.3.3.2 Regulatory Basis

The acceptance criteria for the development and implementation of an onsite meteorological program are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The staff considered the following regulatory requirements in reviewing the applicant's development and implementation of an onsite meteorological program:

- 10 CFR 52.17(a), which requires that the application contain a description of the seismic, meteorological, hydrological, and geological characteristics of the proposed site.

- 10 CFR 100.20(c), which requires that the meteorological characteristics of the site, necessary for safety analysis or that may have an impact on plant design, be identified and characterized as part of the NRC's review of the acceptability of a site.

- 10 CFR 100.21(c), which requires that site atmospheric dispersion characteristics be evaluated and dispersion parameters established such that (1) radiological effluent release limits associated with normal operation from the type of facility to be located at the site can be met for any individual located offsite; and (2) radiological dose consequences of postulated accidents shall meet the criteria set forth in
- 10 CFR 50.34(a)(1) for the type of facility proposed to be located at the site.

- 10 CFR 100.21(d), which requires that the physical characteristics of the site, including meteorology, geology, seismology, and hydrology be evaluated and site parameters established, such that the potential threats from such physical characteristics will pose no undue risk to the type of facility proposed to be located at the site.

The assessment and conclusions made in this section, regarding the site-specific adequacy of onsite meteorological instrumentation (including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the QA program for sensors and recorders, and data acquisition and reduction procedures), are pertinent to the staff's evaluation, in SER Chapter 13, of the applicant's proposed emergency plan, in accordance with the following requirements of 10 CFR 50.47, "Emergency Plans," and 10 CFR Part 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities":

- 10 CFR 50.47(b), which requires that the onsite emergency response plan have adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition.

- 10 CFR Part 50, Appendix E, which requires emergency plans to have adequate provisions for equipment for determining the magnitude of and for continuously assessing impact of the release of radioactive materials to the environment.

The development and implementation of an onsite meteorological program is necessary for the collection of onsite meteorological information, so as to be able to demonstrate compliance, at the COL stage, with the numerical guides for doses contained in 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and limiting Conditions for Operation to Meet the Criterion 'As Low as Reasonable Achievable' for Radioactive material in Light-Water-Cooled Nuclear Power Reactor Effluents."

RS-002, Section 2.3.3 specifies that an application meets the above requirements, if the application satisfies the following criteria:

- The onsite meteorological measurements programs should produce data that describe the meteorological characteristics of the site and its vicinity for the purpose of making atmospheric dispersion estimate 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. The criteria for an acceptable onsite meteorological measurements program are documented in the Regulatory Position, Section C, "Meteorological Monitoring Programs for Nuclear Power Plants," of RG 1.23.

To the extent applicable to the above-outlined acceptance criteria, the applicant applied the NRC-endorsed methodologies and parameters found in the following:

- RG 1.23, which provides criteria for an acceptable onsite meteorological measurements program, data from which are used as input to atmospheric dispersion models.

- RG 1.70, which provides guidance on information appropriate for presentation regarding an onsite meteorological measurements program.

- RG 4.2, "Preparation of Environmental Reports for Nuclear Power Stations," which states that the meteorological description of the site and its surrounding area should include data from the onsite meteorological program.

When independently assessing the sufficiency of the information presented by the applicant in SSAR Chapter 2.3.3, the NRC staff applied the same above-cited methodologies and parameters.

2.3.3.3 Technical Evaluation

Using the approaches and methodologies described in RS-002 Section 2.3.3, the NRC staff reviewed the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007. In reviewing and evaluating the applicant's onsite meteorological program, the staff used (or relied on) the following design parameters and site interface values proposed by the applicant in SSAR Section 1.3: building height, cooling tower height, cooling tower base diameter, and cooling tower diameter at the top.

The applicant used the existing onsite meteorological measurements program at the Vogtle facility (Units 1 & 2) to collect data for the proposed VEGP site and plans to continue to use this monitoring program to support operation of the proposed facility. If any changes are made to the monitoring program, the COL applicant should update the description of the proposed operational onsite meteorological measurements program at the time of the COL application in accordance with Section C.III.2.2.3.3 of RG 1.206, "Combined License Applications for Nuclear Power Plants."

2.3.3.3.1 Instrument Description

The Vogtle meteorological monitoring program began operation in 1979. Instruments for measuring pertinent meteorological parameters were mounted on a 45-meter tower located on a cleared area on the site. The facility updated the meteorological monitoring program in 1984 to meet the criteria of NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans [RERP] and Preparedness in Support of Nuclear Power Plants." The updated monitoring equipment has observation heights at 10 and 60 meters above ground level. Measured data include wind speed and direction at 10 and 60 meters, temperature at 10 meters, differential temperature between 60 and 10 meters, dew point temperature at 10 meters, precipitation at the tower base, and sigma theta (wind direction standard deviation) at 10 and 60 meters. Currently, the original 45-meter tower is used as a backup meteorological monitoring system during periods of equipment failure on the 60-meter tower. The backup system can measure wind speed, wind direction, temperature, and sigma theta at the 10-meter level.

The meteorology tower is located about 4525 feet south of the proposed power block area. The applicant stated that the closest major structures to the meteorological measurement tower would be the proposed Unit 3 and 4 reactor buildings and proposed natural draft cooling towers. The cooling towers would be the largest structures in the vicinity of the meteorology tower and would have the greatest potential to influence the accuracy of future measurements because of the postulated downwind wake created by these structures.

The applicant stated that the region potentially affected by wake from the proposed cooling towers will extend about 1650 feet downwind. It based this value on the EPA 1981 version of the "Guideline for Determination of Good Engineering Practice Stack Height," which states that the distance downwind affected by the wake of a hyperbolically shaped natural draft cooling tower is about five times the width of the tower at the top of the structure. Since the closest cooling tower will be 3025 feet from the primary meteorological tower, the applicant determined that the primary meteorology tower will be outside of the potential wake zone.

RG 1.23 indicates that obstructions to flow (such as buildings) should be located at least 10 obstruction heights from the meteorological tower to prevent adverse building wake effects. Since the height of the proposed tallest power block structure is 234 feet above plant grade, the zone of turbulent flow created by the reactor buildings will be limited to about 2340 feet downwind. The staff concludes that building wake from the proposed reactor buildings will not cause any adverse affects on measurements because the meteorology tower is located 4525 feet south of the proposed power block area.

The 10-building-height distance of separation is typically applied to square or rectangular structures, whereas rounded and sloping structures such as hyperbolic natural draft cooling towers can be expected to produce a smaller wake zone. According to the applicant, the preliminary design for the natural draft cooling towers calls for them to be about 600 feet high, with a base diameter of 550 feet and a top diameter of 330 feet. In RAI 2.3.3-2, the staff asked the applicant to include the proposed natural draft cooling tower height and width as part of SSAR Table 1-1, which lists postulated design parameters, since this information is used to determine the potential wake effects from these towers. The applicant complied with this request.

Section 123 of the Clean Air Act as amended in 1990 defines good engineering practice stack height as the height necessary to ensure that emissions from a stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of a source as a result of atmospheric downwash, eddies, and wakes which may be created by the source itself, by nearby structures, or by nearby terrain obstacles. The EPA defines "nearby structures" in its regulations (40 CFR 51.100(jj)(1)) as that distance up to five times the lesser of the height or the width dimension of a structure; that is, the downwind distance in which a structure is presumed to have a significant influence as a result of downwash, eddies, and wakes extends downwind approximately five times either the height or width (whichever is less) of the structure. The EPA regulatory guidance document for determining good engineering practice stack heights (EPA-450-4/80/023R, June 1985) also states that this area of influence becomes significantly smaller as the height to width ratio of a structure increases. Based on the EPA guidance for this type of structure, which will have a maximum width of 550 feet, the outermost boundary of influence exerted by the proposed cooling towers is estimated to be no more than 2750 feet. Since this distance is shorter than the 3025-foot separation between the proposed cooling towers and the primary meteorological tower, the staff concludes that the proposed natural draft cooling towers will not adversely affect measurements made at the primary meteorological tower. The staff calculated a larger area that may be affected by cooling tower wake because the updated 1985 EPA guidance used by the staff recommends using the maximum width of the structure, whereas the 1981 EPA guidance used by the applicant recommended using the width at the top of the structure for calculating potential wake influences.

The base of the primary tower is at an elevation similar to plant grade for the proposed facility, and the ground cover at the base of the tower is primarily native grass. The applicant stated that it evaluated minor structures in the vicinity of the primary meteorological tower as having no adverse effect on the measurements taken at the meteorological measurement tower. After conducting a site audit on December 6, 2006, the staff agrees with the applicant that the meteorology towers are sited in an appropriate area and these minor structures will have no adverse impact on the accuracy of measurements. The staff also noted during its site audit that the meteorology towers are located far enough from the surrounding tree line to prevent adverse effects on measurements.
SER Figure 2.3.3-1 shows the proposed layout of the VEGP site.

The primary meteorological equipment is mounted on a 200-foot Unarco-Rohn, Inc., Model 55G tower. All instrumentation (primary and backup) is mounted on a Tower Systems, Inc., Model TS-2500 instrument elevator system. The instruments are standard Climatronics products. The applicant uses Yokogawa digital equipment to receive the observations, which are displayed using the Meteorological Information and Dispersion Assessment System (MIDAS). The Climatronics Signal Conditioning Equipment is powered by dual (redundant) Hewlett Packard Model 6291A direct current power supplies.

During a site audit conducted on December 6, 2006, the staff reviewed the applicant's meteorology equipment calibration procedures in detail and found them to be adequate to ensure a reliable meteorological measurements program in accordance with RG 1.23. For example, the delta temperature calibration involves temperature baths using reference temperatures of 32 °F and 100 °F; the applicant checks to ensure on a regular basis that the delta-temperature instrumentation is taking accurate measurements. The applicant uses similar procedures for the other meteorological measurement equipment.

The applicant monitors the meteorology instruments at least once a week. Maintenance is performed in accordance with instrument manuals and is intended to maintain, at least, a 90-percent data recovery. From 1998–2002, the average data recovery rates are well above the RG 1.23 90-percent threshold.

Although all of the 5-year average recovery rates were still above 90 percent, the staff computed slightly different values for some of the annual data recovery rates. During a site audit conducted on December 6, 2006, the staff asked the applicant to verify the validity of the yearly data recovery statistics presented in the application. In a letter dated January 30, 2007, the applicant agreed with the values presented by the staff and stated that the hourly meteorological database was going to be updated. In RAI 2.3.3-1, the staff asked the applicant to provide the NRC with a copy of the updated hourly meteorological database. The applicant complied with this request. After receiving the updated and revised meteorological data, the staff was able to produce the same data recovery statistics as the applicant.

The applicant provided system performance specifications for the meteorological monitoring program, which are listed in SER Table 2.3.3-1. These values are consistent with RG 1.23 and thus accepted by the staff. Meteorological data samples are taken every 5 seconds and recorded as 15- and 60-minute averages. The 15-minute averages are used for emergency planning purposes, while the January 1998 through December 2002 hourly averages were used to compute the short-term and long-term diffusion estimates presented in SSAR Sections 2.3.4 and 2.3.5.

The description of meteorological instrumentation, including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the QA program for sensors and recorders, and data acquisition and reduction procedures are in compliance with the guidelines of RG 1.23. Thus, the staff considers the meteorological instrumentation to be acceptable.

2.3.3.3.2 Meteorological Data

The applicant used the existing onsite meteorological measurements program from the Vogtle facility (Units 1 & 2) to collect hourly meteorological data. The applicant provided seasonal and annual summaries of onsite meteorological data in the SSAR, based on hourly measurements, from instrumentation mounted on the primary tower, taken over the 5-year period from 1998 through 2002. The applicant provided a copy of this 1998–2002 hourly database to the staff.

The staff performed a quality review of the 1998–2002 hourly meteorological database using the methodology described in NUREG-0917, "Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data," issued July 1982. The staff used computer spreadsheets to perform further review. During a site audit conducted on December 6, 2006, the staff notified the applicant that it had identified a few inconsistencies in the data (such as overly persistent wind directions or stability classes, temperature observations switching between degrees Celsius (°C) and Fahrenheit (°F), or delta-temperature measurements exceeding the auto-convective lapse rate) and asked the applicant for an explanation. The applicant responded in a letter dated January 30, 2007, that it would revise the onsite meteorological database to address these concerns. The staff reviewed a copy of this revised database and finds that the applicant has addressed all of the above concerns; a comparison between the JFD used by the applicant as input to the PAVAN and XOQDOQ atmospheric dispersion computer codes and a staff-generated JFD from the hourly database provided by the applicant shows that the two JFDs are similar.

To further check the validity and accuracy of the onsite meteorology data, the staff compared hourly data from the VEGP application to concurrent data obtained from the NCDC integrated hourly surface observations for Augusta. SER Table 2.3.3-2 compares 1998–2002 annual temperature, atmospheric moisture, wind speed, and wind direction statistics between the VEGP onsite data and the Augusta NWS data. The comparison of the 1998–2002 onsite temperature, atmospheric moisture, wind speed, and wind direction data with similar data recorded at Augusta for the same period of record shows that the Vogtle onsite data are reasonable.

Because of the reasonable correlation between the Augusta and Vogtle data, long-term temperature and atmospheric moisture data from Augusta are appropriate for determining the ambient air temperature and humidity site characteristics presented in SSAR Section 2.3.1. The Augusta annual maximum and minimum temperatures tend to be slightly more extreme than the Vogtle data. This implies that using Augusta data to characterize the extreme temperatures expected onsite is a conservative approach.

Based on an independent analysis of the onsite meteorological data and a comparison with hourly data from the Augusta NWS station, the staff accepts the 5 years of onsite data provided by the applicant as being representative of the site and an acceptable basis for estimating atmospheric dispersion for DBA and routine releases in SSAR Sections 2.3.4 and 2.3.5.

2.3.3.4 Conclusion

The NRC staff evaluated the relevant sections of the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007, pursuant to the acceptance criteria of RS-002 Section 2.3.3 and applicable regulatory requirements of 10 CFR Part 52 and 10 CFR Part 100. Based on the preceding discussion, the staff concludes that the applicant has successfully implemented an appropriate onsite meteorological measurements program and that data from this program provide an acceptable basis for estimating atmospheric dispersion for DBA and routine releases from a nuclear power plant of the type specified by the applicant. Therefore, the staff finds that the applicant has provided the information required to address 10 CFR 52.17(a)(1), 10 CFR 100.20(c), and 10 CFR 100.21(d). The staff also finds that analysis and conclusions regarding the site-specific adequacy of onsite meteorological instrumentation are sufficient to support the staff's evaluation of the applicant's proposed emergency plan, in SER Chapter 13, per 10 CFR 50.47 and 10 CFR Part 50, Appendix E.

Table 2.3.3-1 - Onsite Meteorological Monitoring Program Specifications

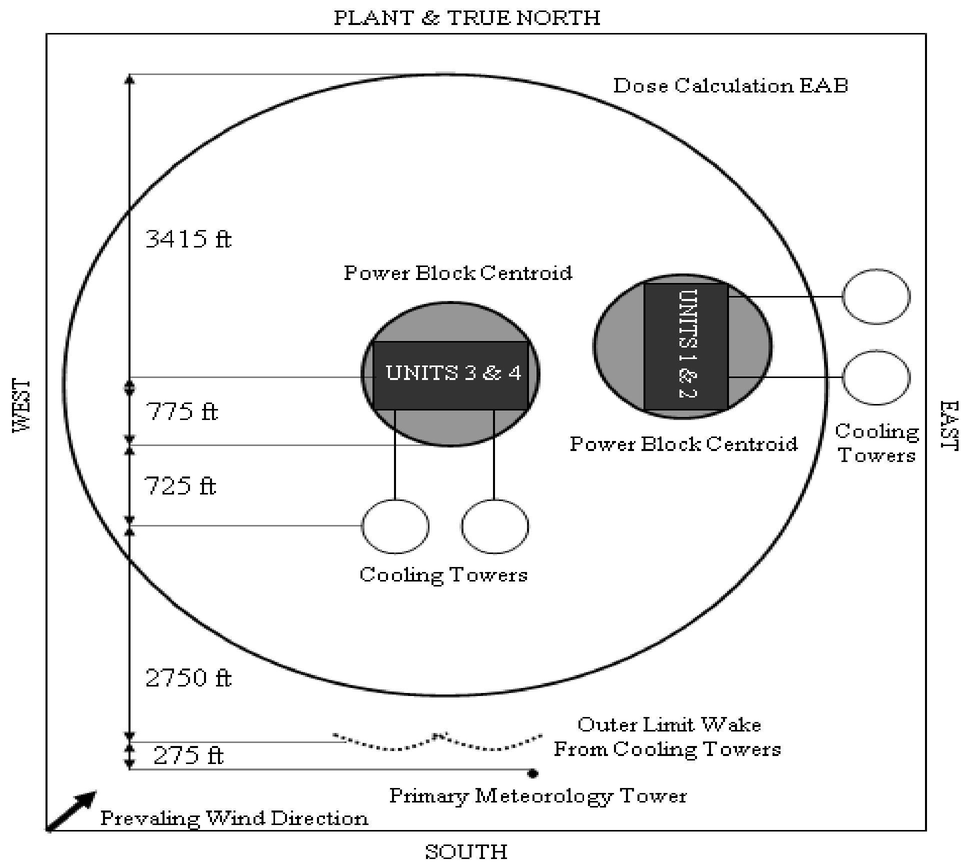
PARAMETER	RANGE	SYSTEM ACCURACY
Wind speed	0 - 100 mi/h	± 0.5 mi/h
Wind Direction	0 ° – 360 °	± 5 °
Ambient Temperature	-10 ° – 120 °F	± 0.9 °F
Differential Temperature	-5 ° – 10 °F	± 0.27 °F

Table 2.3.3-2 - Comparison of Augusta NWS and Vogtle Meteorology Observations

	ANNUAL AVERAGE TEMPERATURE		EXTREME MAXIMUM ANNUAL TEMPERATURE		EXTREME MINIMUM ANNUAL TEMPERATURE	
	AUGUSTA	VOGTLE	AUGUSTA	VOGTLE	AUGUSTA	VOGTLE
1998	65 °F	66 °F	103 °F	102 °F	19 °F	25 °F
1999	64 °F	65 °F	107 °F	104 °F	13 °F	17 °F
2000	63 °F	63 °F	101 °F	98 °F	13 °F	17 °F
2001	64 °F	64 °F	97 °F	94 °F	12 °F	20 °F
2002	64 °F	65 °F	101 °F	96 °F	16 °F	17 °F

	ANNUAL AVERAGE DEWPOINT		ANNUAL AVERAGE WIND SPEED		ANNUAL PREVAILING WIND DIRECTION	
	AUGUSTA	VOGTLE	AUGUSTA	VOGTLE	AUGUSTA	VOGTLE
1998	53 °F	53 °F	4.9 mi/h	5.1 mi/h	WSW	WSW
1999	51 °F	50 °F	5.3 mi/h	5.1 mi/h	WSW	SW
2000	52 °F	49 °F	5.1 mi/h	5.3 mi/h	WSW	SW
2001	52 °F	50 °F	5.1 mi/h	5.5 mi/h	WSW	W
2002	53 °F	51 °F	5.3 mi/h	5.2 mi/h	WSW	W

Figure 2.3.3-1 - Proposed Layout for VEGP Site



2.3.4 Short-Term Diffusion Estimates

2.3.4.1 Introduction

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 the outer boundary of the LPZ. The applicant provided the following specific information:

- Atmospheric transport and diffusion models to calculate dispersion estimates (atmospheric dispersion factors, relative concentrations, or χ/Q values) for postulated accidental radioactive releases.
- Meteorological data summaries used as input to dispersion models.
- Diffusion parameters.
- Determination of χ/Q values used for assessment of consequences of postulated radioactive atmospheric releases from design-basis and other accidents.

This section verifies that the applicant has used appropriate atmospheric dispersion models and meteorological data to calculate relative concentrations at appropriate distances and directions from postulated release points for the evaluation of accidental airborne releases of radioactive material.

2.3.4.2 Regulatory Basis

The acceptance criteria for calculating atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The staff considered the following regulatory requirements in reviewing the applicant's calculation of atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents

- 10 CFR 100.20(c), which requires that the meteorological characteristics of the site, necessary for safety analysis or that may have an impact on plant design, be identified and characterized as part of the NRC's review of the acceptability of a site.
- 10 CFR 100.21(c)(2), which requires that site atmospheric dispersion characteristics be evaluated and dispersion parameters established such that radiological dose consequences of postulated accidents shall meet the criteria set forth in 10 CFR 50.34(a)(1) for the type of facility proposed to be located at the site.

The applicant also originally identified Appendix E to 10 CFR Part 50 as applicable to SSAR Section 2.3.4. In RAI 2.3.4-2, the staff asked the applicant to explain how Appendix E applies to the development of the short-term (accidental release) atmospheric dispersion estimates presented in SSAR Section 2.3.4. The applicant responded by deleting the reference to Appendix E to 10 CFR Part 50 in SSAR Section 2.3.4.

RS-002, Section 2.3.4 specifies that an application meets the above requirements, if the application provides the following information:

- A description of the atmospheric dispersion models used to calculate relative concentrations (χ/Q values) in air resulting from accidental releases of radioactive material to the atmosphere. The models should be 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.

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

- The variation of atmospheric diffusion parameters used to characterize lateral and vertical plume spread as a function of distance, topography, and atmospheric conditions, as related to measured meteorological parameters. The methodology for establishing these relationships should be appropriate for estimating the consequences of accidents within the range of distances which are of interest with respect to site characteristics and established regulatory criteria.

- Cumulative probability distributions of relative concentrations (χ/Q values) describing the probabilities of these χ/Q values being exceeded. These cumulative probability distributions should be presented for appropriate distances and time periods as specified in Section 2.3.4.2 of RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." The methods of generating these distributions should be adequately described.

- Relative concentrations used for assessment of consequences of atmospheric radioactive releases from design-basis and other accidents.

To the extent applicable to the above-outlined acceptance criteria, the applicant applied the NRC-endorsed analytical methodologies, models and parameters found in the following:

- RG 1.23, which provides criteria for an acceptable onsite meteorological measurements program, data from which are used as input to atmospheric dispersion models.

- RG 1.70, which states that the SSAR should provide atmospheric estimates at the EAB and outer boundary of the LPZ for appropriate time periods up to 30 days after an accident based on the most representative meteorological data and potential impacts of topography on atmospheric dispersion site characteristics.

- RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," which provides acceptable methods for characterizing annual average atmospheric transport and diffusion conditions for evaluating the consequences of radiological releases at the EAB and outer boundary of the LPZ.

- RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," which provides acceptable methods for characterizing atmospheric dispersion conditions for appropriate time periods up to 30 days for evaluating the consequences of DBA radiological releases to the EAB and outer boundary of the LPZ.

- RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," which provides criteria on the use of alternative radiological source terms for evaluating the consequences of DBAs.

- RG 4.7, which provides criteria on the amount of meteorological data necessary to ensure the generation of representative atmospheric dispersion site characteristics.

The applicant originally identified RG 1.78 as applicable to SSAR Section 2.3.4. In RAI 2.3.4-3, the staff asked the applicant to explain how RG 1.78 applies to the development of the short-term (accidental release) atmospheric dispersion site characteristics presented in SSAR Section 2.3.4. The applicant responded by deleting the reference to RG 1.78 for SSAR Section 2.3.4.

When independently assessing the veracity of the information presented by the applicant in SSAR Chapter 2.3.4, the NRC staff applied the same above-cited methodologies, models and parameters.

2.3.4.3 Technical Evaluation

Using the approaches and analytic methodologies described in RS-002 Section 2.3.4, the NRC staff reviewed the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007. In reviewing and evaluating the applicant's short-term atmospheric dispersion estimates, the staff used (or relied on) only the elevation of the post-accident release point from the design parameters and site interface values presented by the applicant in SSAR Section 1.3.

2.3.4.3.1 Atmospheric Dispersion Mode

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,") to estimate χ/Q values at the EAB and at the outer boundary of the LPZ for potential accidental releases of radioactive material. The PAVAN model implements the methodology outlined in RG 1.145.

The PAVAN code estimates χ/Q values for various time-average periods ranging from 2 hours to 30 days. The meteorological input to PAVAN consists of a joint frequency distribution (JFD) of hourly values of wind speed and wind direction by atmospheric stability class. In response to RAI 2.3.4-5, the applicant provided a copy of the input file used to compute the χ/Q values listed in SSAR Section 2.3.4. The staff used this input file, as well as the hourly meteorological data, to verify the χ/Q values presented by the applicant, as discussed in SER Section 2.3.4.3.4.

The χ/Q values calculated through PAVAN are based on the theoretical assumption that material released to the atmosphere will be normally distributed (Gaussian) about the plume centerline. A straight-line trajectory is assumed between the point of release and all distances for which χ/Q values are calculated.

For each of the 16 downwind direction sectors (e.g., N, NNE, NE, ENE), PAVAN calculates χ/Q values for each combination of wind speed and atmospheric stability at the appropriate downwind distance (i.e., the EAB and the outer boundary of the LPZ). The χ/Q values calculated for each sector are then ordered from greatest to smallest and an associated cumulative frequency distribution is derived based on the frequency distribution of wind speed and stabilities for each sector. The smallest χ/Q value in a distribution will have a corresponding cumulative frequency equal to the wind direction frequency for that particular sector. PAVAN determines for each sector an upper envelope curve based on the derived data (plotted as χ/Q versus probability of being exceeded), such that no plotted point is above the curve. From this upper envelope, the χ/Q value, which is equaled or exceeded 0.5 percent of the total time, is obtained. The maximum 0.5 percent χ/Q value from the 16 sectors becomes the 0–2 hour "maximum sector χ/Q value."

Using the same approach, PAVAN also combines all χ/Q values independent of wind direction into a cumulative frequency distribution for the entire site. An upper envelope curve is determined, and the program selects the χ/Q value which is equaled or exceeded 5.0 percent of the total time. This is known as the 0–2 hour "5-percent overall site χ/Q value."

The larger of the two χ/Q values, either the 0.5-percent maximum sector value or the 5-percent overall site value, is selected to represent the χ/Q value for the 0–2 hour time interval (note that this resulting χ/Q value is based on 1-hour averaged data but is conservatively assumed to apply for 2 hours).

To determine χ/Q values for longer time periods (i.e., 0–8 hour, 8–24 hour, 1–4 days, and 4-30 days), PAVAN performs a logarithmic interpolation between the 0–2 hour χ/Q values and the annual average (8760-hour) χ/Q values for each of the 16 sectors and overall site. For each time period, the highest among the 16 sector and overall site χ/Q values is identified and becomes the short-term site characteristic χ/Q value for that time period.

2.3.4.3.2 Meteorological Data Input

The meteorological input to PAVAN used by the applicant consisted of a JFD of wind speed, wind direction, and atmospheric stability based on hourly onsite data from January 1998 through December 2002. The wind data were obtained from the 10-meter level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 60-meter and 10-meter levels on the onsite meteorological tower.

As discussed in SER Section 2.3.3, the staff considers the 1998–2002 onsite meteorological database suitable for input to the PAVAN model.

2.3.4.3.3 Diffusion Parameters

The applicant chose to implement the diffusion parameter assumptions outlined in RG 1.145, as a function of atmospheric stability, for its PAVAN model runs. The staff evaluated the applicability of the PAVAN diffusion parameters and concluded that no unique topographic features (such as rough terrain, restricted flow conditions, or coastal or desert areas) preclude the use of the PAVAN model for the VEGP site. Therefore, the staff finds that the applicant's use of diffusion parameter assumptions, as outlined in RG 1.145, was acceptable.

2.3.4.3.4 Relative Concentration for Accident Consequences Analysis

The applicant modeled one ground-level release point and did not take credit for building wake effects. Ignoring building wake effects for a ground-level release decreases the amount of atmospheric turbulence assumed to be in the vicinity of the release point, resulting in higher (more conservative) χ/Q values. A ground-level release assumption is therefore acceptable to the staff.

The applicant defined a "dose calculation" EAB as a circle that extends 0.5 mile beyond the power block area.[9] Consequently, the applicant executed PAVAN using a distance from release point to the

[9] Because the power block area is defined as being within a 775-foot-radius circle centered on a point between the two proposed AP1000 units, the dose calculation EAB can also be defined as a circle with a radius of 3,415 feet from the proposed power block centroid.

dose calculation EAB of 0.5 mile (800 meters) for all downwind sectors. The applicant stated that because the dose calculation EAB is circumscribed the “true” (actual) EAB for the site, any χ/Q values produced by PAVAN will be conservative estimates. The staff verified that the dose calculation EAB is within the true EAB for the site and is therefore acceptable to the staff.

The outer boundary of the LPZ for the proposed facility is a 2-mile-radius circle centered on the existing power block. The applicant chose to use a downwind distance of 1.4 miles (2304 meters) for all direction sectors for calculating LPZ χ/Q values because this is the shortest distance in any direction from the proposed power block area boundary to the predefined LPZ. The use of the shortest distance results in higher (more conservative) χ/Q values and is therefore acceptable to the staff.

SER Table 2.3.4-1 lists the short-term atmospheric dispersion estimates for the dose calculation EAB and the outer boundary of the LPZ that the applicant derived from its PAVAN modeling run results. The applicant identified these χ/Q values as site characteristics in SSAR Table 1-1 because these are the atmospheric dispersion site characteristics used by the applicant to demonstrate compliance with the terms of 10 CFR 100.21(c)(2) for the radiological dose consequences of postulated accidents.

The applicant originally identified the 0.5-percent maximum sector EAB χ/Q value as being larger than the 5-percent overall site EAB χ/Q value. In contrast, by way of confirmatory analysis, the staff found the 5-percent overall site χ/Q value to be the larger of the two values. In RAI 2.3.4-4, the staff asked the applicant to confirm which of the two χ/Q values is more limiting for the site. The applicant responded that a new PAVAN run, using the revised meteorological database discussed in SER Section 2.3.3, verified the staff’s results: the 5-percentile overall site EAB χ/Q value did indeed bound the 0.5-percentile maximum sector EAB χ/Q value.

The staff confirmed the applicant’s atmospheric dispersion estimates by running the PAVAN computer model and obtaining similar results (i.e., plus or minus 4 percent).

In light of the foregoing, the staff accepts the short-term χ/Q values presented by the applicant. The staff will include the short-term χ/Qs listed in SER Table 2.3.4-1 as site characteristics in any ESP that the NRC may issue for the VEGP site.

2.3.4.4 Conclusion

The NRC staff has evaluated the relevant sections of the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007, pursuant to the acceptance criteria described in RS-002 Section 2.3.4 and the applicable regulatory requirements of 10 CFR Part 52 and 10 CFR Part 100. As discussed above, the applicant provided meteorological data and an atmospheric dispersion model that are appropriate for the characteristics of the site. Therefore, the staff concludes that representative atmospheric transport and diffusion conditions have been calculated at the EAB and the outer boundary of the LPZ, and, thus, that the applicant has provided the information required to comply with the applicable provisions of 10 CFR Part 52 and 10 CFR 100.21(c)(2).

Table 2.3.4-1 - Short-Term (Accidental Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2 hr χ/Q value @ EAB	3.49×10^{-4} s/m^3	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accidental airborne releases.
0–8 hr χ/Q value @ LPZ outer boundary	7.04×10^{-5} s/m^3	
8–24 hr χ/Q value @ LPZ outer boundary	5.25×10^{-5} s/m^3	
1–4 day χ/Q value @ LPZ outer boundary	2.77×10^{-5} s/m^3	
4–30 day χ/Q value @ LPZ outer boundary	1.11×10^{-5} s/m^3	

2.3.5 Long-Term Diffusion Estimates

2.3.5.1 Introduction

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

- 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.
- 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.
- meteorological data used as input to dispersion models.
- diffusion parameters.
- relative concentration factors (χ/Q values) and relative deposition factors (D/Q values) used to assess the consequences of routine airborne radioactive releases.

This section verifies that the applicant has used appropriate atmospheric dispersion models and meteorological data to calculate relative concentration and relative deposition at appropriate distances and directions from postulated release points for the evaluation of routine airborne releases of radioactive material.

2.3.5.2 Regulatory Basis

The acceptance criteria for calculating atmospheric dispersion estimates for routine releases of radiological effluents are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The staff considered the following regulatory requirements in reviewing the applicant's calculation of atmospheric dispersion estimates for routine releases of radiological effluents:

- 10 CFR 100.20(c), which requires that the meteorological characteristics of the site, necessary for safety analysis or that may have an impact on plant design, be identified and characterized as part of the NRC's review of the acceptability of a site.
- 10 CFR 100.21(c)(1), which requires that site atmospheric dispersion characteristics be evaluated and dispersion parameters established such that radiological effluent release limits associated with normal operation from the type of facility to be located at the site can be met for any individual located offsite.

Characterization of atmospheric transport and diffusion conditions is necessary for estimating the radiological consequences of routine releases of radioactive materials to the atmosphere, so as to demonstrate compliance, at the COL stage, with the numerical guides for doses contained in 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and limiting Conditions for Operation to Meet the Criterion 'As Low as Reasonable Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents."

The applicant originally identified in its application Appendix E to 10 CFR Part 50 as applicable to SSAR Section 2.3.5. In RAI 2.3.5-3, the staff asked the applicant to explain how Appendix E applies to the development of the long-term (routine release) atmospheric dispersion estimates presented in SSAR Section 2.3.5. The applicant responded by deleting the reference to Appendix E to 10 CFR Part 50 in SSAR Section 2.3.5.

RS-002, Section 2.3.5 specifies that an application meets the above requirements, if the application provides the following information:

- 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.

- A discussion of the relationship between atmospheric diffusion parameters, such as vertical plume spread, and measured meteorological parameters. Use of these parameters should be substantiated as to their appropriateness for use in estimating the consequences of routine releases from the site boundary to a radius of 50 miles from the plant site.

- 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.

- Relative concentration (χ/Q) and relative deposition (D/Q) values used for assessment of consequences of routine radioactive gas 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.

To the extent applicable to the above-outlined acceptance criteria, the applicant applied the NRC-endorsed analytical methodologies, models and parameters found in the following:

- RG 1.23, which provides criteria for an acceptable onsite meteorological measurements program, data from which are used as input to atmospheric dispersion models.

- RG 1.70, which states that the SSAR should provide realistic estimates of annual average atmospheric transport and diffusion characteristics out 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 value at or beyond the site boundary for each venting location.

- 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," which presents identification criteria to be used for specific receptors of interest.

- RG 1.111, which provides acceptable methods for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine effluent releases.

- RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," which provides criteria for identifying release points and release characteristics.

When independently assessing the veracity of the information presented by the applicant in SSAR Chapter 2.3.5, the NRC staff applied the same above-cited methodologies, models and parameters.

2.3.5.3 Technical Evaluation

Using the approaches and analytic methodologies described in RS-001 Section 2.3.5, the NRC staff reviewed the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007. In reviewing and evaluating the applicant's long-term atmospheric dispersion estimates, the staff used (or relied on) none of the applicant's proposed design parameters and site interface values presented in SSAR Section 1.3, but did rely on the routine release point elevation, containment building minimum cross-sectional area, and the equivalent structural height values presented by the applicant in SSAR Section 2.3.5.

2.3.5.3.1 Atmospheric Dispersion Model

The applicant used the NRC-sponsored computer code XOQDOQ (described in NUREG/CR-2919, "XOQDOQ Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations,") to estimate χ/Q and D/Q values resulting from routine releases. The XOQDOQ model implements the methodology outlined in RG 1.111.

The XOQDOQ model is a straight-line Gaussian plume model based on the theoretical assumption that material released to the atmosphere will be normally distributed (Gaussian) about the plume centerline. In predictions of χ/Q and D/Q values for long time periods (i.e., annual averages), the plume's horizontal distribution is assumed to be evenly distributed within the downwind direction sector (e.g., "sector averaging").

Because geographic features such as hills, valleys, and large bodies of water can potentially influence dispersion and airflow patterns, terrain recirculation factors can be used to adjust the results of a straight-line trajectory model such as XOQDOQ to account for terrain-induced flows, recirculation, or stagnation. In RAI 2.3.5-5, the staff asked the applicant to explain why it did not use terrain recirculation factors, which were used in Chapter 8 of Revision 21 of the VEGP Offsite Dose Calculation Manual (ODCM, dated October 1, 2003), in developing the long-term χ/Qs presented in the VEGP SSAR. The applicant responded that the topographic features in the site vicinity do not require the use of terrain recirculation factors and that the analyses reported in the Unit 1/Unit 2 FSAR did not use these factors. The applicant also stated that most terrain recirculation factors used in the ODCM for ground-level releases are about 1. Based on SSAR Figure 2.3-15, topographical descriptions in SSAR Section 2.3.1, and a site audit conducted on December 6, 2006, the staff agrees with the applicant that the site can be characterized as having open terrain with gently rolling hills. Thus, the staff concludes that XOQDOQ modeling results are applicable to the site and no unique topographic features (such as valley, desert, or overall water trajectories) preclude the use of the model for the proposed VEGP site.

2.3.5.3.2 Release Characteristics and Receptors

The applicant modeled one ground-level release point, assuming a minimum building cross-sectional area of 2,926 square meters and a containment "equivalent" structure height of 65.6 meters. The staff asked the applicant in RAI 2.3.5-1 to provide the basis for the calculation of the containment building minimum cross-sectional area and equivalent structural height. In its response, the applicant stated that the equivalent structure height was determined by dividing the building cross-sectional area by the width of the proposed reactor containment at the bottom.

A ground-level release is a conservative assumption resulting in higher χ/Q and D/Q values when compared to a mixed-mode (e.g., part-time ground, part-time elevated) release or a 100-percent elevated release, as discussed in RG 1.111. A ground-level release assumption is therefore acceptable to the staff.

The applicant executed XOQDOQ using a distance from the release point to the dose calculation EAB of 0.5 mile (800 meters) for all downwind sectors as discussed in SSAR Section 2.3.4.3. The applicant also placed receptors of interest (i.e., resident, meat animal, and vegetable garden) in all compass directions at a downwind distance of 1,071 meters. This distance is based on the closest of these receptors (the nearest resident in the west-southwest sector), as identified in the VEGP "Annual Radiological Environmental Operating Report (AREOP) for 2004," produced by Southern Company (ADAMS Accession No. ML051380059). This is a conservative assumption and is therefore acceptable to the staff. SER Table 2.3.5-1 compares the AREOP distances and the distances used as input to the XOQDOQ model.

2.3.5.3.3 Meteorological Data Input

The meteorological input to XOQDOQ consists of a JFD of wind speed, wind direction, and atmospheric stability based on hourly onsite data from January 1998 through December 2002. The wind data were obtained from the 10-meter level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 60-meter and 10-meter levels on the onsite meteorological tower.

As discussed in SER Section 2.3.3, the staff considers the 1998–2002 onsite meteorological database suitable for input to the XOQDOQ model.

2.3.5.3.4 Diffusion Parameters

The applicant chose to implement the diffusion parameter assumptions outlined in RG 1.111, as a function of atmospheric stability, for its XOQDOQ model runs. The staff evaluated the applicability of the XOQDOQ diffusion parameters and concluded that no unique topographic features (such as valley, desert, or over water trajectories) preclude the use of the XOQDOQ model for the VEGP site. Therefore, the staff finds that the applicant's use of diffusion parameter assumptions, as outlined in RG 1.111, was acceptable.

2.3.5.3.5 Resulting Relative Concentration and Relative Deposition Factors

SER Table 2.3.5-2 lists the long-term atmospheric dispersion and deposition estimates for the dose calculation EAB and special receptors of interest that the applicant derived from its XOQDOQ modeling results. The applicant identified these χ/Q and D/Q values as site characteristics in SSAR Table 1-1 because these are the atmospheric dispersion site characteristics used by the applicant to demonstrate compliance with the terms of 10 CFR 100.21(c)(1) for the radiological dose consequences related to routine operation.

In response to RAI 2.3.5-6, the applicant provided long-term atmospheric dispersion and deposition estimates for all 16 radial sectors from the site boundary, to a distance of 50 miles from the proposed facility, in SSAR Table 2.3-18. The COL applicant will need to use this information to show that the proposed plant's gaseous radiological waste systems include all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit return, can, for a favorable cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor, in accordance with the requirements of Section II.D of Appendix I to 10 CFR Part 50.

The χ/Q values presented in SER Table 2.3.5-2 reflect several plume radioactive decay and deposition scenarios. Section C.3 of RG 1.111 states that radioactive decay and dry deposition should be considered in radiological impact evaluations of potential annual radiation doses to the public, resulting from routine releases of radioactive materials in gaseous effluents. Section C.3.a of RG 1.111 states that an overall half-life of 2.26 days is acceptable for evaluating the radioactive decay of short-lived noble gases and an overall half-life of 8 days is acceptable for evaluating the radioactive decay for all iodines released to the atmosphere.

Definitions for the χ/Q categories listed in the headings of SER Table 2.3.5-2 are as follows:

- Undepleted/No Decay χ/Q values are χ/Qs used to evaluate ground-level concentrations of long-lived noble gases, tritium, and carbon-14. The plume is assumed to travel downwind, without undergoing dry deposition or radioactive decay.

- Undepleted/2.26-Day Decay χ/Q values are χ/Qs used to evaluate ground-level concentrations of short-lived noble gases. The plume is assumed to travel downwind, without undergoing dry deposition, but is decayed, assuming a half-life of 2.26 days, based on the half-life of xenon-133m.

- Depleted/8.00-Day Decay χ/Q values are χ/Qs used to evaluate ground-level concentrations of radioiodine and particulates. The plume is assumed to travel downwind, with dry deposition, and is decayed, assuming a half-life of 8.00 days, based on the half-life of iodine-131.

The applicant provided a copy of its XOQDOQ input file in response to RAI 2.3.5-4. Using this information as well as the updated meteorological data provided by the applicant in its March 30, 2007 letter, the staff confirmed the applicant's χ/Q and D/Q values by running the XOQDOQ computer code and obtaining the same results.

In light of the foregoing, the staff accepts the long-term χ/Q and D/Q values presented by the applicant. The staff will include the long-term atmospheric dispersion and deposition factors listed in SER Table 2.3.5-2 as site characteristics in any ESP that the NRC might issue for the VEGP site.

2.3.5.4 Conclusion

The NRC staff evaluated the relevant sections of the application, as supplemented by letters dated January 30, 2007, March 26, 2007, and March 30, 2007, pursuant to the acceptance criteria of RS-002 Section 2.3.5 and applicable regulatory requirements of 10 CFR Part 52 and 10 CFR Part 100. As discussed above, the applicant has provided meteorological data and an atmospheric dispersion model that are appropriate for the characteristics of the site and release points. Therefore, the staff concludes that the applicant has calculated representative atmospheric transport and diffusion conditions for 16 radial sectors from the site boundary to a distance of 50 miles and for the specific receptor locations.

Therefore, the applicant has provided the information required to address 10 CFR 52.17(a), 10 CFR 100.20, and 10 CFR 100.21(c)(1). The staff also concludes that the applicant's characterization of long-term atmospheric transport and diffusion conditions would be appropriate, at the COL stage, for use in demonstrating compliance with the numerical guides for doses contained in Appendix I to 10 CFR Part 50.

Table 2.3.5-1 - Distances between the Proposed Units 3 and 4 Power Block and Receptors of Interest[10]

RECEPTOR	DOWNWIND DIRECTION SECTOR	DISTANCE COMPILED FROM THE AREOP	DISTANCE USED
Nearest Resident	N	2032 m	1071 m
	NNE	>8045 m	1071 m
	NE	>8045 m	1071 m
	ENE	>8045 m	1071 m
	E	>8045 m	1071 m
	ESE	7118 m	1071 m
	SE	7327 m	1071 m
	SSE	7410 m	1071 m
	S	6835 m	1071 m
	SSW	7068 m	1071 m
	SW	3633 m	1071 m
	WSW	1071 m	1071 m
	W	5024 m	1071 m
	WNW	2069 m	1071 m
	NW	>8045 m	1071 m
	NNW	1946 m	1071 m
Meat Animal	N	>8045 m	1071 m
	NNE	>8045 m	1071 m
	NE	>8045 m	1071 m
	ENE	>8045 m	1071 m
	E	>8045 m	1071 m
	ESE	>8045 m	1071 m
	SE	>8045 m	1071 m
	SSE	7414 m	1071 m
	S	>8045 m	1071 m
	SSW	6736 m	1071 m
	SW	7155 m	1071 m
	WSW	6366 m	1071 m
	W	6170 m	1071 m
	WNW	>8045 m	1071 m
	NW	2400 m	1071 m
	NNW	>8045 m	1071 m
Vegetable Garden	N	>8045 m	1071 m
	NNE	>8045 m	1071 m
	NE	>8045 m	1071 m
	ENE	>8045 m	1071 m
	E	>8045 m	1071 m
	ESE	>8045 m	1071 m
	SE	>8045 m	1071 m
	SSE	>8045 m	1071 m
	S	>8045 m	1071 m
	SSW	>8045 m	1071 m
	SW	>8045 m	1071 m
	WSW	4273 m	1071 m
	W	>8045 m	1071 m
	WNW	4458 m	1071 m
	NW	5899 m	1071 m
	NNW	>8045 m	1071 m

[10] Note that 2004 AREOP did not report any milk-giving animals (either cows or milk) within a 5-mile radius of the proposed VEGP site.

Table 2.3.5-2 - Long-Term (Routine Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average Undepleted/No Decay χ/Q Value @ EAB, northeast, 0.5 mile	5.5×10^{-6} s/m^3	The maximum annual average EAB undepleted/no decay atmospheric dispersion factor (χ/Q value) for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ EAB, northeast, 0.5 mile	5.5×10^{-6} s/m^3	The maximum annual average EAB undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Depleted/8.00-Day Decay χ/Q Value @ EAB, northeast, 0.5 mile	5.0×10^{-6} s/m^3	The maximum annual average EAB depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average D/Q Value @ EAB, northeast and east-northeast, 0.5 mile	1.7×10^{-8} 1/m^2	The maximum annual average EAB relative deposition factor (D/Q value) for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Resident, northeast, 0.67 mile	3.4×10^{-6} s/m^3	The maximum annual average resident undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Resident, northeast, 0.67 mile	3.4×10^{-6} s/m^3	The maximum annual average resident undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Resident, northeast, 0.67 mile	3.0×10^{-6} s/m^3	The maximum annual average resident depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average D/Q Value @ Nearest Resident, northeast, east-northeast, and east, 0.67 mile	1.0×10^{-8} 1/m^2	The maximum annual average resident D/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Meat Animal, northeast, 0.67 mile	3.4×10^{-6} s/m^3	The maximum annual average meat animal undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Meat Animal, northeast, 0.67 mile	3.4×10^{-6} s/m^3	The maximum annual average meat animal undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Meat Animal, northeast, 0.67 mile	3.0×10^{-6} s/m^3	The maximum annual average meat animal depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average D/Q Value @ Nearest Meat Animal, northeast, east-northeast, and east, 0.67 mile	1.0×10^{-8} 1/m^2	The maximum annual average meat animal 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 Vegetable Garden, northeast, 0.67 mile	3.4×10^{-6} s/m^3	The maximum annual average vegetable garden undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Vegetable Garden, northeast, 0.67 mile	3.4×10^{-6} s/m^3	The maximum annual average vegetable garden undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Vegetable Garden, northeast, 0.67 mile	3.0×10^{-6} s/m^3	The maximum annual average vegetable garden depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average D/Q Value @ Nearest Vegetable Garden, northeast, east-northeast, and east, 0.67 mile	1.0×10^{-8} 1/m^2	The maximum annual average vegetable garden D/Q value for use in determining gaseous pathway doses to the maximally exposed individual.

2.4 Hydrologic Engineering

2.4.1 Hydrologic Description

2.4.1.1 Introduction

Attachment 2 of RS-002 [Review Standard] discusses the site characteristics that could affect the safe design and siting of proposed plant or plants. Section 2.4 of the applicant's SSAR describes the hydrological setting and the data used in the applicant's safety conclusions regarding hydrology. The NRC staff's review of the SSAR covers: (1) interface of the plant with the hydrosphere; (2) hydrological causal mechanisms; (3) surface and ground water use; (4) data that forms the basis of the applicant's analysis and conclusions; (5) alternate conceptual models; (6) consideration of other site-related evaluation criteria; and (7) additional information for applications under 10 CFR Part 52.

The VEGP site is located on the southwest side of the Savannah River (SNC 2007). The VEGP site currently hosts two nuclear power plants, VEGP Units 1 and 2. The VEGP application proposed the addition of two new nuclear power reactors at the VEGP site (SNC 2007).

2.4.1.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 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. 10 CFR 100.20(c) also requires 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).

Section 2.4.1 of RS-002 provides the following criteria that was used by the NRC staff to evaluate this SSAR section.

- 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) that might be constructed on the proposed site.

- Meeting Section 2.4.1 of RS-002 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. 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, the applicant's SSAR 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 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 technical evaluation consists of: (1) a review of the applicant's technical information presented in the SSAR; and (2) NRC staff's technical evaluation of the hydrology near the site, including appropriateness of the data used by the applicant in its SSAR.

2.4.1.3.1 Technical Information Presented by the Applicant

In Section 2.4 of the SSAR, the applicant described the site area and the facilities that currently exist on the proposed site, including the hydrological and geological setting. In addition, the description included the hydrologic characteristics of the Savannah River Basin along with the major dams and multipurpose projects that manage water supply and provide flood control within the basin. The applicant described that the VEGP site is located on the southeast side of the Savannah River, approximately 15 miles east-northeast of Waynesboro, Georgia, 26 miles southeast of Augusta, Georgia, and 100 miles north-northwest of Savannah, Georgia (SNC, 2006). The VEGP site is located approximately 150 river miles upstream of the mouth of the Savannah River. Elevations in the Savannah River basin range from sea level at the mouth to 5030 ft mean sea level (MSL) at Little Bald Peak in North Carolina. The Savannah River system drains a total of 10,577 square miles. The contributing watershed area of the Savannah River near the VEGP site is approximately 8304 square miles. There are 14 dams in the Savannah River Basin upstream of the VEGP site (SNC, 2006) owned and operated by the U.S. Army Corps of Engineers (USACE) or one of several power generation companies in Georgia and South Carolina. The entire 312-mile reach of the Savannah River is regulated by three major USACE multipurpose projects. The three reservoirs created by these projects are

Hartwell Lake and Dam, Richard B. Russell Lake and Dam, and J. Strom Thurmond Lake and Dam (also known as Clarks Hill Lake and Dam).

The applicant mentioned that the average daily discharge at the USGS gauge 02197320, Savannah River near Jackson, SC, which is located approximately six river miles upstream of the VEGP site, based on 31 years of data is 8913 cubic feet per second (cfps) (SNC, 2006). Based on the same record, the average discharge at this location varies from 7216 cfps in September to 11,347 cfps in March.

The applicant described that the VEGP site is located on a high bluff on the west bank of the Savannah River and has an area of approximately 3169 acres (SNC, 2006). The grade elevations of proposed Units 3 and 4 will be 220 feet MSL or higher. Approximately 4 miles from the VEGP site, Georgia State Highway 23 runs along a topographic ridgeline. The ridgeline separates drainages that generally flow northeast towards the Savannah River from drainages that generally flow to the southwest.

The applicant also detailed the local site drainage at the VEGP site, the current water uses within the Savannah River Basin, and the proposed water consumption for the two new units. A storm water drainage system exists on the VEGP site. This system was developed during construction of existing Units 1 and 2 and provides drainage away from the site. Surface runoff from the high ground where Units 1 and 2 are located is collected in four major drainage channels that are aligned with access roads and railroad facilities (SNC, 2006). The outfall of the drainage channels is to the north, the south, the east, and the west of the site.

The applicant described that annual peak discharges in the Savannah River at Augusta, Georgia, reported by the USGS based on observed streamflow at gauge 02197000, located approximately 48.7 miles upstream of the VEGP site, are presented in the SSAR (SNC, 2006). The annual peak discharges were estimated by USGS for water years (October 1 of the previous calendar year through September 30 of current year) 1796, 1840, 1852, 1864, 1865, and 1876. The maximum annual peak discharge in the period of record is 350,000 cfps, observed on October 2, 1929. The oldest annual peak discharge, on January 17, 1796, was estimated from reported river stages using slope-conveyance methods. The estimated values of the peak discharge on this date vary from 280,000 cfps for a reported stage of 38 feet to 360,000 cfps for a reported maximum flood stage of 40 feet. Based on the elevation of the USGS gauge 02197000 being 96.58 feet MSL, the maximum historic flood elevation of the Savannah River at Augusta, Georgia is estimated between 134.6 and 136.6 feet MSL (SNC, 2006).

Average daily and annual peak discharge data for nine streamflow gauges maintained by the USGS on the Savannah River were used in preparation of SSAR Sections 2.4.11 and 2.4.2, respectively.

Unregulated annual peak discharge values for the period after 1952 were estimated by modeling using the 1990 reservoir operation rules and the stage-storage-discharge characteristics of the three major USACE projects. Estimates of regulated peak discharge values for the period prior to 1952 were also generated using the same approach. Four USGS topographic quadrangles were used to create a map of the topography at the VEGP site. Cross-section profiles of the Savannah River at several locations were used in the SSAR. Air temperature records from eight NWS meteorological stations were used to analyze historical air temperature variations in the SSAR.

2.4.1.3.2 NRC Staff's Technical Evaluation

The NRC staff reviewed the description of the site region, general location and hydrologic interfaces of the VEGP site, and the description of the local site drainage provided by the applicant. The NRC staff independently obtained descriptions and maps of the general region surrounding the VEGP site. The NRC staff created Figure 2.4.1-1 that shows a map of the region where the VEGP site is located. The estimated distances from the VEGP site to the Georgia cities of Augusta, Waynesboro, and Savannah, are 25.7, 14.8, and 83.2 miles, respectively.

The Savannah River Basin straddles the State boundary between Georgia and South Carolina (Figure 2.4.1-2). The NRC staff created the map shown in Figure 2.4.1-2 by using USGS hydrologic unit codes geographical information system (GIS) coverages from the Natural Resources Conservation Service Geospatial Data Gateway. The Savannah River Basin consists of 9 level 4 and 312 level 6 hydrologic unit codes (Seaber et al., 1987), with a total area of 10,218 square miles. The area of the Savannah River Basin estimated from the GIS coverages is 3.4 percent less (10,218 square miles versus 10,577 square miles) than that reported by SNC (2006). The NRC staff's research indicated that the Nature Conservancy (2007) reports the area of the Savannah River Basin as 10,577 square miles. The contributing drainage area at the streamflow gauge at Hardeeville, South Carolina, about 10 miles above the mouth of the Savannah River, is approximately 10,250 square miles (Cooney et al., 2005). The differences in the reported drainage areas for the Savannah River Basin are minor and are not expected to result in any significant differences in estimation of the probable maximum participation (PMP) or the probable maximum flood (PMF) for the Savannah River Basin. The estimation of the drainage area is an intermediate step in the determination of the probable maximum flood in streams and rivers.

Based on its independent assessment, the NRC staff concluded that the applicant presented sufficient information related to hydrologic description in SSAR Section 2.4.1. Later sections of this SER describe the NRC staff's review of hydrological causal mechanisms, water uses, data, and conceptual models.

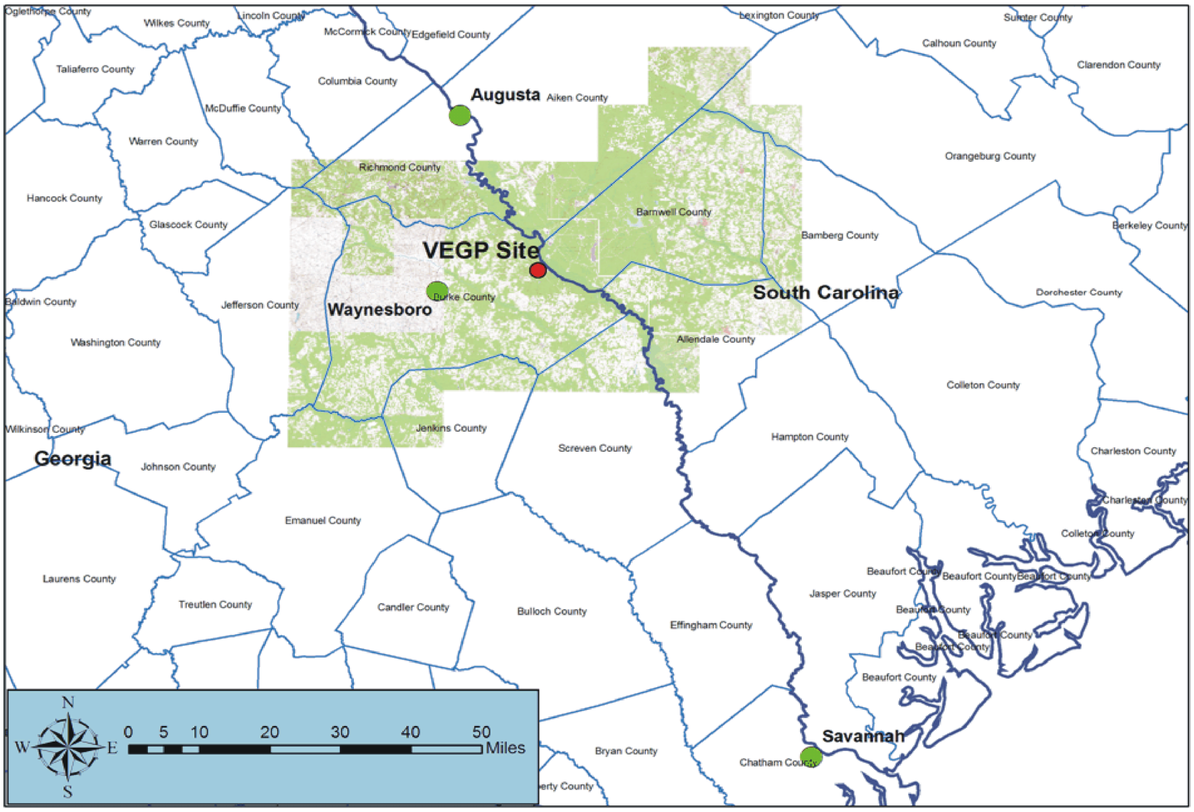


Figure 2.4.1-1 - Location map of the VEGP site

The cities of Augusta, Waynesboro, and Savannah are 25.7, 14.8, and 83.2 miles from the site, respectively. The Savannah River marks the state boundary between South Carolina and Georgia near the VEGP site.

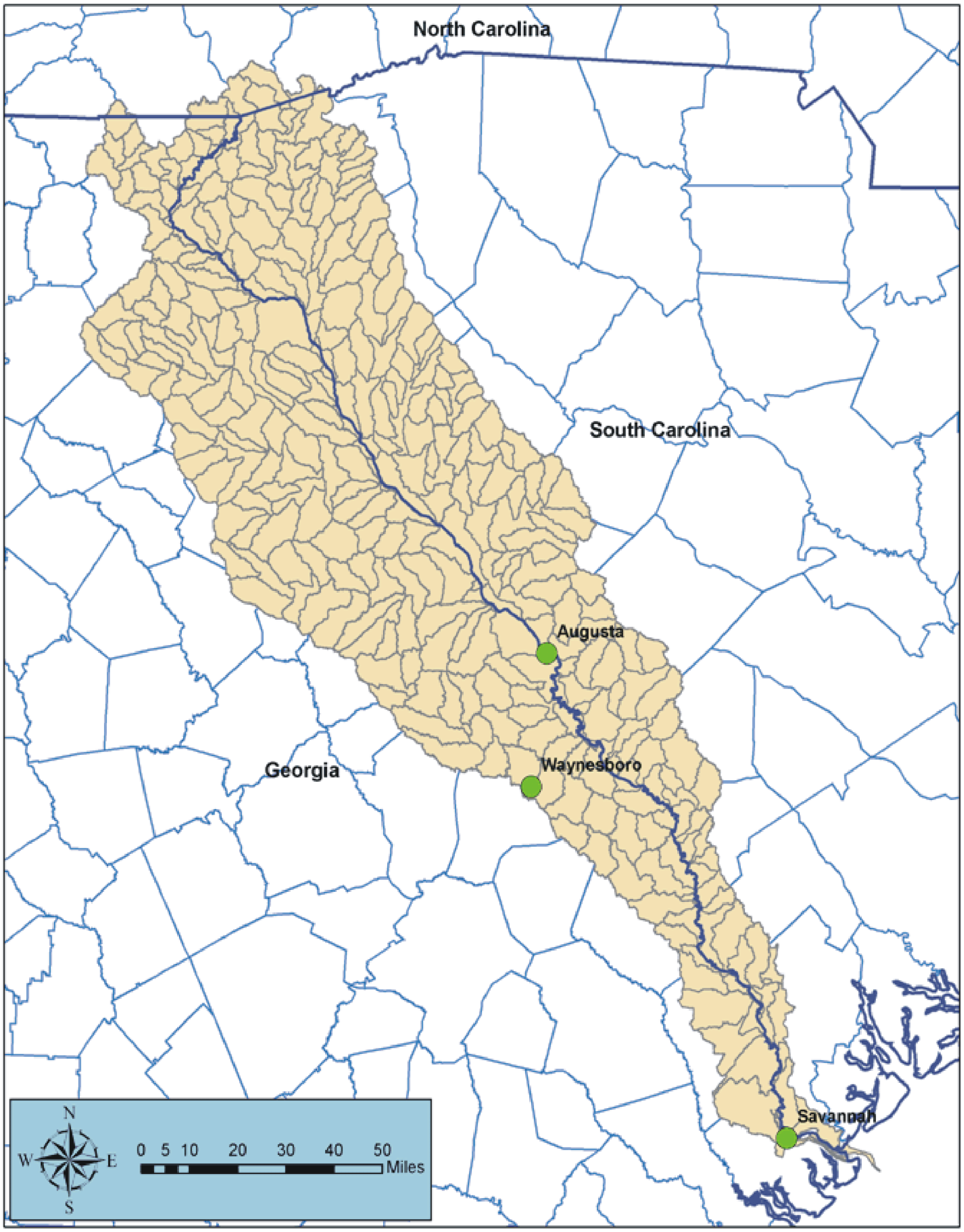


Figure 2.4.1-2 - The Savannah River Basin that straddles the state boundary between Georgia and South Carolina. Portions of the headwaters lie in North Carolina.

2.4.1.4 Conclusion

As set forth above, the applicant has presented and substantiated sufficient information pertaining to the hydrologic description at the proposed site. Section 2.4.1 of RS-002 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the hydrology in the vicinity of the site and site regions, including interface of the plant with the hydrosphere, hydrological causing mechanisms, surface and ground water uses, spatial and temporal data sets, and alternate conceptual models of site hydrology.

Therefore, the NRC staff concludes that the identification and consideration of the hydrological setting of the site set forth above are acceptable and meet the applicable requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d). In view of the above, the NRC staff finds the applicant's proposed site characterization related to the hydrological setting for the ESP application to be acceptable.

2.4.2 Floods

Section 2.4.2 of the SSAR identified historical flooding (defined as occurrences of abnormally high water stage or overflow from a stream, floodway, lake, or coastal area) at the proposed site or in the region of the site. The applicant, in Section 2.4.2 of the SSAR, summarized and identified the individual types of flood-producing phenomena, and combinations of flood-producing phenomena, considered in establishing the flood design bases for safety-related plant features. In addition, the SSAR covered the potential effects of local intense precipitation. Although topical information may appear in SSAR Sections 2.4.3 through 2.4.7 and Section 2.4.9, the types of events considered and the controlling event are reviewed in this section of the SER.

The NRC staff reviews the flood history and the potential for flooding for the sources and events listed below. Factors affecting potential runoff (such as urbanization, forest fire, or change in agricultural use), erosion, and sediment deposition are considered in the NRC staff's review. In addition to describing flood history, the applicant also determined the local intense precipitation on the site in order to estimate local flooding. Local intense precipitation is reported as a site characteristic used in site grading design. The NRC staff's review of the SSAR covered¨ (1) local flooding on the site and drainage design; (2) stream flooding; (3) surges; (4) seiches; (5) tsunami; (6) seismically induced dam failures (or breaches); (7) flooding caused by landslides; (8) effects of ice formation in water bodies; (9) combined events criteria; (10) consideration of other site-related evaluation criteria; and (11) additional information for 10 CFR Part 52 applications.

2.4.2.1 Introduction

The VEGP site is located on the southeast side of the Savannah River, approximately 15 miles east-northeast of Waynesboro, Georgia, 26 miles southeast of Augusta, Georgia, and 100 miles north-northwest of Savannah, Georgia (SNC, 2006). The VEGP site is located approximately

150 river miles upstream of the mouth of the Savannah River. Elevations in the Savannah River basin range from sea level at the mouth to 5030 feet MSL at Little Bald Peak in North Carolina. The Savannah River system drains a total of 10,577 square miles. The contributing watershed area of the Savannah River near the VEGP site is approximately 8304 square miles.

There are 14 dams in the Savannah River Basin upstream of the VEGP site (SNC, 2006), which are owned and operated by the USACE or one of several power generation companies in Georgia and South Carolina. The three major USACE multipurpose projects regulate the entire 312-mile reach of the Savannah River. The three reservoirs created by these projects are Hartwell Lake and Dam, Richard B. Russell Lake and Dam, and J. Strom Thurmond Lake and Dam (also known as Clarks Hill Lake and Dam).

The VEGP site is located on a high bluff on the west bank of the Savannah River and has an area of approximately 3169 acres (SNC, 2006). The grade elevations of the proposed Units 3 and 4 will be 220 feet MSL or higher. Approximately 4 miles from the VEGP site, Georgia State Highway 23 runs along a topographic ridgeline. The ridgeline separates drainages that generally flow northeast toward the Savannah River from drainages that generally flow to the southwest.

Potential causes of floods at the VEGP site are local runoff from intense point-rainfall near the site and flooding in the Savannah River caused by precipitation in the river basin or floods from cascading failure of upstream dams on the river. The VEGP site is located approximately 150 river miles inland from the ocean; therefore, flooding caused by surges, seiches, and oceanic tsunamis is unlikely to occur. Section 2.4.7 of the SERs addresses Ice-related events that may result in flooding.

2.4.2.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 10 CFR 100.20(c), also requires 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).

Section 2.4.2 of RS-002 provides the review guidance that the NRC staff used to evaluate this SSAR section.

- 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.

As stated in Section 2.4.2 of RS-002, 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 (Flood History), the NRC 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 NRC staff accepts the applicant's conclusions. If, in the NRC staff's opinion, significant discrepancies exist, the applicant must provide additional data, reestimate the effects on a nuclear unit(s) of a specified type that might be constructed on the proposed site, or revise the applicable flood design bases, as appropriate.

- For SSAR Section 2.4.2.2 (Flood Design Considerations), the applicant's estimate of controlling flood levels is acceptable if it is no more than 5 percent less conservative than the NRC 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 NRC staff's estimate.

- For SSAR Section 2.4.2.3 (Effects of Local Intense Precipitation), 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 NRC 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 NRC 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 NRC 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 technical evaluation consists of: (1) a review of the applicant's technical information presented in the SSAR; and (2) the NRC staff's technical evaluation to determine the potential for site flooding due to various flooding mechanisms.

2.4.2.3.1 Technical Information Presented by the Applicant

Flood History

In Section 2.4.2 of the SSAR, the applicant characterized the historical flooding in streams near the VEGP site using the discharge record at the USGS gauge 02197000, located on the Savannah River at Augusta, Georgia, approximately 48.7 river miles upstream of the site (SNC, 2006). The maximum annual peak flood discharge of 350,000 cfps was reported on October 2, 1929. The discharge on January 17, 1796 was estimated to be between 280,000 cfps for a reported stage of 38 feet (USGS, 2006; gauge datum at 96.58 feet MSL) and 360,000 cfps for a reported stage of 40 feet (USGS, 1990). Based on an elevation of 96.58 feet MSL for the Augusta, Georgia stream gauge datum, the applicant concluded that the historical maximum stage of the Savannah River near the VEGP site is, therefore, between 134.6 and 136.6 feet MSL.

The applicant noted that the average annual peak discharges have declined since the three dams were constructed on the Savannah River (SNC, 2006).

Design-Basis Flood

The applicant selected the design-basis flood from several flooding scenarios including an approximate estimate of the PMF, flooding caused by local intense precipitation on local drainages, and potential dam-failure-generated floods with coincident wind setup and wave runup (SNC, 2006). Flooding from storm surges, seiches, and tsunamis was not considered since the VEGP site is located approximately 150 river miles inland from the Atlantic Coast (SNC, 2006).

The applicant determined that the design-basis flood for the VEGP site is a flood generated by an upstream breach of dams with coincident wind setup and wave runup. SSAR Section 2.4.4 provides a detailed estimation of this flooding event, which was reviewed by the NRC staff in Section 2.4.4 below.

Local Intense Precipitation

The local intense precipitation was estimated from the recommendations of Hydrometeorological Report Nos. 51 and 52 (SNC, 2006). The 6-hour, 10-square miles PMP depth was estimated from Hydrometeorological Report No. 51 for the location of the VEGP site. A multiplier for the VEGP site was estimated from Hydrometeorological Report No. 52 that, when applied to the 6-hour, 10-square miles PMP depth, yielded the 1-hour, 1-square mile PMP depth. Another set of multipliers for the VEGP site was also obtained from Hydrometeorological

Report No. 52. This set of multipliers was applied to the 1-hour, 1-square mile PMP depth to obtain PMP depths at 30, 15, and 5 minutes. The applicant's local intense precipitation is presented in Table 2.4.2-1.

Table 2.4.2-1 - Local Intense Precipitation Depths for Various Durations at the VEGP Site

Duration	Area (square miles)	Multiplier	Applied to	Local Intense Precipitation (inches)
6 hours	10	NA	NA	31.0
1 hour	1	0.620	6-hour, 10-square miles value	19.2
30 minutes	1	0.736	1-hour, 1-square mile value	14.1
15 minutes	1	0.509	1-hour, 1-square mile value	9.8
5 minutes	1	0.323	1-hour, 1-square mile value	6.2

2.4.2.3.2 NRC Staff's Technical Evaluation

The NRC staff's technical evaluation consisted of a review of the data and methods presented in the applicant's SSAR. Sections 2.4.2 through 2.4.7, and 2.4.9 of the SER describe the NRC staff's review of various flooding mechanisms. Based on these reviews, the NRC staff verified that the design-basis flooding scenario at the VEGP site consisted of a domino-type dam-failure scenario-generated flood, and coincident wind setup and wave runup scenario.

The NRC staff independently estimated the local intense precipitation for the VEGP site in order to verify applicant's submission in SSAR Section 2.4.2. Hydrometeorological Report No. 52 recommends that local intense precipitation or point precipitation be estimated as a 1-hour, 1-square mile PMP event. Hydrometeorological Report No. 52 presents a set of maps of estimated PMP depths for several durations ranging from 6 to 72 hours and several areas ranging from 10 to 20,000 square miles. The PMP approach only addressed areas 10 square miles and larger and durations of 6 hours and greater. In order to estimate PMP depths at a point (essentially a 1 square mile area) and for durations of 1 hour and less, Hydrometeorological Report No. 52 recommends the use of a set of multipliers to first estimate the 1-hour, 1-square mile PMP depth from the 6-hour, 10-square miles PMP depth followed by the application of the multipliers to the 1-hour, 1-square mile PMP depth to obtain shorter-duration PMP depths for a 1-square mile area.

The 6-hour, 10-square miles PMP for the VEGP site location was estimated from the PMP depth map corresponding to 6-hour duration and 10-square miles drainage area. Hydrometeorological Report No. 52 maps of multipliers were used to obtain the set of multipliers for the VEGP site. Table 2.4.2-2 shows the NRC staff's estimate of the local intense precipitation.

Table 2.4.2-2 - The NRC Staff-estimated Local Intense Precipitation Depths for Various Durations at the VEGP Site

Duration	Area (square miles)	Multiplier	Applied to	Local Intense Precipitation (inches)
6 hours	10	NA	NA	31.0
1 hour	1	0.621	6-hour, 10-square miles value	19.3
30 minutes	1	0.738	1-hour, 1-square mile value	14.2
15 minutes	1	0.509	1-hour, 1-square mile value	9.8
5 minutes	1	0.323	1-hour, 1-square mile value	6.2

The NRC staff concluded that the local intense precipitation values reported by the applicant in the SSAR are essentially identical (less than 5% different) to those independently estimated by the NRC staff and, thus, are acceptable. The local intense precipitation values reported by the applicant in Table 2.4.2-3 of the SSAR will be used as a site characteristic for the VEGP site.

2.4.2.4 Conclusion

The NRC staff independently confirmed the local intense precipitation values estimated and presented by the applicant in SSAR Section 2.4.2. The local intense precipitation values reported by the applicant in Table 2.4.2-3 of the SSAR will be used as a site characteristic for the VEGP site. As discussed in Section 2.4.4 of this SER, the NRC staff also verified that the controlling flood for the VEGP site consists of a domino-type dam failure scenario-generated flood and coincident wind setup and wave runup scenario.

The applicant has presented and substantiated sufficient information pertaining to the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism at the proposed site. RS-002, Section 2.4.2 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism in the vicinity of the site and site regions. The applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area, and reasonable combinations of these phenomena in establishing the design-basis information pertaining to the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism. The applicant's analysis contained sufficient margin for the limited accuracy, quantity, and period of time in which the historical data has been accumulated. As documented in SERs for previous licensing actions, the NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in these site characteristics. Accordingly, the NRC staff concludes that the use of these methodologies results in site characteristics containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. The site characteristics previously identified are acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d).

In view of the above, the NRC staff finds the applicant's proposed site characteristics related to the local intense precipitation for inclusion for the ESP application to be acceptable.

2.4.3 Probable Maximum Flood (PMF) On Streams And Rivers

In this section of the SSAR, the applicant developed the hydrometeorological design basis to determine the extent of any flood protection required for those SSC necessary to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition. The NRC staff's review of the SSAR covers: (1) design bases for flooding in streams and rivers; (2) design bases for site drainage; (3) consideration of other site-related evaluation criteria; and (4) additional information for 10 CFR Part 52 applications.

2.4.3.1 Introduction

The VEGP site is located on the southeast side of the Savannah River, approximately 15 miles east-northeast of Waynesboro, Georgia; 26 miles southeast of Augusta, Georgia; and 100 miles north-northwest of Savannah, Georgia (SNC, 2006). The VEGP site is located approximately 150 river miles upstream of the mouth of the Savannah River. The Elevations in the Savannah River basin range from sea level at the mouth to 5030 feet MSL at Little Bald Peak in North Carolina. The Savannah River system drains a total of 10,577 square miles. The contributing watershed area of the Savannah River near the VEGP site is approximately 8304 square miles.

A PMP in the watershed of the Savannah River can cause a flood near the site. The NRC staff's evaluation in this section consisted of verifying the applicant's approach for estimating the PMF in the Savannah River near the VEGP site and independently estimating the PMF.

2.4.3.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 10 CFR 100.20(c), also requires 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).

To evaluate the information provided in SSAR 2.4 per the above acceptance criteria, applicant applied the NRC-endorsed analytical methodologies found in RG 1.59, Revision 2, issued August 1977.

Section 2.4.3 of RS-002 provides the review guidance used by the NRC staff to evaluate this SSAR section.

- 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 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.

- 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 NRC staff will assess the flood level. The NRC 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 NRC staff estimates. If the applicant's estimates of discharge are more than 5 percent less conservative than the NRC staff's, the applicant should fully document and justify its estimates or accept the NRC staff estimates.

- When condition (2) or (3) applies, the NRC staff analyses may be less rigorous. For condition (2), acceptance is based on the protection level estimated for another flood-producing phenomenon exceeding the NRC staff estimate of PMF water levels. For condition (3), the site grade should be well above the NRC 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 NRC 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 technical evaluation consists of: (1) a review of the applicant's technical information presented in the SSAR; and (2) NRC staff's technical evaluation to determine the potential for site flooding due to PMF.

2.4.3.3.1 Technical Information Presented by the Applicant

The proposed site grade for the new units is 220 feet MSL. The applicant reviewed studies and analysis that were performed for the existing VEGP units to verify that its conclusions are valid for proposed units. The applicant also performed an approximate PMF estimation as described in RG 1.59 to alternatively estimate the maximum flood stage in the Savannah River near the VEGP site.

Previous Studies

For the original VEGP Units 1 and 2, the applicant used two approaches in determining the PMF in the Savannah River near the VEGP site.

- The first approach used PMP values estimated from Hydrometeorological Report Nos. 51 and 52 and routed the PMP using the U.S. Army Corps of Engineers (USACE) HEC-1 Flood Hydrograph Computer Program. The watershed that was upstream of the Thurmond Dam was characterized by NWS-estimated unit hydrographs of 10 subbasins. The applicant used the USACE DAMBRK computer program to model separately the valley storage below the Thurmond Dam. The peak PMF discharge at the VEGP site was reported as 895,000 cfps when ignoring valley storage and as 540,000 cfps when accounting for valley storage. The associated flood water surface elevations were 136 feet MSL and 126 feet MSL, respectively. The flood water surface elevation with coincident wind wave action was reported as 163 feet MSL and 153 feet MSL.

- In the second approach, the USACE DAMBRK computer program was used to route the USACE-derived PMF outflow hydrograph from the Thurmond Dam to the VEGP site and combining the PMF outflow hydrograph with the PMF discharge of the drainage area downstream of this dam. The PMF discharge in the Savannah River near the VEGP site was estimated as 710,000 cfps with a corresponding water surface elevation of 138 feet MSL. The PMF water surface elevation with coincident wind wave action was estimated as 165 feet MSL.

Approximate PMF Estimation

The applicant used the alternative method for estimation of the PMF described in RG 1.59. The PMF values corresponding to 100, 500, 1000, 5000, 10,000, and 20,000 square miles of contributing areas were obtained from PMF isoline maps given in RG 1.59. The applicant estimated a best-fit power curve to this data and used the estimated power curve to predict the PMF in the Savannah River near the VEGP site. The applicant estimated that the PMF at the VEGP site corresponding to a contributing area of 8,304 square miles is 920,000 cfps.

In SSAR Section 2.4.4, the applicant simulated floods caused by dam failure to determine the flood water surface elevation that corresponded to the PMF discharge from a stage-discharge relationship obtained from a steady-state backwater analysis for the Savannah River. The flood water surface elevation corresponding to the peak PMF discharge was 138.8 feet MSL.

As described in SSAR Section 2.4.4, the applicant used a 50 miles per hour windspeed over a fetch of 11 miles to estimate the wind setup and wave runup. The estimated wind setup and wave runup was 11.3 feet. The PMF water surface elevation with coincident wind wave action was estimated as 150.1 feet MSL, 69.9 feet below the proposed site grade. As such, the applicant concluded that the VEGP site is a dry site.

2.4.3.3.2 NRC Staff's Technical Evaluation

NRC staff's technical evaluation consisted of reviewing the data and methods presented in the applicant's SSAR. The NRC staff independently estimated the PMF and performed an assessment of impacts for flooding on the VEGP site.

In order to verify the applicant's submittal related to PMF in the Savannah River near the VEGP site, the NRC staff carried out an independent and conservative estimate of the PMF. The NRC staff first estimated the PMP in the Savannah River Basin, as described in Hydrometeorological Report Nos. 51 and 52. The cumulative PMP depths for 6, 12, 24, 48, and 72 hours were obtained from the PMP maps in Hydrometeorological Report No. 51 for drainage areas of 10, 200, 1000, 5000, 10,000, and 20,000 square miles (Table 2.4.3-1). The NRC staff plotted a set of depth-area-duration curves for the PMP values (Figure 2.4.3-1).

Table 2.4.3-1 - PMP Depths for Various Drainage Areas and Durations near the VEGP Site

Area (square miles)	Duration (hours)				
	6	12	24	48	72
10	31.0	37.0	43.8	48.2	51.0
200	23.0	27.9	35.0	38.0	42.0
1000	16.9	22.5	28.5	33.5	35.2
5000	9.7	14.0	19.3	23.8	27.5
10000	7.4	11.1	15.8	20.0	23.3
20000	5.4	8.8	12.5	16.2	19.2

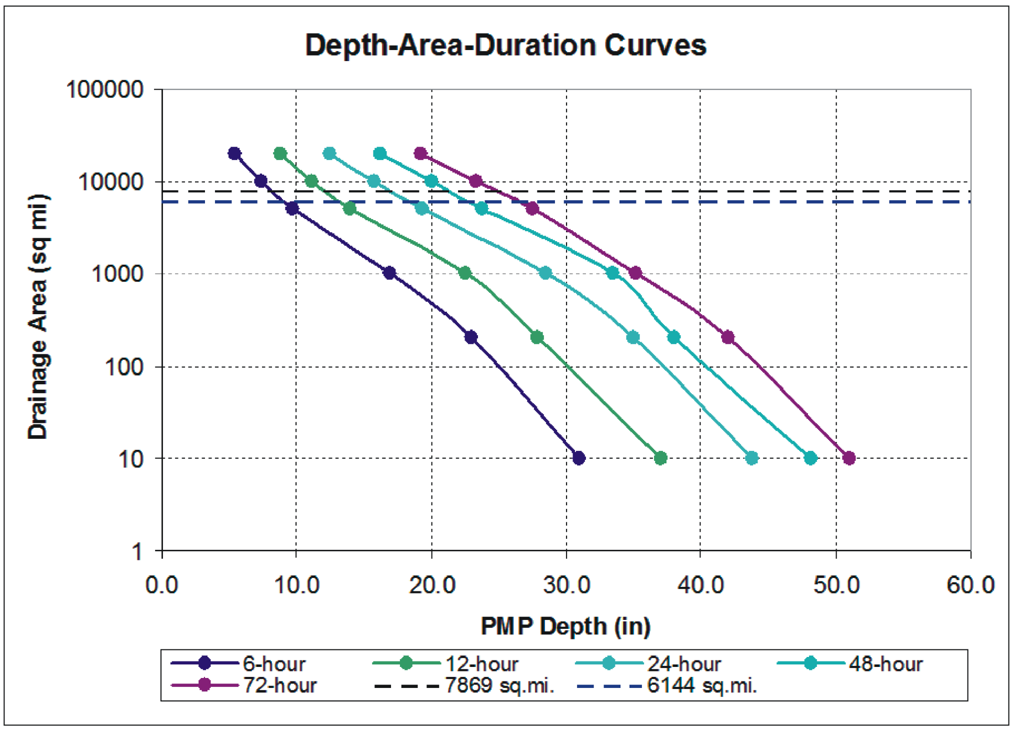


Figure 2.4.3-1 - PMP Depth-Area-Duration Curves Near the VEGP site

The drainage area at the VEGP site was estimated from the hydrologic unit codes that drain areas upstream of the site. The NRC staff estimated the drainage area at the VEGP site to be 7869 square miles. The cumulative PMP values for durations of 6, 12, 24, 48, and 72 hours were then estimated for the corresponding drainage area of the Savannah River near the VEGP site from the depth-area-duration plot (Table 2.4.3-2).

Table 2.4.3-2 - Cumulative PMP for the Savannah River Drainage Area Upstream of the VEGP Site

Area (square miles)	Duration (hours)				
	6	12	24	48	72
7869	8.2	12.1	17.1	21.3	24.9

The incremental PMP depths were calculated from the estimated cumulative PMP depths and the recommended procedure of the American National Standards Institute/American Nuclear Society (ANSI/ANS) Standard 2.8-1992 to estimate the time distribution of the 72-hour PMP storm at 6-hour increments (Table 2.4.3-3).

Table 2.4.3-3 - Incremental 6-hourly PMP Values of the 72-hour PMP Storm for the Savannah River Drainage Near the VEGP Site

6-hr period	Depth (inches)	Group	ANSI/ANS-2.8-1992 Rearrange	PMP Depth (inches)	Time (hour)
1	8.20	1	2.50	1.05	6
2	3.90		3.90	1.05	12
3	2.50		8.20	1.05	18
4	2.50		2.50	1.05	24
5	1.05	2	1.05	2.50	30
6	1.05		1.05	3.90	36
7	1.05		1.05	8.20	42
8	1.05		1.05	2.50	48
9	0.90	3	0.90	0.90	54
10	0.90		0.90	0.90	60
11	0.90		0.90	0.90	66
12	0.90		0.90	0.90	72

In order to estimate the flooding hazard at the VEGP site from a PMF in the Savannah River, the NRC staff adopted a bounding approach. The NRC staff started with a very conservative scenario under which the PMF is obtained by assuming that no losses occur during the PMP event and all of the runoff generated within the drainage area of the Savannah River upstream of the VEGP site is instantaneously delivered to the river near the VEGP site. Under this extremely conservative scenario of PMF generation, the NRC staff estimated the peak PMF discharge in the Savannah River near the VEGP site as 6.94 million cfps by multiplying the drainage area with the precipitation depth during the 6–hour period with maximum estimated PMP precipitation. Then the volume of water thus obtained was converted to an average discharge during that 6-hour period. The stage-discharge relationship estimated during the review of dam failure-generated floods, described in Section 2.4.4 of this report, indicated that the water surface elevation corresponding to a discharge of 6.94 million cfps would exceed the site grade. The NRC staff determined that this first PMF estimation approach was unnecessarily conservative. Therefore the NRC staff refined its approach for estimating the PMF in the Savannah River near the VEGP site.

In this new approach, the NRC staff estimated the PMF inflow into the Thurmond Lake and then the routed outflow from the Thurmond Dam to the VEGP site. The NRC staff estimated the PMP storm over the 6144 square miles of contributing area for Thurmond Lake, following the same procedure described above for estimation of the PMP storm for the 7689 square miles contributing area at the VEGP site. The NRC staff estimated the maximum depth of PMP for any 6-hour duration in the PMP storm for the contributing area of the Thurmond Lake to be 8.9 inches. In addition, the NRC staff estimated the corresponding maximum PMF inflow into Thurmond Lake assuming no losses and instantaneous translation as 5.9 million cfps. The NRC staff postulated that this inflow will then be released from the Thurmond Dam and flow downstream to the VEGP site. In Section 2.4.4, the NRC staff computed the flood from the cascading failure of the Russell Dam located upstream of the Thurmond Dam followed by the failure of the Thurmond Dam itself. The inflow into the Thurmond Lake due to the upstream failure of the Russell Dam was 6.5 million cfps. The NRC staff estimated the corresponding peak discharge as 2.5 million cfps and the corresponding water surface elevation as 170.1 feet MSL in the Savannah River near the VEGP site after being attenuated along the 70-mile river reach between the Thurmond Dam and the site. The PMF generated by a PMP in the drainage area of the Thurmond Lake would produce an inflow (5.9 million cubic feet per second) less severe than that generated by the postulated failure of the Russell Dam upstream of the Thurmond Lake (6.5 million cfps). Therefore, the NRC staff concluded that the PMF inflow into the Thurmond Lake is bounded by inflow into the Thurmond Lake caused by the postulated breach of the Russell Dam.

The NRC staff postulated that the outflow from the Thurmond Dam would combine with the flood response from the contributing area downstream of the dam and upstream of the VEGP site during the PMP event. This contributing area is 1545 square miles in size (7689 square miles contributing area at the VEGP site – 6144 square miles contributing area for the Thurmond Lake). The NRC staff estimated the peak PMF runoff from this contributing area by conservatively assuming that no losses occur during the PMP event, that the runoff generated anywhere in this area is instantaneously translated to the VEGP site, and that the timing of the peak flow from this area coincides with that of the peak flow of the discharge from the Thurmond Lake routed to the VEGP site. The NRC staff estimated the peak discharge from the 1545 square miles contributing area downstream of the Thurmond dam as approximately 1.4 million cfps (8.2 inches of excess rainfall over 1545 square miles of drainage area converted to average discharge over a duration of six hours).

The NRC staff conservatively estimated the combined peak discharge in the Savannah River near the VEGP site by adding the bounding peak discharge of 2.5 million cfps near the VEGP site to the peak PMF discharge of 1.4 million cfps from the 1545 square miles of contributing area downstream of the Thurmond Dam and upstream of the VEGP site. The bounding peak PMF discharge in the Savannah River near the VEGP site is thus estimated as 3.9 million cfps. This peak discharge is less than the 5.9 million cfps needed to raise the stillwater elevation in the Savannah River to inundate the proposed site grade of 220 feet MSL.

The NRC staff estimated the maximum wind wave runup at the VEGP site corresponding to an ANSI/ANS-2.8-1992-recommended windspeed of 50 miles per hour and a maximum fetch of 11 miles, as approximately 19 feet (see Section 2.4.4 of this SER). The NRC staff also estimated the stillwater elevation corresponding to a discharge of 3.9 million cfps in the

Savannah River near the VEGP site using the stage-discharge function estimated in Section 2.4.4 of this SER. The NRC staff-estimated stillwater elevation corresponding to a discharge of 3.9 million cfps was 194.8 feet MSL. The bounding maximum water surface elevation accounting for wind wave action was, therefore, 213.8 feet MSL (194.8 feet MSL + 19 feet). The staff emphasizes that this NRC-estimated bounding value is very conservative (beyond any scenario that would be plausibly expected), and the staff does consider the applicant's model and calculated PMF value to be acceptable. The NRC staff concluded, therefore, that the VEGP site will remain dry during a bounding PMF event in the Savannah River watershed. This conclusion meets the criterion (3) described above in Section 2.4.3.2.

2.4.3.4 Conclusion

The VEGP site is a dry site with respect to floods in rivers and streams. All safety-related SSC will be placed above the highest flood water surface elevation.

As set forth above, the applicant has presented and substantiated sufficient information pertaining to the PMF on streams and rivers at the proposed site. RS-002, Section 2.4.3 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the PMF on streams and rivers. Furthermore, the applicant considered local flooding of the site drainage under local intense precipitation in establishing design-basis information pertaining to flooding, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in this analysis, as documented in SERs for previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in an analysis containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the applicant's analysis is acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of the probable maximum floods on streams and rivers set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d).

In view of the above, the NRC staff finds the applicant's analysis related to the PMF on streams and rivers for the ESP application to be acceptable.

2.4.4 Potential Dam Failures

In this section of the site SSAR (SSAR), the hydrological design basis is developed to ensure that any potential hazard to the safety-related facilities resulting from the failure of onsite, upstream, and downstream water control structures are considered in plant design. The NRC staff's review of the SSAR covers: flood waves from severe breaching of an upstream dam; domino-type or cascading dam failures; dynamic effects of dam-failure induced flood waves on structures; loss of water supply at the plant due to failure of a downstream dam; effects of sediment deposition and erosion; failure of onsite water control or storage structures; potential effects of seismic and non-seismic information on the postulated design bases and how they relate to dam failures in the vicinity of the site and the site region; and additional information for 10 CFR Part 52 applications.

2.4.4.1 Introduction

The VEGP Site is located at Savannah River mile 150.9, and three large dams lie upstream of the site. Hartwell Dam, located 138 miles upstream of the VEGP site; Richard B. Russell Dam, located 108 miles upstream of the site; and J. Strom Thurmond Dam, located 71 miles upstream of the VEGP site, respectively (USACE 1996). Floods initiated by a domino-type failure of these upstream dams were found to produce a peak discharge and peak stage at the site that was larger than flood waves discussed in Section 2.4.3 of this SER (i.e., waves induced by rainfall events alone).

2.4.4.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 10 CFR 100.20(c), also requires 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).

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

To evaluate the information provided in SSAR 2.4 per the above acceptance criteria, the applicant applied the NRC-endorsed analytical methodologies found in the following:

- RG 1.70, Revision 3, issued November 1978

- RG 1.29, “Seismic Design Classification”

- RG 1.59, Revision 2, issued August 1977

- RG 1.102, Revision 1, “Flood Protection for Nuclear Power Plants,” issued September 1976.

Section 2.4.4 of RS-002 provides the review guidance that the NRC staff used to evaluate this SSAR section.

- 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.

- 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 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 NRC 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 NRC 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 NRC 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 NRC 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 (ADAMS Accession No. ML040700094), are acceptable to the NRC staff; however, other criteria 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.

2.4.4.3 Technical Evaluation

The technical evaluation consists of: (1) a review of the information provided by the applicant; and (2) the NRC staff's technical evaluation to determine the potential for site flooding resulting from dam failure.

2.4.4.3.1 Technical Information Presented by the Applicant

In the SSAR, the applicant presented the potential for a domino-type failure of Russell and Thurmond dams to induce flooding at the VEGP site. The applicant performed the calculation using the USACE developed Hydrologic Engineering Center River Analysis System (HEC-RAS) numerical model (2005a). The NRC staff obtained the related input files though a RAI 2.4.1-1 (Enclosure Attachment 2). The applicant's simulation conservatively estimated the volume of the dams upstream of Russell Reservoir, and placed the entire flood volume of these dams in Russell Reservoir at the start of the simulation.

The applicant stated in the SSAR that Russell Dam was breached by overtopping in the HEC-RAS model. After investigating the applicant's model input files, the NRC staff determined that the dam was actually breached by a piping-type failure placed midway up the dam (elevation 420 feet MSL). The dam was assumed to breach 2 hours after the start of the simulation.

The SSAR describes how the applicant chose its breach parameters, and how the selection process applied references from the relevant technical literature. The applicant selected methods that were described in the US Bureau of Reclamation (USBR), Department of Interior (1998) Predication of Embankment Dam Breach Parameters: A Literature Review and Needs Assessment, Dam Safety Office, Water Resources Research Laboratory. These USBR methods are accepted current engineering practices. Breaches of both dams extend the full height of the each dam, and the HEC-RAS model defined them using three parameters: bottom width of the breach, left and right side slope, and breach formation time. For the Russell Dam, the bottom width was 750 feet, the side slopes were 2, and the breach time was 1.0 hour. For the Thurmond Dam, the bottom width was 755 feet, the side slopes were 2, and the breach time was 1.0 hour.

The SSAR states that the applicant assigned the initial water surface elevation in Thurmond Reservoir to be 344.7 feet MSL. After reviewing the applicant's HEC-RAS input files, the NRC staff determined that the actual initial elevation assumed in the model analysis was 342.1 feet MSL. The applicant correctly described elevation 342.1 feet MSL to be the Standard Project Flood (SPF) elevation for Thurmond Reservoir (USACE 1996).

The applicant's computed results for the unsteady dam beach and routing analysis was a peak water surface elevation of 166.8 feet MSL at the VEGP site. The computed peak flow at the VEGP site was approximately 2.3 million cfps. The applicant also computed the wave runup due to the maximum wave height. Based on ANS/ANSI 2.8 (1992), a 50 miles per hour wind was applied to the longest fetch (11.1 miles) during passage of the flood wave. The resulting maximum wave height was 7.5 feet, with a corresponding maximum runup height of 11.3 feet. After combining the runup height and the peak flood stage, the applicant computed the maximum flood level at the VEGP site as 178.1 feet MSL. This elevation is 41.9 feet below site grade.

2.4.4.3.2 NRC Staff's Technical Evaluation

NRC staff independently reviewed the applicant's estimate of the flood water height at the VEGP site resulting from a domino-type failure of upstream dams. This evaluation consisted of a steady flow analysis, used to compute the Savannah River discharge necessary for the water surface elevation at the site to reach the site grade, and (b) an unsteady flow analysis, used to compute the maximum stage and discharge in the Savannah River should an upstream domino-type dam failure occur.

Steady Flow Analysis

The NRC staff performed a steady flow analysis to compute the stage versus discharge rating curve at the VEGP site. The analysis used the current public release of HEC-RAS, version 4.0, which is a numerical model developed by the USACE HEC (HEC-RAS, 2006).

In response to RAI 2.4.1-1, the applicant provided electronically the initial geometric description of Russell and Thurmond dams and the Savannah River cross-sections between river miles 259.2 and 99.4. The applicant stated in SSAR Section 2.4.4.2 that these data were supplied in HEC-RAS format directly from the USACE, Savannah River District. The NRC staff's analysis utilized the latest public release of HEC-RAS, a numerical model developed by the HEC, USACE (HEC-RAS 2006). The NRC staff independently confirmed the geometric description of the dams and cross-sections using USACE (1996) and a 30-meter digital elevation model (DEM) data from the USGS.

The applicant-developed HEC-RAS model was modified by the NRC staff to remove cross-sections and reservoirs upstream of Thurmond Dam tailrace for the steady-state flow analysis. The NRC staff then applied a series of constant flow upstream boundary conditions ranging between 3,800 and 6,400,000 cfps to compute the rating curve for the Savannah River adjacent to the site. Based on this rating curve, the river discharge at the site necessary for the static water surface elevation to reach elevation 220 feet MSL is approximately 5.9 million cfps. This discharge is greater than 2.5 times the peak unsteady-flow discharge computed by the applicant as passing at the VEGP site during the dam break analysis. However, as discussed below, the discharge conservatively estimated by the NRC staff, using the unsteady flow analysis, did not exceed 5.9 million cfps.

Unsteady Flow Analysis

The NRC staff performed an unsteady flow analysis to examine the sensitivity of the applicant's model parameters. Using the model input files provided by the applicant, this analysis used a bounding assumption to simplify the distribution of impounded water in the Savannah River basin upstream of Thurmond Dam. This assumption assigned, as an initial condition of the model, the volume of water impounded in Russell Reservoir to be equal to the maximum volume of water impounded by all dam upstream, including Russell Dam. In other words, the initial Russell Reservoir volume assigned by the applicant, and used by the NRC staff in the unsteady-flow analysis, was 8,022,500 acre-ft. As shown in Table 2.4.4.1, this initial impounded volume was greater than the cumulative impounded volume of all reservoirs in the Savannah River watershed upstream of Russell Dam.

The NRC staff's analysis was similar to the applicant's in that Russell Dam was assumed to breach early in the simulation, followed by an overtopping breach of Thurmond Dam downstream. Both the applicant's and the NRC staff's analyses excluded all bridges and dams downstream of Thurmond Dam, which could constrict the flow of the flood wave and hence attenuate the flood at the VEGP site. The NRC staff assumed that the initial water surface elevation in Thurmond Reservoir was at the SPF level (elevation of 342.1 feet). The initial Savannah River discharge passing through Thurmond Dam before the breach and downstream, including at the VEGP Site, was 560,000 cfps. This discharge represents the SPF maximum estimated outflow at Thurmond Dam (USACE 1996).

Table 2.4.4.1 - Storage Volumes of Reservoirs Upstream of Russell Dam

Dam	River System	River Mile above Savannah River Mouth (1)	Maximum Storage (acre-feet) (2)
Bad Creek	Keowee	368.6	33,892
Jocassee	Keowee	366.5	1,287,788
Keowee	Keowee	351.5	955,586
Burton	Tallulah	381.4	108,000
Nacoochee	Tallulah	377.1	8,100
Mathis-Terrora	Tallulah	362.8	31,000
Tallulah Falls	Tallulah	359.9	2,400
Tugaloo	Tugaloo	358.1	42,200
Yonah	Tugaloo	354.9	11,700
Hartwell	Savannah	288.9	3,438,700
Russell	Savannah	259.1	1,488,166
Total			7,407,532

(1) From USACE (1996)
(2) From NID (2007)

The Russell Dam breach simulated by the applicant extended from the thalweg (elevation 345 feet) and to the top of the dam. The final bottom width of the breach was 750 feet, and the breach side slope was 2, resulting in a top width of 1350 feet. These breach parameters are reasonable, and fall within the range suggested by USBR (1998). However, to test the sensitivity of the model to these selected values, the NRC staff increased the total breach area by 50 percent (a more conservative assumption). Specifically, the breach bottom width was increased to 975 feet, the side slope was increased to 4, and the top width was increased to 2175 feet. The impact of this 50 percent increase in total breach area was to increase the peak discharge from Russell Dam, from 4.5 million cfps to 6.5 million cfps (approximately 45 percent increase in peak discharge).

The Thurmond Dam breach occurred approximately 2.5 hours after the Russell Dam breach, when the water surface elevation exceeded the top of the dam by 0.1 feet (i.e., elevation 351.1 feet). The applicant's Russell Dam breach parameters were that the final dam breach extended from the top to the bottom (elevation 200 feet) of the dam, with a bottom width of 755 feet, top width of 1359 feet, and side slopes of 2. These breach parameters are reasonable, and fall within the range suggested by USBR (1998). However, to test the sensitivity of the model to these selected values, the NRC staff increased the breach area by 50 percent (a more conservative assumption). NRC staff assigned the breach bottom width to be 981.5 feet, top width of 2189.5 feet, and side slopes of 4. The impact of this 50 percent increase in breach area was to increase the peak discharge issuing from Thurmond Dam. Under this scenario, with both Russell and Thurmond dam breach areas increased by 50 percent, the increase in peak Thurmond Dam discharge was from 5.5 million cfps to

7.8 million cfps (approximately 41 percent increase). The peak water surface elevation at Thurmond Dam also increased from 352.4 feet to 353.0 feet.

After the peak flood wave passed Thurmond Dam, the peak was attenuated because of the large overbank areas between Thurmond Dam and the VEGP site. Much of the overbank lengths in this region are very broad, with some overbank areas extending laterally from the river for more than 5 miles.

The NRC staff's evaluation mentioned above assumes that the time for the full breach to develop was 1.0 hour. As described in USBR (1998), the breach formation time could take anywhere from 0.1 to 1.0 hour for engineered, compacted earth dams, using the 1987 Engineering Guidelines for the Evaluation of Hydropower Projects, FERC 0119-1, Office of Hydropower Licensing, Federal Energy Regulatory Commission (FERC) method. The sensitivity of the HEC-RAS model to this parameter was tested by decreasing the parameter to 0.1 hour. The simulation results show that the Russell Dam discharge increased to 6.7 million cfps. However, the overtopping breach at Thurmond Dam did not increase with the decrease in breach formation time. Maximum breach discharge is a function of maximum water surface elevation at the dam, and, due to the rapidity of the breach, the maximum stage at the dam was lowered by 2.4 feet (350.6 feet versus 353.0 feet). As expected, the maximum stage adjacent to the VEGP site was also lower with the 0.1 hour (169.9 feet) versus the 1.0 hour breach formation time. Therefore, the 1.0 hour breach formation time parameter was used for the NRC staff's final analysis.

The NRC staff computed the peak discharge at the VEGP site, after it was attenuated along the 70 miles between Thurmond Dam and the site, with approximately 2.5 million cfps. The hydrograph of water surface elevation in the Savannah River near the VEGP site is shown in Figure 2.4.4-1 of the SER. The applicant computed the peak static water surface elevation at the VEGP site as 166.8 feet (Southern 2007). The NRC staff's analysis, with a 50 percent increase in breach area, produced a peak water surface elevation of 170.1 feet at the site, an increase in peak flood stage of 3.3 feet.

In order to satisfy the combined effects guidance in ANS/ANSI 2.8 (1992), the maximum wave height and associated maximum wave runup were computed and added to the peak flood wave elevation. The windspeed for the site was assumed to be 50 miles per hour following the guidelines in ANS/ANSI 2.8 (1992). Based on an estimated fetch of 11.2 miles, the maximum wave height was computed to be 9.8 feet using procedures discussed in USACE (2006). In Section 2.4.4 of the SSAR, the applicant stated that the embankment slope near the site will be 2H:1V. Given this slope value and the maximum wave height, the maximum wave runup at the VEGP site was determined to be 19 feet. Combining this value with the peak static water surface elevation determined with the NRC staff's more conservative breach parameters results in a maximum flood elevation at the VEGP site of 189.1 feet MSL. Even with a more conservative estimate of breaching parameters, the peak flood wave is 30.9 feet below the plant grade (elevation 220 feet MSL). Therefore, the NRC staff concludes that the VEGP site will not be affected by the potential failure of dams upstream of the site. The NRC staff did not apply the "no more than 5% less conservative" criterion to determine the agreement between the NRC staff's estimate of the maximum flood discharge and the corresponding water surface elevation and that of the applicant's from dam-break flooding in the Savannah River. The NRC staff only applies this criterion to compare agreement between the results obtained by the applicant and the results from the NRC staff's independent analysis when the complexity and the conservativeness of the two analyses are the same. Since the NRC staff's independent analysis of the dam-break flooding in the Savannah River is a bounding analysis that is more conservative than the analysis performed by the applicant, the NRC staff did not apply the above-mentioned criterion. The NRC staff, based on its independent analysis of dam-break flooding in the Savannah River, determined that the VEGP site would not flood during the postulated dam-break scenario. Thus the NRC staff agrees with the applicant that the VEGP site is "dry."

2.4.4.4 Conclusion

It is possible that dams upstream of the VEGP site could fail and potentially cause a domino-type cascading failure of multiple dams. However, this failure of upstream dams would not affect the VEGP site. The analysis performed by the applicant follows methods accepted in current engineering practice. The NRC staff reviewed these results by first computing the rating curve at the site, and determining that the peak flood wave discharge that was necessary to reach plant grade was more than 2.5 times the peak flood computed by the applicant. The NRC staff then adjusted the breach parameters in the applicant’s HEC-RAS model to examine the sensitivity of model results. Although the peak wave could be increased using more conservative values than standard engineering practice, the resulting peak flood wave passing the VEGP site was still below the site grade by more than 30 feet. Therefore, NRC staff concludes the site is dry, and that safe operation and/or shutdown of the plant will not be affected by failure of dams upstream of the site.

As set forth above, the applicant has presented and substantiated sufficient information pertaining to the effects of dam failures at the proposed site. RS-002, Section 2.4.4 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the effects of dam failures. Furthermore, the applicant considered dam failures in establishing design-basis information pertaining to flooding and safety-related water supply, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in these site characteristics, as documented in SERs from previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in site characteristics containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the site characteristics identified in this section are acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of the dam failures set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d). The NRC staff finds the applicant’s proposed site characteristics related to the maximum flood elevation, wind run-up, and combined effects maximum flood elevation associated with dam failures for the ESP application to be acceptable.

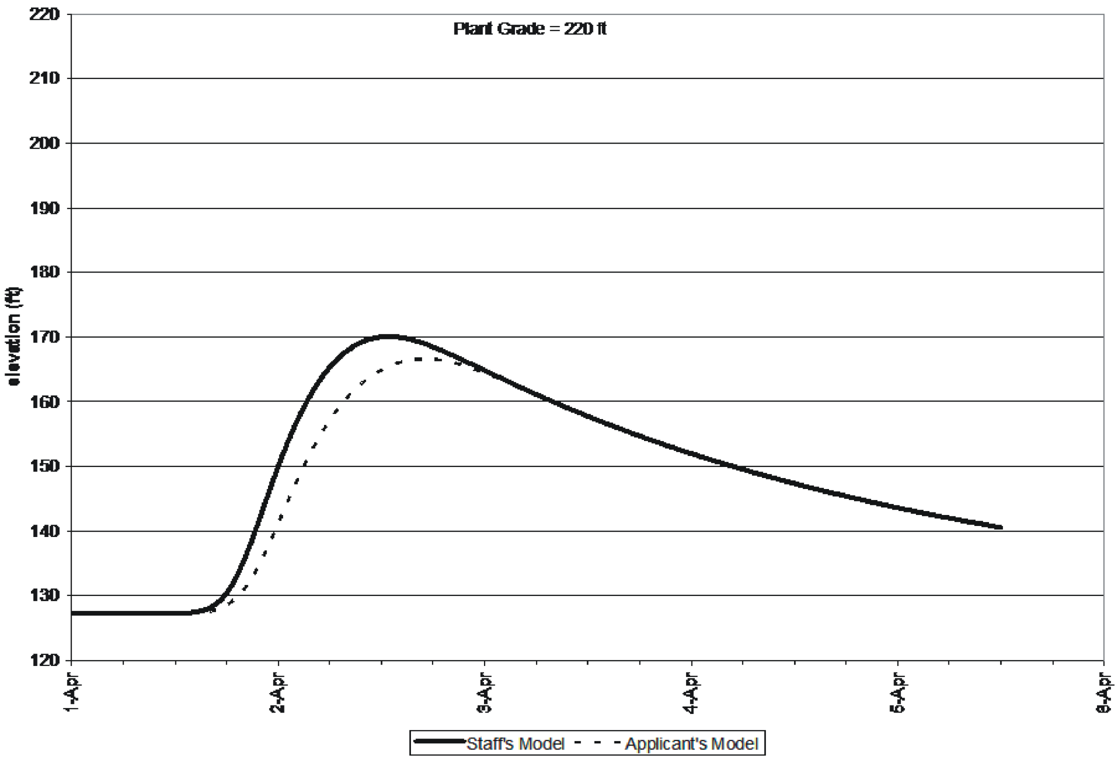


Figure 2.4.4-1 - Stage hydrograph at the VEGP Site

2.4.5 Probable Maximum Surge And Seiche Flooding

In this section of the SSAR, the hydrometeorological design basis is developed to ensure that any potential hazard to the safety-related facilities due to the effects of probable maximum surge and seiche is considered in plant design. The NRC staff's review of the SSAR covers: (1) probable maximum hurricane; (2) probable maximum wind storm; (3) seiche and resonance; (4) wave runup; (5) effects of sediment erosion and deposition; (6) consideration of other site-related evaluation criteria; and (7) additional information for 10 CFR Part 52 applications.

2.4.5.1 Introduction

The VEGP site is located on the southeast side of the Savannah River, approximately 15 miles east-northeast of Waynesboro, Georgia, 26 miles southeast of Augusta, Georgia, and 100 miles north-northwest of Savannah, Georgia (SNC, 2006). The VEGP site is located approximately 150 river miles upstream of the mouth of the Savannah River. The grade elevation of the existing VEGP units and the new proposed units is 220 feet MSL.

The Savannah River is the only large body of water that could potentially flood the VEGP site due to surge and seiche effects. Section 2.4.4 discuss the increase in water surface elevation along one bank from the wind blowing across the river's surface.

2.4.5.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 10 CFR 100.20(c), also requires 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).

To evaluate the information provided in SSAR 2.4 per the above acceptance criteria, applicant applied the NRC-endorsed analytical methodologies found in the following:

- RG 1.70, Revision 3, issued November 1978

- RG 1.29

- RG 1.59, Revision 2, issued August 1977

- RG 1.102, Revision 1, issued September 1976

- RG 1.125, Revision 1, "Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants," issued October 1978

Section 2.4.5 of RS-002 provides the review guidance used by the NRC staff to evaluate this SSAR section.

- 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.

- 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 NRC 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 NRC staff.

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

- Detailed descriptions of shoreline protection and safety-related facilities are provided to enable an independent NRC 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 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.

- 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 NRC 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 NRC 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 NRC 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 NRC 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 NRC staff uses USACE criteria and methods, as generally summarized in RS-002, and other standard techniques to evaluate the potential for oscillation of waves at natural periodicity.

2.4.5.3 Technical Evaluation

The technical evaluation consists of: (1) a review of the technical information provided by the applicant; and (2) NRC staff's technical evaluation to determine the potential for site flooding due to surge and seiche.

2.4.5.3.1 Technical Information Presented by the Applicant

The proposed site grade for the new units is 220 feet MSL. The applicant reported three major hurricanes, defined as those of Category 3 or larger (Saffir/Simpson Hurricane Scale) that have affected the Atlantic coast of Georgia between 1841 and 2004 (SNC, 2006). The most severe observed hurricane with a landfall location within 100 miles of the Savannah River estuary was

Hurricane Hugo, which made landfall near Charleston, South Carolina (SNC, 2006). The applicant reported that Hurricane Hugo produced a 20-ft storm surge in the Cape Romain-Bulls Bay area in South Carolina.

The applicant estimated the probable maximum surge height at the mouth of the Savannah River using the RG 1.59 values of 28.2 feet mean low water (MLW) at Folly Island, South Carolina, and 33.9 feet MLW at Jekyll Island, Georgia, which are located northeast and southwest of the Savannah River estuary, respectively (SNC, 2006). The applicant obtained from ANSI/ANS-2.8 (1992) the 10 percent exceedance high tide at the Savannah River estuary as 9.0 feet MLW with MLW at the entrance to Savannah River being at 1.2 feet below MSL. The applicant estimated the probable maximum surge water surface elevation with a coincident 10 percent exceedance high tide at the mouth of the Savannah River as 32.3 feet MLW or 31.1 feet MSL (SNC, 2006).

The applicant noted that probable maximum surge data from RG 1.59 do not include hurricanes after 1975. Inclusion of the more recent hurricane data in RG 1.59 could have slightly altered the probable maximum surge estimate (SNC, 2006).

The applicant postulated that a probable maximum surge at the mouth of the Savannah River would only have an insignificant effect near the VEGP site because the surge height would dissipate before reaching the VEGP site, which is located approximately 151 river miles inland from the mouth, and the proposed site grade is 220 feet MSL (SNC, 2006).

2.4.5.3.2 NRC Staff's Technical Evaluation

The NRC staff's technical evaluation consisted of a review of the data, the references, and the methods presented in the applicant's SSAR.

The NRC staff reviewed the references provided by the applicant in the SSAR and agreed that three hurricanes exceeding Category 3 have been reported by Blake et al. (2007) on the Georgia coastline within 100 miles of Savannah, Georgia. The NRC staff downloaded historical hurricane track data for the Atlantic basin from the NOAA Coastal Services Center (2007) and created a map of these hurricane tracks in the vicinity of the VEGP site (Figure 2.4.5-1). The NRC staff determined from this map that three Category 4 hurricanes and five Category 3 hurricanes have come within 150 miles and 100 miles of the VEGP site, respectively. One Category 1 and one Category 2 hurricane came within 50 miles of the VEGP site. Within a 25 mile-radius of the Savannah River Estuary (Figure 2.4.5-2), four Category 3 hurricanes have been observed. Within a 50 mile-radius of the Savannah River Estuary, six Category 3 and one Category 4 hurricane have occurred (Figure 2.4.5-2). Based on these historical data, the NRC staff concluded that storm surges caused by severe hurricanes that exceed Category 4 can occur in the vicinity of the Savannah River Estuary.

The NRC staff reviewed the probable maximum surge estimation performed by the applicant. The NRC staff concluded that the applicant appropriately applied the method described in Appendix C of RG 1.59 to the Savannah River estuary location. In addition, the NRC staff finds that the applicant's estimate of total probable maximum surge height of 32.3 feet MLW or 31.1 feet MSL is acceptable.

The NRC staff reviewed the location of the VEGP site in relation to the Savannah River Estuary, and concluded that effects of storm surge and seiche at the site would likely be small. To quantitatively bound these effects, the NRC staff used the HEC-RAS model described in Section 2.4.4 of this SER. The downstream boundary condition, applied at river mile 99.4, of the NRC staff's unsteady flow analysis was modified to a constant stage height. The selected height for this analysis was elevation 119.7 feet MSL. This elevation is the sum of the peak flood stage at the model's boundary during the dam break simulation (elevation 88.6 feet MSL) and the computed maximum storm surge occurring at the mouth of the Savannah River using RG 1.59 (31.1 feet). This estimate of storm surge at river mile 99.4 does not take into account attenuation of the surge that would occur between the mouth and the model boundary. The peak stage at the site computed during the domino-type failure of the upstream dams using this revised downstream boundary condition was elevation 172.1 feet MSL, which is 47.9 feet below the site grade. Wind blowing along the water surface could increase the water surface elevation along one bank. These effects were computed in Section 2.4.4 to be approximately 19 feet. Combining these effects results in a water surface elevation of 191.1 feet MSL, which is 28.9 feet below the site grade. Therefore, the NRC staff concluded that the probable maximum surge and seiche will not affect the VEGP site.

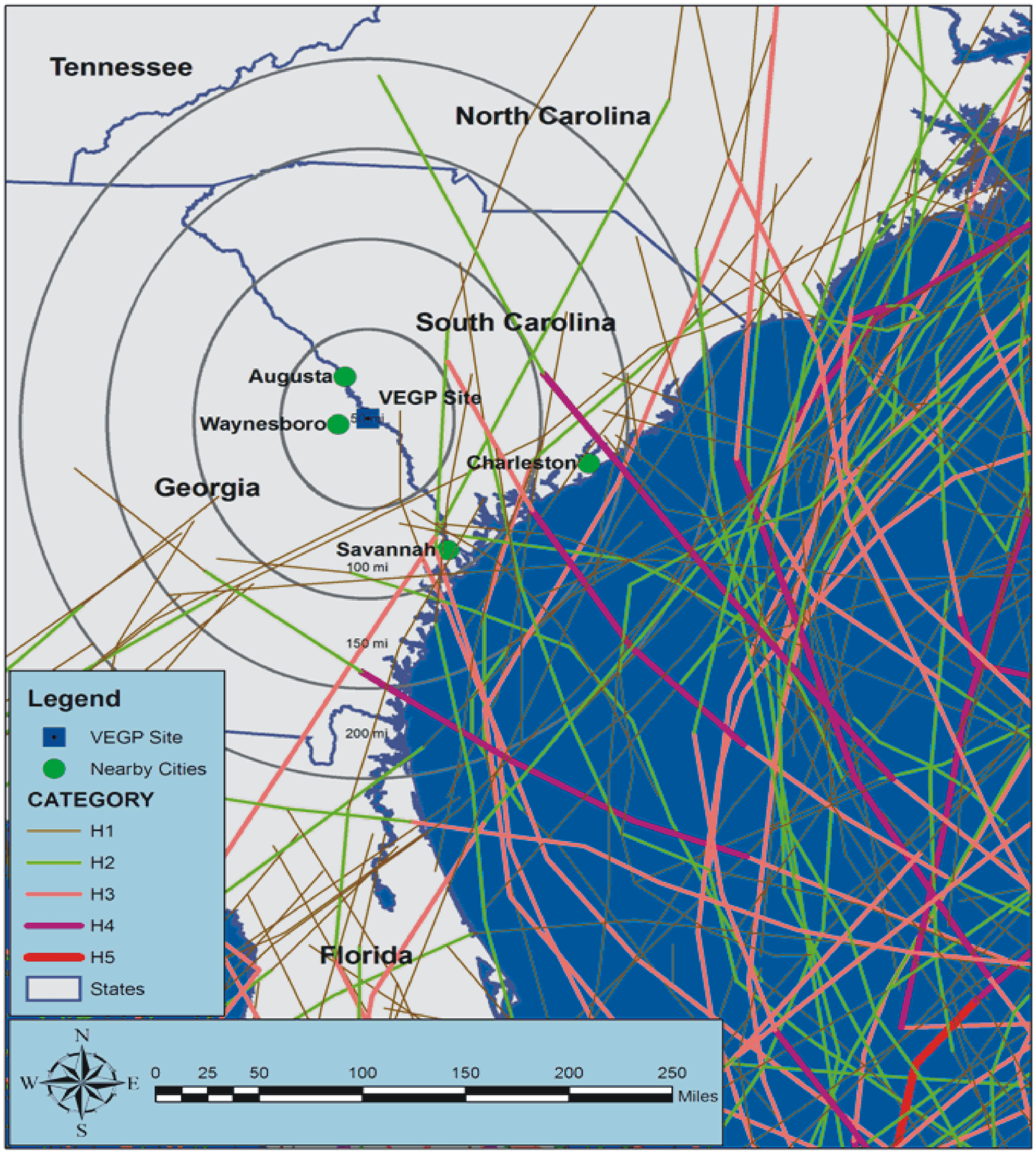


Figure 2.4.5-1 - Hurricane tracks near the VEGP site. The hurricane track data was downloaded from the NOAA Coastal Services Center and all hurricanes (Category H1 through H5) from the dataset were selected to show on the map.

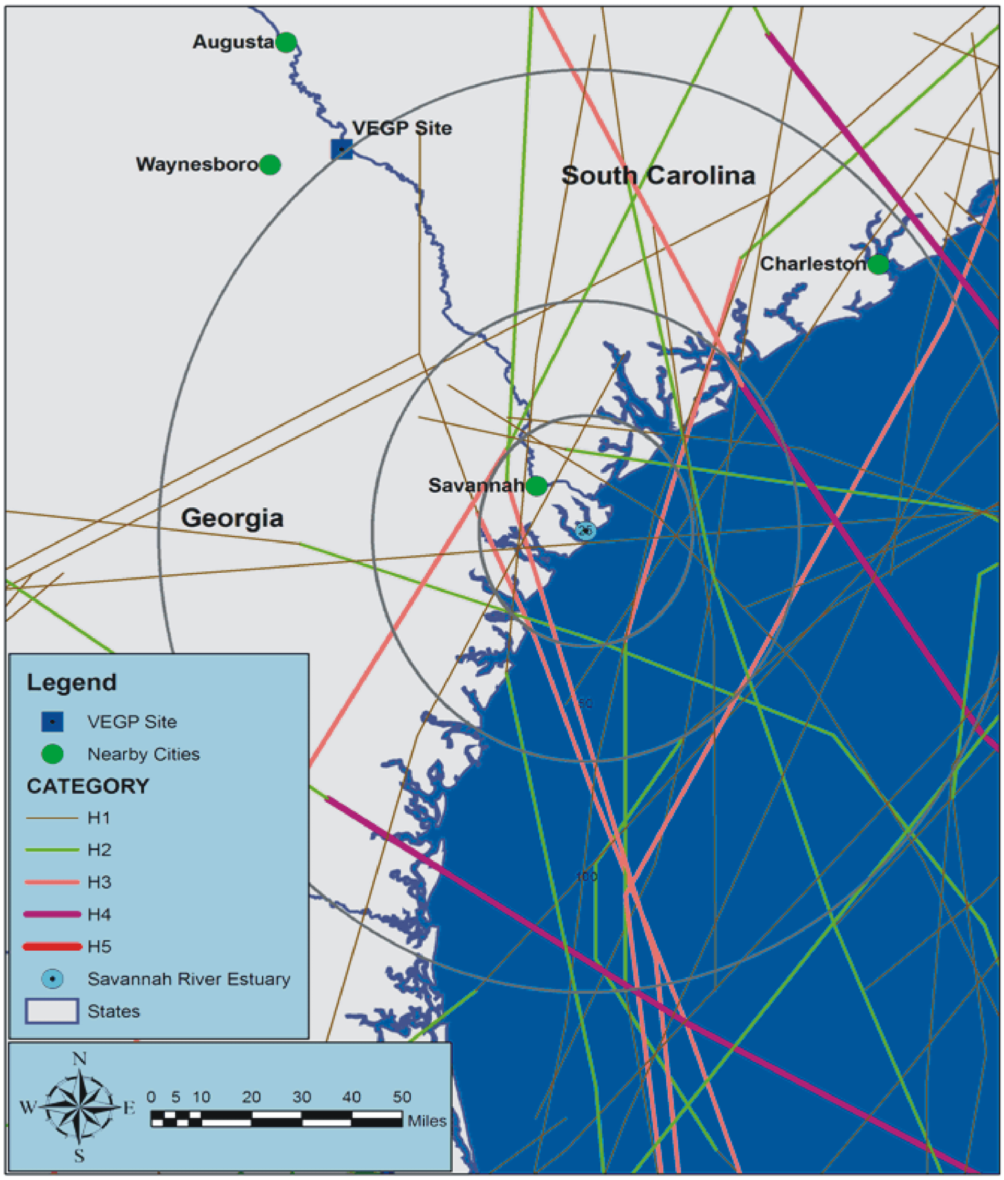


Figure 2.4.5-2 - Hurricane tracks near the Savannah River Estuary. The hurricane track data was downloaded from the NOAA Coastal Services Center and all hurricanes (Category H1 through H5) from the data set were selected to show on the map.

2.4.5.4 Conclusion

A probable maximum surge in the Savannah River Estuary can occur. However, this probable maximum surge does not affect the VEGP site. The VEGP site is also not affected by seiche because the site is located approximately 150 river miles inland from the ocean and there are no large bodies of water in the vicinity. All safety-related SSC will be placed above the highest flood water surface elevation that is controlled by flooding in the Savannah River resulting from cascading upstream dam failures.

As set forth above, the applicant has presented and substantiated sufficient information pertaining to the effects of storm surge and seiche at the proposed site. Section 2.4.5 of RS-002 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the effects of storm surge and seiche. Furthermore, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area while describing the effects of surge and seiche near the site, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in this analysis, as documented in SERs for previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in an analysis containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the applicant’s analysis is acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of surge and seiche phenomena set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d). The NRC staff finds the applicant’s analysis related to surge and seiche for the ESP application to be acceptable.

2.4.6 Probable Maximum Tsunami Hazards

In this section of the SSAR, the geohydrological design basis is developed to ensure that any plant design considers potential hazards to the safety-related facilities due to the effects of probable maximum tsunami. The NRC staff’s review of the SSAR covers: (1) historical tsunami data; (2) probable maximum tsunami; (3) tsunami propagation models; (4) wave runup, inundation, and drawdown; (5) hydrostatic and hydrodynamic forces; (6) debris and water-borne projectiles; (7) effects of sediment erosion and deposition; (8) consideration of other site-related evaluation criteria; and (9) additional information for 10 CFR Part 52 applications.

2.4.6.1 Introduction

The VEGP site is located on the southeast side of the Savannah River, approximately 15 miles east-northeast of Waynesboro, Georgia; 26 miles southeast of Augusta, Georgia; and 100 miles north-northwest of Savannah, Georgia (SNC, 2006). The VEGP site is located approximately 150 river miles upstream of the mouth of the Savannah River. The grade elevation of the existing VEGP units and the proposed new units is 220 feet MSL.

A probable maximum tsunami can be caused near the mouth of the Savannah River by a tsunamigenic source in the Atlantic Ocean. There are no large inland bodies of water near the VEGP site in which a tsunami may be generated.

2.4.6.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 10 CFR 100.20(c), also requires 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).

- 10 CFR 100.23, as it relates to investigating the tsunami potential at the site.

To evaluate the information provided in SSAR 2.4 per the above acceptance criteria, applicant applied the NRC-endorsed analytical methodologies found in the following:

- RG 1.70, Revision 3, issued November 1978
- RG 1.29
- RG 1.59, Revision 2, issued August 1977
- RG 1.102, Revision 1, issued September 1976
- RG 1.125, Revision 1, issued October 1978

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

- 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.

- 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 general design criteria [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 NRC 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 NRC 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 NRC 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 NRC staff's, the applicant should fully document and justify its estimates or accept the NRC 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 technical evaluation consists of: (1) a review of the applicant's technical information presented in the SSAR; and (2) NRC staff's technical evaluation to determine the potential for tsunami hazards at the site.

2.4.6.3.1 Technical Information Presented by the Applicant

The applicant stated in SSAR Section 2.4.6 that since the VEGP site is not located on an open ocean coast of a large body of water, a tsunami would not produce maximum water level at the site (SNC, 2006).

The Atlantic Ocean is subject to infrequent seismic and volcanic activities that have resulted in few recorded tsunamis. The most notable Atlantic tsunami was generated by the Great Lisbon Earthquake of 1755. The earthquake generated a tsunami that traveled across the Atlantic and produced waves 10 to 15 feet in height on the Caribbean coasts and computer models suggested a wave height of 10 feet along the east coast of the U.S.

The applicant estimated that effects of any tsunami with similar height approaching the Savannah River estuary would be dissipated before reaching the VEGP site, which is located approximately 151 river miles inland and has a grade elevation of 220 feet MSL (SNC, 2006).

2.4.6.3.2 NRC Staff's Technical Evaluation

The NRC staff's technical evaluation consisted of a review of the data and the references presented in the applicant's SSAR. The NRC staff also carried out a hierarchical review of tsunamis near the VEGP site.

The NRC staff carried out a search of the National Geophysical Data Center (NGDC) Tsunami Runup Database to locate all reported tsunami runups on the U.S. east coast. This search returned reported tsunami runup events in the general region of the Savannah River estuary that are shown on the map below (Figure 2.4.6-1).

The NGDC database did not contain the actual runup heights for several of the runup locations shown on the map (Figure 2.4.6-1). The NGDC database reported an observed runup height less than 1 foot at Charleston, South Carolina, near the Savannah River Estuary resulting from the 1929 Grand Banks submarine landslide-generated tsunami. The NGDC database lists the 1886 earthquake in Charleston, South Carolina as having generated three runup events in Copper River, South Carolina and Jacksonville and Mayport in Florida. Runup heights at the three locations are not available. The event description in the NGDC database lists extensive damage to Charleston, South Carolina by a "mighty tidal," presumably the tsunami wave (NGDC, 2007a).

The NGDC tsunami runup database lists the tsunami caused by the 1755 Great Lisbon Earthquake as resulting in runups on the east coast of the U.S. However, the NGDC database does not include runup heights on the east coast of the U.S. (NGDC, 2007b). A computer modeling of the tsunami wave generated by the 1755 Great Lisbon Earthquake suggested runups of approximately 10 feet on the U.S. east coast (Mader, 2001).

Based on the historical tsunami data near the Savannah River estuary, the NRC staff concluded that the region is subject to tsunamis but there is not enough historical data to ascertain the severity of runups near the Savannah River estuary. In order to determine whether tsunamis pose a hazard to the VEGP site, the NRC staff adopted a bounding approach.

Figure 2.4.6-1 - Locations of Tsunami Runups Reported in the NGDC Tsunami Runup Database near the Savannah River Estuary

The NRC staff evaluated three metrics related to the geographical and topographical location of the site in relation to tsunami wave inundation: (1) distance of the site from the shoreline; (2) upriver distance of the site from the shoreline; and (3) elevation of the site relative to the shoreline. These three metrics specifically address: (1) if the site is located within the horizontal extent of the tsunami wave inundation zone; (2) if the tsunami wave can produce a bore in the Savannah River that may travel upstream to the site; and (3) if the tsunami wave can run up to site grade.

The NRC staff's search of the NGDC tsunami database revealed that the maximum observed horizontal distance of inundation during a tsunami is approximately 3.4 miles. The accounts from the 2004 Sumatra tsunami indicated the maximum extent of horizontal distance could be 5.0 miles from the shoreline on the island of Sumatra, Indonesia. The VEGP site is located more than 100 miles inland from the east coast of the U.S. Since the distance of the site from the shoreline is an order of magnitude more than the maximum observed horizontal inundation distance from a tsunami, the NRC staff concluded that a tsunami arriving at the Savannah River Estuary from the Atlantic Ocean will not inundate the VEGP site.

The NRC staff's search of the NGDC tsunami database revealed that the maximum observed tsunami runup, defined as the highest ground elevation the waters from a tsunami reached, is 1720 feet caused by the giant Lituya Bay subaerial landslide on July 10, 1958. There have been other tsunamis caused by landslides in Lituya Bay on October 27, 1936, on an unspecified day in 1853, and on September 10, 1899, which had reported runups of 490 feet, 394 feet, and 200 feet, respectively. The NGDC tsunami database also reports runups of 820 feet and 738 feet on May 18, 1980 in Spirit Lake located in the Washington State, which was caused by the catastrophic collapse of the north flank of the Mount St. Helens dome and the subsequent pyroclastic flow into the lake. The NGDC tsunami database also contains a few observed runups exceeding 150 feet (Table 2.4.6-1).

The tsunami events that caused runups exceeding 150 feet have properties that are not similar to those at the Savannah River Estuary. The Lituya Bay tsunami events are characterized by subaerial landslides in a very narrow inlet bay flanked by steep and high slopes. The Spirit Lake events were cause by the catastrophic failure of the north flank of the Mount St. Helens volcano. The 1674 tsunami runups on Ambon Island, Indonesia were caused by a near-field tsunamigenic earthquake in the Banda Sea. The events in Japan and Russia and those in Alaska were generated by tsunamigenic sources in the Pacific Ocean. The NRC staff concluded that none of these runup events can be considered representative of tsunamigenic conditions that may affect the Savannah River Estuary. Therefore, the NRC staff carried out a search for tsunami runups with tsunamigenic sources located in the Atlantic Ocean and in the Caribbean Sea, the most likely locations of tsunamigenic sources relevant to the Savannah River Estuary. Table 2.4.6-2 shows the results of this search.

Table 2.4.6-1 - Tsunami Runups Exceeding 150 Feet in the NGDC Tsunami Database

Date			Cause*	Country	Location	Runup (feet)
Year	Month	Day				
1958	7	10	3	USA	Lituya Bay, Alaska	1720
1980	5	18	6	USA	Spirit Lake West, Washington	820
1980	5	18	6	USA	Spirit Lake East, Washington	738
1936	10	27	8	USA	Lituya Bay, Alaska	490
1853	--	--	8	USA	Lituya Bay, Alaska	394
1674	2	17	1	Indonesia	Ceyt, Ambon Island	328
1674	2	17	1	Indonesia	Hila, Ambon Island	328
1674	2	17	1	Indonesia	Hitu Peninsula, Ambon Island	328
1674	2	17	1	Indonesia	Lima, Ambon Island	328
1741	8	29	5	Japan	Sado Island	295
1788	7	21	1	USA	Unga Island, Alaska	289
1788	8	6	1	USA	Unga Island, Alaska	289
1771	4	24	1	Japan	Ishigaki Island	280
1899	9	10	3	USA	Lituya Bay, Alaska	200
1737	10	17	0	Russia	Bering and Commander Islands	197
1771	4	24	1	Japan	Shiraho	197
1771	4	24	1	Japan	Ara	185
1792	5	21	5	Japan	Shimbara	180
1964	3	28	3	USA	Valdez Inlet, Alaska	170
2004	12	26	1	Indonesia	Labuhan, NW Coast of Sumatra	167
1650	9	29	6	Greece	West Coast Patmos	164
2004	12	26	1	Indonesia	Rhiting, Aceh, Sumatra	160
1771	4	24	1	Japan	Nobaruzaki	153

* Cause Codes:

0: Unknown
1: Earthquake
2: Questionable Earthquake
3: Earthquake and Landslide
4: Volcano and Earthquake
5: Volcano, Earthquake, and Landslide
6: Volcano
7: Volcano and Landslide
8: Landslide
9: Meteorological
10: Explosion
11: Astronomical Tide

Table 2.4.6-2 - Runups Exceeding 30 Feet Caused by Tsunamigenic Sources in the Atlantic Ocean and the Caribbean Sea

Date			Cause*	Country	Location	Runup (feet)
Year	Month	Day				
1755	11	1	1	Portugal	Lagos	98
1954	10	--	0	Greenland	Aputiteq Point	60
1755	11	1	1	Portugal	Lisbon	40
1894	11	21	6	Ireland	West Coast	40
1867	11	18	1	Guadeloupe	Deshaies	33
1867	11	18	1	Guadeloupe	Sainte-Rose	33
1900	10	29	1	Venezuela	Puerto Tuy	33

The 1755 Great Lisbon Earthquake, the only known great teletsunami in the Atlantic basin, produced runups of nearly 100 feet in Lagos, Portugal and approximately 40 feet in Lisbon, Portugal. According to the NGDC tsunami database, reported runups at Saint Martin harbor and Samana Bay in the Dominican Republic, both in the Caribbean Sea, were approximately 15 feet and 12 feet, respectively. Computer modeling of the tsunami waves generated by the 1755 Great Lisbon Earthquake, Mader (2001) estimated the runup heights on the east coast of the U.S. to be approximately 10 feet.

Based on the above data, the NRC staff concluded that all known tsunami runups on the Atlantic coast of the U.S. have been at least an order of magnitude less than the elevation of the site grade of the proposed new units at the VEGP site.

A tidal bore is a solitary, non-linear, shallow-water undular wave (Chen, 2003) that is caused by a large tide and typically propagates upstream in a slowly flowing estuary. The tidal bore is hydraulically similar to a traveling hydraulic jump characterized by supercritical flow upstream of the estuary. The formation of supercritical flow in the estuary is a necessary condition for the formation of a tidal bore (Chen, 2003). Supercritical flow is described by the Froude number, the ratio of inertial to gravity forces in open channel flow (Chow, 1959), exceeding 1.0. The Froude number is expressed by

$$Fr = V \big/ (gL)^{1/2} \quad (1)$$

where V is the velocity of flow, g is the acceleration due to gravity, and L is a characteristic length taken as the hydraulic depth for open channels. The hydraulic depth is defined as the ratio of the cross sectional area of discharge normal to the direction of flow to the top width of the free surface (Chow, 1959). For wide rectangular channels, therefore

$$Fr = V \,/\, (gh)^{1/2} \quad (2)$$

where h is the depth of flow. Therefore, the criteria for supercritical flow in wide, rectangular channels, Fr >= 1.0, can also be stated as

$$V \geq (gh)^{1/2} \quad (3)$$

The right hand side of equation (3) is the celerity, or speed, of a shallow-water wave. Therefore, when the Froude number exceeds 1.0, the velocity of flow exceeds shallow-water wave celerity.

Tidal bores are rare occurrences. Bartsch-Winkler and Lynch (1988) presented a catalog of worldwide occurrences and characteristics of tidal bores. This catalog listed 67 known locations where tidal bores occur. The only documented occurrences of tidal bores in the U.S. are those in the Knik and Turnagain Arms of Cook Inlet in Alaska (Bartsch-Winkler and Lynch, 1988). The NRC staff's additional search did not find any reference to the formation of a tidal bore in the Savannah River Estuary. The NRC staff concluded that a tsunami-induced bore traveling upstream from the mouth of the Savannah River would not occur.

A tsunami that causes a runup near the mouth of the Savannah River would have to reach an elevation of 220 feet MSL more than 100 miles inland in order to inundate the VEGP site. Both these metrics are an order of magnitude greater than the maximum estimated tsunami runup on the Atlantic coast near the site and the maximum reported horizontal extent of tsunami inundation anywhere, respectively. Based on the data pertaining to the geographical and topographical location of the VEGP site as it relates to tsunamis, the NRC staff concluded that a tsunami at the mouth of the Savannah River would not affect the VEGP site, which is located more than 100 miles from the mouth and at a grade elevation of 220 feet MSL.

2.4.6.4 Conclusion

The VEGP site is not affected by probable maximum tsunami. All safety-related SSC will be placed above the highest flood water surface elevation that is controlled by flooding in the Savannah River resulting from to cascading upstream dam failures.

As set forth above, the applicant has presented and substantiated sufficient information pertaining to the effects of probable maximum tsunami hazards at the proposed site. RS-002, Section 2.4.6 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the effects of probable maximum tsunami hazards. Furthermore, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area while describing the probable maximum tsunami hazards, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in this analysis, as documented in SERs for previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in an analysis containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the applicant's analysis is acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of the probable maximum tsunami hazards set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d). The

NRC staff finds the applicant's proposed analysis related to probable maximum tsunami hazards for the ESP application to be acceptable.

2.4.7 Ice Effects

This section of the applicant's SSAR develops the hydrometeorological design basis to ensure that ice-induced hazards do not affect safety-related facilities and water supply. The applicant is responsible for providing site characteristics and other hydrometeorological parameters related to ice formation at or near the site to the organization responsible for review of the SSCs to ascertain whether the mechanical or structural design basis for the plant properly considers ice effects on potentially affected SSC. The review covers: (1) historical ice accumulation; (2) high and low water levels; (3) ice sheet formation; (4) ice-induced forces and blockages; (5) consideration of other site-related evaluation criteria; and (6) additional information for 10 CFR Part 52 applications.

2.4.7.1 Introduction

The VEGP site is located on the southeast side of the Savannah River, approximately 15 miles east-northeast of Waynesboro, Georgia, 26 miles southeast of Augusta, Georgia, and 100 miles north-northwest of Savannah, Georgia (SNC 2007). The VEGP site is located approximately 150 river miles upstream of the mouth of the Savannah River. The grade elevation of the existing VEGP units and the new proposed units is 220 feet MSL.

The site may be affected by icing in the Savannah River near the site. There are no large inland bodies of water near the VEGP site and no water reservoirs are proposed for safety-related use.

2.4.7.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 10 CFR 100.20(c), also requires 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).

To evaluate the information provided in SSAR 2.4 per the above acceptance criteria, applicant applied the NRC-endorsed analytical methodologies found in the following:

- RG 1.59, Revision 2, issued August 1977.

- 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 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 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.

- 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 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 NRC staff estimates. If the applicant's estimates are more than 5 percent less conservative than the NRC staff's, the applicant should fully document and justify its estimates or accept the NRC staff estimates.

2.4.7.3 Technical Evaluation

The technical evaluation consists of: (1) a review of the applicant's technical information presented in the SSAR; and (2) NRC staff's technical evaluation to determine the potential for ice-related hazards at the site.

2.4.7.3.1 Technical Information Presented by the Applicant

The applicant used air temperature records from eight locations, including seven cooperative stations, around the VEGP site to analyze historical extreme air temperature variations (SNC 2007). The applicant also used air temperature data from onsite measurements.

The climate at the VEGP site consists of short, mild winters and long, humid summers (SNC 2007). At the Augusta, Georgia station, based on 129 years of records, January is the coldest month with a mean temperature of 46.8 ºF. Among the eight stations, the lowest air temperature was -4.0 ºF at Aiken, South Carolina in January 1985. During the same period, the air temperature at the VEGP site was -0.1 ºF, with air temperatures remaining below freezing (32 ºF) for approximately 50 hours (SNC 2007). Onsite measurements from 1984 to 2002 showed that mean daily air temperature remained below freezing for a maximum of three consecutive days (SNC 2007).

Historical water temperature data from five USGS gauging stations located on the Savannah River covering an area that includes the VEGP site showed that the minimum water temperature is observed in the month of February and varies from 39.2 ºF and 42.8 ºF (SNC 2007).

Based on historical air and water temperature records, the applicant concluded that it is very unlikely that surface or frazil ice formation would occur in the Savannah River in the vicinity of the proposed intake location of the new VEGP units (SNC 2007).

The applicant reported in SSAR Section 2.4.7 that the USACE Ice Jam Database includes no recorded ice jam events in the lower reaches of the Savannah River. The existence of dams and reservoirs on the Savannah River upstream of the VEGP site reduce the possibility of any surface ice or ice floes moving downstream (SNC 2007). Since the water temperature in the lower reach of the Savannah River consistently remains above freezing, the applicant concluded that formation of frazil ice or ice jams is very unlikely at the proposed intake location for the new VEGP units.

The proposed VEGP units would use a closed-cycle cooling system with cooling towers for the circulating water system cooling (SNC 2007). Makeup water for the circulating water system cooling towers will be supplied from the Savannah River using a new intake system comprising of an intake canal and a pump intake structure located upstream of the existing river intake system for VEGP Units 1 and 2 (SNC 2007).

The reactors for the proposed VEGP units will use passive UHS systems that do not require any safety-related water supply (SNC 2007). The proposed reactors would have a non-safety related auxiliary heat sink service water system that will be used for shutdown, normal operations, and anticipated operational events (SNC 2007). The makeup water to the service water system will be supplied from groundwater wells or an onsite water storage tank (SNC 2007). No water will be necessary from the Savannah River or any other open surface water source for the proposed reactors' UHS (SNC 2007). The applicant concluded, therefore, that any ice event in the Savannah River will not have an impact on the safe operation of the proposed units (SNC 2007).

2.4.7.3.2 NRC Staff's Technical Evaluation

The NRC staff's technical evaluation consisted of a review of the data and the references presented in the applicant's SSAR.

The NRC staff carried out a review of historical air temperature data near the VEGP site. The stations used by the NRC staff and their periods of record are shown in Table 2.4.7-1.

Table 2.4.7-1 - Meteorological stations near the VEGP site used by the NRC staff

Name (State)	COOP ID	Start Date	End Date
Augusta Bush Field Airport (Georgia)	090495	03/01/1949	04/30/2007
Louisville 1E (Georgia)	095314	01/01/1893	03/31/2007
Midville Experiment Station (Georgia)	095863	06/01/1957	03/31/2007
Millen 4N (Georgia)	095882	11/01/1891	12/31/1998
Newington (Georgia)	096323	09/01/1956	02/28/2003
Waynesboro 2S (Georgia)	099194	11/01/1893	02/28/2007
Aiken 5SE (South Carolina)	380074	01/01/1893	03/31/2007
Bamberg (South Carolina)	380448	08/01/1951	01/31/2007
Blackville 3W (South Carolina)	380764	06/01/1894	07/31/2002

In reviewing the daily minimum air temperature record at these stations, the NRC staff determined that the lowest daily minimum air temperature, -4 ºF, was observed at the Aiken 5SE station on January 21, 1985. The range of the lowest daily minimum air temperatures at all stations was 0 ºF to -4 ºF. The NRC staff estimated the mean daily minimum air temperature during the winter months, December through March, for all stations (see Table 2.4.7-2). None of these temperatures was below freezing.

Table 2.4.7-2 - Mean Daily Minimum Air Temperatures During the Months of December Through March for All Stations Used in the NRC Staff's Review

Name (State)	Mean Daily Minimum Air Temperature (ºF)			
	December	January	February	March
Augusta Bush Field Airport (Georgia)	34.7	33.5	35.8	42.3
Louisville 1E (Georgia)	49.2	49.9	55.7	62.4
Midville Experiment Station (Georgia)	37.1	35.5	38.3	45.2
Millen 4N (Georgia)	38.1	37.6	39.8	45.9
Newington (Georgia)	38.8	36.4	39.4	45.5
Waynesboro 2S (Georgia)	42.3	41.5	45.5	52.5
Aiken 5SE (South Carolina)	39.0	37.8	40.7	47.3
Bamberg (South Carolina)	37.4	35.5	37.9	43.8
Blackville 3W (South Carolina)	52.1	54.4	59.4	67.8

The NRC staff also identified the longest consecutive period during which the mean daily air temperature (estimated as the average of the daily minimum and maximum temperatures) was below freezing at each of the stations (see Table 2.4.7-3). The longest duration, that of nine days, of mean daily air temperature below freezing was observed at the Aiken station from January 13 to January 21, 1893.

According to USACE (2002), frazil ice forms in turbulent, supercooled water that is not covered by an ice layer. The NRC staff identified the maximum number of consecutive days that mean daily air temperature falls below 18 ºF for each of the stations (Table 2.4.7-3a). Two consecutive days of mean daily air temperatures below 18 ºF were observed twice at Waynesboro 2S and once at Blackville 3W. At all other stations experienced only 1 consecutive day with the mean air temperature below 18 ºF.

In response to NRC staff's RAI 2.4.1-1, the applicant provided water temperature data at the Shell Bluff Landing site, which is located approximately 11 river miles upstream of the VEGP site. The NRC staff reviewed water temperature data supplied by the applicant. The period of record for these monthly water temperatures was from January 30, 1973 to August 13, 1996. From these data, the NRC staff computed the following water temperature statistics: the minimum water temperature was 41.0 °F, the average water temperature was 63.4 °F, the median water temperature was 64.4 °F, and the maximum water temperature was 81.0 °F.

Based on its independent review of air temperature data near the VEGP site, the NRC staff concluded that the occurrenceS of air temperatures below freezing at and near the VEGP site are brief and infrequent. Although air temperature could fall below 18 ºF in the vicinity of the VEGP site, the duration of such a freezing spell would be unlikely to exceed two days. Since the water temperatures in the Savannah River near the site have never approached freezing (minimum water temperature estimated from 13 years of monthly data was 41.0 ºF), the NRC staff concluded that the VEGP site would not support the formation of frazil ice.

Table 2.4.7-3 - Longest Consecutive Period of Mean Daily Air Temperature below Freezing for All Stations Used in the NRC Staff's Review

Name (State)	Longest Consecutive Period of Mean Daily Air Temperature Below Freezing	
	Duration (days)	Dates
Augusta Bush Field Airport (Georgia)	6	01/10/1982 – 01/15/1982, 12/30/2000 – 04/01/2001
Louisville 1E (Georgia)	8	01/14/1893 – 01/21/1893
Midville Experiment Station (Georgia)	4	02/16/1958 – 02/19/1958, 01/08/1970 – 01/11/1970, 12/23/1989 – 12/26/1989
Millen 4N (Georgia)	5	01/13/1912 – 01/17/1912, 01/25/1940 – 01/29/1940
Newington (Georgia)	5	01/16/1977 – 01/20/1977
Waynesboro 2S (Georgia)	6	12/30/1917 – 01/04/1918, 01/11/1982 – 01/16/1982
Aiken 5SE (South Carolina)	9	01/13/1893 – 01/21/1893
Bamberg (South Carolina)	5	02/01/1980 – 02/05/1980, 12/31/2000 – 01/04/2001
Blackville 3W (South Carolina)	5	12/30/1899 – 01/03/1900

Table 2.4.7-3a - Number of Days with Minimum Daily Temperature at or below 18 ºF

Name (State)	Longest Consecutive Period of Mean Daily Air Temperature Below 18 ºF
Augusta Bush Field Airport (Georgia)	1
Louisville 1E (Georgia)	1
Midville Experiment Station (Georgia)	1
Millen 4N (Georgia)	1
Newington (Georgia)	1
Waynesboro 2S (Georgia)	2
Aiken 5SE (South Carolina)	1
Bamberg (South Carolina)	1
Blackville 3W (South Carolina)	2

The proposed units at the VEGP site have no safety-related water requirement and would not use any safety-related intakes. Consequently, formation of ice sheets, forces induced by ice, and blockages caused by ice are not areas of concern for this review.

The NRC staff searched the USACE Ice Jam Database for ice jam events reported in the states of Georgia, North Carolina, and South Carolina (CRREL, 2007a; 2007b; 2007c). The Ice Jam Database contains no ice jams reported in Georgia and South Carolina (CRREL, 2007d; 2007f). There are two ice jams reported in North Carolina (CRREL 2007e), one on the Neuse River and the other on the Missouri River. Based on these search results, the NRC staff concluded that ice jams in the Savannah River near the VEGP site are not likely.

The NRC staff proposed a site characteristic related to frazil ice that states that hydrometeorologic conditions at the VEGP site do not support formation of frazil ice.

2.4.7.4 Conclusion

Based on its review and independent analysis of data available publicly and those provided by the applicant, the NRC staff concluded that icing in the vicinity of the VEGP site is unlikely. Since the proposed units have no requirement other than initial filling and occasional makeup purposes, for continuous safety-related water supply, no safety-related water reservoirs or canals, intakes, and structures will be used. Therefore, the NRC staff concluded that ice effects will not affect safety of the proposed units.

As set forth above, the applicant has presented and substantiated sufficient information pertaining to the identification and evaluation of ice effects at the proposed site. Section 2.4.7 of RS-002 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating ice effects at the site. Furthermore, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area while describing the hydrologic interface of the plant with the site, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in this site characteristic, as documented in SERs for previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in a site characteristic containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the site characteristic previously identified is acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of the site characteristic related to ice effects set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d). The NRC staff finds the applicant's proposed site characteristic related to ice effects for the ESP application to be acceptable.

2.4.8 Cooling Water Canals and Reservoirs

This section of the applicant's SSAR develops the hydraulic design basis for canal and reservoirs used to transport and impound water supplied to the safety-related structures, systems, and components (SSCs). The NRC staff's review of the SSAR covers (1) hydraulic design bases for protection of structures, (2) hydraulic design bases of canals, (3) hydraulic design bases of reservoirs, (4) consideration of other site-related evaluation criteria, and (5) 10 CFR Part 50, Appendix A, GDC 44, for CP and OL applications, as it relates to providing a UHS for normal operating and accident conditions.

2.4.8.1 Introduction

The VEGP site is located on the southwest side of the Savannah River (SNC 2008a). The two proposed plant units will use a closed-cycle cooling system with cooling towers. The Savannah River will provide makeup water for the cooling towers' evaporative and other losses using a new intake system consisting of a 200-foot-long intake canal and an intake structure.

The proposed units at the VEGP site will not rely on external sources of safety-related UHS cooling water. The applicant has not proposed any safety-related cooling water supply canals and reservoirs.

2.4.8.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in the site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit

- 10 CFR 100.20(c), with respect to the requirement 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

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 of the specified type 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 of the specified type 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.

2.4.8.3 Technical Evaluation

The technical evaluation consists of (1) a review of the technical information presented in the application, and (2) the NRC staff's technical evaluation to determine the acceptability of the design bases for canals and reservoirs.

2.4.8.3.1 Technical Information Presented by the Applicant

The proposed VEGP units will use a closed-cycle cooling system with cooling towers for condenser heat removal during normal operation (SNC 2008a). To replenish the water losses from evaporation, drift, and blowdown, the Savannah River will supply makeup water at a maximum rate of approximately 57,784 gallons per minute (SNC 2008a). The makeup water intake system for the proposed units will be located upstream of the intake for the existing units (SNC 2008a).

The proposed plants for the new VEGP units use a passive UHS with in-plant storage of safety-related cooling water (SNC 2008a). The proposed plant design does not require an external water-cooled UHS (SNC 2008a). The makeup water intake that will supply water to the condenser heat removal system will not be safety related (SNC 2008a). Because the proposed VEGP units will not rely on the Savannah River for safety-related water supply, low-water conditions in the river will not affect safety-related SSCs (SNC 2008a).

2.4.8.3.2 Technical Evaluation

The NRC staff's technical evaluation consisted of a review of the data and the references presented in the applicant's SSAR in its various revisions. The ESP SER with Open Items was based on SSAR, Revision 2 (SNC 2007), and this final ESP SER is based on SSAR, Revision 4 (SNC 2008a) and Revision 4S-2 (SNC 2008b).

On the basis of its initial review of the information presented in the SSAR, the NRC staff concluded that, as proposed in the application, the new VEGP Units 3 and 4 would not rely on any external water source for safety-related cooling water. The applicant did not propose any safety-related canals or reservoirs as a source for cooling water. However, safety-related water would be needed for initial filling and occasional makeup purposes. In this regard, the applicant did not provide design parameters for these values. This omission was designated Open Item 2.4-1.

The NRC staff identified in Section 2.4.8 of the ESP SER with Open Items a permit condition stating that VEGP Units 3 and 4 will not rely on any external water source for safety-related cooling water other than initial filling and occasional makeup water. This permit condition precluded the use of onsite surface and ground water for safety-related water supply except for initial filling and occasional makeup water.

The NRC staff discussed these issues with the applicant and reviewed the water components of the passive containment cooling system of a nuclear power reactor design that fits within the bounding parameters provided in the proposed permit application. The applicant stated that storage volume for each of the two water tanks would be approximately 800,000 gallons (SNC 2007g). The applicant also stated that the VEGP Units 3 and 4 water storage tanks will require initial filling and occasional makeup water to these tanks. For the VEGP site, the applicant proposes to use ground water as the source of water for the tanks, as described in SSAR Section 2.4.12.2 and Table 2.4.12-12 (SNC 2008b). The NRC staff determined that the capacity of the three existing and two proposed deep ground-water wells at the VEGP site under the current groundwater use permit issued by the State of Georgia Environmental Protection Division to SNC for 5.5 million gallons a day (MGD) annual average flow will be sufficient for initial filling and occasional makeup water supply, due to evaporative losses, to the two tanks providing water to the passive containment cooling system. The staff determined that neither the initial filling of the two tanks and occasional makeup involves reliance on external sources of safety-related UHS cooling water. Apart from the water stored in these two tanks to supply water to the passive containment cooling system, no other water is required by any safety-related system. Therefore, Open Item 2.4-1 is now closed, and the permit condition stated above is not required.

2.4.8.4 Conclusion

As proposed, VEGP Units 3 and 4 will not rely on any external water source for safety-related cooling water except for initial filling and makeup water. The units will not use any safety-related canals or reservoirs. The SSAR should address the requirements of 10 CFR Part 52 and 10 CFR Part 100 as they relate to identifying and evaluating design bases of canals and reservoirs at the site. As set forth above, the applicant presented and substantiated sufficient information pertaining to the design bases of canals and reservoirs at the proposed site.

Therefore, the NRC staff concludes that the identification and consideration of the safety-related canals and reservoirs set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d). The NRC staff finds the applicant's site characterization related to canals and reservoirs acceptable for the ESP application.

2.4.9 Channel Diversions

In this section of the applicant's SSAR, the geohydrologic design basis is developed to ensure that the plant and essential water supplies will not be adversely affected. This review includes stream channel diversions away from the site (which may lead to loss of safety related water) and stream channel diversions towards the site (which may lead to flooding). Additionally, in such an event, the applicant needs to show that alternate water supplies are available to safety-related equipment. The NRC staff's review of the SSAR covers: (1) historical channel diversions; (2) regional topographic evidence; (3) ice causes; (4) flooding of site due to channel diversion; (5) human-induced causes of channel diversion; (6) alternate water sources; (7) consideration of other site-related evaluation criteria; and (8) additional information for 10 CFR Part 52 applications.

2.4.9.1 Introduction

The VEGP site is located on the southwest side of the Savannah River (SNC 2007). The site is located on a plateau with natural drainages that drain water away from the site in all directions. The proposed site grade for the new units is 220 feet MSL. The two proposed units will use a closed-cycle cooling system with cooling towers. Make-up water for the cooling towers' evaporative and other losses will be supplied from the Savannah River using a new intake system consisting of a canal and an intake structure.

The proposed units at the VEGP site will not rely on safety-related cooling water from the Savannah River. The highest water surface elevation caused by flooding in the Savannah River is 178.1 feet MSL, more than 30 feet below the proposed site grade.

2.4.9.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 10 CFR 100.20(c) and 10 CFR 100.20(d), also requires 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).

Section 2.4.9 of RS-002 provides the following criteria that were used by the NRC staff to evaluate this SSAR section.

- 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 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.

- 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

The technical evaluation consists of: (1) a review of the technical information presented in the application; and (2) NRC staff's technical evaluation to determine the effects of potential channel diversions near the site.

2.4.9.3.1 Technical Information Presented by the Applicant

The applicant provided information related to physiographic, topographic, hydrologic, and geologic characteristics of the region within which the VEGP site is located (SNC, 207). Based on these data, the applicant concluded that it could not completely discount diversion of the river channel in this region (SNC 2007).

The applicant stated that although meandering of the river channel upstream and downstream of the VEGP site can be observed on topographic maps, the Savannah River near the VEGP site has a relatively straight and stable reach from River Mile 143 to River Mile 152 and the river plan-form did not change between 1965 and 1989 as inferred from USGS topographic maps (SNC 2007). The applicant also stated that the flow in the Savannah River is controlled by upstream multipurpose projects in the Savannah River system (SNC 2007). The effect of the control on the Savannah River results in lowering of peak flows and augmentation of low flows with an associated reduction in the morphological activity of the river (SNC 2007). The applicant concluded that it is unlikely the river will be diverted away from the VEGP site due to natural causes.

2.4.9.3.2 NRC Staff's Technical Evaluation

The NRC staff's technical evaluation consisted of a review of the approach presented in the applicant's SSAR.

As proposed in the application, the new VEGP Units 3 and 4 will not rely on any external water source for safety-related cooling water. The applicant did not propose any safety-related intakes for cooling water from the Savannah River. The NRC staff concluded that diversion of the Savannah River away from the VEGP site for any cause would not adversely affect the safety of the proposed VEGP Units 3 and 4.

The topographic elevations within the floodplain adjacent to the Savannah River northeast of the VEGP site are approximately 90 feet MSL and lower. The proposed grade elevation of the VEGP Units 3 and 4 is 220 feet MSL. In order to cause flooding at the VEGP site, the Savannah River would have to erode through more than 100 feet of terrain. Upstream dams regulate peak flood discharges in the Savannah River near the VEGP site and the river plan-form near the VEGP site is relatively straight. Based on these topographic, morphologic, and hydrologic characteristics, the NRC staff concluded that it is unlikely that flooding at the VEGP site can occur due to the Savannah River diverting towards the VEGP site.

2.4.9.4 Conclusion

As proposed, VEGP Units 3 and 4 will not rely on any external water source for safety-related cooling water. The NRC staff concluded that diversion of the Savannah River away from the VEGP site for any reason would not result in an adverse effect on safety of proposed VEGP Units 3 and 4. Based on topographic, morphologic, and hydrologic characteristics of the Savannah River, the NRC staff concluded that flooding of the VEGP site due to the river diverting towards the site is unlikely.

As set forth above, the applicant has presented and substantiated sufficient information pertaining to the identification and evaluation of channel diversions at the proposed site. Section 2.4.9 of RS-002 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating channel diversions affecting the site. Furthermore, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area while describing the hydrologic interface of the plant with the site, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in this analysis, as documented in SERs for previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in an analysis containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the applicant's analysis is acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of the channel diversion characterization set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d).

In view of the above, the NRC staff finds the applicant's site characterization related to channel diversions to be acceptable for the ESP application.

2.4.10 Flooding Protection Requirements

In this section of the applicant's SSAR, the locations and elevations of safety-related facilities and those of structures and components required for protection of safety-related facilities are compared with design-basis flood conditions to determine if flood effects need to be considered in plant design or in emergency procedures. The NRC staff's review of the SSAR covers: (1) safety-related facilities exposed to flooding; (2) type of flooding protection; (3) emergency procedures; (4) consideration of other site-related evaluation criteria; and (5) additional information for 10 CFR Part 52 applications.

2.4.10.1 Introduction

The VEGP site is located on the southwest side of the Savannah River (SNC 2007). The proposed site grade for the new units is 220 feet MSL. The proposed units at the VEGP site will not rely on safety-related cooling water from the Savannah River.

2.4.10.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in site vicinity:

- 10 CFR 52.17(a), with respect to the requirement that the application contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit(s).

- 10 CFR 100.20(c), also requires 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).

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.

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 technical evaluation consists of: (1) a review of the technical information presented in the application; and (2) NRC staff's technical evaluation to determine flooding protection requirements.

2.4.10.3.1 Technical Information Presented by the Applicant

The applicant stated that entrances and openings of all safety-related SSCs will be placed at or above the proposed site grade of 220 feet MSL (SNC 2007). The design-basis flood elevation in the Savannah River is 178.1 feet MSL (SNC 2007). The applicant concluded that safety-related SSC of the proposed VEGP Units 3 and 4 will not be exposed to flooding from the Savannah River.

The applicant stated that the effects of local intense precipitation will be considered in the design of site drainage system (SNC 2007). The applicant committed to designing the site drainage system such that all safety-related SSC would be safe from flooding from local intense precipitation (SNC 2007). All drainage structures such as culverts, storm drains, and bridges would be assumed to be blocked during the local intense precipitation event (SNC 2007).

2.4.10.3.2 NRC Staff's Technical Evaluation

In the preceding sections of this report, the NRC staff estimated the highest water surface elevation due to flooding in the Savannah River and concluded that it is well below the proposed site grade. The NRC staff concluded that protection from flooding in the Savannah River is not needed for a safety-related SSC if its entrances and openings are located above the proposed site grade of 220 feet MSL.

2.4.10.4 Conclusion

The proposed site grade of 220 feet MSL is safe from flooding in the Savannah River. The entrances and openings of all safety-related SSC that are located above the proposed site grade would be safe from flooding.

As set forth above, the applicant has presented and substantiated sufficient information pertaining to the flood protection measures at the proposed site. RS-002, Section 2.4.10 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating flood protection measures at the site. Furthermore, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area while describing the flooding protection requirements at the site, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in this analysis, as documented in SERs for previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in an analysis containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the applicant's analysis previously identified are acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of the flooding protection requirement analysis set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d). In view of the above, the NRC staff finds the applicant's analysis related to flooding protection requirements to be acceptable for the ESP application.

2.4.11 Low Water Considerations

In this section of the applicant's SSAR, natural events that may reduce or limit the available safety-related cooling water supply, are identified and the applicant ensures that an adequate water supply will exist to shut down the plant under conditions requiring safety-related cooling. The NRC staff's review of the SSAR covers: (1) low water from drought; (2) low water from other phenomena; (3) effect of low water on safety-related water supply; (4) water use limits; (5) consideration of other site-related evaluation criteria; and (6) additional information for 10 CFR Part 52 applications.

2.4.11.1 Introduction

The VEGP site is located on the southwest side of the Savannah River (SNC 2007). The proposed units at the VEGP site will not rely on safety-related cooling water from any external source, including the Savannah River and groundwater.

2.4.11.2 Regulatory Basis

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.

Section 2.4.11 of RS-002 provides the following criteria that were used by the NRC staff to evaluate this SSAR section.

- 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.

- 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 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 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. 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.

Low Flow in Rivers and Streams

- 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.

- Low Water Resulting from Surges, Seiches, or Tsunami

- 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 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

The technical evaluation consists of: (1) a review of the technical information presented in the application; and (2) NRC staff's technical evaluation to determine effects of low water conditions.

2.4.11.3.1 Technical Information Presented by the Applicant

The applicant stated that proposed VEGP Units 3 and 4 will not use any external water sources for safety-related cooling water supply (SNC 2007).

2.4.11.3.2 NRC Staff's Technical Evaluation

The applicant stated that proposed VEGP Units 3 and 4 will not need any external water sources for safety-related cooling water supply for continuous use. While, the NRC staff determined that initial filling and occasional makeup water requirements for two water storage tanks exist, as described in Section 2.4.8.3.2 of this report, the NRC staff determined that low water conditions will not affect any safety-related SSCs.

2.4.11.4 Conclusion

The proposed VEGP Units 3 and 4 will not rely on any external source of water supply for safety-related cooling on a continuous basis; therefore, low water conditions will not affect any safety-related SSCs. RS-002, Section 2.4.11 provides that the SSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating low water conditions affecting the site. As set forth above, the applicant has presented and substantiated sufficient information pertaining to the identification and evaluation of low water conditions at the proposed site.

Therefore, the NRC staff concludes that the identification and consideration of the low water conditions set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d). In view of the above, the NRC staff finds the applicant’s site characterization related to low water considerations for inclusion in an ESP for the applicant’s site to be acceptable.

2.4.12 Ground Water

2.4.12.1 Introduction

This section of the applicant’s SSAR evaluates the hydrogeological characteristics of the site and describes the effects of ground water on the plant foundations and the reliability of safety-related water supply and dewatering systems. The NRC staff’s review of the SSAR covers: (1) local and regional ground-water characteristics and use; (2) effects on plant foundations and other safety-related SSCs; (3) reliability of ground-water resources and systems used for safety-related purposes; (4) reliability of dewatering systems; and (5) consideration of other site-related evaluation criteria.

The proposed VEGP Units 3 and 4 are to be located on a topographic ridge perpendicular to the Savannah River that forms a boundary between two watersheds. The watershed to the northwest is dominated by Mallard Pond and an unnamed drainage creek from it that discharges to the Savannah River. The watershed to the southeast is dominated by Daniels Branch, Telfair Pond, and Beaverdam Creek. Beaverdam Creek discharges to the Savannah River. Construction of the proposed facilities may alter the topography of the site and alter recharge to the unconfined aquifer in the immediate vicinity of the proposed units. Ground water has no safety-related role in the operation of the proposed VEGP units; however, the three existing and two proposed deep groundwater wells at the VEGP site will be sufficient for initial filling and occasional makeup water supply to the two tanks providing water to the passive containment cooling system.

Section 2.4.13 of this SER provides a complete discussion and evaluation of accidental radioactive releases (i.e., the release, migration, and the resulting hazard).

2.4.12.2 Regulatory Basis

The acceptance criteria for this section relate to the following regulations:

- 10 CFR Part 52 and 10 CFR Part 100 requires the site evaluation to consider hydrologic characteristics.

- 10 CFR 100.23 sets forth the criteria to determine the suitability of design bases for a nuclear unit of specified type 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.

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 staff's review of the applicant's SSAR should verify the description of ground-water conditions at the proposed site and the effect of the construction and operation of a nuclear unit of specified type that might be constructed on the site on those conditions. Meeting this requirement provides reasonable assurance that the release of radioactive effluents from a unit 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.

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 used the following criteria:

- Section 2.4.12.1 of the SSAR must fully describe regional and local ground-water aquifers, sources, and sinks. In addition, it must describe the type of ground-water use, wells, pump, storage facilities, and the flow needed for the proposed plants of specified type that might be constructed on the site. 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 hazard phenomena must be compared to RG 1.27 guidelines. This section must adequately describe and reference the bases and data sources.

- Section 2.4.12.2 of the SSAR must describe present and projected local and regional ground-water use. This section must discuss and tabulate existing uses, including amounts, water levels, location, drawdown, and source aquifers. It must also indicate flow directions, gradients, velocities, water levels, and the effects of potential future use on these parameters, including any possibility for reversing the direction of ground-water flow. In addition, SSAR Section 2.4.12.2 must identify any potential ground-water recharge area within the influence of the proposed plants of specified type that might be constructed on the site, as well as the effects of construction, including dewatering. This section must also discuss the influence of existing and potential future wells with respect to ground water beneath the site and describe and reference the bases and data sources. 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 evaluate whether the applicant has met the requirements of 10 CFR 50.55, “Conditions of Construction Permits,” 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 applicant must provide the bases for the design of the system and determination of the design basis for ground-water levels. The application must provide information 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

- If wells are proposed for safety-related purposes, the applicant must describe the hydrodynamic design bases (and development thereof) for protection against seismically induced pressure waves, which should be consistent with site characteristics.

2.4.12.3 Technical Evaluation

This section reviews the applicant's information and evaluates the effects of ground water.

2.4.12.3.1 Technical Information Presented by the Applicant

In Section 2.4.12 of the SSAR, both Revision 4 (SNC 2008a) and Revision 4-S2 (SNC 2008b), Southern Nuclear Operating Company (Southern) presented information and data describing the local and regional ground-water systems and use, monitoring or safeguard requirements, and design basis for subsurface hydrologic loading. Much of the information and data was available in Revision 2 of the SSAR (SNC 2007) and was described in the ESP SER with Open Items; however, a substantial body of work on groundwater models and modeling of the VEGP site was included in Revision 4-S2 (SNC 2008b) and the responses to the additional RAIs (SNC 2008c).

The VEGP site is located on a ridge perpendicular to the Savannah River which lies to the northeast. This ridge separates two drainages. Mallard Pond and an unnamed drainage stream lie to the northwest, and Red Branch, Daniels Branch, Telfair Pond, and Beaverdam Creek lie to the southeast (SNC 2008a, Part 2, Section 2.4.1.2.2).

The applicant described the hydrogeology in Section 2.4.12.1.1 of the SSAR (SNC 2008b). The thickness of Coastal Plain sediments varies from less than 200 feet at the fall line to 4000 feet at the coastline, and is approximately 1000 feet thick at the site (SNC 2008b, Section 2.4.12.1.1). A surface topography of gently rolling hills ranges in elevation from 80 feet above MSL to nearly 300 feet above MSL in the immediate vicinity of the VEGP site (SNC 2008a, Part 3, Sections 2.4.1 and 2.6.1). Developed portions of the site have ground surface elevations of approximately 220 feet MSL (SNC 2008b, Section 2.4.12, pg. 2.4.12-1, and Figure 2.4.12-1). The Savannah River has incised the Coastal Plain sediments and formed steep bluffs exhibiting topographic relief of nearly 150 feet from the river to the developed portions of the existing VEGP site (SNC 2008a, Part 3, Section 2.6.1).

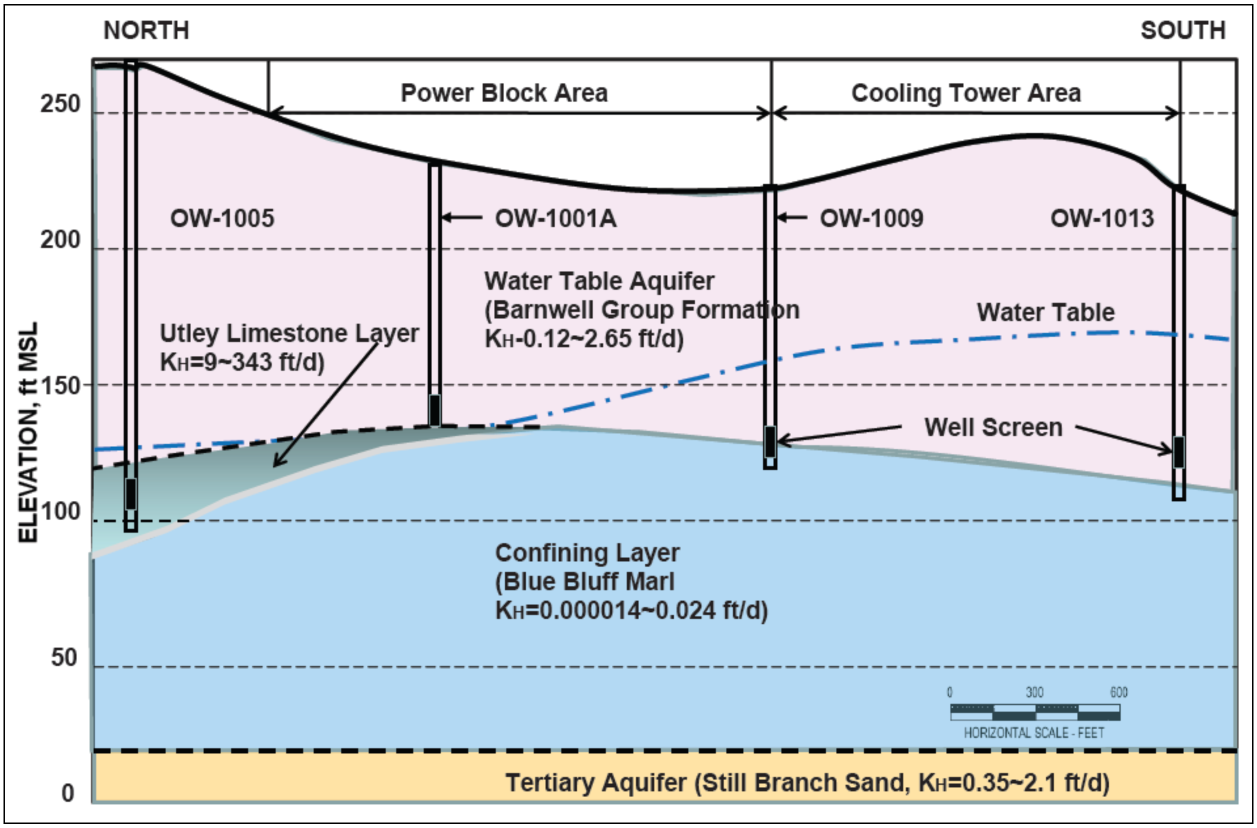


Figure 2.4.12-1 Hydrogeologic cross-section of the Water Table aquifer at the Vogtle site (KH is the horizontal hydraulic conductivity)

Precipitation onto outcrops of aquifer sediments creates a ground-water source. Locally, net infiltration from precipitation recharges the Water Table aquifer (SNC 2008b, Section 2.4.12.1.1). Net infiltration from precipitation recharges the locally confined Tertiary and Cretaceous aquifers at outcrops of these formations nearer the fall line (SNC 2008b, Section 2.4.12.1.1).

The applicant stated that the Water Table aquifer discharges to ground-water wells and local drainages, including springs and seeps that ultimately drain to the Savannah River (SNC 2008b, Section 2.4.12.1.2). Figure 2.4.12-7 of the SSAR (SNC 2008b) depicts the piezometric surface of the Water Table aquifer and implies that ground-water flow throughout the proposed powerblock area is moving to the north-northwest and Mallard Pond. Depictions of the piezometric surface from 1971 (see SNC 2003 drawing AX6DD329) and 1984 (see SNC 2003 drawing AX6DD330) reveal the evolution of decline in the piezometric surface of the Water Table aquifer.

The applicant stated that the Tertiary aquifer drains to the Savannah River (see Figure 2.4.12-14 in SNC 2008b) and discharges to wells, natural springs, and subaqueous outcrops presumed to exist offshore (SNC 2008b, Section 2.4.12.1.2). Discharge to the Savannah River occurs where the river has completely eroded the Blue Bluff Marl confining layer (SNC 2008b, Section 2.4.12.1.2). Depictions of the piezometric surface from 1971 (see SNC 2003 drawing AX6DD327) and 1984 (see SNC 2003 drawing AX6DD328) reveal the evolution of the piezometric surface of the Tertiary aquifer.

The applicant concluded that piezometric head data for observation wells OW-1001 and OW-1001A were invalid and removed the data from the ESP application (SNC 2008b, Section 2.4.12.1.3, pg. 2.4.12-12). The well screen for OW-1001A ranges in elevation from 146.13 to 136.13 feet MSL (SNC 2008b, Section 2.4.12.1.3). In the vicinity of the proposed VEGP Unit 4, which is close to these wells, the top of the Blue Bluff Marl is located between 121.9 feet and 138.2 feet MSL (SNC 2008a, Part 2, Section 2.5.1.2.3.2 and Figure 2.5.1-47), with the lower value in the vicinity of OW-1001A. Omission of these data and information led the applicant to interpolate other nearby measurements and assign a piezometric head value to this location of approximately 147 feet (SNC 2008b, Figure 2.4.12-7) when the information suggests a head value less than the screened interval.

The applicant reported hydraulic properties of the Barnwell Formation sediments and included the range of hydraulic conductivity measurements for the Utley Limestone from 3,250 to 125,400 feet/year (9 to 343 feet/day). The applicant derived a value for effective porosity of 0.34 (SNC 2008b, Section 2.4.12.1.4) from the median specific gravity and moisture content measurements for Barnwell sediments. Using ground-water data from June 2005 through July 2007, the applicant estimated a hydraulic gradient of 0.014 feet/feet to apply to the Water Table aquifer across the site (SNC 2008b, Section 2.4.12.1.3).

The applicant reported a range of 480 to 1220 feet/year (1.3 to 3.3 feet/day) for hydraulic conductivity values in the engineered backfill (SNC 2008b, Section 2.4.12.1.4). The applicant obtained this value from the prior postconstruction testing of backfill regions underlying VEGP Units 1 and 2, as reported in the updated final safety analysis report (UFSAR), Table 2.4.12-14 (SNC 2003). The applicant used a value of 0.34 for the porosity of the engineered backfill, as applied in the FSAR for VEGP Units 1 and 2 (SNC 2003, Sections 2.4.13.1.1 and 2.4.12.2.4.3, and Table 2.4.12-14).

The applicant reported hydraulic properties of the Tertiary aquifer sediments (SNC 2008b, Section 2.4.12.1.4, Table 2.4.12-3). These include a range of hydraulic conductivities from 0.35 to 2.1 feet/day with a geometric mean of 0.83 feet/day, an effective porosity of 0.31, and a storage coefficient of 1.0×10^{-4}. The applicant estimated a hydraulic gradient of 0.005 feet/feet to apply to a distance of 5600 feet between the center of the proposed powerblock area and the Savannah River.

In Section 2.4.12.1.4 of SNC 2008b and Appendix 2.4B of SNC 2008c, the applicant presents the development and application of a two-dimensional, single-layer, steady-state ground-water model of the Water Table aquifer underlying the VEGP site. The model domain includes the watersheds on either side of the ridge on which VEGP Units 3 and 4 are proposed to be sited and is bounded above by the land surface and below by the top of the Blue Bluff Marl. The model varied spatially the hydraulic conductivity assignments to represent the presence or absence of the possibly more conductive Utley Limestone unit. In addition, the model assigned engineered fill areas associated with existing and proposed VEGP units the maximum hydraulic conductivity of engineered backfill measured at VEGP Units 1 and 2. The aquifer recharge rate assignments accounted for variations in surface slopes, vegetative cover, and land use, including structures and paved areas.

The applicant executed a series of simulations for seven alternative models. The seven models involved different combinations of hydraulic conductivity and recharge to calibrate the model (SNC 2008b, Section 2.4.12.1.4, pg. 2.4.12-18). The applicant also considered the seven model simulations to represent alternative conceptual models of the site and aquifer. The seven models include the following:

1. uniform hydraulic conductivity and recharge (single values of each for the entire model domain)

2. uniform hydraulic conductivity, variable recharge (open and forested areas, buildings and pavement)

3. accounting for thickness of the Utley Limestone (variable hydraulic conductivity, model 2 recharge pattern and values)

4. simplified Utley Limestone (simplified version of model 3)

5. high conductivity zone upstream of Mallard Pond (acknowledges Utley cave and spring)

6. low conductivity zone in southwestern part of model domain (attempt to reduce bias in model results; in models 1 through 5 the predicted hydraulic head in Daniels Branch, Telfair Pond watershed, is lower than observed while predicted head in Mallard Pond watershed is higher than observed)

7. simplified version of model 6

The applicant stated that, while the solutions obtained with models 6 and 7 were very similar and close to the measured water levels, model 7 provided the best match with the observed data and was selected for analysis of the postconstruction setting (SNC 2008b). The applicant analyzed travel time by using model 7 to simulate the travel path from the VEGP Unit 4 auxiliary building to the upper reaches of Mallard Pond. Essentially, the ground water moved through three regions of the model—the saturated engineered backfill, the aquifer from the excavation (backfill) to the high conductivity zone above Mallard Pond, and the high conductivity zone to Mallard Pond. The applicant predicted travel times through the three zones to be 2.4 years, 3.2 years, and 1.1 years for a total ground-water travel time of 6.7 years (see Figure 78 in Appendix 2.4B, SNC 2008b).

The applicant provided data about regional and local ground-water use (SNC 2008b, Section 2.4.12.2, pg. 2.4.12-23). The application lists permits issued by the State of Georgia Environmental Protection Division for ground-water withdrawals that exceed 100,000 gallons per day during any single month for municipal, industrial, and agricultural users. In addition, users are listed as shown in the Safe Drinking Water Information System maintained by EPA. The applicant provided the locations of the nearest examples of each of these ground-water users. The application summarizes current well location and usage by VEGP Units 1 and 2.

The applicant also provided a forecast of water resource usage in Burke County and summarized the projected ground-water use for the proposed units. Part 3 of the application (i.e., the environmental report) includes additional information and data (SNC 2008a, Part 3, Section 2.3.2).

Regarding the reliability of ground-water resources and systems used for safety-related purposes, the applicant stated that a future plant that fits within the bounding parameters provided in the proposed permit application has a passive safety-related UHS. Consequently, no safety-related ground-water supplies are necessary except for initial fill up and occasional makeup water (SNC 2008b, Section 2.4.12, pg. 2.4.12-1).

The applicant stated that the plant grade for the proposed units is elevation 220 feet MSL, and the foundation embedment depth is 39.5 feet from plant grade (SNC 2008b, Section 2.4.12, pg. 2.4.12-1). The elevation of containment and auxiliary building foundations is approximately 180.5 feet MSL. The applicant stated that the maximum ground-water elevation of the Water Table aquifer underlying the proposed VEGP units is 165 feet MSL (SNC 2008a, Part 2, Table 1-1). Regarding the reliability of dewatering systems, the applicant stated that a future plant that fits within the bounding parameters provided in the proposed permit application will not require a permanent dewatering system to lower the design-basis ground-water level because all safety-related SSCs are well above the highest recorded water table elevation in the powerblock area (SNC 2008b, Section 2.4.12.4, pg. 2.4.12-25).

The applicant stated that the excavated natural materials will be replaced with compacted structural fill with properties that provide an adequate factor of safety against liquefaction (SNC 2008a, Part 2, Section 2.5.4.8.3.1). The applicant reported confirmatory liquefaction analyses in Section 2.5.4.8 (SNC 2008a, Part 2, Section 2.5.4.8). The applicant concluded that the liquefaction potential of the compacted structural fill was not a concern and materials comprising the Blue Bluff Marl had an adequate factor of safety against liquefaction (SNC 2008a, Part 2, Section 2.5.4.8.4).

The applicant committed to review and evaluate existing SNC ground-water monitoring programs and observation well locations for adequacy and to describe that evaluation and the resulting long-term ground-water monitoring program for the proposed units in the COL application (SNC 2008b, Section 2.4.12.3, pg. 2.4.12-24).

2.4.12.3.2 Technical Evaluation

The technical evaluation by NRC staff is presented below for each of the specific RS-002 acceptance criteria. As a result of a series of requests, beginning at the initial site audit conducted in January 2007, the applicant has revised Section 2.4.12 of the SSAR with each revision of the application. The applicant provided the latest version of this FSAR section to the NRC as a supplement to Revision 4 of the application (SNC 2008b).

In an initial request for additional information (RAI) the NRC staff asked the applicant for (1) an interpretation of field observations and the potential for an alternative conceptual model allowing communication between the Water Table aquifer and the Tertiary aquifer, (2) a description of the process to develop the conceptual model (i.e., alternatives considered and the methodology used by the model to account for transient behavior), and (3) all available location information on the sediments related to the Water Table aquifer (e.g., thickness and continuity of the Barnwell sands, silts and clays, the Utley Limestone, and the Lisbon Formation). Southern responded to these requests (SNC 2007c) and incorporated new material in Revision 2 of the SSAR.

The NRC staff issued the SER with Open Items and included Open Item 2.4-2, which requested that the applicant provide an improved and complete description of the local hydrological conditions, including alternative conceptual models, to demonstrate that the design basis related to ground-water-induced loadings would not be exceeded. Future projections were needed of the impact on the Water Table aquifer arising from potential changes in land use and aquifer recharge as a result of construction of the proposed facilities. The applicant developed a ground-water model of the Water Table aquifer and incorporated its description and results into Revision 3 of the SSAR.

The NRC staff's review of the ground-water model described in SSAR, Revision 3, as well as model input and output, revealed issues with model convergence, mass balance, and calibration bias. The NRC staff also realized that alternative conceptual models were not presented. Rather, the applicant presented a sequence of models used to achieve calibration of a single conceptual model. The staff raised these concerns with the applicant at a public meeting at the NRC in Rockville, Maryland, on April 8, 2008, at a site audit at the applicant's consultant's offices in Frederick, Maryland, on April 9, 2008, and through additional RAIs dated July 22, 2008. The applicant addressed these issues in the supplement to Revision 4 of the application (SNC 2008b) and in responses to the RAIs (SNC 2008c).

The applicant's analysis, which was initially based entirely on field data and the assumption that postconstruction ground-water levels would not exceed prior measured levels, evolved into an analysis based on field data, a model of the Water Table aquifer, and postconstruction projections of the water table. This final analysis provided reasonable assurance that the design basis related to ground-water-induced loadings would not be exceeded.

Local and Regional Ground-Water Characteristics and Use

Based on a review of USGS documents (Clarke and West 1997, 1998; Cherry 2006; Cherry and Clarke 2007), State of Georgia documents, Huddlestun and Summerour (1996), and Summerour et al. (1994, 1998), the NRC staff determined that the applicant's description of the regional and local hydrogeologic conditions is accurate with one potential exception-ground-water flow within the Water Table aquifer may not always be from the powerblock area to the north-northwest and Mallard Pond. The NRC staff's investigations of the site and review of topographic maps confirm that the proposed location is on a ridge perpendicular to the Savannah River and separating drainages to the north-northwest (e.g., Mallard Pond) and to the south-southeast (e.g., Daniels Branch, Telfair Pond, and Beaverdam Creek).

The NRC staff confirmed that the recorded piezometric surface contour plots, including seasonal and climatic fluctuations of the Water Table aquifer, indicate ground-water movement toward the north-northwest and Mallard Pond from release points within the powerblock area. However, a number of lines of reasoning, described below, led the NRC staff to question whether this would be the only ground-water flow and contaminant migration direction for future accidental effluent release events.

First, the applicant stated that the piezometric head level in the Water Table aquifer is a function of the topography and recharge, which both change in the vicinity of the proposed VEGP Units 3 and 4. Substantial areas of the proposed site will be leveled and made impervious by construction of buildings and paved surfaces. Other substantial areas of the proposed site will be leveled and might be made more transmissive (i.e., able to accept more recharge) by converting them to gravel surfaces that would be maintained essentially vegetation free. Stormwater management facilities that will be constructed to route runoff from significant storm events away from the site could reduce potential infiltration rates. Each of these actions implies a potentially substantial change in the net infiltration to the Water Table aquifer in the immediate vicinity of the proposed VEGP Units 3 and 4. The applicant's model of the Water Table aquifer (SNC 2008b, 2008c) includes an evaluation of current, spatially varying recharge patterns and postconstruction changes to recharge resulting from changes in land use and vegetation. In addition, the NRC staff has used the applicant's model and conservatively analyzed a higher postconstruction recharge with a lower hydraulic conductivity assigned to the engineered backfill in the excavated region.

Second, the NRC staff's review of the historical piezometric head contours in the Water Table aquifer for the years 1971 (see SNC 2003, drawing AX6DD329), 1984 (see SNC 2003, drawing AX6DD330), and 2005 (see SNC 2008b, SSAR Figure 2.4.12-7) revealed evidence of change that has occurred since 1971 in the piezometric head as a result of the construction and operation of VEGP Units 1 and 2. This suggests that the assumption that the current piezometric surface will exist after construction and during operation of the proposed units is not realistic. However, the NRC staff notes that the broad and essentially flat area created for construction of the proposed VEGP Units 3 and 4 does represent a current local topographic high, and it is likely that the highest postconstruction recharge rates within the region disturbed by construction would be in the vicinity of the cooling tower area and not near the powerblock area. Thus, while the same ground-water surface will not exist, the location of the ground-water high divide will remain in the vicinity of the proposed cooling towers.

Finally, the NRC staff used the applicant's model of the Water Table aquifer to evaluate the sensitivity of the model solution to drain boundary condition elevations, to the use of minimum light detection and ranging (LiDAR) data rather than average LiDAR data in drain cells, to the use of drain cells instead of constant head boundary conditions for the perennial reach of Daniels Branch, and to postconstruction conditions more extreme than those evaluated by the applicant. In the latter cases, the staff evaluated the origin of releases to the watershed that lies to the southeast of the proposed facilities. To do this, the staff first assigned drain boundary condition cells elevations consistent with the land surface and conductance consistent with neighboring cells. This did not result in a substantial change in the model solution. The NRC staff next used minimum rather than average LiDAR to set drain elevations in the Daniels Branch drainage to evaluate ground-water movement to that drainage. This modification in the model boundary condition did not substantially change the essential feature of the applicant's model in this regard (i.e., that ground water moved beneath and was not intercepted in the upper reach of the Daniels Branch). The staff then used a drain boundary condition in the perennial reach of the Daniels Branch which did cause the cell ground-water level prediction to increase (i.e., the predicted ground-water elevation in the drainage was higher than in the constant head boundary condition model). However, ground water continued to discharge to the perennial reach of the streambed, but at a lower rate. Next, the staff used a series of recharge rate cases to evaluate the sensitivity of the applicant's results. These post construction cases included the hydraulic conductivity of the engineered fill (3.3 feet/day) in the excavation and a suite of high expected value and low recharge rates applied to the powerblock area and the cooling tower area. None of the cases revealed discharge to the Daniels Branch drainage; however, one case exhibited ground-water flow under the streambed. In addition, the case in which a high recharge was applied to both the proposed powerblock and cooling tower areas resulted in movement of some pathways directly toward the Savannah River from the southeast corner of the powerblock. However, such a result is not plausible because the powerblock grounds are actually engineered (e.g., sloped, paved) to promote runoff rather than infiltration and recharge. If comparable recharge rates were applied to VEGP Units 1 and 2 then flow toward the river from the proposed VEGP Units 3 and 4 would not occur. Thus, the staff attempted to test the hypothesis that ground water from the powerblock could discharge to the other watersheds but did not do so. However, because a pathway from the powerblock into the Daniels Branch drainage was demonstrated, by the staff, the uncertainty in the aquifer structure and hydraulic properties compels the staff to view this pathway as plausible and to continue to examine the alternative conceptual model of ground-water flow from the powerblock being intercepted by the upper reaches of the Daniels Branch. SER Section 2.4.13 further discusses alternative conceptual models of the future ground-water pathway.

The NRC staff confirmed the applicant's hydraulic conductivity values for the Water Table aquifer. The NRC staff independently determined that the USGS-derived minimum and maximum range of transmissivity values based on field data (i.e., 500 feet2/day to 9500 $feet^2$/day or 3700 gallons/day/feet to 71,000 gallons/day/feet) (Clarke and West 1998, Table 3), when combined with the local thickness of the Water Table aquifer (i.e., approximately 30 feet), are indicative of the higher values of the Utley Limestone of the Barnwell Formation cited by the applicant.

The NRC staff's review of the SSAR (SNC 2008b, Section 2.4.12) and USGS documents (Clarke and West 1997, 1998; Cherry 2006; Cherry and Clarke 2007) supports the applicant's interpretation that the Tertiary aquifer drains toward the Savannah River. The sequence of piezometric head maps from 1971 (see SNC 2003 drawing AX6DD327), 1984 (see SNC 2003 drawing AX6DD328), and the seasonal fluctuations in the 2005 to 2006 time period (see SNC 2008b, SSAR Figures 2.4.12-14 through 2.4.12-18) indicate the direction that ground-water flow has been maintained. These piezometric head data reveal a pattern of decline in head values over time, but the change will not affect both the existing and future groundwater uses.

Regarding the applicant's reported values of hydraulic conductivity in the Tertiary aquifer, the NRC staff independently reviewed USGS minimum and maximum ranges of transmissivity estimates based on field data (1,346 to 91,200 gallons/day/foot) and on regional simulation (100 to 185,000 gallons/day/foot) (Clarke and West 1998, Table 12). When combined with the local thickness of the Tertiary aquifer (approximately 182 feet), the USGS data bracket the central value of hydraulic conductivity provided by the applicant (i.e., 0.83 feet/day), but are generally higher.

One purpose of using an alternative conceptual model is to acknowledge the uncertainty in the interpretation of field observations and data sets that are by their nature incomplete. An example lies in the interpretation of data available from observation wells OW-1001 and OW-1001A. A poorly constructed and slowly responding well (i.e., OW-1001) may still provide valid data, until the validity of the data are disproved by completion of a competent observation well at the location. Observations of hydraulic head below the screened interval elevation of a well (i.e., OW-1001A) are obviously not valid as head observations; however, they suggest that the hydraulic head at that location is below the bottom of the screen (i.e., 136.13 feet). Again, until they are replaced with a competent observation well and an unambiguous data set, OW-1001 and OW-1001A provide information that suggests an alternate interpretation of local communication between the Water Table and Tertiary aquifers. Data from Borehole B-1004 in the vicinity of these observation wells suggest that the Blue Bluff Marl is approximately 95 feet thick at this location (SNC 2008a, Part 2, Figure 2.5.1-51). The data and information from the two observation wells are consistent with ground-water movement from the Water Table aquifer into the Tertiary aquifer at this location; however, the thickness of the marl unit suggests the integrity of this confining unit. Section 2.4.13 of this SER further discusses this alternate conceptual model.

The NRC staff reviewed aspects of the ground-water system that led to the applicant's statement that ground-water in South Carolina neither affects nor is affected by VEGP site operation. The NRC staff reviewed the USGS ground-water model of the region that included the VEGP site in Georgia as well as the SRS in South Carolina (Clarke and West 1998; Cherry 2006). This recent USGS work presents a current interpretation of ground-water data and provides insight into where the Savannah River has incised confining zones, allowing releases to occur from confined aquifers into the Savannah River alluvium and hence to the Savannah River. The deep confined aquifers of the Cretaceous aquifer system (i.e., described as the Dublin and Midville aquifer systems in USGS reports) are not incised by the river opposite the VEGP site, but are incised several miles upstream (Clarke and West 1998, Figure 5). Therefore, the confining zones are intact beneath the Savannah River opposite the VEGP site. This allows complete communication of ground water in the Cretaceous aquifer between the States of Georgia and South Carolina. Accordingly, at the request of NRC staff, the USGS analyzed alternate water use rates at the VEGP site using its regional model to predict impacts and ground-water origins (Cherry and Clarke 2007). For those scenarios that examined the anticipated pumping rate for the proposed VEGP Units 3 and 4, the ground water appeared to originate in the upland areas of Georgia, with none of the recharge originating in South Carolina.

Water use data for a period of 20 years ending in the year 2000 suggest that withdrawal rates for surface water and ground water remained nearly unchanged (Fanning 2003) in the vicinity of the VEGP site. Projected water demand in Burke County, Georgia, indicates an increase of 50 percent by 2035 (Rutherford 2000). In South Carolina, analysts project an increase of 50 percent by 2045 (SC DNR 2004). However, despite these projections, a recent USGS report assigned lower ground-water pumping rates for the region in the future (i.e., through 2020) than have occurred during the recent drought (Cherry 2006, Figure 34). This suggests that stress on the ground-water resource was highest during the recent drought and could now diminish. Future demand includes production from the Water Table aquifer; however, wells in the Water Table aquifer are relatively low-production wells providing ground water for domestic use. Such wells exhibit a relatively local drawdown and, when located on the VEGP property boundary, are so distant from the proposed powerblock area that they would not substantially influence the elevation of the water table or the pathway of accidental releases.

The aquifers of interest in the evaluation of safety-related issues are the unconfined or Water Table aquifer and the uppermost confined or Tertiary aquifer. The two aquifers are separated by the Blue Bluff Marl formation, which has a thickness of approximately 63 feet (SNC 2008b). An accidental release to ground water would contaminate the Water Table aquifer. It is possible, but perhaps unlikely, that hydraulic communication exists between the Water Table and Tertiary aquifers. However, such communication, if it exists, could lead to an accidental release reaching the Tertiary aquifer. The staff conducted a confirmatory analysis of this scenario and documented the results in Section 2.4.13 of this SER. Based on its review of available data on the piezometric levels of these aquifers, the NRC staff concludes that they are influenced by local changes in aquifer characteristics and water use and discharge locally to surface drainage systems that ultimately discharge to the Savannah River. Changes in ground-water use with a potential to affect regional ground-water characteristics (i.e., the deep confined or Cretaceous aquifer system) over the long term will not influence the safety-related analysis of the ground-water system, which focuses on the unconfined or Water Table aquifer.

Effects on Plant Foundations and Other Safety-Related Structures, Systems, and Components

The proposed VEGP Units 3 and 4 will have foundations for the containment and auxiliary buildings at elevation 180.5 feet MSL. The applicant's parameter for maximum water table elevation or design ground-water level is 165 feet MSL (SNC 2008a, Part 2, Table 1-1). The applicant based this ground-water level on monitoring of the unconfined aquifer over the past decade. The plant grade elevation is 220 feet MSL. Foundations of all safety-related structures will be on structural backfill that will be placed above the Blue Bluff Marl on an engineered fill. The excavated natural materials will be replaced with compacted structural fill with properties that provide an adequate factor of safety against liquefaction (SNC 2008a, Part 2, Section 2.5.4.8.3.1). The maximum ground-water level from the site parameter list for the plant fitting within the bounding parameters in the proposed permit application is 2 feet below the design grade elevation. Therefore, the safety-related structural requirement for a plant that fits within the bounding parameters in the proposed permit application located at the proposed VEGP site is a ground-water elevation less than 218 feet MSL.

Based on the maximum observed ground-water level of 165 feet MSL, the water table elevation of the unconfined aquifer will not contribute a buoyant force on the nuclear island structure, which will have a foundation elevation at or higher than 180.5 feet MSL. However, after construction activity and modification of surface condition of the area surrounding the safety-related plant structures, changes in land use and ground-water recharge will likely alter the elevation of the ground-water table.

As part of the SER with Open Items, the NRC staff wrote, "The applicant should provide an improved and complete description of the current and future local hydrological conditions, including alternate conceptual models, to demonstrate that the design bases related to groundwater-induced loadings on subsurface portions of safety-related SSCs would not be exceeded. Alternatively, the applicant can provide design parameters for buoyancy evaluation of the plant structures." This was Open Item 2.4-2.

In response, the applicant has provided additional data from COL borings, revised its interpretations of data sets, and developed a ground-water model of the Water Table aquifer. The applicant's model of the Water Table aquifer (SNC 2008b, 2008c) includes an evaluation of current, spatially varying recharge patterns and of post-construction changes to recharge resulting from changes in land use and vegetation. These additional data and analyses have allowed the NRC staff to evaluate alternative conceptual models, alternative directions of ground-water movement, and the effects of ground-water-induced loadings on subsurface portions of safety-related SSCs.

The NRC staff used the applicant's model and analyzed a higher post construction recharge assignment to the powerblock and cooling tower areas, along with a lower hydraulic conductivity assignment to the engineered backfill in the excavated region of the powerblock area. Using a hypothetical high recharge rate of half of the precipitation (i.e., 24 inches/year) and a low hydraulic conductivity in the engineered backfill (i.e., the minimum of observed values in engineered backfill for VEGP Units 1 and 2 or 1.3 feet/day), the predicted hydraulic head was still below the foundations of all proposed structures and well below the design requirement of a plant that fits within the bounding parameters in the proposed permit application (i.e., a maximum water table elevation of 218 feet MSL). Therefore, based on its independent analysis, the NRC staff finds the applicant's site characteristic value for the maximum ground-water elevation at the VEGP site to be acceptable. This elevation will be far enough below the site grade so as to not represent a safety concern for the plant fitting within the bounding parameters proposed in the application. This analysis by NRC staff enables closure of Open Item 2.4-2. Therefore, Open Item 2.4-2 is closed.

Reliability of Ground-Water Resources and Systems Used for Safety-Related Purposes

Any plant that fits within the bounding parameters provided in the proposed permit application will not need ground water for safety-related use. Therefore, the NRC staff did not evaluate the reliability of the ground-water source for safety-related use. The NRC staff determined that the proposed VEGP Units 3 and 4 will have no SSCs that rely on ground water for a safety-related use other than initial filling and occasional makeup to water storage tanks associated with the passive containment cooling system.

Reliability of Dewatering Systems

The applicant proposed no permanent dewatering systems as part of the operation of the proposed VEGP Units 3 and 4. On the basis of the field data and the applicant's ground-water model results, as well as its own modeling efforts, the NRC staff concludes that a permanent dewatering system will not be required for a future plant fitting within the bounding parameters provided in the proposed permit application.

2.4.12.4 Conclusion

As set forth above, the applicant has substantiated sufficient information pertaining to the identification and evaluation of the effects of ground water in the vicinity of the proposed site. Section 2.4.12, "Groundwater," of RS-002 directs the applicant to address in the SSAR the requirements of 10 CFR Part 52 and 10 CFR Part 100 as they relate to identifying and evaluating the effects of ground water in the vicinity of the site and site regions. Furthermore, the applicant considered the most severe natural phenomena historically reported for the site and surrounding area while describing the hydrologic interface of the plant with the site with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in this site characteristic, as documented in the SERs for previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in a site characteristic containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the NRC staff considers the identifed site characteristic for the highest ground water elevation to be acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

Therefore, the NRC staff concludes that the identification and consideration of the ground-water elevation characteristic set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.23(d)(4). In view of the above, the NRC staff finds the proposed hydrology-related site characteristic to be acceptable for inclusion in an ESP for the applicant's site.

2.4.13 Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters

2.4.13.1 Introduction

This section of the applicant's SSAR evaluates the hydrogeological characteristics of the site in terms of the effects of accidental releases of radioactive liquid effluents in ground and surface waters on existing uses and known and likely future uses of ground and surface water resources. The NRC staff's review of the applicant's SSAR, described in this section, addresses only accidental releases of radioactive liquid effluent with regard to surface and subsurface site characteristics. The NRC staff's review of the SSAR covers (1) alternate conceptual models, (2) characteristics that affect transport, (3) pathways, and (4) consideration of other site-related evaluation criteria.

This section of the SER reviews the applicant's process to identify and quantify the accidental radioactive liquid effluent release, its pathway to the accessible environment, and its migration and attenuation in surface waters and ground waters.

2.4.13.2 Regulatory Basis

The acceptance criteria for identifying potential hazards in the site vicinity are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the identification of potential hazards in the site vicinity:

- 10 CFR 52.17(a) requires the application to contain information regarding the physical characteristics of a site (including seismology, meteorology, geology, and hydrology) to determine its acceptability to host a nuclear unit.

- 10 CFR 100.20(c) requires 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.

- 10 CFR 100.21(d) requires that the physical characteristics of the site (including seismology, meteorology, geology, and hydrology) must be evaluated and site parameters established such that potential threats from such physical characteristics will pose no undue risk to the type of facility to be located at the site.

Section 2.4.13 of RS-002 provides the following criteria that the NRC staff used to evaluate this SSAR section:

- 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. The geologic and hydrologic characteristics of the site may have a bearing on the potential consequences of radioactive materials escaping from a nuclear unit of specified type that might be constructed on the proposed site. An applicant should plan special precautions if a reactor 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 a site's hydrologic characteristics with respect to the potential consequences of radioactive materials escaping from a nuclear unit of specified type 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 of specified type 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.

- 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:

  — The applicant should describe radionuclide transport characteristics of the ground-water environment with respect to existing and future users. In addition, the applicant should describe 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. These estimates and bases should be consistent with site characteristics. The application should identify potential pathways of contamination to ground-water users and describe and reference data sources.

  — The applicant should describe transport characteristics of the surface water environment with respect to existing and known future users for conditions which reflect worst-case release mechanisms and source terms to postulate the most pessimistic contamination from accidentally released liquid effluents. The applicant should also describe 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. The application should identify potential pathways of contamination to surface water users and describe and reference sources of information and data. The NRC 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 use conservative site-specific hydrologic parameters. 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

This section consists of (1) a review of the information provided by the applicant and (2) the NRC staff's evaluation of the applicant's submittal.

2.4.13.3.1 Technical Information Presented by the Applicant

In Section 2.4.13 of the SSAR, Revision 4-S2 (SNC 2008b), Southern presented information and data describing a postulated accidental release of radioactive liquid effluents in ground water and surface water. Southern also described (1) the conceptual models of the site, (2) characteristics that affect radionuclide transport, (3) contamination pathways, and (4) other site-related evaluation criteria.

In SSAR Section 2.4.13.1.1, the applicant selected the accident scenario from the information provided by the reactor vendor for the future plant fitting within the bounding parameters provided in the SSAR. The accident scenario is an instantaneous release from an effluent holdup tank located at the lowest level of the auxiliary building within the powerblock area (SNC 2008b). The applicant stated that the effluent holdup tank has a volume of 28,000 gallons, and a postulated rupture leads to a loss of 80 percent of that volume or 22,400 gallons in accordance with Branch Technical Position (BTP) 11-6. In its analysis, the applicant assumed that the release instantaneously enters the backfilled region of the Water Table aquifer, which underlies the auxiliary building, and displaces all pore water in a space 21 feet wide, 21 feet long, and 20 feet deep.

The applicant presented field observations of the current Water Table aquifer and a model of the aquifer in a variety of post construction settings to conclude that ground water will flow north in the future from the proposed powerblock area toward Mallard Pond (SNC 2008b, Figure 2.4.13-1). Southern concluded that the most critical release pathway in the ground-water environment will be from the proposed VEGP Unit 4 auxiliary building northward to the south side of Mallard Pond. The travel distance scaled from the curvilinear pathway shown in Figure 78 of Appendix 2.4B (SNC 2008b) revealed an approximate distance of 2550 feet; 150 feet through backfill, 1200 feet through undisturbed aquifer to a point south of observation well OW-1005, and an additional 1200 feet to the south side of Mallard Pond through an undisturbed but higher conductivity segment of aquifer. Using a ground-water model of the Water Table aquifer to trace the pathway of contaminants, the applicant reported travel times through the three curvilinear aquifer segments of 2.4, 3.2, and 1.1 years, respectively, for a total travel time of 6.7 years from the release point below the auxiliary building to Mallard Pond.

In SSAR Section 2.4.12.1.4 (SNC 2008b), the applicant reported hydraulic properties of the Barnwell Formation sediments used in the safety analyses and included the range of hydraulic conductivity measurements for the Utley Limestone from 3,250 to 125,400 feet/year (9 to 343 feet/day). The applicant also derived a value for effective porosity of 0.34 (SNC 2008b, Section 2.4.12.1.4) from the median specific gravity and moisture content measurements. The applicant estimated a maximum hydraulic gradient of 0.014 feet/feet to apply to the Water Table aquifer in the vicinity of the proposed Units 3 and 4 (SNC 2008b, Section 2.4.12.1.3). A maximum gradient of 0.023 feet/feet can be derived from the hydraulic head data for the aquifer between OW-1005 and Mallard Pond. The applicant used the ground-water model and estimated the travel times for the last two segments in the aquifer as 3.2 and 1.1 years respectively, for a total of 4.3 years.

In SSAR Section 2.4.12.1.4 (SNC 2008b), the applicant reported the range of measured hydraulic conductivity values in the engineered backfill as 480 to 1220 feet/year (1.3 to 3.3 feet/day). As reported in UFSAR Table 2.4.12-14, the applicant obtained these values from the prior postconstruction testing of backfill regions underlying existing VEGP Units 1 and 2 (SNC 2003). The applicant also estimated the backfill porosity to be 0.34 based on information from the UFSAR (SNC 2003). An estimate of the hydraulic gradient in the engineered backfill is the same as in the surrounding Water Table aquifer, a maximum estimated value of 0.014 ft/ft. The applicant used the ground-water model and estimated the travel time to be 2.4 years.

The applicant also postulated an alternative release pathway from the powerblock area through the Tertiary aquifer to the Savannah River (SNC 2008b, Figure 2.4.13-2). In SSAR Section 2.4.12.1.4, Table 2.4.12-3, the applicant reported hydraulic properties of the Tertiary aquifer sediments (SNC 2008b) used in the safety analyses and included a range of hydraulic conductivities from 0.35 to 2.1 feet/day, with a geometric mean of 0.83 feet/day and an effective porosity of 0.31. The applicant estimated a maximum hydraulic gradient of 0.005 feet/feet to apply to a distance of 5600 feet between the center of the powerblock and the Savannah River (SNC 2008b, Section 2.4.12.1.4). Based on the geometric mean of the hydraulic conductivity, the maximum gradient, and the effective porosity, the applicant estimates the travel time to be 1142 years.

As the applicant described, Mallard Pond is controlled by a combination of standpipe and spillway with discharge to a stream that ultimately discharges to the Savannah River (SNC 2007c, 2008b). The applicant identified two companies as the nearest downstream industrial surface water users; both withdraw water from the Savannah River and are located near River Mile 45, about 106 miles downstream of VEGP (SNC 2008b, Section 2.4.13.1.2.1).

For the Mallard Pond drainage pathway, the applicant's analysis considered (1) radionuclide decay associated with travel times in the ground-water pathway, (2) adsorption and decay during a retarded travel time for sorbed radionuclides in the groundwater pathway and the dilution of the ground water released to Mallard Pond (i.e., 0.094 gallons/ per minute) in the stream below the pond (i.e., 1125 gallons/minute). The applicant performed analytical tests to estimate distribution coefficients for cobalt, strontium, and cesium. The minimum values of the distribution coefficient from 16 soil samples, identified by the applicant as being representative of backfill material, were 1.4 milliliters per gram (mL/g) for cobalt, 6.0 mL/g for strontium, and 3.5 mL/g for cesium. Minimum values from three samples of aquifer materials, identified by the applicant as being representative of Barnwell Group sediments, were 3.9 mL/g for cobalt, 14.4 mL/g for strontium, and 22.7 mL/g for cesium. Ground-water wells withdrawing aquifer water did not intercept either of the pathways analyzed by the applicant.

In RAI 2.4.13-2 (SNC 2007c), the NRC staff requested that the applicant evaluate the potential for chelation and complexation agents (e.g., organic acids) to mix with radiological liquid effluents and adversely impact sorption phenomena. The NRC staff requested that the applicant clearly state whether or not mixing with chelation agents was possible. In its RAI response (SNC 2007c), the applicant stated that the site does not prohibit the use of chelating agents, but does require a comprehensive evaluation before their use. The applicant stated that it will tightly control any future use of chelating agents at VEGP and that it does not anticipate using chelating agents if they could come in contact with radioactive materials. In summary, the applicant stated that it would be extremely unlikely for radioactive liquids to come into contact with chelating agents.

In RAI 2.4.13-3 (SNC 2007c), the NRC staff requested that the applicant more fully describe the basis for the estimated ground-water flow into Mallard Pond and provide all data supporting the dilution of the release in surface water flow within the Mallard Pond drainage. In SSAR Section 2.4.13.1.3.1, the applicant fully described the ground-water release (SNC 2008b) and provided a calculation package detailing the measurements made for Mallard Pond and its downstream drainage (SNC 2007c). This calculation package, dated September 27, 1985, documents field observations made during June and July of 1985. These measurements represent single moment-in-time measurements. The applicant's calculation package states that the discharge downstream of the confluence of the Mallard Pond drainage and West Branch drainage ranges from 800 to 1200 gallons/minute (SNC 2007c). The applicant used a discharge rate of 1125 gallons/minute in calculations of the release dilution (SNC 2008b, Section 2.4.13.1.3.1). After the NRC issued the SER with Open Items, the applicant developed a ground-water model of the Water Table aquifer and provided simulations of postconstruction events that better describe future ground-water flow in the vicinity of the proposed VEGP Units 3 and 4 (SNC 2008b, Appendix 2.4B)

Of the 56 radionuclides in the effluent holdup tank inventory (SNC 2008b, Table 2.4.13-1), the applicant only identified 10 that will require more than decay in the ground-water pathway to be reduced to less than 1 percent of their maximum effluent concentration limits (ECLs) (SNC 2008b). The 10 radionuclides were H-3, Mn-54, Fe-55, Co-60, Sr-90, Ag-110m, I-129, Cs-134, Cs-137, and Ce-144.

In SSAR Section 2.4.13.1.3.1, the applicant identified eight radionuclides that will require more than decay and adsorption in the ground-water pathway to be reduced to less than 1 percent of their ECLs (SNC 2008a). Distribution coefficients were only available for cobalt, strontium, and cesium. Following inclusion of adsorption and decay associated with retarded travel time, the applicant identified the remaining eight radionuclides requiring further analysis as H-3, Mn-54, Fe-55, Sr-90, Ag-110m, I-129, Cs-137, and Ce-144.

The applicant applied dilution downstream of Mallard Pond to the decayed radioisotope concentrations entering Mallard Pond from the Water Table aquifer. The applicant's estimated concentration of each radioisotope downstream of the dilution location is below its respective ECLs. The highest contributor to dose is H-3, which, according to the applicant, represents nearly 6 percent of its ECL (SNC 2008b, Section 2.4.13.1.3.1, Table 2.4.13-5). The applicant calculated the cumulative measure, (i.e., the sum of all ratios), and reported 0.058, which is less than one and meets the requirement in Note 4 in Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release Sewerage," to 10 CFR Part 20, "Standards for Protection against Radiation" (SNC 2008b, Section 2.4.13.1.4).

The applicant noted that it demonstrated compliance for a point along the stream within the restricted area which does not represent a potable water source. The applicant stated that the stream is a gaining stream (i.e., it does not discharge to ground water) which discharges to the Savannah River. The applicant identified the Savannah River as being the nearest potable water supply in an unrestricted area. The applicant indicated that a conservative representation of Savannah River flow is the 100-year drought flow of 3298 cubic feet/second (1,480,000 gallons/minute) while the tributary flow rate is 1125 gallons/minute, thus the additional dilution would further reduce radionuclide concentration by a factor of about a 1,000 (SNC 2008b, Section 2.4.13.1.4).

For the alternative Tertiary aquifer pathway mentioned above, the applicant stated that, using only the radioactive decay in the Tertiary aquifer pathway, the cumulative measure applied to ground-water quality before discharge to the Savannah River (i.e., the sum of all ratios) is 0.036. Therefore, this value is in compliance with 10 CFR Part 20 limits (SNC 2008b, Section 2.4.13.1.4).

In SSAR Section 2.4.13.2, the applicant stated that no outdoor tanks contain liquid radioactive waste in the reactor design under consideration; therefore, no accident scenario is projected to result in a liquid effluent release directly to the surface water environment (SNC 2008b).

2.4.13.3.2 Technical Evaluation

The NRC staff has divided its technical evaluation into four topics—alternate conceptual models, characteristics that affect radionuclide transport, contamination pathways, and contaminant transport analyses.

The applicant provided this section of the application to the NRC as a supplement to Revision 4 of the application (SNC 2008b). As a result of a series of requests, beginning at the initial site audit conducted in January 2007, the applicant has revised Section 2.4.13 of the SSAR with each revision of the application.

The staff issued an initial RAI on March 15, 2007, which asked the applicant to describe and discuss (1) the process followed to establish the conceptual model for the plausible transport pathways and travel times, (2) the process used to evaluate the potential of chelating agents (e.g., organic acids) that may combine with radionuclides and influence the movement of radionuclides in the environment, and (3) the process used to estimate the ground-water flux carrying an accidental release from the powerblock to Mallard Pond. Southern responded to these requests (SNC 2007c) and incorporated revisions into Revision 2 of the SSAR.

The NRC staff issued the SER with Open Items and included Open Item 2.4-3 asking that the applicant include an analysis providing assurance that it had considered an adequate number of combinations of release location and plausible alternative pathways. The NRC staff cited the inevitable change in site hydrology (e.g., changes in surface material and vegetation, slope, infiltration or recharge, runoff) as potentially significant in forecasts of aquifer response to construction of the proposed facility and potential future ground-water pathways. The NRC staff's analysis, which did not apply adsorption because of the potential impact of chelating agents, concluded that dilution in the Savannah River was required to meet the requirements of Table 2, Column 2, of Appendix B to 10 CFR Part 20. Accordingly, public access to ground water or surface water before its discharge to the river was an issue, and the staff included Open Item 2.4-4 requesting that the applicant specify the nearest point of public access along each potential pathway.

In response to these open items, the applicant developed a ground-water model of the Water Table aquifer and incorporated its description and results into Revision 3 of the SSAR. The applicant exercised the model using alternative combinations of the magnitude and distribution of recharge rates, the magnitude and distribution of hydraulic conductivity, and external and internal boundary conditions. In addition to revising the section to reflect the application of a ground-water model, the applicant better described the point of public exposure for each of the pathways analyzed.

The NRC staff's review of the ground-water model results in Revision 3 of the SSAR, as well as model input and output, revealed issues with model convergence, mass balance, and calibration bias. The NRC staff also noted that the applicant did not present alternative conceptual models. Instead, the applicant presented a sequence of models used to achieve calibration of a single conceptual model. The staff raised these concerns with the applicant at a public meeting at NRC in Rockville, Maryland, on April 8, 2008, at a site audit at the applicant's consultant's offices in Frederick, Maryland, on April 9, 2008, and in RAIs sent on July 22, 2008. The applicant addressed these concerns in its supplement to Revision 4 of the application (SNC 2008b) and in responses to the RAIs (SNC 2008c).

The applicant's analysis of radioactive liquid effluent pathways, which was originally based entirely on field data and the assumption that prior pathways would not be altered in the future, evolved into an analysis based on field data, as well as a model of the Water Table aquifer, enabling a more thorough analysis of plausible postconstruction conditions.

Alternate Conceptual Models

Transport of an accidental release of radioactive liquid effluent is viewed as a combinatorial problem with multiple possible environmental pathways. Among all plausible alternative conceptual models and pathways, the critical one results in the plausible yet conservative release consequence that is ultimately of interest for the site safety evaluation.

In general, the process of determining plausible pathways is uncertain because of spatially and temporally varying characteristics and because the release may occur in the future after substantial change has or may have occurred to the local landscape and near-field hydrology of the proposed site. This is even more important in the case of the VEGP site because it sits atop a ground-water divide and thus is very sensitive to changes in hydraulic conductivity and recharge. The existing hydrology of the site does not necessarily represent the future hydrology of the site. Construction of a large industrial facility such as the proposed nuclear power plants can lead to substantial change to the postconstruction landscape and hydrologic features of this site. These changes lead to alterations in the distribution of recharge in the vicinity of the proposed plants and in the water table of the aquifer underlying the proposed site.

The applicant developed a two-dimensional, single-layer, steady-state ground-water model of the Water Table aquifer underlying the VEGP site (SNC 2008b). Section 2.4.12 of this SER describes this model. Based on field data and the results of the simulation of seven alternative ground-water models, the applicant concluded that all contaminants released from the Nuclear Island area at the proposed VEGP Units 3 and 4 would move to the north and discharge to

Mallard Pond. Upon evaluation of the modeling results, the NRC staff concluded that this alternative pathway is perhaps the most plausible of alternative pathways. The applicant used model 7 to define, using tracer particles, plausible ground-water pathways and simulate the travel path from the proposed VEGP Unit 4 auxiliary building to the upper reach of Mallard Pond. Essentially, the ground water moved through three regions of the model—the saturated engineered backfill, the aquifer from the excavation (backfill) to the high conductivity zone above Mallard Pond, and through the aquifer's high conductivity zone to Mallard Pond. As described in Section 2.4.12, the applicant predicted travel times through the three zones to be 2.4 years, 3.2 years, and 1.1 years, respectively, for a total ground-water travel time of 6.7 years. Section 2.4.13.1.3.1 of the SSAR (SNC 2008b) further describes this pathway through the Water Table aquifer, which the NRC staff evaluates below.

The applicant presented an alternative ground-water pathway involving the Tertiary aquifer in Section 2.4.13.1.3.2 of the SSAR (SNC 2008b). The Blue Bluff Marl appears to be of substantial thickness and low hydraulic conductivity in the vicinity of the proposed construction; however, based on an alternative interpretation of field data (i.e., the possibility that ground water could move from the Water Table aquifer into the Tertiary aquifer) that cannot be completely excluded, the applicant evaluated a Tertiary aquifer pathway. The NRC staff considers this pathway to be plausible but unlikely. This pathway requires that a release to the Water Table aquifer be transported through the underlying mud unit, ultimately releasing to and moving through the confined Tertiary aquifer and discharging into the Savannah River opposite the site.

As described in Section 2.4.12 of this SER, the NRC staff used the applicant's model of the Water Table aquifer to evaluate the sensitivity of the model's solution to drain boundary condition elevations, to the use of minimum LiDAR data to define drainages, and to a variety of postconstruction conditions more extreme than those evaluated by the applicant. The staff used a matrix of recharge rates applied to the powerblock area and cooling tower area to explore the potential for change in the water table to yield alternative pathways for releases from the powerblock area. In addition, the staff evaluated the sensitivity of the simulation to the hydraulic conductivity of the backfill by assuming a less permeable or less conductive material. Using the matrix of recharge rates, the staff analyzed combinations of the following—powerblock area recharge high (i.e., half precipitation, 24 inches/year), expected (i.e., one-eighth precipitation, 6 inches/year), or zero, and cooling tower area recharge high ((i.e., half precipitation, 24 inches/year), expected (i.e., quarter precipitation, 12 inches/year), or zero.

A review of surface treatments and slopes within the powerblock and cooling tower areas reveals that it is unlikely that recharge rates inside a powerblock area would ever be greater than those inside a cooling tower area. Slopes, surface materials, and surface water control structures within the powerblock area are designed to conduct water away, especially during high precipitation events. Lesser slopes, gravel-covered surfaces, and surfaces maintained free of vegetation are typical of cooling tower areas, and all substantially increase the potential for recharge, especially during normal precipitation events. Accordingly, cases involving high and expected, high and low, and expected and low recharge for the powerblock and cooling tower areas, respectively, are implausible.

Given the historical measurements of the Water Table aquifer, as well as the natural flow and discharge of the Water Table aquifer to surrounding ravines or drainages, at least four potential ground-water pathway directions could be evaluated relative to the plausible combinations of recharge and hydraulic conductivity that contribute to a calibrated model. These potential ground-water pathways include ground-water flow from the powerblock toward (1) the Mallard Pond drainage, (2) the Daniels Branch drainage, (3) the Savannah River, and (4) an unnamed drainage located south of the VEGP Units 1 and 2 cooling towers. The applicant-produced ground-water model (SNC 2008b, 2008c, Appendix 2.4B) served as the starting point for the analysis. This model reproduces the general magnitude and location of the present-day ground-water high and surrounding contours. The staff then made perturbations to recharge rates and hydraulic conductivity to evaluate alternative pathways.

For all plausible recharge rate cases, as well as in the case of a lower conductivity backfill material, no ground-water pathway beginning inside the proposed powerblock area resulted in a simulated discharge to the Daniels Branch drainage or to the drainage located south of the VEGP Units 1 and 2 cooling towers. The high recharge cases with both maximum- and minimum-field-measured backfill hydraulic conductivity values did yield pathways that flow under the upper reaches of the Daniels Branch; however, the ground water was simulated to be below the streambed and it did not discharge into the Daniels Branch. In these same two cases, Water Table aquifer pathways were simulated that discharged into the Savannah River; however, this is an artifact of the case and not necessarily realistic. The model assigned higher recharge rates to the VEGP Units 3 and 4 powerblock and cooling tower areas than to the comparable VEGP Units 1 and 2 areas. If the model treated all powerblock and cooling tower areas similarly, the resulting higher water table that would underlie VEGP Units 1 and 2 would preclude ground-water movement directly towards the Savannah River from the VEGP Units 3 and 4 powerblock. For all plausible recharge rate cases, the majority of pathway traces showed ground-water movement to the north and traces beginning inside the powerblock area released to Mallard Pond.

However, the NRC staff postulated plausible pathways by conservatively extending the release points outside the proposed power block area. Based on measured hydraulic heads, site topography, and model simulations, the NRC staff concludes that, of the four possible ground-water pathways in the Water Table aquifer leading to the receptor, the Mallard Pond drainage pathway is the most plausible, the Daniels Branch drainage pathway is plausible but perhaps unlikely, the Savannah River drainage pathway is implausible, and the drainage to the south of VEGP Units 1 and 2 cooling towers is implausible. The decision to categorize the Daniels Branch drainage as plausible but unlikely results from (1) the ability to configure a relatively simple model and create pathways from the proposed powerblock area to ground water underlying the upper reaches of the Daniels Branch drainage, (2) uncertainty in future recharge rates and their spatial distribution, and (3) uncertainty in the magnitude and spatial distribution of the hydraulic conductivity of the Barnwell Group sediments, including the Utley Limestone, in the vicinity of the proposed facility. Thus, the uncertainties that exist with regard to the existing hydrogeological setting and future conditions require the NRC staff to conclude that the Daniels Branch pathway is plausible but perhaps unlikely. The possible Water Table aquifer pathways toward the Savannah River and toward the drainage located south of the VEGP Units 1 and 2 cooling towers did not conform to known aspects of the field setting; therefore, the staff determined that they were implausible. The following sections on the characteristics that affect transport and pathways evaluate the pathways found to be plausible in terms of their compliance with 10 CFR Part 20, Appendix B, Table 2.

The applicant provided parameters for an accidental release, including the tank, its relative location in the facility, its volume, and its contents. The applicant specified a single possible location for the accidental release of radioactive liquid effluents. The NRC staff postulated that a release could occur anywhere within the powerblock area. This assumption allows the identification of all potential alternative pathways and the selection of the most critical ones to conservatively estimate accidental release consequences.

The NRC staff found that the applicant's analysis in the SSAR was sufficient with respect to data (e.g., both past and present) and with respect to the model developed, thus enabling the staff to perform its evaluation. However, the NRC staff concluded that the additional ground-water pathway it identified previously (i.e., the pathway from the proposed powerblock area to the Daniels Branch drainage) is plausible. In the SER with Open Items, the NRC wrote that the applicant's SSAR, Revision 2, was incomplete because it did not consider the inevitable change in hydrology, and, hence, the potential change in flow direction within the Water Table aquifer for some release locations within the powerblock area. The analysis provided no assurance that the applicant had considered an adequate number of combinations of release locations and feasible pathways. This was Open Item 2.4-3. The applicant did develop and apply a model of the Water Table aquifer and has included ground-water pathways in both the Water Table and Tertiary aquifer. Therefore, Open Item 2.4-3 is closed.

<u>Characteristics that Affect Transport</u>

The NRC staff independently determined that the USGS-derived minimum and maximum range of transmissivity values based on field data (i.e., 500 to 9500 $feet^2$/day) (Clarke and West 1998, Table 3), when combined with the local thickness of the Water Table aquifer (i.e., approximately 30 feet), provide hydraulic conductivities ranging from 16.5 to 316 feet/day that are indicative of the values for the Utley Limestone of the Barnwell Formation cited by the applicant (i.e., 3,250 to 125,400 feet/year or 9 to 343 feet/day based on aquifer tests (SNC 2008a, Section 2.4.12). In model 7, the applicant identified hydraulic conductivity values of 32, 100, and 8 feet/day applied to three zones of the Water Table aquifer. The applicant assigned the majority of the model domain a value of 32 feet/day; it assigned a zone immediately upgradient of Mallard Pond a value of 100 feet/day, and it assigned the southwestern quadrant of the model domain the low value of 8 feet/day. A sensitivity case based on model 7 used hydraulic conductivity values of 25, 65, and 5 feet/day and divided the center of the model into a low and high zone; the remainder of the model was assigned the middle value. In this case, the applicant assigned the majority of the model domain associated with Utley Limestone the highest value, 65 feet/day, and assigned a small zone between the proposed location of the VEGP Units 3 and 4 the lowest value, 5 feet/day. Overall, the NRC staff found the model values to be comparable to the applicant data and USGS values of hydraulic conductivity.

The NRC staff reviewed the applicant's prior estimates of the magnitude of the hydraulic gradient (i.e., 0.014 and 0.023 for the backfill to OW-1005 segment and the OW-1005 to Mallard Pond segments, respectively), effective porosity (i.e., 0.34 and 0.31), and ground-water flux (i.e., 0.094 gallons/minute into Mallard Pond) and found them appropriate for simple, conservative effluent transport analyses. Ultimately, the applicant used the model-based values of hydraulic conductivity and hydraulic gradient to derive travel time along a pathway. The beginning of this section and the entirety of Section 2.4.12 summarize the NRC staff's review of the applicant's ground-water model. On the basis of its review, the staff concludes that the ground-water model exhibits mass balance and convergence.

The NRC staff reviewed the hydraulic properties assigned by the applicant to the engineered backfill. The applicant's analysis of transport characteristics in the engineered backfill relies on the observed maximum hydraulic conductivity of the existing units' engineered backfill (1220 feet/year, 3.3 feet/day) and the estimated values of effective porosity (0.34) and hydraulic gradient taken from the Water Table model. The NRC staff also used the minimum measured hydraulic conductivity (480 feet/year or 1.3 feet/day) in sensitivity analyses. The staff notes that the entire range of hydraulic conductivity for the backfill is below the range applied in the model to the natural sediments of the Water Table aquifer. This is not unexpected given the relatively high compaction and well-graded sediments of the backfill material, especially compared to portions of the Barnwell Group sediments, including the Utley Limestone, which are known to be more conductive.

Regarding the applicant's reported values of hydraulic conductivity in the Tertiary aquifer, the NRC staff independently reviewed the USGS minimum and maximum ranges of transmissivity estimates based on field data (180 to 12,200 feet2/day) and regional simulation (13 to 24,700 feet2/day) (Clarke and West 1998, Table 12). When combined with the local thickness of the Tertiary aquifer (approximately 182 feet), the USGS data, while being generally higher, do bracket the central value of hydraulic conductivity provided by the applicant (i.e., 0.83 feet/day). The NRC staff reviewed the applicant's estimates of the magnitude of the hydraulic gradient (i.e., 0.005) and effective porosity (i.e., 0.309). Ultimately, the NRC staff's use of the highest observed transmissivity value attributed to the Tertiary aquifer (i.e., 2.1 feet/day) ensures a conservative estimate of pore-water velocity and travel time (i.e., 450 years). The NRC staff notes that the applicant employed the geometric mean of the hydraulic conductivity values (i.e., 0.83 feet/day) and an effective porosity of 0.309 and calculated a travel time of 1142 years. Such a value represents the central tendency of the travel time and should not be viewed as overly conservative.

The applicant has not stated that it will avoid the use of complexants or chelating agents at the proposed VEGP Units 3 and 4. In response to RAI 2.4.13-2 (SNC 2007c), Southern indicated that it does not prohibit the use of chelating agents; rather it requires a comprehensive evaluation prior to use. Southern's statements suggest that, while it stopped routine use of chelating agents a number of years ago, circumstances could result in a mixture of chelating agents and radioactive liquid effluent. Accordingly, the NRC staff's analysis assumed that complexants or chelating agents may be present.

The NRC staff reviewed the applicant's estimate of streamflow necessary to dilute the radiological effluent released through the Water Table aquifer into Mallard Pond after an accident. For the streamflow dilution, the applicant used a measured streamflow of 1125 gallons/minute at a point just downstream of the confluence of the stream discharging from Mallard Pond and its west branch, which is a single moment-in-time measurement made in June and July 1985. The NRC staff determined that a lower streamflow than that measured by the applicant is feasible. Because the data were not gathered during the most severe drought of record (USACE 2006), the NRC staff concludes that it is reasonable to assume that the discharge from Mallard Pond could cease entirely for a period of time. It should also be noted that the stream downstream of Mallard Pond crosses the VEGP property boundary and then reenters the VEGP property before discharging to the Savannah River (SNC 2008b, Section 2.4.13.1.4). Thus, the discharge from Mallard Pond enters the public domain before its discharge to the Savannah River.

The applicant stated that the magnitude of the 100-year drought flow of the Savannah River was 3298 cubic feet per second (cfps) (1.48x106 gallons/minute). The minimum release from Thurmond Dam is currently set at 3600 cfps (1.616x106 gallons/minute) by the U.S. Army Corps of Engineers. A USGS streamflow gauge near the VEGP site shows higher flows, suggesting that at low flows the Savannah River actually picks up some additional flow between Thurmond Dam and the VEGP site. These additional flows are contributed by and consistent with tributary and ground-water discharges flowing into the Savannah River. The staff determined that, based on the above, 3600 cfps is a conservative estimate of monthly and annual flows.

The applicant believes that the drainage below Mallard Pond, when it enters the Hancock Landing property, does not represent a potable water supply and that 10 CFR Part 20 requirements do not apply. The applicant identified the Savannah River as the potential water supply to which 10 CFR Part 20 compliance applies and identified the closest surface water withdrawal downstream of the release as two industrial surface water users, both located about 106 miles downstream of the VEGP site. However, the NRC staff does not concur with this selection and instead determined based on the information provided by the applicant that the intersection between the Creek below Mallard Pond and the Hancock Landing property is the point of compliance. The staff evaluated both points of compliance and determined that for both points, 10 CFR Part 20 limits can be met. In addition, although the staff disagrees with the applicant's point of compliance for 10 CFR Part 20 limits, the staff concurs that the applicant adequately demonstrated that 10 CFR Part 20 limits can be met downstream of Mallard Pond, inside the exclusion area boundary (i.e. before reaching an unrestrictred area).

Contamination Pathways

To bound the most severe radiological consequences of radioactive liquid effluent release, the NRC staff postulated plausible alternative pathways to the accessible environment. The NRC staff concludes that the Mallard Pond drainage would likely intercept most accidental release pathways originating inside the powerblock area of the proposed VEGP Units 3 and 4. However, the future direction of ground-water flow within the Water Table aquifer may change, and it is not unreasonable to expect that some accidental release locations within the powerblock area could result in releases moving to the west and south. Such releases could flow into the upper reaches of the Daniels Branch drainage and ultimately to the Savannah River. Another feasible accidental release pathway would involve transport from the Water Table aquifer into the Tertiary aquifer, with subsequent migration toward and discharge into the Savannah River from the Tertiary aquifer. The NRC staff concludes that these three pathways represent plausible alternate pathways for the transport of an accidental release of radioactive liquid effluents and analyzed all three.

The NRC staff reviewed the Mallard Pond drainage accidental release pathway postulated by the applicant, and, assuming no credit for adsorption because of the potential presence of chelating agents, concludes that such a release and pathway analysis would require inclusion of release and dilution into the Savannah River to ensure that radionuclide concentrations meet site suitability requirements (10 CFR Part 20, Appendix B, Table 2).
The postulated release posed by the applicant is conservative because it ignores the leak containment and detection systems associated with the effluent holdup tank; the integrity of the engineered system, including the foundation of the auxiliary building; the time required to move through the vadose zone; the dispersal of contaminants in the vadose zone and aquifer; and the opportunity to remediate contaminant plumes in the ground-water environment.

<u>Contaminant Transport Analysis</u>

The NRC staff reviewed the applicant's calculations regarding the inventory, its accidental release, and its decay, adsorption, and dilution during transport through the environment. The NRC staff concludes that the applicant's use of adsorption to allow additional decay of cobalt, strontium, and cesium isotopes during retarded travel times was not warranted given the potential for chelating agents to be present. The NRC staff also concludes that neither the analysis nor the data adequately support the flow measurements and dilution calculations performed by the applicant for the Mallard Pond drainage north of the proposed VEGP Units 3 and 4. Consequently, it is reasonable to assume that flow from Mallard Pond ceased in the past and could cease in the future during times of extreme drought because of the standpipe discharge control structure. Neglecting adsorption and onsite dilution, the NRC staff determined that release from the drainage to the Savannah River will require mixing with approximately 10 percent of the Savannah River low flow (i.e., 160,000 gallons/minute) to achieve concentrations meeting the site suitability requirements (i.e., a sum of fractions less than one).

The NRC staff considered alternate subsurface conceptual models and release locations, with the release moving in another direction (e.g., towards the southwest), and determined that a pathway leading to the upper reaches of the Daniels Branch drainage was plausible but unlikely. As in the case of the Mallard Pond drainage analysis, the potential presence of chelating agents precludes the application of adsorption phenomena, and the release could not meet the 10 CFR Part 20 requirements before reaching the site boundary. Such a pathway (i.e., the Daniels Branch drainage) could pose a greater threat than the Mallard Pond drainage pathway quantified by the applicant in SSAR Section 2.4.13 (SNC 2008b).

The NRC staff concludes that, in addition to alternate conceptual models involving the direction of ground-water flow in the Water Table aquifer, an alternate conceptual model exists that suggests possible local communication between the unconfined Water Table aquifer and the confined Tertiary aquifer. The NRC staff determined that limited evidence indicates the possibility of a local hydraulic flaw in the aquitard separating these two aquifers. If an accidental release from the proposed VEGP Units 3 and 4 were to be intercepted by such a local communication region of the Water Table aquifer, then the staff concludes that the release could move into the Tertiary aquifer and move toward and discharge into the Savannah River. Using the maximum hydraulic conductivity cited by the applicant for the Tertiary aquifer, the shortest travel time to the river would be approximately 450 years. After accounting for decay during this travel time, of all radionuclides listed (SNC 2008b, Table 2.4.13-1), only I-129 and

Cs-137 would require future concentration reduction by mixing or dilution in the Savannah River. The NRC staff determined that dilution in only 76 gallons/minute of flow in the Savannah River (i.e., less than 0.005 percent of the 3600 cfps low flow) would be required to achieve the level of less than 1 percent of their ECLs. In this instance, the hierarchical process followed by the NRC staff to evaluate alternate conceptual models yields a release that is of less consequence than either a release through Mallard Pond or to the Daniels Branch drainage.

When the SER with Open Items was released, the NRC staff's review of the release location, migration, attenuation, and dilution of the radioactive liquid effluent release was incomplete. As stated in Open Item 2.4-3, the applicant had not considered a sufficient number of alternate conceptual models to identify potential release points and pathways. In addition, the analysis of the Mallard Pond drainage pathway raised an issue concerning the point of compliance, and the staff required the applicant to specify the nearest point along each potential pathway that was accessible to the public. This was Open Item 2.4-4. Later, the applicant provided the analysis of pathways and radionuclide transport through Revision 4 (2008b) and the response to RAIs (2008c). Also, the applicant provided a map of the site boundary and noted that the stream draining the Mallard Pond drainage does leave the site and reenters it before discharging to the Savannah River. It is also clear from the applicant's map that the stream draining to the upper reaches of the Daniels Branch leaves the site just before entering Lower Debris Basin 2. Therefore, Open Item 2.4-4 is closed.

The NRC Staff conducted a further analysis of the Mallard Pond and upper Daniels Branch drainages. The staff determined the catchment areas for both watersheds and applied monitored runoff rates from unregulated watersheds in the region to estimate the minimum monthly runoff rate for the Mallard Pond and upper Daniels Branch drainages. The catchment areas were based on standard 10-meter resolution USGS digital elevation models (DEMs) acquired from the U.S. Department of Agriculture Geospatial Gateway. The DEM for each catchment was checked for anomalous sinks or peaks and processed to produce flow direction and flow accumulation data. The staff identified a drainage outlet location at the intersection of the drainage channel and site boundary. Using these inputs, the staff used the ArcGIS "watershed" function to trace the catchment boundary and determine the catchment area. The area of the Mallard Pond catchment was 3.266 square kilometers, and the upper Daniels Branch catchment was 3.122 square kilometers. The staff used stream gauge data from six unregulated watersheds in Georgia and South Carolina to quantify the runoff from the VEGP watersheds. One gauge had a duration of record from 1929 to present, another from 1949 to present, and all others were of relatively short duration. The staff determined streamflow or runoff as a function of watershed area for these watersheds and defined the minimum watershed flow as the average of the lowest 12-month period. In other words, the staff used a 12-month floating window to search the data and define the 12-month period with the lowest annual flow of record. The average flow for that year was considered to be the minimum watershed flow. The minimum watershed flow for the Mallard Pond drainage was 279 gallons/minute, and for the upper reaches of the Daniels Branch drainage it was 267 gallons/minute.

The migration and fate of an accidental release of a radioactive liquid effluent can be estimated by assuming that (1) migration from the engineered backfill is the same or nearly the same for both pathways, (2) chelating agents are not present, and therefore, the minimum measured distribution coefficients are assumed to conservatively represent cobalt, strontium, and cesium movement, and (3) the runoff measured at other nearby unregulated watersheds is an appropriate surrogate for minimum annual runoff at watersheds on and adjacent to the VEGP site. For the analysis of the Mallard Pond drainage, key data include the travel times through the backfill and aquifer (i.e., 2.4 and 4.3 years (SNC 2008b)), the ground-water flux from the engineered backfill carrying the radioactive contamination, (i.e., 0.094 gallons/minute (SNC 2008b)), and the minimum distribution coefficients for backfill and aquifer materials (see FSAR Table 2.4.13-3 (SNC 2008b)). The resulting sum of fractions, where the fraction is the ratio of radionuclide concentration to its effluent concentration limit, is 0.235, which is below the requirement of one (10 CFR Part 20, Appendix B, Table 2).

For the analysis of the upper reach of the Daniels Branch drainage, key data include the travel times through the backfill and aquifer, the ground-water flux from the backfill, and the minimum distribution coefficients. The staff assumed the travel time through the backfill to be the same in both cases (i.e., 2.4 years). The staff also assumed that travel through the aquifer occurs from the engineered backfill to the nearest reach of Daniels Branch drainage, approximately 1500 feet away, and occurs at a ground-water velocity comparable to that currently observed. This results in a travel time estimate of 2.6 years. The resulting sum of fractions for this pathway is 0.336, which is also below the requirement of one (10 CFR Part 20, Appendix B, Table 2).

The NRC staff’s analysis demonstrates that a release to the ground-water environment of a radioactive liquid effluent will meet the requirements of 10 CFR Part 20, Appendix B, Table 2. However, use of the minimum distribution coefficients in the analysis implies that no chelating agents can be comingled with the radioactive liquid effluents. Therefore, COL Action Item 2.4-1 requires that the COL or CP applicant confirm that no chelating agents will be comingled with radioactive waste liquids and that such agents will not be used to mitigate an accidental release. Alternatively, the COL or CP applicant may repeat experiments that include chelating agents to produce the distribution coefficients, and incorporate these newly determined distribution coefficients into the analysis to demonstrate that the requirements of 10 CFR Part 20, Appendix B, Table 2, are satisfied.

2.4.13.4 Conclusion

As set forth above, the applicant has substantiated sufficient information pertaining to the identification and evaluation of the effects of accidental releases of radioactive liquid effluents in ground and surface waters on existing users and known and likely future users of ground and surface water resources in the vicinity of the proposed site. Section 2.4.13 of RS-002 indicates that the SSAR should address the requirements of 10 CFR Part 100 as they relate to identifying and evaluating the effects of accidental releases of radioactive liquid effluents in ground and surface waters on existing users and known and likely future users in the vicinity of the site. Furthermore, the applicant considered the most severe natural phenomena historically reported for the site and surrounding area while describing the hydrologic interface of the plant with the site with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The NRC staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in this analysis, as documented in the SERs for previous licensing actions. Accordingly, the NRC staff concludes that the use of these methodologies results in an analysis containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the staff considers the applicant’s analysis to be acceptable for use in establishing the design bases for those SSCs important to safety as may be proposed in a COL or CP application.

The NRC staff concludes that the identification and consideration of accidental releases of radioactive liquid effluents in ground and surface waters set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d).

2.4.14 Site Characteristics

This section of the SER lists site characteristics and bounding parameters recommended by the NRC staff for inclusion in the ESP that may be granted for the VEGP site as given in table below.

Table 2.4.14-1 - Proposed Site Characteristics Related to Hydrology

SITE CHARACTERISTIC	VALUE	DEFINITION
Proposed Facility Boundaries	Figure 2.4.14-1	The site boundary within which all safety-related SSC will be located.
Highest Ground Water Elevation	165 feet MSL at the Water Table Aquifer	The highest elevation of the water table within the site boundaries.
Maximum Flood Elevation (maximum hydrostatic water surface elevation due to a postulated upstream dam breach scenario)	166.79 feet MSL	The stillwater elevation, without accounting for wind-induced waves that the water surface reaches during a flood event.
Wind run-up (to add to the maximum flood elevation)	11.31 feet	The water surface elevation reached by wind-induced waves running up on the shore.
Combined Effects Maximum Flood Elevation	178.10 feet MSL;	The water surface elevation obtained by adding wind run-up to the highest flood level.
Local Intense Precipitation	19.2 inches during 1 hour 6.2 inches during 5 minutes	The depth of PMP for duration of one hour on a one square-mile drainage area. The surface water drainage system should be designed for a flood produced by the local intense precipitation. The local intense precipitation is specified by SSAR Table 2.4.2-3 (see Table 2.4.2-1 of this SER).
Frazil Ice	The ESP site does not have the potential for the formation of frazil and anchor ice	Ice crystals that form in turbulent, open waters in presence of supercooling. Frazil ice is very sticky and may lead to blockages of intake screens and trash racks.

Table 2.4.14-2 Bounding Parameters

Bounding Parameters	Value	Definition
Plant Grade Elevation	220 feet MSL	The elevation of the finished ground surface that prevents the flood produced by the local intense precipitation from affecting the safety-related SSCs.

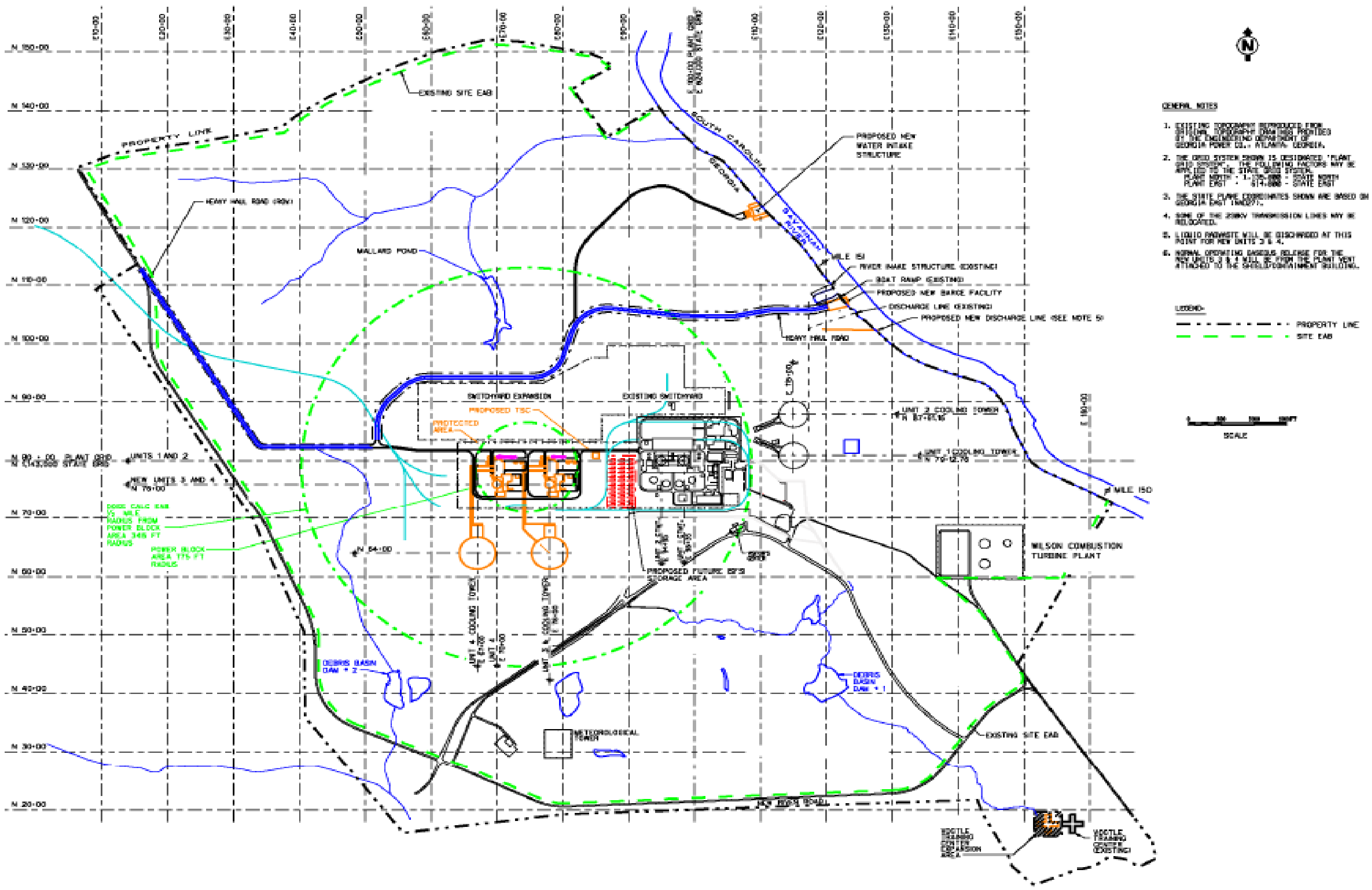


Figure 2.4.14-1 - The Proposed facility boundary for the VEGP site (Taken from SSAR Figure 1-4).

2.5 Geology, Seismology, and Geotechnical Engineering

In Section 2.5, “Geology, Seismology, and Geotechnical Engineering,” of the VEGP SSAR, the applicant described geologic, seismic, and geotechnical engineering properties of the VEGP ESP site. SSAR Section 2.5.1, “Basic Geologic and Seismic Information,” presents information on geologic and seismic characteristics of the VEGP site and region surrounding the site. SSAR Section 2.5.2, “Vibratory Ground Motion,” describes the vibratory ground motion assessment for the ESP site through a PSHA and develops the SSE ground motion. SSAR Section 2.5.3, “Surface Faulting,” evaluates the potential for surface tectonic and non-tectonic deformation at the ESP site. SSAR Sections 2.5.4, “Stability of Subsurface Materials and Foundations,” 2.5.5, “Stability of Slopes,” and 2.5.6, “Embankments and Dams,” describe foundation and subsurface material stability at the ESP site.

The applicant reviewed reports from previous investigations for the existing VEGP Units 1 and 2 as a starting point for the characterization of the geologic, seismic, and geotechnical engineering properties of the site. The applicant also referred to published geologic literature and seismicity data, new borehole data for the proposed VEGP Units 3 and 4, seismic reflection and refraction surveys, and detailed investigations of the nearby SRS. Results of the investigations and analyses performed by the applicant for each of the SSAR Sections (2.5.1 to 2.5.6) provide information used to determine the SSE, as described in NRC RG 1.165 titled, “Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion.”

The applicant defined the following four terms for areas in which investigations for the VEGP ESP site occurred, as designated by RG 1.165.

> Site region: an area within 320 km (200 mi) of the site location.
> Site vicinity: an area within 40 km (25 mi) of the site location.
> Site area: an area within 8 km (5 mi) of the site location.
> Site: an area within 1 km (0.6 mi) of the proposed VEGP Units 3 and 4 locations.

This RG also provides guidance on recommended levels of investigation for each of these areas.

The applicant also used the seismic source and ground motion models published in the EPRI’s (1986) “Seismic Hazard Methodology for the Central and Eastern United States [CEUS as the starting point for its seismic hazard evaluation. The applicant used the procedures recommended in RG 1.165 for performing the probabilistic seismic hazard analysis (PSHA) for the ESP site, and employed the performance-based approach described in RG 1.208, “A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion” for determining the SSE.

The applicant conducted field investigations, examined relevant geologic literature, and concluded that no geologic or seismic hazards have the potential to affect the VEGP ESP site, except for the Charleston seismic zone and a small magnitude local earthquake occurring in the site region. The applicant also concluded that there is only limited potential for non-tectonic surface deformation within the 8 km (5 mi) site area radius, and that this potential could be mitigated by excavation of shallow deposits overlying the foundation bearing unit.

This SER, compiled by the NRC staff, is divided into six main sections, 2.5.1 to 2.5.6, which parallel the six main sections included in the applicant's SSAR. Each of the six SER sections is then divided into four sub-sections: (1) "Technical Information in the Application" that describes the contents of the SSAR, the investigations performed by the applicant, and the results; (2) "Regulatory Basis" that provides a summary of the regulations and NRC regulatory guides used by the applicant to formulate the SSAR; (3) "Technical Evaluation" that describes the staff's evaluation of what the applicant did, including any requests for additional information (RAI's), open items, and any confirmatory analyses performed by the NRC staff; and (4) the final "Conclusions" sub-section for each main section that documents whether or not the applicant provided a thorough characterization for the site and if its results provide an adequate basis for the conclusions made by the applicant.

2.5.1 Basic Geologic and Seismic Information

Section 2.5.1.1 of this SER provides a summary of relevant geologic and seismic information contained in SSAR Section 2.5.1 of the VEGP application. SER Section 2.5.1.2 provides a summary of the regulations and guidance used by the applicant to perform its investigation. SER Section 2.5.1.3 provides a review of the staff's evaluation of SSAR 2.5.1, including any requests for additional information, any open items, and any confirmatory analyses performed by the staff. Finally, SER Section 2.5.1.4 provides an overall summary of the applicant's conclusions, as well as the staff's conclusions, restates any bases covered in the application, and confirms that regulations were met or fulfilled by the applicant.

In SSAR Section 2.5.1, the applicant described geologic and seismic characteristics of the VEGP site region and site area. SSAR Section 2.5.1.1, "Regional Geology," describes the geologic and tectonic setting of the site region (within a 320 km (200 mi) radius), and SSAR Section 2.5.1.2, "Site Geology," describes the structural geology of the site area (within an 8 km (5 mi) radius). In SSAR Section 2.5.1, the applicant also provided an update of geologic, seismic and geophysical data for the VEGP site and then reviewed the updated information, pursuant to RG 1.165, to determine whether any of the data published since the mid-1980's requires an update to the 1986 EPRI seismic source model.

The applicant developed SSAR Section 2.5.1 based on information derived from the review of previously prepared reports for existing VEGP Units 1 and 2, and published geologic literature, new boreholes drilled for potential VEGP Units 3 and 4, and seismic reflection and refraction surveys conducted for the ESP application. The applicant also used recently published literature to supplement and update existing geologic and seismic information.

2.5.1.1 Technical Information in the Application

2.5.1.1.1 Regional Geologic Description

SSAR Section 2.5.1.1, "Regional Geology," discusses the physiography, geomorphology, geologic history, stratigraphy, and geologic setting within a 320 km (200 mi) radius of the VEGP site. The applicant reviewed previous reports prepared for VEGP Units 1 and 2, as well as geophysical data and published geologic literature, in order to compile the regional geologic description. The applicant collected new data in order to assess whether or not the Pen Branch fault is a capable tectonic structure of Quaternary age (1.8 million years ago (mya) to present). The applicant concluded that regional geologic characteristics pose no safety issues that would impact the VEGP site. The applicant applied the information in this section towards developing a basis for evaluation of the geologic and seismic hazards covered in succeeding sections of the SSAR. Based on its review, the applicant presented the following information related to the regional geology for the ESP site.

Physiography, Geomorphology and Geologic History

SSAR Section 2.5.1.1.1 describes the regional physiography and geomorphology of the ESP site. From northwest to southeast, the site region includes parts of the Valley and Ridge, Blue Ridge, Piedmont, and Coastal Plain physiographic provinces. Figure 2.5.1-1, reproduced from SSAR Figure 2.5.1-1, illustrates these four provinces. The VEGP ESP site lies within the Coastal Plain province approximately 48 km (30 mi) southeast of the line (“fall line”) separating crystalline rocks of the Piedmont province from sediments of the Coastal Plain province. The Coastal Plain province is one of low topographic relief. Depositional landforms and topography strongly modified by fluvial erosion characterize the VEGP ESP site within the Coastal Plain province. Based on published information (Soller and Mills, 1991), the applicant described Carolina Bays (shallow, elliptical landforms which commonly occur in the Coastal Plain province) as surficial, non-tectonic features resulting from erosion by southwesterly-oriented winds (eolian erosion) that have no effect on subsurface sediments. Several investigators have documented that strata are continuous and undeformed beneath both bay and interbay areas.

The applicant described the geologic history of the ESP site in SSAR Section 2.5.1.1.2. Although the ESP site is located in the Coastal Plain, all major lithotectonic (characteristically unified rock assemblage) divisions of the Appalachian mountain belt occur within the site region. The applicant stated that geologic structures and stratigraphic sequences within these lithotectonic divisions represent a complex geologic evolution ending in the modern-day, passive Atlantic continental margin. This complex evolution resulted in the deposition of Cretaceous (144 to 65 mya) and Tertiary (65 to 1.8 mya) age sediments of the Coastal Plain; Quaternary (1.8 mya to present) materials in fluvial terraces along the Savannah River and its tributaries; and colluvial (loose, heterogeneous soil material and rock fragments), alluvial (unconsolidated material deposited during relatively recent geologic time by running water) and eolian sediments, all within the site area.

Stratigraphy and Geologic Setting

In SSAR Section 2.5.1.1.3, the applicant described regional stratigraphy and geologic setting (including stratigraphy, rock type, and geologic history) for the (1) Valley and Ridge; (2) Blue Ridge; (3) Piedmont; (4) Mesozoic rift basins; and (5) Coastal Plain provinces.

1. Folded and thrust-faulted Paleozoic (543 to 248 mya) sedimentary cover rocks overlying crystalline basement represent the Valley and Ridge lithotectonic terrane, located about 290 km (180 mi) west-northwest of the VEGP ESP site. A series of northeast-southwest trending, parallel valleys, and ridges are responsible for the physiographic expression within the Valley and Ridge terrace. Most of the folding and faulting deformation is likely late Paleozoic in age (at least 248 mya).

2. A complexly folded, faulted, penetratively deformed, metamorphosed crystalline basement and cover rock sequence containing intrusive igneous rocks represents the Blue Ridge lithotectonic province, located about 225 km (140 mi) northwest of the ESP site. Multiple deformation events indicated by deformation features in the rocks relate to late Proterozoic to late Paleozoic (248 mya and older) extension and compression.

3. Variably deformed and metamorphosed igneous and sedimentary rocks ranging in age from Proterozoic to Permian (248 mya and older) represent the Piedmont Province, located about 48 km (30 mi) northwest of the ESP site. The applicant stated that Piedmont province rocks generally underlie Coastal Plain province sediments, but that the southeastern extent of the Piedmont province beneath the Coastal Plain is unknown.

4. Mesozoic Rift Basins typically consist of non-marine sandstone, conglomerate, siltstone, shale, carbonates, coal, and basaltic igneous rocks. One of these basins, the Dunbarton Triassic basin, is beneath the Coastal Plain sediments at the VEGP ESP site. Geophysical investigations, including seismic reflection, suggest that the Triassic (206 to 24 mya) section of the Dunbarton basin is at least 2 km (1.2 mi) thick. The primary fault bounding this basin on the northwest side is the Pen Branch fault, which dips to the southeast. The applicant described the Pen Branch fault to be a Paleozoic reverse fault, reactivated as an extensional normal fault during the Mesozoic (248 to 65 mya) and subsequently reactivated as a reverse fault during the Cenozoic (65 mya to present).

5. Erosion-beveled rocks of Paleozoic and Triassic age (543 to 206 mya) and unconsolidated to poorly consolidated Coastal Plain sediments deposited unconformably above the erosional surface represent the Coastal Plain province where the ESP site is located. This seaward-dipping wedge extends from the contact with crystalline rocks of the Piedmont physiographic province (the fall line) to the edge of the continental shelf. Sediment thickness increases from zero at the fall line to about 1200 m (4000 feet) at the Georgia coastline. The sediment thickness is about 335 m (1000 feet) in the center of the VEGP site area and is composed of Upper Cretaceous, Tertiary, and unconsolidated Quaternary deposits.

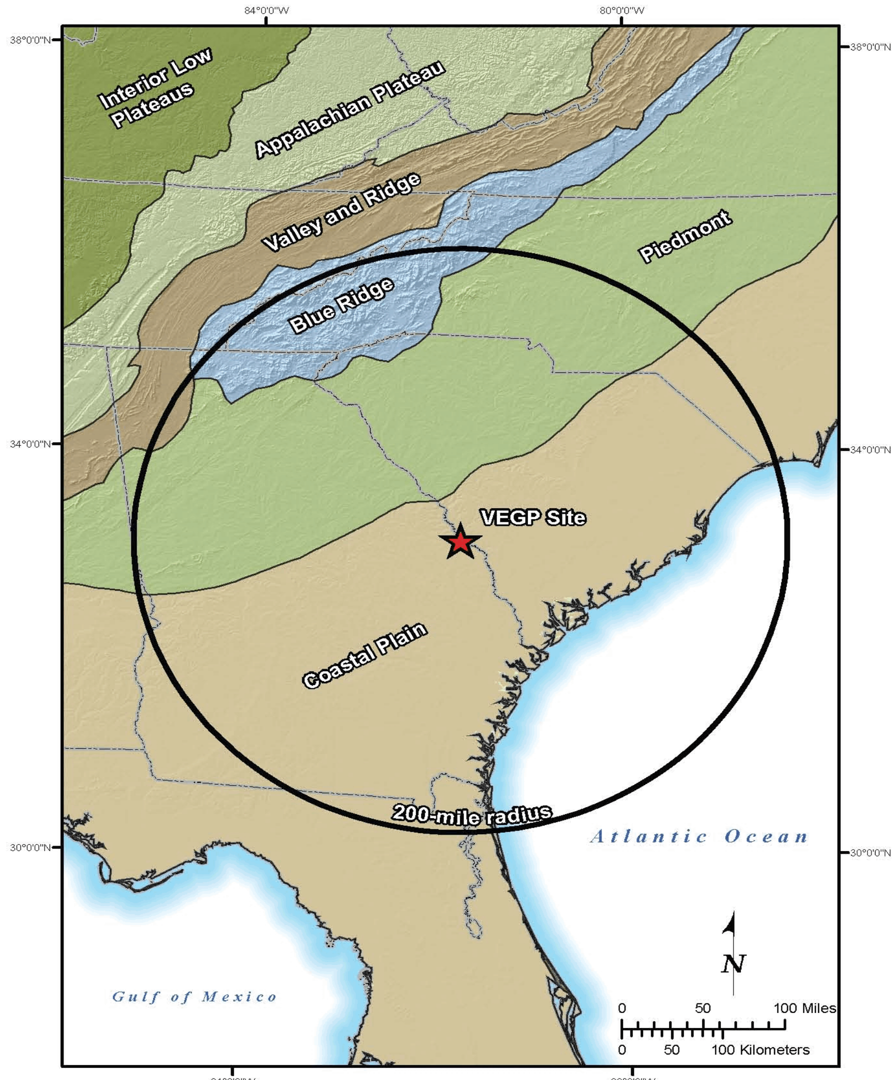


Figure 2.5.1-1 - Physiographic Provinces of the Southeastern United States

Quaternary Period (1.8 mya-present) surfaces and deposits are preserved primarily in the fluvial terraces along the Savannah River and its major tributaries, as well as in colluvium, alluvium, and eolian sediments in upland settings. Nested fluvial terraces, preserved along the east side of the Savannah River, can be used to evaluate Quaternary deformation within the Savannah River area. Major stream terraces develop as a result of sequential erosional and depositional events which may be due to tectonism, isostacy, or climatic variations. In SSAR Section 2.5.1.1.3.5, the applicant described two prominent terraces above the modern flood plain and along the east side of the Savannah River in the ESP site vicinity. The Bush Field terrace (mapped as Quaternary terrace surface "Qtb") is preserved primarily on the northeast side of the Savannah River and its surface ranges from 8 to 13 m (26 to 43 ft) above the river. Ellenton terrace surfaces (mapped as "Qte") range from 17 to 25 m (56 to 82 ft) above the river. The applicant estimated the age of the older Ellenton terrace to be 350 thousand to 1 million years old. The younger Qtb terrace is estimated to be about 90 thousand years old.

2.5.1.1.2 Regional Tectonic Description

The applicant described the tectonic setting, tectonic structures, and seismic source zones in sub-sections 2.5.1.1.4.1 through 2.5.1.1.4.6 of SSAR Section 2.5.1.1.4. The applicant discussed plate tectonic evolution of the Appalachian orogenic belt at the latitude of the ESP site, tectonic stress in the mid-continent region, principal regional tectonic structures, Charleston tectonic features, SRS tectonic features, and seismic sources defined by regional seismicity. SSAR Section 2.5.1.1.5 outlines the applicant's review of regional gravity and magnetic data, and the models used to supplement their interpretations of regional geologic and tectonic features discussed in SSAR Sections 2.5.1.1.3 and 2.5.1.1.4. The applicant concluded that (1) tectonic features in the site region are Paleozoic (> 248 mya), Mesozoic (248 to 65 mya), and Cenozoic (< 65.5 mya) in age but only the Quaternary (< than 1.8 mya) features require additional consideration for this ESP; (2) there is no significant change to the understanding of stress in the CEUS that would require updates to the currently accepted data; (3) of 11 potential Quaternary features evaluated by the applicant, only paleoliquefaction features associated with the Charleston source earthquakes clearly demonstrate the existence of a Quaternary tectonic feature; (4) based on new source geometry and earthquake recurrence information, the Charleston seismic source requires updated parameters; and (5) that there are no unexplained anomalies expressed in the gravity or magnetic data for the VEGP site region and no evidence present in the data for Cenozoic age structures or deformation. Based on published information, the applicant presented the following information related to the regional tectonic setting:

<u>Plate Tectonic Evolution and Stress Field</u>

The applicant discussed plate tectonic evolution of the Appalachian orogenic belt at the latitude of the site region in SSAR Section 2.5.1.1.4.1 and acknowledged the four principal tectonic elements of the Appalachian orogen: the Valley and Ridge province, Blue Ridge province, Piedmont province, and Coastal Plain province. These four tectonic elements correspond to the four physiographic provinces described in SSAR Section 2.5.1.1.1 and shown in Figure 2.5.1-1. The Appalachian orogenic belt, trending northeast-southwest and extending from southern New York State into Alabama, records the opening (between 900 to 543 mya) and closing (543 to 248 mya) of the proto-Atlantic Ocean along the eastern margin of ancestral North America. Compressional deformation due to continental collisions occurred during the Ordovician (490-443 mya), Devonian (417 to 354 mya), and Late Paleozoic (320 to 250 mya). Triassic (248 to 206 mya) basins, including the Dunbarton Basin, which occur in the Appalachian orogenic belt, represent Mesozoic rifting. Stratigraphic units of the coastal plain, the province within which the ESP site lies, record development of a passive continental margin along the east coast of the United States that followed the Mesozoic rifting and the opening of the present-day Atlantic ocean basin. The applicant concluded that, despite uncertainties in regard to origin, mode of emplacement, and boundaries of the different structural and lithologic terranes that exist in the principal tectonic provinces, there is reasonable agreement among existing tectonic models on regional structural features of the southern Appalachian orogenic belt.

In SSAR Section 2.5.1.1.4.2, the applicant discussed the regional tectonic stress acting on the mid-continent region, specifically the CEUS. The 1986 EPRI evaluation of intra-plate stresses determined that the CEUS is characterized by northeast-southwest directed horizontal compressive stress attributed mostly to ridge-push forces associated with the Mid-Atlantic ridge. The applicant concluded that based on investigations conducted since the EPRI study, which support the initial EPRI findings, there is no significant change to the understanding of stress in the CEUS and therefore it is not necessary to reevaluate the seismic potential of tectonic sources in the region based on the regional tectonic stress.

Principal Regional Tectonic Structures

In SSAR Section 2.5.1.1.4.3, the applicant defined and discussed four categories of principal regional tectonic structures occurring within a 320 km (200 mi) radius of the VEGP site based on age of formation or reactivation of the structures. These four categories included tectonic structures of (1) Paleozoic (543 to 248 mya); (2) Mesozoic (248 to 65 mya); (3) Tertiary (65 to 1.8 mya); and (4) Quaternary (1.8 mya to present) age. The applicant also discussed regional geophysical anomalies and lineaments potentially equated with tectonic features.

1. Paleozoic Tectonic Structures. The applicant indicated that rocks and structures within the physiographic provinces included in the site region are associated with thrust sheets that formed by convergent Appalachian orogenic events during the Paleozoic. In the case of the Coastal Plain province where the ESP site is located, these rocks and structures are buried beneath sedimentary cover. The majority of these structural features dip eastward into a basal, shallow dipping fault (decollement) structure. The applicant discussed two primary Paleozoic fault zones, the Augusta and the Modoc, as well as a number of other Paleozoic faults within the ESP site region, including the Hayesville Fault, the Brevard Fault, the Towaliga Fault, the Central Piedmont Suture, and the Eastern Piedmont Fault System. The applicant concluded that none of these structures are capable tectonic sources of concern for the VEGP site and that no new information has been published since 1986 on these Paleozoic faults in the site region that would result in a significant change to the EPRI seismic source model.

2. Mesozoic Tectonic Structures. The applicant recognized the broad zone of fault-bounded depositional basins associated with crustal extension and rifting in early Mesozoic time (Triassic period, 248 to 206 mya). These are relatively common features along the east coast of North America. Figure 2.5.1-2, taken from SSAR Figure 2.5.1-16, shows one of these east-northeast-trending Triassic basins, the Dunbarton Basin, which lies beneath the VEGP site and the SRS. This basin, approximately 50 km (31 mi) long and 10 to 15km (6 to 9 mi) wide, is bounded on its northwest side by the Pen Branch Fault, which experienced normal fault displacement during the Triassic. The Pen Branch fault is interpreted to have been reactivated in the Cenozoic (65 mya to present) as a reverse fault. The applicant stated that no definitive

correlation of seismicity with any Mesozoic normal fault has been conclusively demonstrated.

3. Tertiary Tectonic Structures. The applicant stated that only a few tectonic features were active in the Tertiary Period (65 to 1.8 mya) within the ESP site area. The applicant referred to a series of arches and embayments (topographic highs and lows) that exerted control on Coastal Plain sedimentation from late Cretaceous through Pleistocene time (144 mya to 10,000 ya) as indicative of episodic differential tectonic movement. The applicant concluded that the most prominent arches in the VEGP site region, the Cape Fear Arch on the South Carolina-North Carolina border, and the Yamacraw Arch on the Georgia-South Carolina border show no evidence of being active.

4. Quaternary Tectonic Structures. The applicant discussed 11 potential Quaternary features within a 320 km (200 mi) radius of the VEGP ESP site as shown in Figure 2.5.1-3, reproduced from SSAR Figure 2.5.1-17. Table 2.5.1-1, reproduced from SSAR Table 2.5.1-1, provides definitions and classes used to categorize these same potential features. The 11 potential Quaternary features discussed by the applicant include the Charleston, Georgetown, and Bluffton paleoliquefaction features, the East Coast Fault System (ECFS), the Cooke fault, the Helena Banks fault zone, the Pen Branch fault, the Belair fault, the fall lines of Weems (1998), the Cape Fear arch, and the Eastern Tennessee Seismic Zone (ETSZ). The three paleoliquefaction features are classified by Wheeler (2005) as “Class A”, indicating there is geologic evidence to demonstrate the existence of Quaternary tectonic deformation related to these features. The other eight features are classified as “Class C”, indicating there is insufficient geologic evidence to demonstrate the existence of Quaternary deformation associated with these features. The applicant discussed only the Belair Fault Zone and the fall lines of Weems (1998) in SSAR Section 2.5.1.1.4.3 since the other potential Quaternary features are discussed in detail in other sections of the SSAR.

The applicant documented that the Belair Fault Zone, located about 48 km (30 mi) northwest of the ESP site, occurs as a series of northeast-striking, southeast-dipping oblique-slip faults with no evidence of historic or recent associated seismicity. The applicant concluded that Quaternary slip is allowed, but not clearly demonstrated, by available data.

Weems (1998) identified numerous anomalously steep stream segments in the Blue Ridge and Piedmont physiographic provinces of North Carolina, Virginia, and Tennessee and recognized that these steep “fall zones”, located north and northeast of the ESP site, are aligned from stream to stream along paths that are subparallel to the regional structural grain of the Appalachian orogenic belt. Although Weems (1998) favored a neotectonic (less than 23.8 mya) origin for these fall lines, Wheeler (2005) classified them as Class C features because he did not consider Quaternary tectonic faulting to be demonstrated by the available data.

In addition to the 11 potential Quaternary features listed above, the applicant recognized that a number of regional geophysical anomalies and lineaments occur within 320km (200 mi) of the VEGP site, including the East Coast Magnetic Anomaly (ECMA), the Blake Spur Magnetic Anomaly, the Grenville Front, the New York-Alabama Lineament (NYAL), and the Clingman and Ocoee Lineaments.

The applicant described the ECMA and the Blake Spur Magnetic Anomaly, both of which are located off the east coast of North America and interpreted to be Mesozoic in age. The applicant concluded that neither of these anomalies are associated with a regional fault or other tectonic structure and do not represent a potential seismic source for the VEGP site.

The applicant classified the NYAL as a linear feature 1600 km (1000 mi) in length defined by a series of northeast-southwest-trending magnetic gradients in the Valley and Ridge physiographic province that intersects and truncates other magnetic anomalies. King and Zietz (1978) interpreted this lineament to be a major strike-slip fault in Precambrian basement, while Shumaker (2000) equated it to a right-lateral wrench fault that formed during an initial phase of Precambrian continental rifting.

The Clingman Lineament is 1200 km (750 mi) in length and also trends northeast, showing up as an aeromagnetic linear feature passing through parts of the Blue Ridge and the eastern Valley and Ridge provinces from Alabama to Pennsylvania. The Ocoee Lineament is described as a splay that branches southwest from the Clingman Lineament approximately at latitude 36N. The Clingman-Ocoee Lineaments are subparallel to and located 50-100 km (30-60 mi) east of the NYAL.

The applicant described the "Ocoee block" as a Precambrian basement block located northwest of the ESP site and just outside of the 320 km (200 mi) site radius. The majority of southern Appalachian seismicity is interpreted to occur within the Ocoee block that coincides with the western margin of the ETSZ, as discussed in SSAR Section 2.5.1.1.4.6 "Seismic Sources Defined by Regional Seismicity". Johnston et al. (1985) interpreted seismicity within the Ocoee block as related to strike-slip displacement on faults striking north-south and east-west. More recently, Wheeler (1996) proposed that earthquakes within the Ocoee block may be related to reactivation of Precambrian normal faults as reverse or strike-slip faults in the "modern" tectonic setting.

The applicant described regional gravity and magnetic data in relation to the VEGP site region in Section 2.5.1.1.5 of the SSAR. Regional maps of North American gravity and magnetic fields were published by the Geological Society of America in 1987 as part of the Decade of North American Geology project. These maps are at a scale that allows identification and assessment of gravity and magnetic anomalies with wavelengths of about 10 km (6 mi) or greater. The applicant concluded there are no unexplained anomalies in the gravity data for the VEGP site region, and no data or gravity modeling results show evidence of Cenozoic tectonic activity or specific structures of Cenozoic age in the site region.

The applicant discussed regional magnetic signatures for the VEGP site region in Section 2.5.1.1.5.2 of the SSAR. The applicant concluded that (1) magnetic data do not have sufficient resolution to identify discrete faults such as the Pen Branch Fault; (2) there are no unexplained anomalies in the magnetic data for the VEGP site region; and (3) no data show evidence for Cenozoic structures in the VEGP site region.

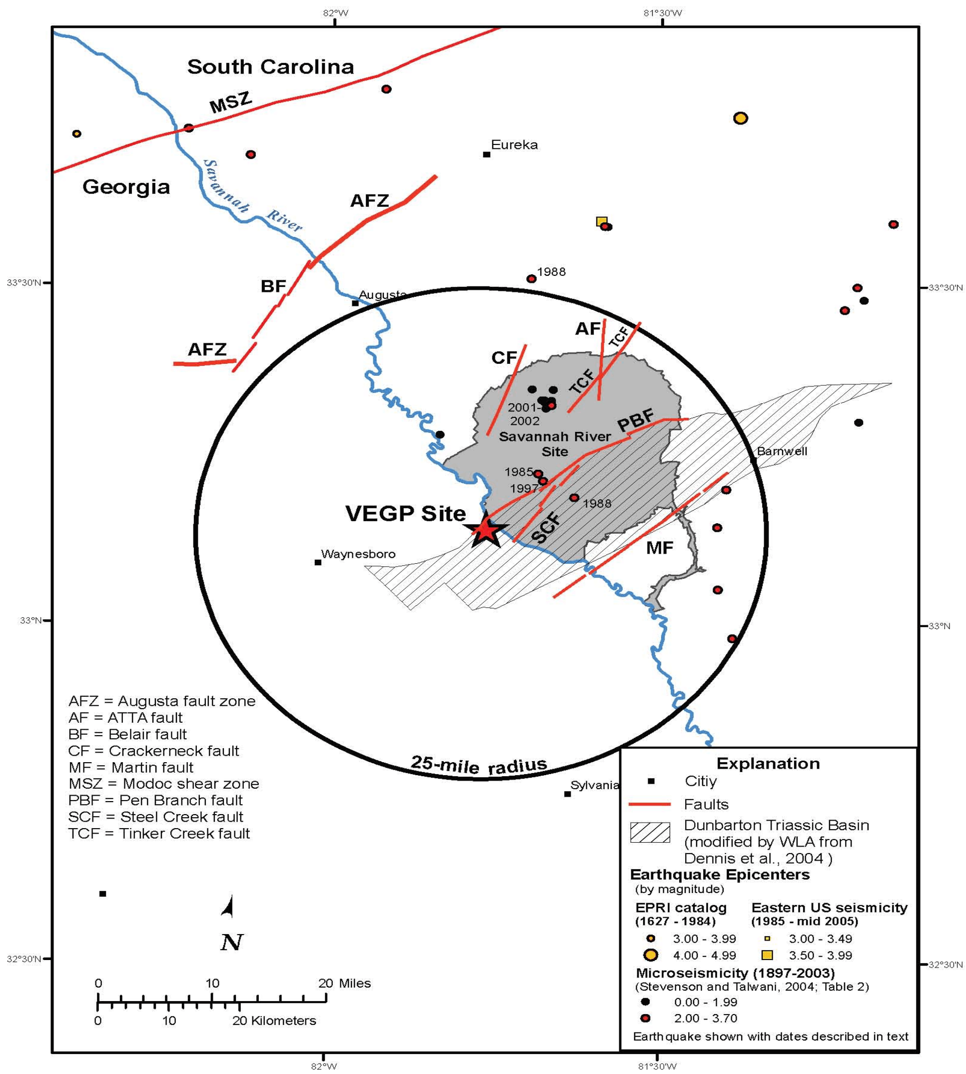


Figure 2.5.1-2 - Site Vicinity Tectonic Features and Seismicity (Reproduced from SSAR Figure 2.5.1-16)

Table 2.5.1-1 - Definitions of Classes Used in the Compilation of Quaternary Faults, Liquefaction Features, and Deformation in the Central and Eastern United States (Reproduced from SSAR Table 2.5.1-1 after Crone and Wheeler, 2000)

Class Category	Definition
Class A	Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed for mapping or inferred from liquefaction to other deformational features.
Class B	Class B Geologic evidence demonstrates the existence of a fault or suggests Quaternary deformation, but either (1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A.
Class C	Class C Geologic evidence is insufficient to demonstrate (1) the existence of tectonic fault, or (2) Quaternary slip or deformation associated with the feature.
Class D	Class D Geologic evidence demonstrates that the feature is not a tectonic fault or feature. This category includes features such as demonstrated joints or joint zones, landslides, erosional or fluvial scarps, or landforms resembling fault scarps, but of demonstrable non-tectonic origin.

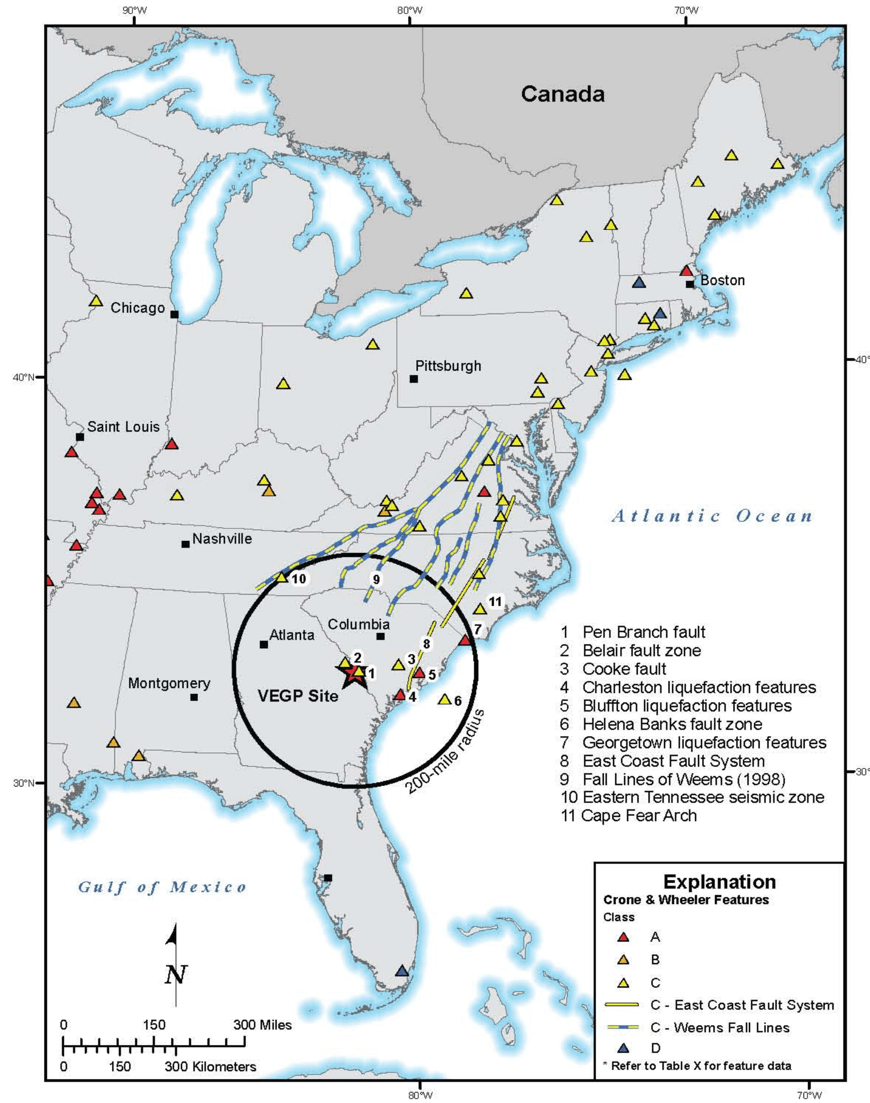


Figure 2.5.1-3 - Potential Quaternary Features Map (Reproduced from SSAR Figure 2.5.1-17)

Savannah River Site Tectonic Features

In SSAR Section 2.5.1.1.4.5, the applicant discussed faults that are interpreted to occur at the SRS on the eastern side of the Savannah River directly across from the VEGP ESP site. Locations of most of these faults are indicated on Figure 2.5.1-2. Most SRS faults are defined in the subsurface by interpretation of seismic reflection profiles, although information from seismic refraction studies and borehole studies is also used. The applicant stated that considerable uncertainty exists in regard to orientation and continuity of some of these faults. The applicant made no conclusion as to the capability of any of the SRS faults except for the Millet fault, which the applicant concluded showed no evidence of being a capable tectonic structure younger than the middle Eocene (40 mya). Four of the SRS faults occur within the VEGP site area: (1) Pen Branch, (2) Steel Creek, (3) Ellenton, and (4) Upper Three Runs faults.

1. The applicant described the northeast-trending Pen Branch fault as extending southwest off the SRS and across the Savannah River to the VEGP site location (Figure 2.5.1-2 from SSAR Figure 2.5.1–16). Since the Pen Branch is interpreted to extend beneath the VEGP site, the applicant discussed this feature in detail in SSAR Section 2.5.1.2.4.

2. The applicant described the northeast-trending Steel Creek fault, shown in Figure 2.5.1-2, as extending southwest into the VEGP site area to a point off the SRS on the west side of the Savannah River. This fault is located about 4 km (2.5 mi) east-southeast of the VEGP site location. Stieve and Stephenson (1995) considered the age of latest movement on this fault to be unresolved, but indicated that Cretaceous (144 to 65 mya) units are cut by the fault.

3. The applicant stated that the Ellenton fault strikes north-northwest, is near vertical, and extends into the VEGP site area with a location about 8 km (5 mi) northwest of the site location. However, data quality for definition of this structure is defined as poor and some researchers do not show this fault trace on their map of SRS faults.

4. The applicant stated that research indicates the Upper Three Runs fault is restricted to crystalline basement rocks, and that seismic reflection revealed no evidence for this fault offsetting Coastal Plain sediments. There is some indication that this fault extends southwest from the SRS, across the Savannah River, into the VEGP site area, and is located about 5 mi north of the site location. However, other investigators do not show this fault trace on their map of SRS faults.

Additional faults have been proposed outside the VEGP site area: (1) ATTA, (2) Crackerneck, (3) Martin, (4) Tinker Creek, (5) Lost Lake, and (6) Millet faults.

1. As described by the applicant, the ATTA fault is near vertical, strikes north-northeast, and is located about 25 km (16 mi) northeast of the VEGP site location, as shown in Figure 2.5.1-2. Research indicated a vertical separation of basement rocks by this fault of 25 m (82 ft) based on seismic reflection data, and also that penetration of the ATTA fault above basement is uncertain due to a lack of good seismic reflectors.

2. The applicant described the Crackerneck fault, which is located about 16 km (10 mi) north of the VEGP site location. Shown in Figure 2.5.1-2, this fault strikes northeast and dips steeply southeast. Research indicates that the fault exhibits a maximum vertical separation of basement rocks of about 30 m (98 ft) based on seismic reflection data, with offset decreasing upward to about 7 m (23 ft) at the top of the Upper Eocene Dry Branch formation (approximately 38.8 mya). The Middle Eocene Blue Bluff Marl (about 40 mya in age), the proposed foundation bearing unit for VEGP Units 3 and 4, underlies the Dry Branch.

3. The applicant described the Martin fault, which is located about 14.5 km (9 mi) south-southeast of the VEGP site location (based on aeromagnetic data). Shown in Figure 2.5.1-2, this fault strikes northeast with an undefined dip. Researchers estimated a vertical separation of the basement surface of about 18.5 to 31 m (60 to 100 ft) based on data from two boreholes.

4. The applicant described the Tinker Creek fault, which is located about 19 km (12 mi) north-northeast of the VEGP site location. Shown in Figure 2.5.1-2, this is interpreted to strike northeast and dips southeast. Seismic reflection data suggest a vertical separation of basement rocks by the Tinker Creek fault of 24 m (79 ft) at its northeastern extent, but the southeastern extent of the fault remains unresolved.

5. Cumbest et al (1998) defined the trace of the Lost Lake Fault based on its apparent control of groundwater flow pathways, locating it about 19 km (12 mi) north of the VEGP site location. The applicant reported that seismic and borehole data to constrain location, geometry, sense of slip, and age of latest movement are lacking.

6. The Millet fault is located about 14.5 km (9 mi) south-southeast of the VEGP site location. A study of this proposed fault by Bechtel (1982) was reviewed by the NRC staff, who concluded that there is no evidence for a capable tectonic structure as young as the Middle Eocene (40 mya) Blue Bluff Marl, which was characterized as tectonically undeformed.

Charleston Tectonic Features

In SSAR Section 2.5.1.1.4.4, the applicant discussed Charleston tectonic features, including potential source faults, area seismic zones, and area seismically-induced liquefaction features. These features, some defined since the EPRI (1986) seismic source models were developed, have been identified in or near the meizoseismal area (area of maximum damage) of the August 1886 Charleston earthquake and occur about 136 km (85 mi) east-southeast of the VEGP site.

The 1886 Charleston earthquake is recognized as one of the largest historical earthquakes to occur in the eastern United States. It produced a Modified Mercalli Intensity (MMI) X in the epicentral area near Charleston, and was felt as far away as Chicago, IL. Bakun and Hopper (2004) estimated a maximum magnitude for the 1886 Charleston earthquake ranging between M 6.4 to 7.1, a value similar to the upper-bound maximum magnitude used by EPRI (1986) for its source model. Due to a lack of observable surface deformation, the source of this earthquake has been inferred based on geology, paleoseismic features, and instrumented seismicity. The applicant recognized that, although the 1886 event was almost certainly related to a capable tectonic source, the earthquake has not been tied to any specific tectonic structure. The applicant concluded, in light of new information about source geometry and earthquake recurrence rate, that the EPRI (1986) source models for the 1886 Charleston earthquake warranted an update. The applicant presented the updated seismic source parameters in SSAR Section 2.5.2.2.2.4.

The applicant discussed the following potential causative faults for the 1886 Charleston earthquake event: (1) East Coast Fault System (ECFS), (2) Adams Run fault, (3) Ashley River fault, (4) Charleston fault, (5) Cooke fault, (6) Helena Banks fault zone, (7) Sawmill Branch fault, (8) Summerville fault, and (9) Woodstock fault. Figure 2.5.1-4, taken from SSAR Figure 2.5.1-19, shows these faults.

1. The applicant described the inferred ECFS, the southern section of which is marked by an alignment of river bends and consequently referred to as the “zone of river anomalies” (ZRA), as a northeast-trending fault system extending a total distance of about 600 km (373 mi) from Charleston, SC to southeastern Virginia. Researchers identified geomorphic anomalies (the ZRA) located along (and northwest of) the Woodstock fault and consequently defined the southern segment of the ECFS to extend the strike trend of the Woodstock fault. Data suggests that the fault system may have been active in the past 130,000 to 10,000 years and may remain active at the present time. It is further suggested that the ECFS may have been the source for the 1886 Charleston earthquake. Wheeler (2005) classified the ECFS as a Class C structure based on lack of demonstrable evidence for tectonic faulting or Quaternary slip or deformation associated with the feature.

2. The applicant described the Adams Run fault as being inferred from microseismicity and borehole data, but stated that the data were not consistent with the occurrence of fault displacement. The applicant further indicated no geomorphic evidence for the Adams Run fault and local microseismicity, as shown in Figure 2.5.1-5 from SSAR Figure 2.5.1-20, does not define a discrete structure.

3. The applicant described the Ashley River fault as being defined by a northwest-trending zone of seismicity in the meizoseismal area of the 1886 Charleston earthquake. This fault is interpreted to be a southwest-side-up reverse fault that offsets the northeast-trending Woodstock fault.

4. The applicant described the Charleston fault, also shown in Figure 2.5.1-5, as being defined by data from geologic maps and boreholes. This fault is interpreted as a major high-angle reverse fault which has been active in the Holocene (past 10,000 years). The applicant indicated that this fault has no clear geomorphic expression, nor is it clearly defined by the pattern of microseismicity in the vicinity of the fault.

5. The applicant described the Cooke fault, shown in Figure 2.5.1-5, as being defined by seismic reflection profiles in the meizoseismal area of the 1886 Charleston earthquake and interpreted as either an east-northeast-striking, northwest-dipping structure, or part of the ECFS. Crone and Wheeler (2000) classified the Cooke fault as a Class C feature based on lack of evidence for faulting younger than Eocene (54.8 to 33.7 mya).

6. The Helena Banks fault zone, located about 15 to 30 km (10 to 20 mi) off the coast of South Carolina, is clearly shown in seismic reflection lines. The applicant documented that Crone and Wheeler (2000) described this fault zone as a potential Quaternary tectonic feature, but classified it as a Class C feature since there is insufficient evidence to demonstrate Quaternary activity in the zone. The applicant stated that data suggest that the fault zone could, at a "low probability", be considered a potentially active fault. The applicant also stated that, if the Helena Banks fault zone is active, it could possibly explain distribution of paleoliquefaction features along the South Carolina coast.

7. The applicant described the Sawmill Branch fault, shown in Figure 2.5.1-5, as a northwest-trending structure defined by microseismicity and interpreted to be an extension of the Ashley River fault that offsets the Woodstock fault in a left-lateral sense. The applicant stated that microseismicity in the vicinity of the proposed Sawmill Branch fault does not clearly define a structure distinct from the Ashley River fault (the Ashley River fault was also defined based on seismicity).

8. The applicant described the Summerville fault, shown in Figure 2.5.1-5, which was initially defined by Weems et al. (1997) based on microseismicity. However, the applicant concluded that there is no geomorphic expression, borehole evidence, or microseismicity related to a discrete structure to indicate the existence of the Summerville fault.

9. The applicant described the Woodstock fault, shown in Figure 2.5.1-5, as a postulated north-northeast-trending, dextral strike-slip fault in the meizoseismal area of the 1886 Charleston earthquake defined by a linear zone of seismicity. Researchers subdivided this fault into two segments offset in a left-lateral sense across the Ashley River fault, and later included it as a part of the proposed ZRA in the southern portion of the ECFS.

<u>Charleston Area Seismic Zones</u>

The applicant discussed three zones of increased seismicity identified in the greater Charleston area, including the (1) Middleton Place-Summerville, (2) Bowman, and (3) Adams Run seismic zones. These three zones are shown in Figure 2.5.1-4. Details of the seismicity data catalog are discussed in SSAR Section 2.5.2.1.

1. The applicant described the Middleton Place-Summerville Seismic Zone as an area of elevated microseismicity located about 19 km (12 mi) northwest of Charleston. Between 1980 and 1991, 58 events with magnitudes ranging from body wave magnitude (mb) 0.8 to 3.3 and hypocentral depths ranging from 2 to 11 km (1 to 7 mi) were recorded in this zone, which lies inside the meizoseismal area of the 1886 Charleston earthquake. The elevated microseismicity in the Middleton Place-Summerville seismic zone has been attributed to stress concentrations associated with intersection of the Ashley River and Woodstock faults, and there is speculation that the 1886 Charleston earthquake had its source in this zone. Persistent foreshock activity was reported prior to the 1886 Charleston earthquake in the Middleton-Summerville seismic zone.

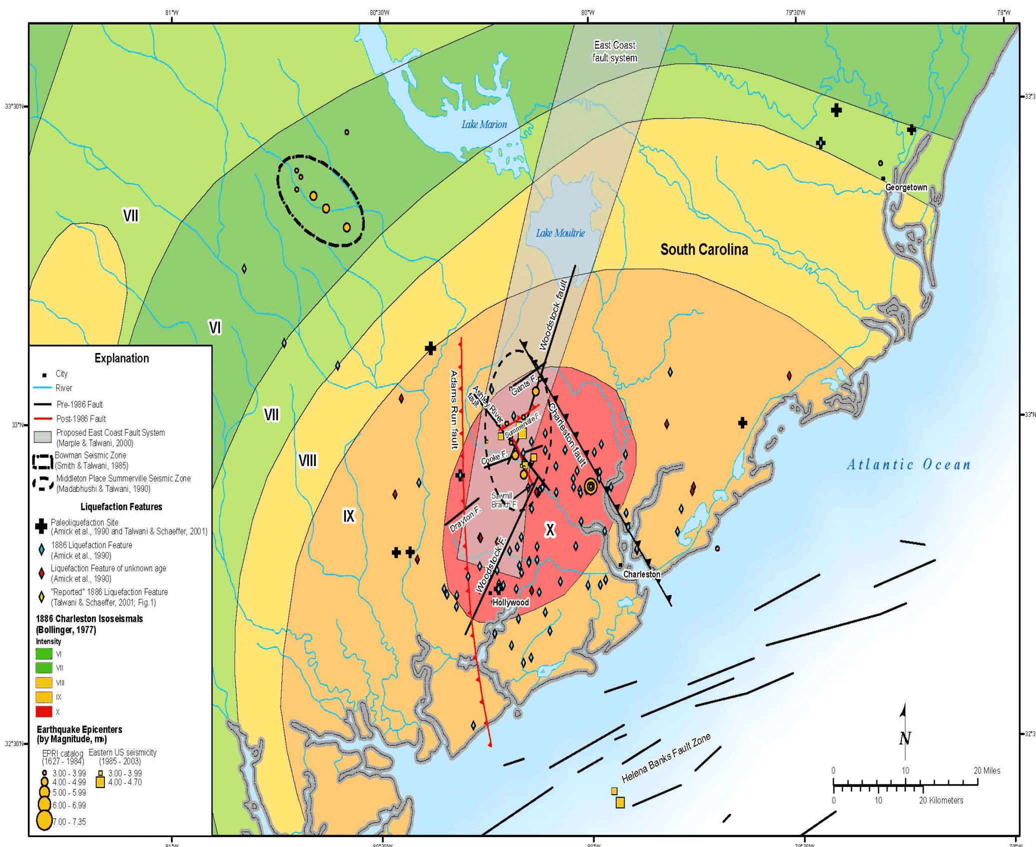


Figure 2.5.1-4 - Local Charleston Tectonic Features (Reproduced from SSAR Figure 2.5.1-19)

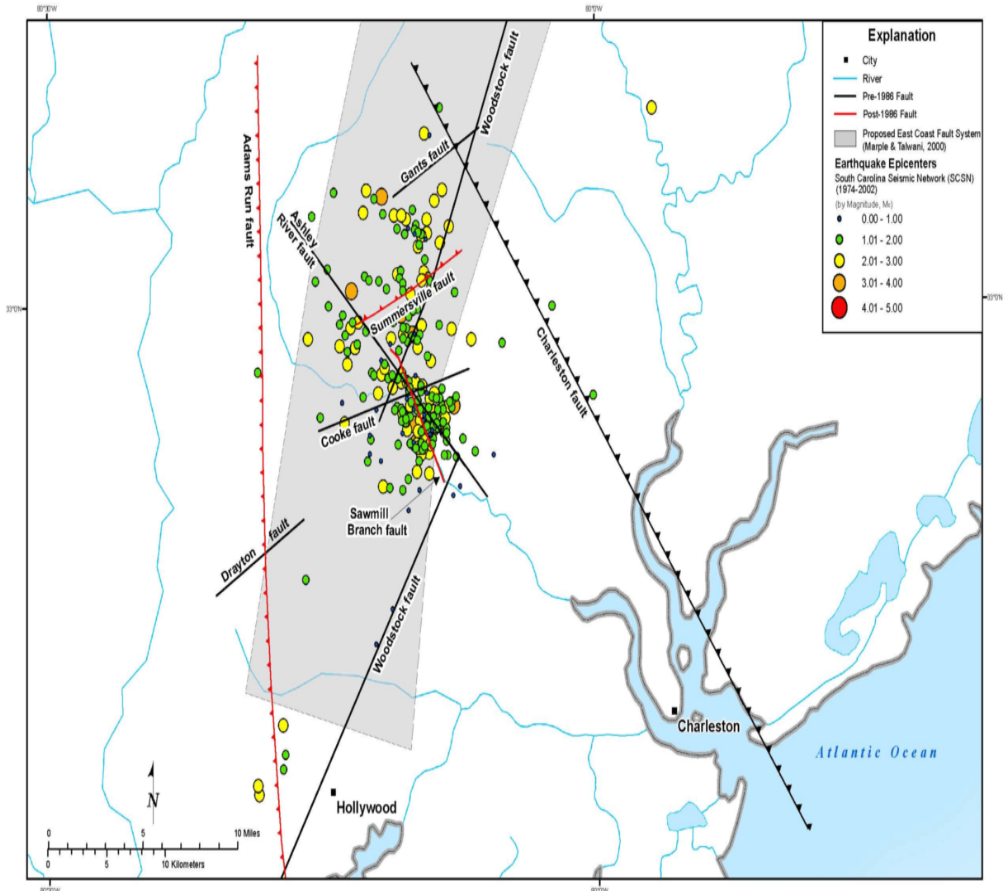


Figure 2.5.1-5 - Local Charleston Seismicity (Reproduced from SSAR Figure 2.5.1-20)

2. The applicant documented that the Bowman seismic zone lies outside the meizoseismal area of the 1886 Charleston earthquake. It is located about 80 km (50 mi) northwest of Charleston and 96 km (60 mi) east-northeast of the VEGP site as shown in Figure 2.5.1-4. The zone was identified based on a series of earthquakes with magnitudes of M3-4 which occurred in that zone between 1971-1974.

3. The applicant described the Adams Run seismic zone, located within the meizoseismal area of the 1886 Charleston earthquake as being defined by four earthquakes with magnitudes less than M2.5. Three of these four earthquakes occurred over a two day period in December 1977. This seismic zone occurs about 120 km (75 mi) east-southeast of the VEGP site and is not shown in Figure 2.5.1-4 as the text indicates.

Charleston Area Seismically-Induced Liquefaction Features

The applicant discussed Charleston area soil liquefaction in SSAR Section 2.5.1.1.4.4, which has proven to be the most broadly observable earthquake-induced phenomenon in the Charleston area. Liquefaction occurs when a mass of saturated, granular material temporarily loses its shear strength and its ability to act as a solid due to an increase in pore water pressures that exceeds overburden pressures. During an earthquake, waves are propagated upward through rock and soil, creating shear stresses that cause sediments with a high volume change capacity (saturated sediments) to compact. As pore water pressures increase, saturated materials are forced to flow in the direction of maximum principal compressive stress, typically upward through zones of weakness in dense overlying sediments. The presence of liquefaction features in the geologic record, and radiometric age dating of these features, aids in formulating an earthquake chronology with estimated magnitudes based on characteristics of the features and their geographic distribution. This extends the earthquake record back in time for defining longer-term earthquake occurrence rates.

The applicant presented data on liquefaction features observed in the South Carolina Coastal Plain and these features are shown in Figure 2.5.1-4. These liquefaction features were produced by the 1886 Charleston earthquake and earlier moderate to large earthquakes in the region. The presence of liquefaction features attributed to the 1886 Charleston earthquake and paleoliquefaction features related to earlier Quaternary earthquake events demonstrates repeated seismicity within the region and, hence, the presence of a capable tectonic source in the vicinity of Charleston. The applicant recognized that liquefaction features interpreted to have been produced by the 1886 Charleston earthquake are most heavily concentrated in the meizoseismal area for that earthquake as well as in some outlying areas. The applicant provided a description of potential Charleston earthquake sources in SSAR Section 2.5.1.1.4.4, but no definitive link has yet been made between a particular fault and the 1886 Charleston event, or any previous earthquake event. The applicant presented refinements of earthquake recurrence estimates for the Charleston area in detail in SSAR Section 2.5.2.2.2.4.

Paleoliquefaction features attributed to pre-1886 earthquakes are abundant along the South Carolina coast. These features were evaluated to estimate earthquake recurrence rates in the Charleston area. Talwani and Schaeffer (2001) proposed two earthquake scenarios: Scenario 1 assumes that some events in the paleoearthquake record were smaller in magnitude (estimated M6+) than events to the northeast of Charleston, while Scenario 2 allows all earthquakes in the record to be large events (estimated M7+) located near Charleston. Based on these two scenarios, Talwani and Schaeffer (2001) estimated recurrence intervals of about 550 years (Scenario 1) and 900-1000 years (Scenario 2).

Seismic Sources Defined by Regional Seismicity

In SSAR Section 2.5.1.1.4.6, the applicant discussed the ETSZ and three other seismogenic and capable tectonic source zones located outside the 320 km (200 mi) radius of the site region (Central Virginia, New Madrid, and Giles County seismic zones (GCSZ)). These seismic zones are shown in SER Figure 2.5.1-6 taken from SSAR Figure 2.5.1-15.

The ETSZ is a northeast-trending area of concentrated seismicity, characteristically generated by small-to-moderate earthquakes, which is located in the Valley and Ridge Physiographic province of eastern Tennessee. The applicant recognized that, although most seismic events in ETSZ have occurred more than 320 km (200 mi) from the VEGP site location and consequently outside the site region, diffuse seismicity on the southeastern margin of the zone is located just within the boundary of the site region. This zone, approximately 300 km (185 mi) long and 50 km (30 mi) wide, has produced no damaging earthquake in historical time. The zone exhibits no geologic evidence of prehistoric earthquakes larger than any historical event that has occurred within the zone. However, the ETSZ has been classified by some as the second most active seismic area in the United States east of the Rocky Mountains (after the New Madrid Seismic Zone (NMSZ)). Others have determined that this zone produced the second highest release of seismic strain energy in the CEUS during the 1980s.

Earthquakes in the ETSZ occur at depths of 5 to 26 km (3 to 16 mi) in Precambrian crystalline basement rocks that underlie exposed thrust sheets made up of Paleozoic rock units, suggesting that seismogenic structures in the zone are not related to surface geologic features of the Appalachian orogen. None of the earthquakes exceeded a moment magnitude of M4.6. Earthquakes within the ETSZ cannot be attributed to known faults and the applicant reported that no capable tectonic sources have been identified within the zone, although seismicity appears to be spatially associated with the prominent magnetic field gradient defined by the NYAL. Most seismicity in the ETSZ lies between the NYAL on the west and the Clingman and Ocoee lineaments on the east, in a “block” labeled as the Ocoee block. The applicant concluded that no new information has been developed since 1986 for the ETSZ to require a significant revision to the EPRI (1986) source model, but provided additional discussion of the ETSZ in relation to potential seismic hazard for the VEGP site location in SSAR Section 2.5.2.2.2.5.

The applicant recognized the potential for distant large earthquakes in the CEUS to contribute to the long-period ground motion hazard at the VEGP site, and consequently discussed the following three additional seismic source zones–(1) Central Virginia, (2) New Madrid, and (3) Giles County–located more than 320 km (200 mi) from the site location.

1. The Central Virginia Seismic Zone (CVSZ), shown in Figure 2.5.1-6, is an area of low-level seismicity located more than 560 km (350 mi) north-northeast of the VEGP site location, extending about 120 km (75 mi) north-south and 144 km (90 mi) east-west between Richmond and Lynchburg, VA. The largest historical earthquake to occur in the CVSZ (December 1875) had a body-wave magnitude of 5.0 and a maximum intensity of VII in its epicentral region. Wheeler and Johnston (1992) indicated that seismicity in the CVSZ ranges in depth from about 4 to 13 km (2 to 8 mi), suggesting that the events extend both above and below the Appalachian detachment zone (discussed in SSAR Section 2.5.1.1.4.1). Two paleoliquefaction sites reflecting prehistoric seismicity have been found within the CVSZ, but no capable tectonic sources have been identified. The applicant concluded that no new information has been developed since 1986 for the CVSZ to require a significant revision to the EPRI (1986) source model.

2. The NMSZ is an area defined by post-Eocene (younger than 33.7 mya) to Quaternary (1.8 mya to the present) faulting located more than 640 km (400 mi) west of the VEGP site location, extending from eastern Missouri to southwestern Tennessee (Figure 2.5.1-6 from SSAR Figure 2.5.1-15). The zone, approximately 220 km (125 mi) long and 40 km (25 mi) wide, is interpreted to be made up of three fault segments: a southern northeast-trending strike-slip fault, a middle northwest-trending reverse fault, and a northern northeast-trending strike-slip fault. Three large-magnitude historical earthquakes occurred in this zone between December 1811 and February 1812 with magnitudes ranging from M7.1 to M7.5. Since the EPRI (1986) study, estimates of maximum magnitude have generally been in the range of those used in the 1986 EPRI models. However, recent summaries of paleoseismic data suggest a mean recurrence time of 500 years, an order of magnitude less than seismicity-based recurrence estimates used in EPRI (1986).

   The applicant concluded that this estimate of recurrence time represents a significant update of source parameters for the NMSZ used by EPRI (1986).

3. The GCSZ is located in Giles County, VA, more than 250 mi from the VEGP site location, as shown in Figure 2.5.1-6. Bollinger and Wheeler (1988) reported that earthquakes in this zone occur in Precambrian crystalline basement beneath the overlying Appalachian thrust sheets at depths from 5 to 25 km (3 to 16 mi). The data on depth of earthquakes in the GCSZ imply that seismogenic structures in the zone are unrelated to surface geology of the Appalachian orogen. Shallow Late Pliocene to Early Quaternary faults near Pembroke, VA, which lie within the area defined as the GCSZ, are classified as Class B features because it is not determined if they are of tectonic origin or related to solution collapse. The applicant concluded that no new information has been developed since 1986 for the GCSZ to require a significant revision to the EPRI (1986) source model.

2.5.1.1.3 Site Area Geologic Description

Sub-sections 2.5.1.2.1 to 2.5.1.2.3 of SSAR Section 2.5.1.2 describe the geology of the site area, including physiography and geomorphology, geologic history, and stratigraphy). The applicant concluded that the physiography, geomorphology, geologic history, and stratigraphy of the site area pose no safety concerns for the ESP site. The applicant presented the following information related to site area geology.

Physiography, Geomorphology and Geologic History

In SSAR Section 2.5.1.2.1, the applicant described physiography and geomorphology of the ESP site area. The site area lies within the Upper Coastal Plain, about 48 km (30 mi) southeast of the fall line that separates the Piedmont and Coastal Plain physiographic provinces, as shown in Figure 2.5.1-1. The Savannah River, located on the east side of the ESP site, is the primary drainage system in the site area and acts as the state line boundary between Georgia and South Carolina. The Savannah River is incised into surrounding topography to form steep bluffs and a topographic relief of nearly 45 m (150 ft) from river level to the VEGP site. The surface topography, characterized by gently rolling hills, ranges from about 60 to 90 m (200 to 300 ft) above mean sea level (msl) across the site area.

The applicant reported that two types of surface depressions occur in the Coastal Plain that are both non-tectonic in origin. The first type of surface depression is referred to as "Carolina Bays", and results from eolian, surficial processes. The second type of non-tectonic surface depression most likely results from the dissolution of calcareous stratigraphic units at depth. The applicant stated that these surface depressions in the site area were noted and extensively studied during the initial site investigations for VEGP Units 1 and 2.

The applicant described the geologic history of the ESP site area in SSAR Section 2.5.1.2.2. The Upper Coastal Plain is a relatively flat-lying section of unconsolidated marine and fluvial sediments overlying a basement complex of Paleozoic (greater than 248 mya) metamorphic and igneous rocks, and Triassic (248 to 206 mya) basin sedimentary rocks. Paleozoic and Triassic rocks were beveled by erosion prior to deposition of Coastal Plain sediments. The applicant reported that this erosional surface dips southeast beneath the sediments at approximately 9.5 m/km (50 ft/mi). The Coastal Plain section consists of stratified sands, clays, limestone, and gravel deposits that dip gently seaward, with the oldest sediments in the site area being Upper Cretaceous (greater than 65 mya) units and the youngest sediments being Quaternary (1.8 mya to Present) alluvium in stream and river valleys.

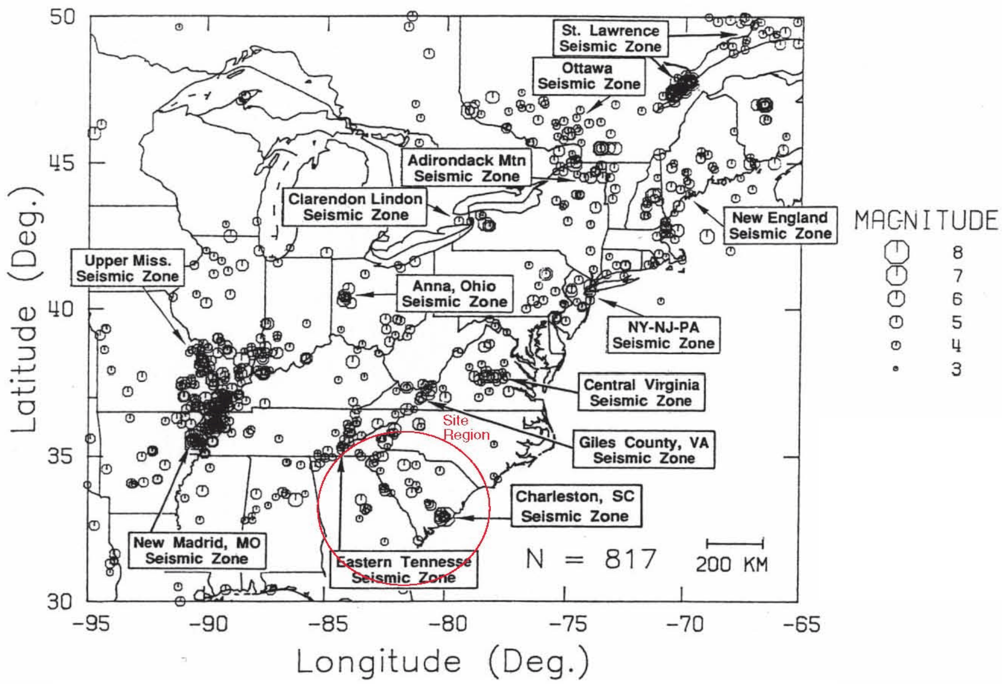


Figure 2.5.1-6 - Seismic Source Zones and Seismicity in the Central and Eastern U.S (Reproduced from SSAR Figure 2.5.1-15)

Stratigraphy

The applicant described the stratigraphy of the ESP site area in SSAR Section 2.5.1.2.3, including basement rock and coastal plain stratigraphy within the site area. The applicant based the stratigraphic descriptions on information from regional geologic maps, site area studies performed for VEGP, borehole data, and surface geophysical surveys. Figure 2.5.1-7, reproduced from SSAR Figure 2.5.1-38, shows a detailed, site-specific stratigraphic column, including sedimentary and depth-to-basement data, based on borehole B-1003, drilled within the VEGP site area.

The applicant described basement rock in the site area in SSAR Section 2.5.1.2.3.1. Basement lithologies consist of Paleozoic (543 to 248 mya) crystalline rock underlying Coastal Plain sediments in the northwestern portion of the site area, and sedimentary rock of the Dunbarton Triassic Basin beneath Coastal Plain sediments in the southeastern part. Based on logs from borehole B-1003 and inferences from seismic reflection and refraction surveys performed as part of the ESP investigation program, the applicant indicated that Triassic basement at the site occurs at a depth of 318 m (1,049 feet), or 250 m (826 ft) below mean sea level. The applicant stated that rocks of the Dunbarton Basin consist of mudstones, sandstones, and conglomerates with varying degrees of lithification based on borehole B-1003.

The applicant described site area Coastal Plain stratigraphy in SSAR Section 2.5.1.2.3.2, including the Cretaceous (144 to 65 mya), Tertiary (65 to 2 mya), and Quaternary (1.8 mya to present) stratigraphy. Weakly consolidated to unconsolidated Coastal Plain sediments that dip and thicken to the southeast unconformably (i.e., not succeeding the underlying rocks in immediate order of age and not fitting together with them as part of a continuous sequence) overlie Paleozoic (543 to 248 mya) and Triassic (248 to 206 mya) basement rocks in the site area. These units range in age from Upper Cretaceous (100 to 65 mya) to Miocene (23.8 to 5.3 mya) and are about 318 m (1,049 ft) thick in the site area.

The upper Cretaceous (100 to 65 mya) stratigraphic units logged in borehole B-1003, which unconformably overlie basement rocks, include the Cape Fear, Pio Nono, Upper Gaillard/Black Creek, and Steel Creek Formations. The applicant stated that these Upper Cretaceous units are primarily a mix of stratified sands, silts, clays, and gravels deposited in a fluvial deltaic environment.

AGE				UNIT	DEPTH (FT)	ELEVATION (FT MSL)
Cenozoic	TerTiary	Eocene	Upper	Barnwell Group	Ground surface	+223
				• Tobacco Road Sand		
				• Dry Branch Formation		
				• Clinchfield Formation		
				o Utley Limestone Member	48	+175
			Middle	Claiborne Group		
				• Lisbon Formation	86	+137
				o Blue Bluff Member / McBean Member		
				• Still Branch Sand	149	+74
				• Congaree Formation	216	+7
			Lower			
		Paleocene	Upper	• Snapp Formation	331	-108
				• Black Mingo Formation	438	-215
			Lower			
Mesozoic	Cretaceous	Upper		• Steel Creek Formation	477	-254
				• Gaillard Formation/ Black Creek Formation	587	-364
				• Pio Nono Formation / Unnamed Sand	798	-575
				• Cape Fear Formation	858	-635
	Triassic			Triassic (Dunbarton) basin	1049	-826
					Boring terminated at 1338	

Figure 2.5.1-7 - Site Stratigraphic Column Based on Boring B-1003 (Reproduced from SSAR Figure 2.5.1-38)

Tertiary (65 to 2 mya) sediments ranging in age from Paleocene (65 to 54.8 mya) to Miocene (23.8-5.3 mya), unconformably overlie the Upper Cretaceous (100 to 65 mya) section in the site area and include the following formations: Black Mingo, Snapp, Congaree, Still Branch Sand, Lisbon, Clinchfield, Dry Branch, Tobacco Road, and Hawthorne of the Barnwell Group, and the Pinehurst. The applicant stated that the Tobacco Road and Hawthorne Formations of the Barnwell Group and the Pinehurst Formation were not identified in any site borings but do occur in the site area. The applicant indicated that fluvial deposits at the base of the Tertiary give way to marginal marine, shallow shelf, mixed inner-tidal deposits, and to high-energy fluvial deposits.

The applicant reported that the Tertiary age (65 to 2 mya) Lisbon Formation includes the extensively mapped, shallow-shelf Blue Bluff Marl, which is the foundation-bearing stratigraphic unit for VEGP Units 1 and 2. This unit is the dominant facies in the VEGP site area and contains shell fragments suspended in a fine-grained micrite (carbonate-rich mud) matrix with occasional shell-rich zones and a carbonate unit referred to as the McBean Limestone.

The applicant reported that Quaternary age (1.8 mya to present) sediments occur as alluvium in stream and river valleys, forming terraces above the modern (Holocene age) flood plain of the Savannah River in the ESP site area. The applicant stated that these terraces are Pleistocene in age.

2.5.1.1.4 Site Area Structural Geology

In SSAR Section 2.5.1.2.4, the applicant reviewed published information to identify four faults and one monoclinal fold within a 5-mile radius of the VEGP ESP site. The four identified faults, each of which originates in basement rock underlying the Coastal Plain sediments, include the Pen Branch, Ellenton, Steel Creek and Upper Three Runs faults. The applicant interpreted the Upper Three Runs and Steel Creek faults as being incapable structures based on the fact that they are restricted to basement rock units and show no evidence that they have offset overlying Coastal Plain sediments. The Ellenton fault is no longer projected on updated fault maps and is considered by the applicant to be an incapable tectonic structure, if it does exist. The Pen Branch fault was examined in detail by the applicant and is discussed in detail below. The northeast-southwest trending monoclinal fold, located in the Blue Bluff Marl, was interpreted by the applicant to be spatially associated with the Pen Branch fault and potentially indicative of reverse fault movement on the Pen Branch.

In addition to reviewing published data, the applicant presented new information from seismic reflection and refraction surveys as well as from an evaluation of Quaternary age fluvial terraces overlying the Pen Branch Fault. The applicant collected this information for the ESP application specifically to determine whether the Pen Branch Fault is a capable tectonic feature. The applicant concluded that the structural geology of the site area poses no safety issues for the ESP site and that the Pen Branch Fault exhibits no Quaternary displacement and does not require further analysis for seismic hazard or surface faulting at the site.

Faults, Folds, Lineaments, Deformation Zones

The Pen Branch fault was first discovered in the subsurface of the SRS. Based on borehole and seismic reflection data, it is interpreted to exceed 40 km (25 mi) in length; to comprise several subparallel, northeast striking, southeast dipping segments; and to project southwestward beneath the VEGP ESP site. Although the Pen Branch fault is interpreted to be a non-capable structure from previous investigations by Bechtel (1989), Snipes et al. (1989), Geomatrix (1993), and Cumbest et al. (1998), the applicant conducted a detailed investigation of the fault based on its proximity to the VEGP site, and presented the findings from that investigation in SSAR Section 2.5.1.2.4.1.

The applicant conducted a review of previous investigations of the Pen Branch fault as a basis for conducting its own investigation. The applicant collected and processed seismic reflection and refraction data at the VEGP site to better characterize the fault parameters. Finally, the applicant undertook a focused geomorphic study to survey and interpret remnants of a Quaternary (1.8 mya to present) river terrace (the Ellenton Terrace), including mapping, collection of elevation data, and construction of a longitudinal profile of the terrace.

The applicant reviewed 17 years of previous investigations of the Pen Branch fault and provided a brief historical interpretation in SSAR Section 2.5.1.2.4.1. The Pen Branch fault is interpreted to be the western boundary fault of the Dunbarton Triassic Basin that juxtaposes Paleozoic (543 to 248 mya) crystalline rock against Triassic (248 to 206 mya) sedimentary rock. Seismic reflection data identifies a maximum vertical separation of the contact between basement rocks and Coastal plain sediments of about 28 m (92 ft), with offset decreasing upward into the Coastal Plain stratigraphic section. There is no evidence for post-Eocene (54.8 to 33.7 mya) displacement in previous subsurface investigations of the Pen Branch fault, which prompted Crone and Wheeler (2000) to assign the Pen Branch fault as a Class C feature.

In January and February 2006, the applicant collected seismic reflection and refraction data along four lines designed to image the Pen Branch fault and assess depth and character of basement rocks beneath the Coastal Plain sediments in the VEGP site area. Based on results of this survey, included in SSAR Section 2.5.1.2.4.2, the applicant concluded that the Pen Branch fault does indeed strike northeast, dips southeast, and lies beneath the site. Just as reported for the Pen Branch fault at the SRS, the strike of the fault beneath the VEGP is somewhat variable. Seismic sections indicate that the fault strikes about N34°E beneath the VEGP (southwest of the Savannah River), changing to about N45°E, then continuing southwest along the strike, and dipping 45°SE. Figure 2.5.1-8, reproduced from SSAR Figure 2.5.1-34, illustrates this interpreted change in strike from the SRS and across the VEGP site. The applicant also interpreted that, based on the new data, there is evidence that the Pen Branch fault intersects a monoclinal fold occurring in the Middle Eocene (54.8 to 33.7) Blue Bluff Marl. The Blue Bluff unit shows reverse fault displacement due to movement on the Pen Branch fault. Therefore the applicant concluded that Eocene age slip occurred on the Pen Branch fault.

In SSAR Section 2.5.1.2.4.3, the applicant described an evaluation of the Ellenton Terrace (Qte), a Quaternary age Savannah River terrace, located about 6 km (4 mi) east-northeast of the VEGP site, which overlies the Pen Branch Fault on the SRS and is estimated to be between 350 thousand and 1 mya old. Savannah River fluvial terraces represent the only significant Quaternary deposits and surfaces that straddle the trace of the Pen Branch fault. The applicant conducted this evaluation of the Qte to improve the resolution of the terrace surface elevation and to independently assess the presence or absence of any Quaternary tectonic deformation associated with the Pen Branch fault. This investigation included a review of previously published literature, aerial photographic analysis and geomorphic mapping, and field reconnaissance. The applicant surveyed about 2600 new elevation data points on the terrace surface and constructed a longitudinal profile approximately normal to the local strike of the Pen Branch Fault and parallel to the long axis of the terrace.

The applicant stated that results of a longitudinal profile of the Ellenton terrace surface in the study area provide evidence of no discernable tectonic deformation that can be attributed to the underlying Pen Branch fault within the resolution of the terrace elevation data, estimated to be about 1 m (3 ft). Based on this lack of evidentiary deformation in the Ellenton Qte, the absence of any post-Eocene (older than 33.7 mya) fault displacements interpreted in the seismic reflection and refraction study, and results of previous studies related to the Pen Branch fault, the applicant concluded that the Pen Branch fault is not a capable tectonic structure and that this conclusion is further supported by the previous results in Bechtel (1989), Snipes et al. (1989), Geomatrix (1993), and Cumbest et al. (1998 and 2000).

2.5.1.1.5 Site Area Earthquakes and Seismicity

Historical and Instrumentally Recorded Seismicity

The applicant summarized seismicity data in the VEGP ESP site vicinity (within a 40-km (25-mi) radius of the site) in SSAR Sections 2.5.3.1.4 and 2.5.3.3. The EPRI catalog of historical seismicity demonstrates that no known earthquake greater than mb 3 occurred within the site vicinity prior to 1984, while the SRS seismic recording network documents no recent microseismic activity (mb less than 3) within an 8 km (5 mi) radius of the VEGP site since 1976. The applicant stated that the nearest microseismic event to the VEGP ESP site was located on the SRS, about 11 km (7 m) northeast of the VEGP site. Figure 2.5.1-2, taken from SSAR Figure 2.5.1-16, shows diffuse microseismic activity recorded by the SRS seismic recording network since 1976, within a 40 km (25 mi) radius of the VEGP site.

Correlation of Earthquakes with Tectonic Features

The applicant described three small earthquakes that occurred between 1985 and 1997 with magnitudes ranging between 2.0 and 2.6 and depths ranging from 2.5 to 6 km (1.5 to 3.5 mi). In addition to these events, the applicant described a magnitude 3.2 event located north of the SRS in Aiken, SC, and a series of several small events (magnitudes ≤ 2.6) that occurred in 2001-2002 within the SRS boundaries. The applicant reviewed the locations of these events with respect to mapped faults in the ESP site vicinity–as well as previous studies of these events by Stevenson and Talwani (2004), Talwani et al. (1985), and Crone and Wheeler (2000)–and concluded that there is no spatial correlation of seismicity with known or postulated faults or geomorphic features.

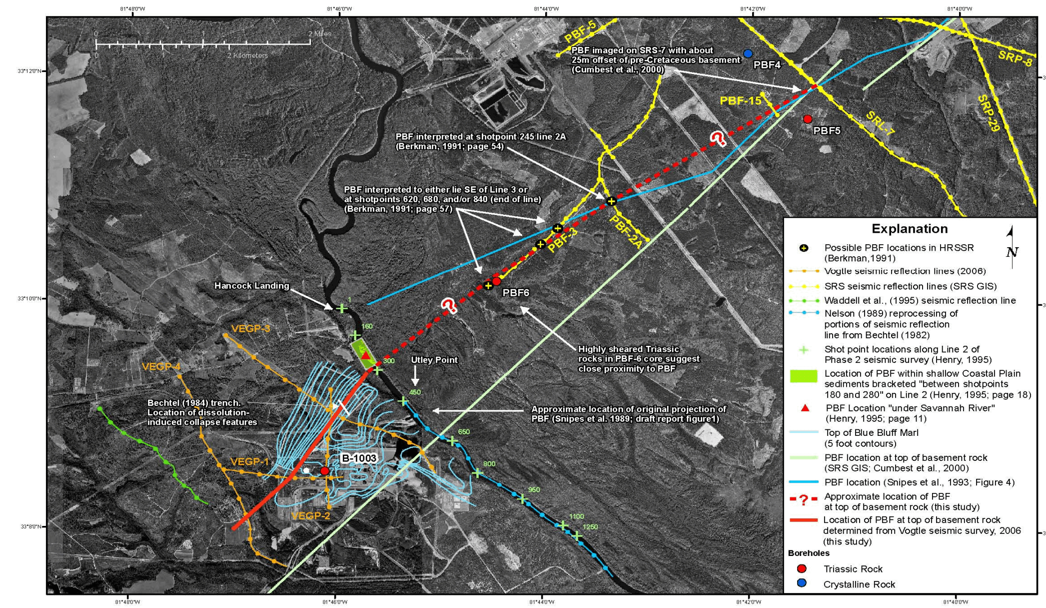


Figure 2.5.1-8 - Location of the Pen Branch Fault (Reproduced from SSAR Figure 2.5.1-34)

2.5.1.1.6 Site Area Non-Tectonic Deformation Features

In SSAR Section 2.5.3.8, the applicant addressed the potential for the following non-tectonic deformation features at the VEGP ESP site: (1) dissolution collapse features and (2) clastic dikes.

In SSAR Section 2.5.3.8.2, the applicant discussed the potential for non-tectonic surface deformation at the ESP site, including interpretation of dissolution collapse features and "clastic dikes". Regarding dissolution collapse features discussed in SSAR Section 2.5.3.8.2.1, the applicant indicated that small-scale structures (including warped bedding, fractures, joints, minor fault offsets, and injected sand dikes) identified in the walls of a trench at the VEGP site were local features related to dissolution of the Utley Limestone (Clinchfield Formation) and subsequent collapse of overlying Tertiary sediments. The age of these features was interpreted to be younger than Eocene-Miocene host sediments and older than the overlying late-Pleistocene Pinehurst Formation. The applicant stated that no late Pleistocene or Holocene dissolution features were identified at the site. The applicant indicated that mitigation of collapse due to dissolution of the Utley Limestone, which overlies the Blue Bluff Marl at the site, could be accomplished by planned excavation and removal of the Utley to establish the foundation grade of the plant atop the Blue Bluff Marl.

In SSAR Section 2.5.3.8.2.2, the applicant addressed clastic dikes, described as relatively planar, narrow (centimeters to decimeters in width), clay-filled features that flare upwards and are decimeters to meters in length. Bechtel (1984) distinguished two types of clastic dikes in the walls of the trench on the VEGP site where dissolution collapse features were found. The first type of clastic dikes was interpreted to be "sand dikes" that resulted from injection of poorly consolidated fine sand into overlying sediments. The second type was "clastic dikes" produced by weathering and soil-formation processes that were enhanced along fractures that formed during dissolution collapse. Bechtel (1984) concluded the dikes were primarily a weathering phenomena controlled by depth of weathering and paleosol development in Coastal Plain sediments and subsequent erosion of the land surface. Clastic dike features identified by Bartholomew et al. (2002) within the site area were observed during the ESP field reconnaissance. The applicant interpreted these features to be non-tectonic in origin, although Bartholomew et al. (2002) suggested they may be evidence for paleoearthquakes associated with late Eocene to late Miocene faulting, possibly along the Pen Branch Fault.

2.5.1.1.7 Human-Induced Effects on Site Area Geologic Conditions

SSAR Section 2.5.1.2.6.5 states that no mining operation, other than borrow of surficial soils, and no excessive extraction or injection of groundwater, or impoundment of water has taken place within the site area that would impact the geologic conditions at the VEGP site.

2.5.1.1.8 Site Area Engineering Geology Evaluation

The applicant described the engineering geology evaluation of the ESP site in SSAR Section 2.5.1.2.6, including engineering soil properties and behavior of foundation materials; zones of alteration, weathering, and structural weakness; deformational zones; prior earthquake effects; and effects of human activities. In SSAR Section 2.5.1.2.6.1 for engineering soil properties and behavior of foundation materials, the applicant indicated that engineering soil properties were discussed in SSAR Section 2.5.4 and acknowledged that variability of properties in the foundation-bearing layer will be evaluated and mapped as the excavation is completed. The applicant discussed zones of alteration, weathering, and structural weakness in SSAR Section 2.5.1.2.6.2 and indicated that any desiccation, weathered zones, joints, or fractures will be mapped and evaluated as the excavation proceeds. In SSAR Section 2.5.1.2.6.4 on prior earthquake effects, the applicant stated that extensive studies of outcrops, alluvial terraces, and flood plain deposits have not shown evidence for post-Miocene (older than 5.3 mya) earthquake activity. In SSAR Section 2.5.1.2.6.5 on effects of human activities, the applicant stated that no effects resulting from human activity (e.g., mining operations, extraction or injection of groundwater, or impoundment of surface water) have occurred in the site area that affected geologic conditions at the site.

2.5.1.2 Regulatory Evaluation

The acceptance criteria for identifying basic geologic and seismic information are based on meeting the relevant requirements of 10 CFR Part 52.17 and 10 CFR Part 100.23. The staff considered the following regulatory requirements in reviewing the applicant's discussion of basic geologic and seismic information:

1. 10 CFR 52.17(a)(1)(vi), which requires that an ESP application contain a description of the geologic and seismic characteristics of the proposed site.

2. 10 CFR 100.23(c), which requires an ESP applicant to investigate geologic, seismic, and engineering characteristics of a site and its environs in sufficient scope and detail to permit an adequate evaluation of the proposed site; to provide sufficient information to support evaluations performed to determine the SSE Ground Motion; and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site.

3. 10 CFR 100.23(d), which requires that geologic and seismic siting factors considered for design include a determination of the SSE Ground Motion for the site; the potential for surface tectonic and non-tectonic deformation; the design bases for seismically-induced floods and water waves; and other design conditions including soil and rock stability, liquefaction potential, and natural and artificial slope stability. Siting factors and potential causes of failure to be evaluated include physical properties of materials underlying the site, ground disruption, and effects of vibratory ground motion that may affect design and operation of the proposed power plant.

The basic geologic and seismic information assembled by the applicant in compliance with the above regulatory requirements should also be sufficient to allow a determination at the COL stage of whether the proposed facility complies with the following requirements in Appendix A to 10 CFR Part 50:

1. GDC 2, which requires that SSCs important to safety be designed to withstand the effects of natural phenomena such as earthquakes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

To the extent applicable in the regulatory requirements cited above, and in accordance with RS-002, the staff applied NRC-endorsed methodologies and approaches (specified in Section 2.5.1 of NUREG-0800) for evaluation of information characterizing the geology and seismology of the proposed site as recommended in RG 1.70, Revision 3 and RG 1.165.

2.5.1.3 Technical Evaluation

This SER section presents the staff's evaluation of the geologic and seismic information submitted by the applicant in SSAR Section 2.5.1. The technical information presented in SSAR Section 2.5.1 resulted from the applicant's surface and subsurface geologic, seismic, and geotechnical investigations, which were undertaken at increasing levels of detail moving closer to the site. Through its review, the staff determined whether the applicant had complied with the applicable regulations and conducted these investigations at the appropriate levels of detail within the four circumscribed areas designated in RG 1.165, which are defined based on various distances from the site (i.e., circular areas drawn with radii of 320 km (200 mi), 40 km (25 mi), 8 km (5 m), and 1 km (0.6 mi) from the site).

SSAR Section 2.5.1 contains geologic and seismic information collected by the applicant in support of the vibratory ground motion analysis and site SSE spectrum provided in SSAR Section 2.5.2. RG 1.165 indicates that applicants may develop the SSE ground motion for a new nuclear power plant using either the EPRI or Lawrence Livermore National Laboratory (LLNL) seismic source models for the CEUS. However, RG 1.165 recommends that applicants update the geologic, seismic, and geophysical database and evaluate any new data to determine whether revisions to the EPRI or LLNL seismic source models are necessary. Consequently, the staff focused its review on geologic and seismic data published since the late 1980s to assess whether these data indicate a need for changes to the EPRI or LLNL seismic source models.

To thoroughly evaluate the geologic and seismic information presented by the applicant, the staff obtained the assistance of the USGS. The staff and its USGS advisors visited the ESP site to confirm interpretations, assumptions, and conclusions presented by the applicant related to potential geologic and seismic hazards.

2.5.1.3.1 Regional Geologic Description

In SSAR Sections 2.5.1.1.1, 2.5.1.1.2, and 2.5.1.1.3, the applicant reviewed and summarized published information related to the physiography and geomorphology (Section 2.5.1.1.1), geologic history (Section 2.5.1.1.2), and stratigraphy and geologic setting (Section 2.5.1.1.3) of the site region. Based on information presented in SSAR Sections 2.5.1.1.1, 2.5.1.1.2, and 2.5.1.1.3, the applicant concluded that the physiography, geomorphology, geologic history, stratigraphy, and geologic setting of the site region posed no safety issues for the ESP site. Consequently, the applicant considered the site suitable in regard to these specific regional features and their characteristics. The staff's evaluation of SSAR Sections 2.5.1.1.1, 2.5.1.1.2, and 2.5.1.1.3 is presented below.

Physiography, Geomorphology, and Geologic History

The staff focused its review of SSAR Sections 2.5.1.1.1 and 2.5.1.1.2 on the applicant's descriptions of the physiography, geomorphology, and geologic history within the site region, with an emphasis on the Quaternary Period (1.8 mya to the present). In SSAR Section 2.5.1.1.1, the applicant described each physiographic province within the site region, with emphasis on the Coastal Plain physiographic province since the ESP site is located in that province. In SSAR Section 2.5.1.1.2, the applicant described geologic history of the site region, including each episode of continental rifting and collision as well as the deposition of Coastal Plain sedimentary units found at the ESP site.

Based on its review of SSAR Sections 2.5.1.1.1 and 2.5.1.1.2, the staff concludes that the applicant presented a thorough and accurate description of the physiography, geomorphology, and geologic history of the site region in support of the ESP application as required by 10 CFR 52.17(a)(1)(vi), and 10 CFR 100.23(c), and 10 CFR 100.23(d). These two SSAR sections present well-documented geologic information, which the applicant derived from published sources. The applicant provided an extensive list of references for these sources, which the staff examined in order to ensure the accuracy of the information presented by the applicant in the SSAR.

Stratigraphy and Geologic Setting

The staff focused its review of SSAR Section 2.5.1.1.3 on the applicant's descriptions of the stratigraphy and geologic setting within the site region. The staff's review concentrated on surfaces and deposits of Quaternary age that are preserved primarily in subhorizontal fluvial terraces occurring along the Savannah River and its major tributaries. Development of fluvial terraces can be related to sequential erosion and deposition in response to faulting, climatic, isostatic (i.e., regional changes in crustal loading leading to upwarping or downwarping of portions of the earth's crust), or eustatic (i.e., global sea level changes) effects or a combination of these mechanisms. Because fluvial terrace deposits initially form as relatively level to gently inclined surfaces, the possibility exists for analyzing variations in elevations of the terrace surfaces to evaluate the potential for Quaternary deformation (i.e., tilting, warping, or offset due to fault displacement) in the site area as long as nontectonic processes, such as surficial erosion or dissolution at depth, have not strongly modified its morphology. In particular, the applicant identified a series of four abandoned fluvial terraces (Qty, Qtb, Qte, and Qto from youngest to oldest) that occur in the site area at elevations above the present-day flood plain of the Savannah River and overlie the Pen Branch fault, a structure that the applicant determined does underlie the ESP site. The applicant used these terraces to assess the presence or absence of Quaternary tectonic deformation on the Pen Branch fault.

Regarding the Pen Branch fault, the applicant analyzed seismic reflection data collected for the ESP application to determine that the fault underlies the ESP site. The fault has also been imaged beneath the SRS on the eastern side of the Savannah River, although it shows no surface expression either at the SRS or the ESP site. Although evidence from stratigraphic data discussed by the applicant in the SSAR suggests that the last motion on the Pen Branch fault was pre-Eocene (greater than 33.7 mya) in age, the applicant understood the need to analyze this fault in more detail because of its location relative to the ESP site.

In RAI 2.5.1-1, the staff asked the applicant to indicate whether the fluvial terraces (Qty, Qtb, Qte, and Qto) are regional in extent or are local features uplifted by slip along the Pen Branch fault. In response, the applicant stated that the four abandoned terraces of the Savannah River extend well beyond the vicinity of the Pen Branch fault and are regional in extent. The four terraces extend for at least 33 km (20 mi) upstream and 29 km (18 mi) downstream (i.e., straight-line distances) from the VEGP ESP site. In addition, the applicant stated that the development of a sequence of laterally extensive fluvial terraces is characteristic of other major Piedmont-draining river systems as well as the Savannah River. In conclusion, the applicant stated, "The fact that the major fluvial terrace surfaces are correlative between major Piedmont-draining river systems suggests that these terraces form in parallel response to regional climatic and/or eustatic conditions, and are not the result of local tectonic perturbations."

Based on an evaluation of the applicant's response, the staff concludes that, since the terraces are regional in extent, it is highly unlikely that they developed due to tectonic displacement along the Pen Branch fault. The trace of the fault is nearly perpendicular to the long axis of the terrace surfaces (see SSAR Figure 2.5.1-43), so the terraces are favorably oriented to register Quaternary deformation along the Pen Branch fault. Alternatively, the staff believes a more likely origin for the terraces involves regional changes in sea level relative to the continental land mass. These regional changes resulted from either climatic, isostatic, or eustatic effects or some combination of these nontectonic mechanisms. Climatic, isostatic, and eustatic perturbations alter sea level relative to the land mass on a regional scale, either by raising the sea level itself (climatic and eustatic changes) or isostatically uplifting blocks of continental crust due to regional crustal unloading (isostatic changes). The mechanism of tectonic perturbations is separate and distinct from these regional changes in sea level and would involve tectonic uplift (e.g., fault displacement) to raise a fault block and produce abandoned fluvial terraces atop that block. The staff's conclusion that the fluvial terraces developed as a result of nontectonic processes rather than by tectonic uplift is based on the staff's evaluation of the applicant's response to RAI 2.5.1-1, and subsequent RAI responses pertaining to the same subject (i.e., RAI 2.5.1-2 and RAI 2.5.1-3).

To evaluate the potential for Quaternary displacement on the Pen Branch fault, the applicant implemented a detailed investigation of fluvial terrace Qte (the Ellenton terrace) at a location approximately 6 km (4 mi) east-northeast of the ESP site. The purpose of the applicant's study was to "improve the resolution of the terrace surface elevation and independently assess the presence or absence of Quaternary tectonic deformation on the Pen Branch fault." A previous study of the fluvial terraces by Geomatrix (1993) concluded that the Pen Branch fault is not a capable tectonic source and that there is no observable deformation, within a resolution of 2-3 m (7-10 ft), of the overlying Ellenton terrace (Qte). The applicant's investigation improved on the previous investigation by surveying approximately 2600 elevation data points along the Qte terrace surface in the vicinity of the Pen Branch fault. The applicant estimated its uncertainty to be about 1 m (3 ft) and concluded that its profile of the Qte fluvial terrace surface demonstrates the absence of discernible tectonic deformation on the underlying Pen Branch fault within a 1-m (3-ft) limit of resolution for the elevation data.

In RAI 2.5.1-2, the staff asked the applicant to address whether the range in elevation of the Qtb (8 to 13 m (26 to 43 ft)) and Qte (18 to 25 m (56 to 82 ft)) terrace surfaces above the Savannah River surface can be attributed to tilting of these terrace surfaces due to Quaternary slip on the Pen Branch fault. The staff also asked the applicant to discuss the implications of the deformation detection limit of about 1 m (3 ft) for the terrace surfaces. This limit resulted from the applicant's field study. This clarification is particularly important for terrace Qte (the Ellenton terrace), which the applicant analyzed in detail to conclude that the terraces do not exhibit deformation due to Quaternary displacement along the Pen Branch fault. The applicant selected terrace surface Qte for the analysis because of its lateral extent and because it could potentially record tectonic deformation along the Pen Branch fault for up to 1 mya based on its interpreted age of 350,000 to 1 million years. The younger terraces, Qty and Qtb, covered shorter time periods, and the older terrace, Qto, exhibited too much dissection for this type of analysis. To define the best-preserved remnants of terrace surface Qte for analysis, the applicant performed geomorphic mapping and field reconnaissance studies and then surveyed approximately 2600 elevation data points on these terrace surface remnants. The applicant estimated that the overall uncertainty in elevation values of the best-preserved remnants of terrace Qte was about 1 m (3 ft) due to the presence of depressions related to dissolution collapse at depth and local deposition of alluvium and colluvium.

In response to RAI 2.5.1-2, the applicant addressed whether the terrace elevation ranges suggested tilting or warping of terrace Qte by tectonic deformation along the Pen Branch fault and the implications of the 1 m (3 ft) limit of detection for deformation. The applicant concluded that variations in elevation of the Qte terrace surface are due largely to the eroded and dissected character of terrace Qte and not from warping or tilting of the terrace by Quaternary displacement on the Pen Branch fault. The applicant cited supporting evidence that these terrace surfaces clearly exhibit a range of surface elevations resulting directly from erosion and dissection which cannot be obviously equated with displacement along the Pen Branch fault. The applicant also concluded that the deformation detection limit of 1 m (3 ft) is an improvement over that attained in previous studies and consequently acceptable for assessing the possibility of Quaternary deformation of the terrace surface due to displacement along the Pen Branch fault. The applicant stated the following:

> Work performed for the VEGP application uses the 350 ka to 1 Ma Ellenton (Qte) terrace surface as a Quaternary strain marker to assess the presence or absence of evidence for tectonic deformation across the underlying Pen Branch fault. A longitudinal profile of the Qte terrace surface in the study area provides evidence demonstrating the absence of tectonic deformation within a resolution of about 1 m (3 ft). This provides a much smaller deformation detection limit than previous studies, thereby providing greater confidence in the evidence demonstrating the lack of Quaternary deformation on the Pen Branch fault.

To completely evaluate the applicant's field study of the Qte fluvial terrace, as well as the applicant's response to RAI 2.5.1-2, the staff and its consultants visited the ESP site and examined the terrace surface. In particular, the staff focused on the adequacy of the applicant's investigations of the Qte terrace and its suitability as a strain marker to assess the presence or absence of tectonic deformation across the underlying Pen Branch fault. Based on the site visit and an examination of aerial photographs and geologic maps, the staff concludes the following:

1. The Qte fluvial terrace shows no obvious surface warping, tilting, or offset.

2. The 1 m (3 ft) detection limit is equivalent to or less than the topographic variations observed for the terrace surface.

3. The variations in elevation of the Qte terrace surface are likely the result of the eroded and dissected character of the Qte surface rather than tectonic tilting and warping due to Quaternary displacement along the Pen Branch fault.

4. The deformation detection limit of 1 m (3 ft), which the applicant achieved during the ESP-related terrace investigations, is a great improvement over previous studies and is a reasonable limit based on measured variability detected in elevation of this terrace surface due to erosion and dissection of the terrace.

SER Figure 2.5.1-9 is a photograph of the Qte fluvial terrace taken during the site visit by the NRC staff and its USGS consultants. This photograph illustrates the relatively flat terrace surface extending a considerable distance toward the horizon, and reinforces the interpretation of the applicant that this terrace surface is not offset by displacement along the Pen Branch fault.

In RAI 2.5.1-3, the staff asked the applicant to discuss the use of the youngest terrace, Qty (4,000 to 90,000 years in age), as an indicator for more recent (i.e., Holocene (10,000 years to the present in age)) potential displacement or uplift along the underlying Pen Branch fault. In response to RAI 2.5.1-3, the applicant stated the following:

> The discontinuous Qty terrace surface of late Pleistocene to possibly Holocene age does not provide constraints for evaluating the potential for Quaternary displacement on the Pen Branch fault. The significantly older and more laterally continuous remnants of the 350 ka to 1 Ma (Geomatrix, 1993) Ellenton terrace (Qte) provide a more robust datum to evaluate potential tectonic deformation on the Pen Branch fault.

The applicant concluded that the discontinuous nature of terrace Qty does not provide adequate constraint for evaluating the potential for Quaternary displacement on the Pen Branch fault. The applicant cited supporting technical evidence derived from field observations and mapping that the terrace is too discontinuous to permit construction of a longitudinal profile for properly assessing tilting and warping of the terrace surface. The applicant also concluded that terrace Qty is not developed only near the Pen Branch fault and cited evidence derived from its field observations and mapping that the Qty terrace extends outside the site area.

After review of the applicant’s response to RAI 2.5.1-3, as well as geologic field maps of the area, the staff concurs with the applicant’s conclusions that terrace Qty is too discontinuous to be a suitable strain marker for deformation of the terrace surface or the underlying strata. Furthermore, the terrace extends beyond the location of the Pen Branch fault. The staff also agrees with the applicant that terrace Qte provides a much more robust indicator for potential Quaternary displacement of the underlying Pen Branch fault than terrace Qty.

Based on review of SSAR Section 2.5.1.1.3, the staff concludes that the applicant presented a thorough and accurate description of the regional stratigraphy and geologic setting in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c) and 10 CFR 100.23(d). In addition, based on observations made during the site visit and review of the applicant’s responses to RAI 2.5.1-1 through RAI 2.5.1-3, the staff concludes that the applicant’s detailed examination of fluvial terrace surface Qte demonstrates the absence of significant Quaternary displacement on the underlying Pen Branch fault. As a result, the staff concurs with the applicant’s conclusion that the Pen Branch Fault is not a capable tectonic structure (as defined by RG 1.165).

2.5.1.3.2 Regional Tectonic Description

In SSAR Sections 2.5.1.1.4 and 2.5.1.1.5, the applicant reviewed and summarized published information related to the tectonic setting (Section 2.5.1.1.4) and gravity and magnetic data (Section 2.5.1.1.5) of the site region. Based on information presented in SSAR Sections 2.5.1.1.4 and 2.5.1.1.5, the applicant concluded the following:

1. Tectonic features in the site region include structures that are Paleozoic (greater than 248 mya), Mesozoic (248 to 65 mya), Tertiary (65 to 1.8 mya), and Quaternary (1.8 mya to present) in age. Only structures of Quaternary age warrant further consideration for the ESP site with regard to the potential for surface fault displacement and seismic hazards.

2. Of the 11 regional geologic features assessed with regard to their potential for Quaternary activity, only the paleoliquefaction features associated with the 1886

Charleston earthquake clearly demonstrate the existence of a Quaternary tectonic feature.

3. Based on more recent information derived from other investigators on source geometry and earthquake recurrence rates for the Charleston seismic source, the 1986 EPRI Charleston seismic source models need to be updated.

4. All regional seismic source zones, other than the Charleston seismic source zone, have less influence on the ESP site due to their distance from the site. The Charleston seismic source model dominates the ground motion hazard for the ESP site.

5. Within the site region, there is no spatial correlation of earthquake epicenters with known or postulated faults. In general, earthquakes occurring in the South Carolina and Georgia portions of the Coastal Plain and Piedmont provinces are not concentrated or aligned with any mapped faults.

The staff's evaluation of SSAR Sections 2.5.1.1.4 (including SSAR Sections 2.5.1.1.4.1 through 2.5.1.1.4.6) and 2.5.1.1.5 (including SSAR Sections 2.5.1.1.5.1 and 2.5.1.1.5.2) is presented below.

Plate Tectonic Evolution and Stress Field

The staff focused its review of SSAR Sections 2.5.1.1.4.1 and 2.5.1.1.4.2 on the applicant's descriptions of plate tectonic evolution and tectonic stresses within the site region, with an emphasis on the Quaternary Period (1.8 mya to present). In SSAR Section 2.5.1.1.4.1, the applicant described plate tectonic evolution of the Appalachian orogenic belt at the latitude of the site region. The applicant stated that stratigraphic units of the Coastal Plain, the province within which the ESP site lies, record development of a passive continental margin along the east coast of the United States that followed Mesozoic extensional rifting and the opening of the present-day Atlantic Ocean basin. In SSAR Section 2.5.1.1.4.2, the applicant described a detailed study of the orientations and magnitudes of the principal tectonic stresses performed by Moos and Zoback (1992) for the SRS. The applicant stated that the regional stress analyses performed for the CEUS, including the study performed by Moos and Zoback (1992), which characterized a northeast-southwest orientation for the maximum principal compressive stress, did not suggest a need to alter the seismic source models developed by EPRI (1986).
Based on its review of SSAR Sections 2.5.1.1.4.1 and 2.5.1.1.4.2, the staff concludes that the applicant presented a thorough and accurate description of plate tectonic evolutionary history and tectonic stress for the site region in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi) and 10 CFR 100.23(c), and 10 CFR 100.23(d). These two SSAR sections present well-documented geologic information, which the applicant derived from published sources. The applicant provided an extensive list of references for these sources, which the staff used to confirm the accuracy of the information in the SSAR.

Principal Regional Tectonic Structures

The staff focused its review of SSAR Section 2.5.1.1.4.3 on the applicant's descriptions of tectonic structures (principally faults), with emphasis on the Quaternary Period. In SSAR Section 2.5.1.1.4.3, the applicant described the principal regional tectonic structures based on the age of formation or reactivation of the structures, including those of Paleozoic (greater than 248 mya), Mesozoic (248 to 65 mya), Tertiary (65 to 1.8 mya), and Quaternary (1.8 mya to the present) age. The staff's evaluation of SSAR Section 2.5.1.1.4.3 is presented below.

Figure 2.5.1-9 - Photograph of the relatively horizontal remnant of fluvial terrace Qte (the Ellenton terrace, dated at 1 Ma to 350 ka years old) which occurs on the eastern side of the Savannah River on SRS property and crosses the trace of the Pen Branch fault. This terrace surface exhibits no tilting, warping, or offset due to Quaternary (1.8 mya to the present) displacement along the Pen Branch fault.

Paleozoic Tectonic Structures. The applicant described the Paleozoic tectonic structures that are located in the site region—the Augusta fault zone, Modoc fault zone, Central Piedmont Suture, Eastern Piedmont Fault System, and the Brevard, Hayesville, and Towaliga faults. The applicant concluded that (1) there is no seismicity that can be associated with any of these Paleozoic features; (2) none of the structures are capable tectonic sources; and (3) there is no new information associated with these Paleozoic structures that would necessitate an update of the EPRI (1986) seismic source models.

In SSAR Section 2.5.1.1.4.3, the applicant described two distinct deformation fabrics that are contained in both the Augusta and Modoc fault zones. These deformation fabrics suggest that more than one phase of tectonic deformation may have occurred in these zones. Specifically, the applicant stated that a brittle deformation fabric overprinted (i.e., postdated) formation of a ductile deformation fabric in the Augusta and Modoc fault zones. In RAI 2.5.1-5, the staff asked the applicant to clarify whether the brittle fabric may have formed during a post-Alleghanian deformation event (e.g., during the Quaternary). This clarification is important to document that these two structures are old tectonic features exhibiting no evidence for reactivation during Quaternary time.

In response to RAI 2.5.1-5, the applicant addressed the timing of the development of these two deformation fabrics. The applicant concluded that the brittle deformation fabrics associated with the Augusta and Modoc fault zones, which postdate the ductile mylonitic deformation fabrics in the zones, are either late Alleghanian (greater than 248 mya, at the end of the Paleozoic) or early Mesozoic in age and do not represent Quaternary reactivation in the modern-day stress regime. The applicant cited several supporting lines of evidence for this conclusion:

1. Both the brittle and ductile fabrics exhibit similar movement directions (i.e., similar kinematic histories) during deformation.

2. The observed normal components of brittle movement are not compatible with the modern-day stress field.

3. The observed mineralization of some brittle fabrics exposed at the surface (e.g., silicification of breccias and growth of zeolite minerals and epidote) cannot form under modern-day geologic and hydrothermal conditions.

Based on its review of the applicant's response to RAI 2.5.1-5, the staff concludes that the brittle deformation fabrics do not represent Quaternary deformation, or deformation in the modern-day stress field, along the Augusta or Modoc fault zones. In particular, the staff concurs with the applicant's assertion that the normal components of the brittle movement are incompatible with the modern-day stress regime (i.e., currently a northeast to east-northeast-trending orientation of maximum principal compressive stress) indicating that these fabrics could have developed only as the result of an earlier stress field. The movement history for the brittle deformation fabrics is compatible with the stress field associated with Alleghanian orogeny at the end of the Paleozoic (greater than 248 mya), such that the brittle fabrics of both the Augusta and Modoc fault zones are considerably older than Quaternary. As the applicant stated, Maher et al. (1994) suggest Alleghanian extensional movement along the Augusta fault zone about 274 mya, and Dallmeyer et al (1986) suggest extensional movement of the Modoc fault zone from 310 to 290 mya. Based on this information, the staff also concludes that it is not necessary for the applicant to reassess the seismic hazard potential of these regional structures for the ESP site.

In RAI 2.5.1-6, the staff asked the applicant to include the Central Piedmont Suture and the Eastern Piedmont Fault System on a corrected SSAR Figure 2.5.1-14. In response to this RAI, the applicant confirmed that this correction would be made in the next revision of the ESP application. The staff confirmed that this change was made in revision 2 to the SSAR.

<u>Mesozoic Tectonic Structures</u>. The applicant discussed Mesozoic tectonic structures in SSAR Section 2.5.1.1.4.3, noting that the Dunbarton Triassic basin, an east-northeast-trending Mesozoic (i.e., Triassic (248 to 206 mya)) extensional rift basin, is located beneath both the ESP site and the SRS. The extensional Dunbarton Triassic basin is bounded on its northwest side by the Pen Branch fault, a structure determined by the applicant to underlie the ESP site and to exhibit rejuvenation as an oblique-slip reverse fault during the Cenozoic (65 mya to present) after earlier normal fault displacement during the Mesozoic (248 to 65 mya). The applicant presented a detailed assessment of the potential for Quaternary (1.8 mya to present) displacement along the Pen Branch fault in SSAR Section 2.5.1.2.4. The staff's evaluation of SSAR Section 2.5.1.2.4 is presented in SER Section 2.5.1.3.4.

With regard to regional Mesozoic extensional tectonic terranes, the applicant recognized that areas of extended crust (e.g., such as the eastern part of the Piedmont and beneath the Coastal Plain province in the southeastern United States) may host large earthquakes that are associated spatially with buried faults initially developed in response to extensional rifting. The Pen Branch fault, which forms the northwest boundary of the Dunbarton Triassic basin, is such a fault. The applicant indicated that these buried faults which bound the Triassic basins may be either listric (i.e., a fault with a dip angle that decreases with depth) or a high-angle fault.
In RAI 2.5.1-9, the staff asked the applicant to discuss whether there is any evidence that these buried normal faults are listric or are high-angle faults that could extend through the crust to depths where larger magnitude earthquakes commonly nucleate. In response, the applicant stated the following:

> Data constraining the down-dip geometry of faults that bound Mesozoic basins are equivocal. Seismic reflection data, borehole studies, gravity and magnetic signatures, and geologic mapping have all been used to characterize these faults, but different studies have depicted these faults as both listric and high-angle features. The effects of these two possible geometries on hazard at the site are highly uncertain, but both geometries can produce moderate-to-large magnitude earthquakes on seismogenic structures. Because of the uncertainty regarding their geometry, the EPRI ESTs used area sources instead of individual fault sources to represent these basin-bounding faults in the PSHA.

Due to the uncertainty in the location and subsurface geometry of these faults that bound Mesozoic basins, the staff concurs with the applicant’s use of area source zones. Rather than characterizing the seismic potential of each identified or postulated fault, seismic hazard studies for the CEUS generally define broad area seismic source zones. Both the EPRI and LLNL seismic source models use this approach, which is endorsed by RG 1.165. Therefore, the staff concludes that the applicant’s response to RAI 2.5.1-9 is adequate and that the applicant has conservatively modeled the seismic sources in the region surrounding the ESP site by using area sources rather than individual fault sources.

<u>Tertiary Tectonic Structures</u>. The applicant described Tertiary tectonic structures in SSAR Section 2.5.1.1.4.3. Within 200 miles of the ESP site only a few tectonic features were active during the Tertiary Period (65 to 1.8 mya). The two most prominent Tertiary structures are the Cape Fear Arch on the South Carolina-North Carolina border and the Yamacraw Arch on the Georgia-South Carolina border. Based on Crone and Wheeler (2000), the applicant concluded that these features do not exhibit any evidence for Quaternary faulting.

<u>Quaternary Tectonic Structures</u>. The applicant discussed potential Quaternary tectonic structures in the region surrounding the ESP site in SSAR Section 2.5.1.1.4.3. To evaluate each of these potential Quaternary features, the applicant used the database of Quaternary tectonic features developed by Crone and Wheeler (2000) and Wheeler (2005) for the CEUS. These two studies present a compilation and description of the faults, paleoliquefaction features, seismic zones, and geomorphic features that may have been active or capable during the Quaternary period. Crone and Wheeler categorize each feature as fitting into one of four “fault classes” (Classes A, B, C, D) based on geologic evidence for Quaternary deformation. This categorization is determined from the authors’ survey of the published literature rather than from direct field examination of the features. These four fault classes are defined by Crone and Wheeler (2000) and Wheeler (2005) as follows:

1. Class A—Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether mapped or inferred from liquefaction or other features.

2. Class B—Geologic evidence demonstrates the existence of Quaternary deformation, but either the fault may not cut deeply enough to be a potential earthquake source or available geologic evidence is too strong to assign the feature to Class C but not strong enough to assign it to Class A.

3. Class C—Geologic evidence is insufficient to demonstrate the existence of tectonic faulting or Quaternary deformation associated with the feature.

4. Class D—Geologic evidence demonstrates that the feature is not a tectonic fault.

Using Crone and Wheeler (2000) and Wheeler (2005), the applicant identified the following potential Quaternary tectonic features in the region surrounding the ESP site:

- Charleston, Georgetown, and Bluffton paleoliquefaction features (Class A)
- ECFS (Class C)
- Cooke fault (Class C)
- Helena Banks fault zone (Class C)
- Pen Branch fault (Class C)
- Belair fault zone (Class C)
- Fall Lines of Weems (Class C)
- Cape Fear Arch (Class C)
- ETSZ (Class C)

The applicant discussed Charleston features (including the ECFS, the Cooke fault, the Helena Banks fault zone, and the Charleston, Georgetown, and Bluffton paleoliquefaction features) in detail in SSAR Section 2.5.1.1.4.4. The applicant presented its detailed analysis of the Pen Branch fault in SSAR Section 2.5.1.2.4 and discussed the ETSZ in SSAR Section 2.5.1.1.4.6. The applicant evaluated the remaining features (i.e., the Belair fault zone, the Fall Lines of Weems, and the Cape Fear Arch) in SSAR Section 2.5.1.1.4.3. The staff's evaluation of those three remaining features is presented below.

Belair Fault Zone

As mapped, the Belair fault zone is located about 20 km (12 mi) north-northwest of the ESP site and is at least 25 km (15 mi) in length. The applicant indicated that undeformed strata overlying the disrupted stratigraphic units constrain the last episode of displacement along this fault zone between post-Late Eocene and pre-26,000 years ago, allowing for Cenozoic (i.e., 65 mya to present), including Quaternary, displacement along the fault zone. The applicant also stated that the Belair fault zone is probably a tear fault or lateral ramp in the hanging wall of the Augusta fault zone. If this association between the Augusta and Belair fault zones exists, then movement on the Belair zone may be related to displacement on the longer, regional-scale Augusta fault zone. In RAI 2.5.1-10, the staff asked the applicant to explain how the inference of Cenozoic displacement on the Belair fault zone and a possible association with the regional Augusta fault zone might affect seismic hazard for the ESP site. This clarification is important to document whether the Belair fault zone is structurally linked with the Augusta fault zone and whether it has experienced displacement during the Quaternary.

In its response to RAI 2.5.1-10, the applicant addressed the possibility of a connection between the Belair and Augusta fault zones. The applicant stated that timing and sense-of-slip for the most recent movements on the Belair and Augusta faults demonstrate that these two structures did not respond as a single tectonic element in Cenozoic or younger time. Prowell et al. (1975) and Prowell and O'Connor (1978) document brittle failure due to reverse slip on the Belair fault in the Cenozoic (65 mya to present). In contrast, the applicant stated that the latest movement on the Augusta fault, as demonstrated by brittle overprinting of ductile fabrics, exhibits a normal sense-of-slip which is constrained to late Alleghanian time (greater than 248 mya) based on Maher (1987) and Maher et al. (1994). The applicant acknowledged that Crone and Wheeler (2000) classified the Belair fault zone as Class C, suggesting Quaternary slip on the Belair fault is allowed but not demonstrated by geologic data. The applicant concluded, based on the evidence supporting different slip histories and opposite senses of dip-slip for the Belair and Augusta faults, that reactivation of these two faults as a single structure during the Cenozoic is not indicated.

Based on its review of the applicant's response to RAI 2.5.1-10, the staff concludes that the Belair and Augusta fault zones are not currently linked tectonic features. In particular, the staff concurs that there is strong field evidence for different slip histories and opposite senses of dip-slip for the Belair and Augusta faults and no indication that the structures were reactivated as a single structure during the Cenozoic.

Fall Lines of Weems (1998)

The applicant discussed a series of anomalously steep stream segments derived by Weems (1998) from a study of longitudinal profiles of streams flowing across the Blue Ridge and Piedmont physiographic provinces in North Carolina, Virginia, and Tennessee. Weems (1998) noted that these steep stream segments occurred as seven "fall zones" that were generally subparallel to the northeast-southeast regional "grain" of the Blue Ridge and Piedmont provinces as reflected by physiography, lithologic belts, and regional tectonic features. Weems (1998) suggested three hypotheses to explain this phenomenon, including climatic factors, rock characteristics, and neotectonic effects (i.e., tectonic deformation that is post-Miocene, or greater than 5.3 mya, in age). The applicant stated that the Fall Lines of Weems are classified as Class C features by Wheeler (2005) since they do not demonstrate Quaternary age deformation. Consequently, the applicant concluded that these features do not represent Quaternary faulting in the site region.

Cape Fear Arch

The Cape Fear Arch is a topographic high located on the South Carolina-North Carolina border which is bounded by the Salisbury embayment topographic low to the northeast and the Georgia embayment low to the southeast. The applicant stated that the Cape Fear Arch, a feature previously discussed under the section on tertiary tectonic structures, was classified as Class C by Crone and Wheeler (2000) based on a lack of evidence for Quaternary faulting. The applicant concluded that this feature does not exhibit evidence of Quaternary faulting in light of the Crone and Wheeler (2000) classification and that there is no existing evidence to indicate this feature is a tectonically active structure.

Based on its review of SSAR Section 2.5.1.1.4.3 related to a discussion of faults, the staff concludes that the applicant presented a thorough and accurate description of regional Paleozoic, Mesozoic, Tertiary, and Quaternary tectonic deformation features in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and

10 CFR 100.23(d). In addition, based on its review of the applicant's responses to RAI 2.5.1-5, RAI 2.5.1-6 and RAI 2.5.1-9, the staff concludes that regional Paleozoic (greater than 248 mya), Mesozoic (248–65 mya), and Tertiary (65–1.8 mya) features are older structures that do not exhibit Quaternary deformation, and no further assessment of seismic hazard potential in relation to any of these regional structures is necessary for the ESP site.

In regard to Quaternary structures discussed by the applicant in SSAR Section 2.5.1.1.4.3, the staff concurs with the applicant that there is strong field evidence for different slip histories and opposite senses of dip-slip for the Belair and Augusta faults, as the applicant qualified in the response to RAI 2.5.1-10. The staff further concurs with the applicant that these structures did not reactivate as a single, linked structure during Cenozoic time (65 mya to present, which includes the Quaternary). In addition, concerning Quaternary history for the seven Fall Lines of Weems (1998), the citation by the applicant of Wheeler (2005) as the primary basis for assessing the potential for Quaternary activity, in relation to the fall lines, is deemed insufficient by the staff. From previous analysis of these features in connection with the SER for North Anna (see NUREG-1835, "Safety Evaluation Report for an Early Site Permit (ESP) at the North Anna ESP Site," issued September 2005), the staff concludes that differential erosion resulting from variable hardness in rock units is a more plausible origin for the fall lines than Quaternary tectonism. The staff further notes that interpretation of the fall lines as Quaternary tectonic features comes solely from Weems, and no other investigators have suggested this origin. Concerning Quaternary activity for the Cape Fear Arch, the staff concurs with the applicant that there is no existing evidence to indicate that this feature is a tectonic structure exhibiting Quaternary deformation.

Furthermore, the staff concurs with the applicant that potential seismic effects of tectonic structures are fully incorporated into PSHA, because area sources, rather than individual fault sources, are used to capture tectonic features in PSHA. Therefore, the staff believes that specific regional structures need not be defined for PSHA and concludes that the applicant thoroughly evaluated the seismic potential for each of the faults in the site region to determine whether the EPRI PSHA source models require updating.

Principal Regional Tectonic Structures—Charleston

The staff focused its review of SSAR Section 2.5.1.1.4.4 on potential Charleston-area source faults, seismic zones, and liquefaction features, with emphasis on the Quaternary Period. In SSAR Section 2.5.1.1.4.4, the applicant described Charleston tectonic features, including potential source faults, seismic zones, and seismically induced liquefaction features. Analysis of Charleston tectonic features is very important in regard to a potential seismic hazard at the ESP site because the earthquake that occurred in 1886 in the Charleston area is one of the largest historical earthquakes ever to occur within the eastern United States and its source is certain to occur within the ESP site region. After a review of more recent geologic investigations in the Charleston area (some of which described liquefaction features related to the 1886 Charleston earthquake and earlier events likely generated from the same seismic source), the applicant concluded that significant new information related to source geometry and earthquake recurrence rate for the Charleston seismic source warrants an update of the EPRI (1986) source models used in the PSHA. The applicant presented and discussed these updated seismic source parameters for the 1886 Charleston earthquake in SSAR Section 2.5.2.2.2.4 The staff's evaluation of SSAR Section 2.5.1.1.4.4 is presented below.

Potential Source Faults for Charleston. The applicant recognized that no known tectonic source exists for the 1886 Charleston earthquake. Consequently, location of a “Charleston tectonic source” is based on historical reports of damage and occurrence of seismically induced liquefaction features to define an area rather than a specific source fault. The applicant discussed nine potential tectonic source faults for the 1886 Charleston earthquake—the ECFS, Adams Run fault, Ashley River fault, Charleston fault, Cooke fault, Helena Banks fault zone, Sawmill Branch fault, Summerville fault, and Woodstock fault. The applicant concluded that no specific linkage between any of these features and the 1886 Charleston earthquake could be proposed based on geomorphic, geologic, borehole, or seismic evidence. The applicant’s discussion of potential tectonic source features for the 1886 Charleston earthquake did not include two faults shown on SSAR Figures 2.5.1-19 and 2.5.1-20 to occur in the meizoseismal area (i.e., the area of maximum damage to structures resulting from the earthquake) of the Charleston earthquake, namely the Gants and Drayton faults. The staff asked, in RAI 2.5.1-13, the applicant to acquire additional descriptive information on these two faults to enable a thorough review of all faults postulated to occur in the meizoseismal area of the 1886 Charleston earthquake.

In response to RAI 2.5.1-13, the applicant provided descriptive information for the Gants and Drayton faults. For the Drayton fault, the applicant concluded that Cenozoic (65 mya to present), and consequently Quaternary (1.8 mya to present), displacement is precluded based on interpretations of seismic reflection data (Hamilton et al., 1983) which suggest that the fault terminates at a depth of about 750 m (2500 ft) below the ground surface in a Jurassic (206 to 144 mya) basalt layer. For the Gants fault, the applicant concluded that seismic reflection data suggested that the fault may disrupt Cenozoic strata, but with decreasing displacement during Cenozoic time. The conclusions drawn by the applicant for both the Gants and Drayton faults are, therefore, supported by the evidence derived from seismic reflection data, as neither fault exhibits any surface expression.

Based on its review of the applicant’s response to RAI 2.5.1-13, the staff concludes that the response provides an adequate description of the Gants and Drayton faults. The staff also concludes that neither of these two faults exhibit any obvious linkage to the 1886 Charleston earthquake in space or time. Because the applicant could not correlate this earthquake with any of the nine potential source faults discussed in SSAR Section 2.5.1.1.4.4, including the Gants and Drayton faults, and uncertainty remains in selecting a specific tectonic source, the staff considers it important that the applicant incorporate the new information on source geometry and earthquake recurrence rate for the 1886 Charleston earthquake into the seismic source models for Charleston. The applicant incorporated these new data into the analyses discussed in SSAR Section 2.5.2.2.2.4 (seismic potential for a Charleston source fault is captured in PSHA by use of a source area rather than a specific tectonic structure for the Charleston area).

Potential Seismic Source Zones for Charleston. Regarding seismic source zones for the 1886 Charleston earthquake, the applicant discussed three zones of increasing seismicity identified in the Charleston area. The zones include the Middleton Place-Summerville, Bowman, and Adams Run seismic zones. The characteristics of these zones are discussed in SSAR Section 2.5.1.1.4.4 and SER Section 2.5.1.1.2. The applicant reached no specific conclusions regarding these three seismic zones in SSAR Section 2.5.1.1.4.4. Details related to specific data in the seismicity catalog for these three zones are discussed in SSAR Section 2.5.2.1. The staff found the descriptions of the seismic source zones, based on published literature (provided by the applicant in SSAR Section 2.5.1.1.4.4) to be acceptable.

Charleston Area Liquefaction Features. Regarding seismically induced liquefaction features in the Charleston area, the applicant stated that such features produced by the 1886 Charleston earthquake are most heavily concentrated in the meizoseismal area for that earthquake. The applicant also reported the locations of prehistoric liquefaction features related to significant seismic events that pre-dated the 1886 Charleston earthquake, but likewise interpreted to most likely have been generated by the same tectonic source. The applicant indicated that, based on consideration of these prehistoric liquefaction data, Talwani and Schaeffer (2001) suggested a mean recurrence interval of 550 years for a Charleston-type earthquake. This interval is roughly an order of magnitude less than the seismicity-based estimates used by EPRI (1986) to characterize recurrence interval for earthquakes generated by the Charleston seismic source. Based on the identification of earthquakes pre-dating the 1886 Charleston seismic event from the prehistoric liquefaction features, the applicant refined earthquake recurrence rate estimates for a Charleston-area earthquake in SSAR Section 2.5.2.2.2.4. The applicant made no specific conclusions regarding seismically induced liquefaction features in SSAR Section 2.5.1.1.4.4.

With regard to liquefaction features in the Charleston area, the staff found that the descriptions of these features provided by the applicant in SSAR Section 2.5.1.1.4.4 needed clarification. To better correlate liquefaction features with proposed tectonic sources, in RAI 2.5.1-11, the staff asked the applicant to include new figures that clearly distinguished liquefaction features related to the 1886 Charleston earthquake from the prehistoric liquefaction events shown in SSAR Figure 2.5.1-19. In RAI 2.5.1-12, the staff asked the applicant to include an additional pertinent reference by Bollinger (1977). The applicant provided the new figures and the reference in its responses to RAI 2.5.1-11 and RAI 2.5.1-12.

The staff concludes that the applicant presented a thorough and accurate geologic description of Charleston tectonic features (including potential source faults, seismic source zones, and liquefaction features) in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). In addition, based on its review of the information presented by the applicant on Charleston tectonic features in SSAR Section 2.5.1.1.4.4, and the applicant's responses to RAI 2.5.1-11, RAI 2.5.1-12, and RAI 2.5.1-13, the staff concurs with the applicant that no specific linkage between any of the nine faults discussed and the 1886 Charleston earthquake can be proposed based on geomorphic, geologic, borehole, or seismic evidence. The staff also concludes that it is important for the applicant to incorporate new information on source geometry and earthquake recurrence rate for the Charleston seismic source into PSHA source models for the ESP site. Furthermore, with regard to seismically induced liquefaction features, the staff concurs with the applicant that liquefaction features produced by the 1886 Charleston earthquake are most heavily concentrated in the meizoseismal area. The applicant refined earthquake recurrence rate estimates for a Charleston-area earthquake in SSAR Section 2.5.2.2.2.4. The staff considers it important for the applicant to define a seismic source zone for a Charleston-area earthquake by considering all faults and liquefaction features that it deemed feasible to include for establishing reasonable geologic boundaries for the seismic source zone.

Principal Regional Tectonic Structures—Savannah River Site

The staff focused its review of SSAR Section 2.5.1.1.4.5 on the applicant's descriptions of SRS faults, with emphasis on the Quaternary Period. In SSAR Section 2.5.1.1.4.5, the applicant discussed SRS tectonic features, including the Pen Branch, Steel Creek, Ellenton, Upper Three Runs, ATTA, Crackerneck, Martin, Tinker Creek, Lost Lake, and Millet faults. The applicant indicated that four of these faults (i.e., the Pen Branch, Steel Creek, Ellenton, and Upper Three

Runs faults) are interpreted to occur within the site area. Because the Pen Branch fault underlies the ESP site, the applicant discussed this fault in great detail in SSAR Section 2.5.1.2.4 on site area structural geology. The staff's evaluation of SSAR Section 2.5.1.1.4.5 is presented below.

Descriptions of faulting at the SRS provided in the SSAR are based on published literature from technical specialists who are very knowledgeable about tectonic features at the SRS. These descriptions are as accurate as possible, based on the consideration that most of these faults are defined in the subsurface primarily from interpretation of seismic reflection profiles (i.e., none of the faults exhibit surface expression at the SRS). The staff asked, in RAI 2.5.1-14, the applicant to obtain clarification of why the density of faults at the SRS on the eastern side of the Savannah River is so much greater than for the ESP site on the western side of the river and the implication this has for the seismic hazard at the ESP site. In RAI 2.5.1-15, the staff asked for a summary of pertinent data derived from the SRS leading to the applicant's conclusion that the Pen Branch fault is not a capable tectonic structure. In RAI 2.5.1-15, the staff also asked the applicant to compare data and analyses for the SRS with data and analyses employed by the applicant to conclude that the Pen Branch fault is not a capable structure at the ESP site. Since detailed studies of faulting at the SRS have been conducted for an extended period of time, and the ESP site is adjacent to the SRS although on the opposite side of the Savannah River, information collected from and analyses performed for the SRS are very pertinent for assessing the potential for capable faults at the ESP site.

In response to RAI 2.5.1-14, the applicant stated that the SRS was the focus of several decades of subsurface exploration and research. The applicant emphasized that the availability of high-resolution seismic reflection profiles that completely traverse the ESP site from north to south (normal-to-regional structural grain) and image the complete Coastal Plain stratigraphic section from the top of the basement to shallow levels, collected as part of the VEGP ESP project, makes the existence of any unrecognized faults at the ESP site unlikely. The applicant also stated that, although the faults shown on the SRS are greater in number, considering the difference in the size of the area of investigation between the SRS and the ESP site, fault densities are comparable. The applicant indicated that resolution and signal-to-noise ratio of the seismic profile that traverses the ESP site (i.e., proposed VEGP Unit 4) are significantly better than almost all of the seismic reflection data available for SRS. Based on these lines of evidence, the applicant concluded that the absence of previously unrecognized faults in the ESP seismic reflection data indicate that faulting at the ESP site and in the site area has been adequately characterized. The applicant thus concluded that no unknown faults exist that would affect the seismic hazard at the site.

In response to RAI 2.5.1-15, the applicant summarized the evidence substantiating that the Pen Branch fault is not a capable tectonic feature as follows:

1. Faulting deforms sediments no younger than Eocene in age. The data for this conclusion are based on 18 closely-spaced SRS drill holes that allowed construction of a subsurface geologic map of a formation above the fault. Additional support for this conclusion is based on geologic mapping and data from 20 auger holes in the Long Branch, South Carolina 7.5 minute quadrangle (Nystrom et al. 1994). The auger holes are located adjacent to the SRS but along strike of the Pen Branch fault and showed no evidence for faulting.

2. Savannah River Quaternary fluvial terraces are not deformed across the fault trace, within a resolution limit of 2 to 3 m (7 to 10 ft), based on longitudinal profiles along two Savannah River terraces (Geomatrix 1993).

3. Based on data from Moos and Zoback (1992), regional principal stress orientations determined from boreholes show that the maximum horizontal stress is parallel to the regional orientation of the Pen Branch fault, making strike-slip faulting unlikely and reverse faulting essentially impossible.

4. The VEGP terrace study documented that no fault-related deformation of the 350 ka to 1 Ma Ellenton (Qte) terrace above the projected surface trace of the Pen Branch Fault occurs within a resolution of 1 m (3 ft). The resolution of this study makes it the most definitive evidence for non-capability of the Pen Branch Fault both at the SRS and the ESP site.

The conclusion stated by the applicant that the absence of previously unrecognized faults in the ESP seismic reflection data indicates that faulting at the ESP site and in the site area has been adequately characterized, as well as its conclusion that there are no unknown faults that would affect the seismic hazard at the site, is supported by the evidence from high-resolution seismic profile data. The conclusion stated by the applicant that faulting does not deform strata younger than Eocene (54.8 to 33.7 mya) is supported by the evidence from 18 drill holes at the SRS. The conclusion stated by the applicant that the analysis of the Ellenton terrace, which overlies the Pen Branch fault, revealed no fault-related deformation within a resolution limit of 1 meter (3 feet) is supported by data collected for the ESP application.

Based on its review of the applicant's responses to RAI 2.5.1-14 and RAI 2.5.1-15, the staff concludes that the applicant adequately addressed the topics of concern raised in RAI 2.5.1-14 and RAI 2.5.1-15. The staff summarizes and discusses the evidence presented by the applicant indicating that the Pen Branch fault is not a capable tectonic structure in SER Section 2.5.1.3.4.

The staff concludes that the applicant presented a thorough and accurate description of SRS tectonic features in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). In addition, based on its review of the information presented by the applicant on SRS tectonic features in SSAR Section 2.5.1.1.4.5 and the applicant's responses to RAI 2.5.1-14 and RAI 2.5.1-15, the staff concurs with the applicant that the absence of previously unrecognized faults in the ESP seismic reflection data indicate that faulting at the ESP site and in the site area has been adequately characterized. The staff also concurs with the applicant that unknown faults that would affect the seismic hazard at the site are not likely to exist, but the staff will examine all excavations for the ESP site applying regulatory guidance in RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants", to ensure that this point is true. The staff further concurs with the applicant's conclusion that faulting does not deform strata younger than Eocene (54.8 to 33.7 mya) because this conclusion is supported by evidence from 18 drill holes at the SRS. Finally, the staff concurs with the applicant's conclusion that the analysis of the Ellenton terrace, which overlies the Pen Branch fault, revealed no fault-related deformation within a resolution limit of 1 m (3 ft) because this conclusion is supported by data collected for the ESP application.

Principal Regional Tectonic Structures—Anomalies and Lineaments

The staff focused its review of SSAR Sections 2.5.1.1.4.3 and 2.5.1.1.5 on the applicant's descriptions of regional geophysical anomalies and lineations and regional gravity and magnetic data, with emphasis on the Quaternary Period. The applicant discussed these anomalies and lineaments in SSAR Section 2.5.1.1.4.3 (the East Coast Magnetic and Blake Spur anomalies and the New York-Alabama, Clingman, and Ocoee lineaments). These two SSAR sections present well-documented geologic information, which the applicant derived from published sources. The applicant provided an extensive list of references for these sources, which the staff examined to ensure the accuracy of the information in the SSAR. The staff's evaluation of SSAR Sections 2.5.1.1.4.3 and 2.5.1.1.5 is presented below.

The applicant concluded that the geophysical anomalies and lineaments discussed in SSAR Section 2.5.1.1.4.3 did not pose concerns for the ESP site in regard to seismic hazard. In SSAR Section 2.5.1.1.5, the applicant summarized regional gravity and magnetic data and concluded that no large, unexplained anomalies exist in either data set, and no evidence exists for Cenozoic (i.e., including Quaternary age) tectonic activity or features based on that data. Information that the applicant presented for these two topics is well documented in published literature.

The staff asked, in RAI 2.5.1-7, the applicant to acquire information on the Grenville Front, listed among the features occurring within the site region but not discussed in SSAR Section 2.5.1.1.4.3, to enable assessment of whether this feature should be considered as a potential seismic source for the ESP site. The staff asked, in RAI 2.5.1-8, the applicant to (1) locate the Clingman and Ocoee lineaments and the Ocoee block on the map shown in SSAR Figure 2.5.1-12; (2) indicate the age of the "modern" tectonic setting referred to by Wheeler (1996) for earthquakes within the region of the Ocoee block to aid assessment of whether faults in this region are potentially capable structures requiring consideration for the ESP site; and (3) indicate whether the New York-Alabama, Clingman, and Ocoee lineaments could be potential seismic sources for the site.

In response to RAI 2.5.1-7, the applicant indicated that the Grenville Front was incorrectly listed as a feature occurring within 320 km (200 mi) of the ESP site (i.e., within the site region) and agreed to include the feature on SSAR Figure 2.5.1-12 to eliminate any confusion about its location. The applicant described the Grenville Front in SSAR Section 2.5.1.1.4.1 as a feature developed in Precambrian time during the Grenville Orogeny (i.e., 1100 mya) and concluded in the response that it does not represent a potential seismic source based on the firm evidence that it developed in Precambrian time.

In the response to RAI 2.5.1-8, the applicant agreed to include the Clingman and Ocoee lineaments and the Ocoee block in SSAR Figure 2.5.1-12. The applicant also indicated that the "modern" tectonic setting refers to the setting for the east coast of the United States as a passive continental margin, with regional tectonic stress for the CEUS characterized by northeast-southwest horizontal compression. The applicant stated that this regional stress orientation is subparallel to the lineaments, suggesting that they are not in the most favorable orientation for failure in this regional stress field. The applicant concluded that, while the New York-Alabama, Clingman, and Ocoee lineaments bound a block (i.e., the Ocoee block) that appears responsible for earthquakes in the ETSZ, most focal mechanism nodal planes derived from fault plane solutions in the ETSZ are not parallel to the northeast-trending lineaments, suggesting that features with this orientation are not favorably oriented for accommodating fault displacement. The applicant cited evidence related to orientation of nodal planes defined in the Ocoee block, derived from Johnston et al. (1985) as stated in SSAR Section 2.5.1.1.4.3, indicating north-south and east-west faults for the Ocoee block rather than structures parallel to the northeast-southwest strike trend of the lineaments. The applicant further stated that the lineaments were known to the technical teams in the 1986 EPRI study, and no new information has been published since 1986 on the lineaments that would require a significant change in the EPRI seismic source model.

Based on its review of the applicant's responses to RAI 2.5.1-7 and RAI 2.5.1-8, the staff concludes that neither the Grenville Front nor the New York-Alabama, Clingman, and Ocoee lineaments are likely to be viable seismic sources.

The staff concludes that the applicant presented a thorough and accurate description of regional geophysical anomalies and lineations and regional gravity and magnetic data in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Furthermore, based on its review of the information presented by the applicant on regional geophysical anomalies and lineations and regional gravity and magnetic data in SSAR Sections 2.5.1.1.4.3 and 2.5.1.1.5 and the applicant's responses to RAI 2.5.1-7 and RAI 2.5.1-8, the staff concurs with the applicant that no regional anomalies or lineaments and no regional gravity or magnetic data indicated features requiring consideration for seismic hazard analysis at the ESP site. The staff further concurs with the applicant that none of the anomalies or lineaments described by the applicant in SSAR Sections 2.5.1.1.4.3 and 2.5.1.1.5 are likely to be seismic sources requiring seismic hazard consideration at the ESP site.

Seismic Source Zones

The staff focused its review of SSAR Section 2.5.1.1.4.6 on the applicant's descriptions of the seismically defined source zones, including selected seismogenic and capable tectonic sources beyond the site region, with emphasis on the Quaternary Period (1.8 mya to present). In SSAR Section 2.5.1.1.4.6, the applicant described seismic sources (defined based on regional seismicity) comprising the ETSZ within the site region and the Central Virginia, New Madrid, and GCSZs outside of the site region. This SSAR section presents well-documented geologic information which the applicant derived from published sources. The applicant provided an extensive list of references for these sources, and the staff directly examined relevant references to ensure the accuracy of the information derived from published sources and presented in the SSAR. The staff's evaluation of SSAR Section 2.5.1.1.4.6 is presented below.

In regard to seismic sources within, and selected sources outside, the site region, the applicant concluded that only the NMSZ required an update of source parameters, in particular, of the recurrence rate. This conclusion was rendered necessary by new information that the applicant reported in the SSAR, as derived from the published literature. The applicant concluded further that information for none of the other three zones (i.e., the East Tennessee, Central Virginia, and Giles County zones) required a significant revision to the 1986 EPRI source model in light of data that were also derived from the published literature. This information included interpretations from Wheeler (2005) that the East Tennessee and GCSZs are Class C features based on a lack of geologic evidence for large earthquakes associated with the zones.

The staff concludes that the applicant presented a thorough and accurate description of seismic source zones defined by seismicity within the site region, including selected sources outside the site region, in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Based on its review of the information presented by the applicant on seismic source zones in SSAR Section 2.5.1.1.4.6, the staff also concludes that all regional seismic source zones discussed by the applicant have less influence on the ESP site due to their distance from the site than the updated Charleston seismic source model discussed in SSAR Section 2.5.2.2.2.4. The staff concurs with the applicant that the Charleston seismic source model dominates ground motion hazard for the site. The applicant incorporated new information on source geometry and earthquake recurrence rate for this source into an updated seismic source model in SSAR Section 2.5.2.2.2.4.

Based on its review of SSAR Section 2.5.1.1.4 and the applicant's responses to RAIs as set forth above, the staff concludes that the applicant identified and properly characterized all regional tectonic features. The staff also concludes that SSAR Section 2.5.1.1.4 provides an accurate and thorough description of regional tectonic features, with an emphasis on potential Quaternary deformation, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d).

2.5.1.3.3 Site Area Geologic Description

In SSAR Sections 2.5.1.2.1, 2.5.1.2.2, and 2.5.1.2.3, the applicant reviewed and summarized published information related to physiography and geomorphology (Section 2.5.1.2.1), geologic history (Section 2.5.1.2.2), and stratigraphy (Section 2.5.1.2.3) of the site area. Based on information presented in SSAR Sections 2.5.1.2.1, 2.5.1.2.2, and 2.5.1.2.3, the applicant concluded that physiography, geomorphology, geologic history, and stratigraphy of the site area pose no safety issues for the ESP site. Consequently, the applicant considered the site suitable in regard to these area-specific features and their characteristics. The staff's evaluation of SSAR Sections 2.5.1.2.1, 2.5.1.2.2, and 2.5.1.2.3 is presented below.

<u>Physiography, Geomorphology, and Geologic History</u>

The staff focused its review of SSAR Sections 2.5.1.2.1 and 2.5.1.2.2 on the applicant's descriptions of physiography, geomorphology, and geologic history of the site area, with emphasis on the Quaternary Period. In SSAR Section 2.5.1.2.1, the applicant described the geomorphology of the Coastal Plain physiographic province within which the ESP site lies. In SSAR Section 2.5.1.2.2, the applicant described geologic history of the site area, emphasizing the Coastal Plain. These two SSAR sections present well-documented geologic information, which the applicant derived from published sources. The applicant provided an extensive list of references for these sources, which the staff examined to ensure the accuracy of the information presented by the applicant in the SSAR.

In the description of site area physiography and geomorphology presented in SSAR Section 2.5.1.2.1, the applicant indicated that the Savannah River is relatively straight and incised in the site area in the vicinity of the projected surface trace of the Pen Branch fault. Tectonic uplift, among other factors, can lower the base level to which a stream will naturally erode, resulting in active erosion by down-cutting and incision of the stream channel. The staff asked, in RAI 2.5.1-4, the applicant to address why the Savannah River is relatively straight and incised at a position that appears to correspond with the location of the Pen Branch fault. This clarification is important to enable an assessment of whether reverse or reverse-oblique slip along the Pen Branch fault occurred to uplift the hanging wall fault block; lower the base level to which the Savannah River would erode; and thus create an incised river channel.

In response to RAI 2.5.1-4, the applicant concluded that the straight, incised segment of the Savannah River is not the result of Quaternary displacement along the Pen Branch fault. The applicant cited three lines of evidence interpreted to preclude Quaternary displacement along the Pen Branch fault as being the mechanism that produced this straight, incised segment of the Savannah River channel:

1. The geomorphic surface of the 350 ka to 1 Ma Ellenton fluvial terrace along the Savannah River is undeformed to within a resolution of 1 m (3 ft). The applicant stated that this observation is the best evidence precluding late Quaternary activity of the Pen Branch fault and establishing that the Pen Branch is not a capable fault. The applicant considered it highly unlikely that changes in the modern river channel morphology at the location of the Pen Branch fault would be the result of Quaternary fault activity if the Ellenton terrace surface is preserved across the fault with no evidence of deformation.

2. Several other examples of linear or incised portions of rivers are present in the Coastal Plain within 80 km (50 mi) of the ESP site that are not associated with any mapped fault. The applicant stated that the occurrence of other linear portions of river channels demonstrates that the morphology of the Savannah River adjacent to the VEGP site is not unique, but relatively common in the region. The applicant indicated that these other linear reaches of river channels are not spatially associated with known mapped faults, strongly suggesting a nontectonic origin for this type of feature.

3. Localized remnant surfaces on the modern flood plain that formed as the result of paleochannel migration indicate that, although the river at present appears relatively straight, it has meandered across the flood plain in recent time. Therefore, the applicant stated that the apparent "straight" segment of the Savannah River channel near the ESP site appears to be an ephemeral feature that changes or evolves through geologic time in response to changes in sediment load, discharge, and eustatic base-level change.

Based on its review of the applicant's response to RAI 2.5.1-4, the staff concludes that the straight, incised channel of the Savannah River which occurs in the site area in the vicinity of the Pen Branch fault does not require a mechanism related to Quaternary displacement along the Pen Branch fault to produce this morphology along the river channel.

Based on its review of SSAR Sections 2.5.1.2.1 and 2.5.1.2.2 and the applicant's response to RAI 2.5.1-4, the staff concludes that the applicant presented a thorough and accurate description of the physiography, geomorphology, and geologic history of the site area in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d).

Stratigraphy

The staff focused its review of SSAR Section 2.5.1.2.3 on the applicant's description of stratigraphic units in the site area, with emphasis on sedimentary units of the Coastal Plain within which the ESP site lies. In SSAR Section 2.5.1.2.3, the applicant described Coastal Plain stratigraphy in the site area in detail and also discussed basement rocks (i.e., both Paleozoic crystalline rocks and sedimentary rocks of the Dunbarton Triassic basin) which underlie Coastal Plain sedimentary units in the site area. The applicant used information derived from borehole B-1003 drilled at the ESP site to describe stratigraphic units of the Coastal Plain that occur at the site. The staff also examined core from this specific borehole during a visit to the ESP site, and this examination of subsurface stratigraphy by the staff added credence to the accuracy of the applicant's description of site stratigraphy. The applicant's discussion of previous data on the site-specific stratigraphic units cited well-documented geologic information derived from published sources. The applicant provided an extensive list of references for these sources, which the staff examined to ensure the accuracy of the information presented in the SSAR.

Based on its review of SSAR Section 2.5.1.2.3, the staff concludes that the applicant presented a thorough and accurate description of stratigraphic relationships for the site area in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). SER Section 2.5.4 provides further discussion of the engineering properties of soil and rock materials that underlie the ESP site and the staff's complete evaluation of the applicant's description of these materials.

2.5.1.3.4 Site Area Structural Geology

In SSAR Section 2.5.1.2.4, the applicant reviewed and summarized published information related to the structural geology of the site area, including the Pen Branch, Ellenton, Steel Creek, and Upper Three Runs faults. Of these four faults, the applicant determined that the Pen Branch fault underlies the ESP site and required further investigation to determine whether it is a capable tectonic feature exhibiting Quaternary displacement. Therefore, in addition to summarizing published results from previous studies of the Pen Branch fault, the applicant presented important new information from seismic reflection and refraction surveys and evaluation of Quaternary-age fluvial terraces overlying the Pen Branch fault. The applicant collected this information for the ESP application specifically to determine whether the Pen Branch fault is a capable tectonic feature. The applicant stated that the Upper Three Runs and Steel Creek faults are restricted entirely to basement rocks and do not offset Coastal Plain deposits, and the Ellenton fault no longer appears on recent maps of the SRS where it was first interpreted to occur based on seismic reflection data.

Based on information presented in SSAR Section 2.5.1.2.4, the applicant concluded that the structural geology of the site area poses no safety issues for the ESP site. With due consideration for the results of previous studies of the Pen Branch fault and the new information collected for the ESP application, the applicant concluded that the Pen Branch fault does not exhibit Quaternary displacement and is not a capable tectonic feature requiring analysis for seismic hazard or surface-faulting issues at the site. The applicant also concluded that the Ellenton, Steel Creek, and Upper Three Runs faults are not capable tectonic features. Consequently, the applicant considered the site suitable in regard to area-specific geologic structures (i.e., faults) and their characteristics, including the Pen Branch fault. The staff's evaluation of SSAR Section 2.5.1.2.4 specifically in regard to the Pen Branch fault, including SSAR Sections 2.5.1.2.4.1, 2.5.1.2.4.2, and 2.5.1.2.4.3 is presented below.

Pen Branch Fault

The staff focused its review of SSAR Section 2.5.1.2.4 on the applicant's descriptions of the Pen Branch fault (SSAR Section 2.5.1.2.4.1), including new information collected for the ESP application derived from site subsurface investigation of the Pen Branch fault (SSAR Section 2.5.1.2.4.2) and evaluation of Quaternary river terrace Qte (Ellenton terrace) which overlies the Pen Branch fault (SSAR Section 2.5.1.2.4.3). The staff's review emphasized the Quaternary Period and included careful analysis of all information presented by the applicant related to determining whether the Pen Branch fault exhibited Quaternary displacement. The applicant's discussion of previous data on the Pen Branch fault cited well-documented geologic information derived from published sources. The applicant provided an extensive list of references for these sources, which the staff examined to ensure the accuracy of the information in the SSAR. However, in the extensive list of references, the applicant did not cite a publication by Hanson et al. (1993) in which the investigators suggested that possible rejuvenation of drainage along projected surface traces of the Pen Branch and Steel Creek faults on the SRS may indicate either local tectonic uplift along these faults at a very low rate of displacement (i.e., 0.002 to

0.009 mm/yr) or nontectonic geologic processes. In RAI 2.5.1-17, the staff asked the applicant to determine whether the concept presented by Hanson et al. (1993), related to the suggestion of possible Quaternary displacement along the Pen Branch fault based on their analysis of drainage morphology at the SRS, held any implications of geologic hazard for the ESP site.

In response to RAI 2.5.1-17, the applicant addressed the suggestion of Hanson et al. (1993) that stream drainage patterns along the trace of the Pen Branch fault on the SRS may suggest local Quaternary tectonic uplift. The applicant summarized results of a 1993 study by Geomatrix that concentrated on collecting and analyzing several types of information in regard to Quaternary tectonic deformation at the SRS. The applicant discussed data derived from a regional slope map, slope profiles, longitudinal stream profiles, and residual maps that Geomatrix (1993) constructed for this analysis. Based on this information, the applicant concluded that no obvious topographic or geomorphic characteristics could be equated with geologic structures or required the occurrence of Quaternary deformation along the Pen Branch fault. The applicant also reviewed data developed from evaluation of drainage basin shape, drainage density, and drainage frequency by Geomatrix (1993). The applicant likewise concluded from this information that none of these aspects of the drainage patterns indicated geologic structures or required Quaternary deformation along the Pen Branch fault. The applicant referred to fluvial terrace studies conducted by Geomatrix (1993), as well as the more refined terrace studies conducted for the ESP application discussed in SSAR Section 2.5.1.2.4.3, as the most conclusive evidence for a lack of Quaternary deformation along the Pen Branch fault.

Based on its review of the applicant’s response to RAI 2.5.1-17, the staff concludes that there is no definitive evidence described by Hansen et al. (1993) indicating the existence of Quaternary displacement along the Pen Branch fault in the site area. The staff further concludes that the applicant’s response to RAI 2.5.1-17 adequately qualified the conclusion presented by the applicant.

In the discussion of geometry of the Pen Branch fault presented in SSAR Section 2.5.1.2.4.2, the applicant stated that the Pen Branch fault at the ESP site is made up of two specific fault segments trending N45°E and N34°E with a dip of 45°SE. Considering the N50° to 70°E modern-day orientation of maximum principal horizontal compressive stress defined by Moos and Zoback (1992) for the site region in relation to orientations of segments of the Pen Branch fault, the staff asked, in RAI 2.5.1-18, the applicant to determine whether either fault segment is favorably oriented to experience displacement in the existing regional stress field.

In response to RAI 2.5.1-18, considering the N50° to 70°E modern-day orientation of maximum principal horizontal compressive stress defined by Moos and Zoback (1992) for the site region, the applicant chose an average orientation of the maximum horizontal stress as N60°E and determined that planes striking N45°E and N34°E and dipping 45°SE form angles to the maximum horizontal stress of approximately 10° and 20°, respectively. The applicant stated that these orientations are not parallel to the maximum horizontal stress and therefore would experience some amount of resolved shearing stress. However, based on Ramsey and Huber (1987), the applicant indicated that planes of such orientations relative to maximum principal horizontal compressive stress would not experience maximum shearing stress. The applicant pointed out that favorably oriented planes for maximum resolved shearing stress occur at 45° to the maximum horizontal compressive stress direction. Moos and Zoback (1992) further stated that stress magnitudes at shallow depths only approach the frictional strength of favorably oriented reverse faults (i.e., 45°). Therefore, the applicant concluded that stress magnitudes resolved along planes of other orientations will be well below those necessary for displacement in the modern-day stress field. The applicant also concluded that the orientation of the Pen Branch fault segments at the ESP site makes them less favorably oriented for failure in response to the intermediate-depth stress perturbation of N33°E which Moos and Zoback (1992) reported.

Based on its review of the applicant's response to RAI 2.5.1-18, the staff concurs with the applicant that neither of the segments of the Pen Branch fault occurring at the ESP site are favorably oriented to experience displacement in the modern-day stress field. As the applicant indicated, shear failure theory predicts that favorably oriented planes for maximum resolved shearing stress occur at 45° to the maximum horizontal compressive stress direction.

The staff concludes that the applicant presented a thorough and accurate description of the Pen Branch and other faults in the site area in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Furthermore, upon consideration of the information the applicant presented in SSAR Section 2.5.1.2.4, including the applicant's responses to RAI 2.5.1-17 and RAI 2.5.1-18, to support its conclusions about the noncapable nature of the Pen Branch fault, the staff concurs with the applicant that no definitive evidence exists to indicate that the Pen Branch fault (1) shows any surface expression; (2) exhibits Quaternary displacement based on analysis of fluvial terraces and age of stratigraphic units which bound the time of fault displacement; or (3) is a capable tectonic structure. SER Section 2.5.3 contains the staff's complete evaluation of surface faulting near the ESP site in regard to the potential for tectonic deformation and vibratory ground motion due to surface faulting.

The technical bases for the staff's conclusions in regard to site area structural geology, specifically that the Pen Branch fault is not a capable tectonic feature at the ESP site, are related to the evidence which the applicant presented in the SSAR and in its responses to RAIs. The evidence presented by the applicant and summarized below covers information acquired from previous investigations at the SRS and the VEGP site; geomorphic mapping and field reconnaissance, seismic reflection and refraction studies, and investigation of Quaternary fluvial terraces performed by the applicant for the ESP application; and analysis of the regional stress field.

Previous Investigations at the Savannah River Site History of and evidence from previous investigations of the Pen Branch fault conducted at the SRS, which the applicant outlined in SSAR Section 2.5.1.2.4.1, are summarized as follows:

1. Based on seismic data, Snipes et al. (1989) suggested Late Eocene (33.7 mya or older) displacement, but no younger, on the Pen Branch fault and concluded that the fault should not be considered a capable tectonic structure at the SRS.

2. Based on a seismic reflection survey designed to investigate the Pen Branch fault, Berkman (1991) reported deformation of the Cretaceous age (144 to 65 mya) Cape Fear Formation, but no younger units, and concluded that the Pen Branch fault is not a capable tectonic feature.

3. A fluvial terrace study performed by Geomatrix (1993) confirmed no tectonic deformation of terrace surfaces overlying the Pen Branch fault within a resolution of 2 to 3 m (7 to 10 ft), and Geomatrix (1993) concluded that the Pen Branch is not a capable tectonic feature.

4. Snipes et al. (1993) reported that the youngest stratigraphic horizon known from borehole studies to be deformed by fault displacement along the Pen Branch fault is the Dry Branch Formation of Late Eocene (33.7 mya or older) age, and that a Quaternary soil horizon overlying the projected trace of the Pen Branch fault at the SRS showed no offset. The applicant reported this information in SSAR Section 2.5.3.6.

5. Based on results of a drilling project designed to investigate the Pen Branch fault using 18 boreholes, Stieve et al. (1994) concluded that the Pen Branch fault is no younger than 50 mya and is not a capable tectonic feature.

6. Cumbest et al. (1998) integrated information from more than 60 boreholes and 100 miles of seismic reflection profiling and concluded that no faults on the SRS, including the Pen Branch Fault, are capable tectonic features.

7. Based on seismic reflection data, Cumbest et al. (2000) concluded that offset along the Pen Branch fault decreased upward within Coastal Plain sediments to no greater than 9 m (30 ft) at the top of Upper Cretaceous/Lower Paleocene units (i.e., about 66.4 mya).

Previous Investigations at the VEGP Site

Henry (1995) collected and interpreted 115 km (70 mi) of seismic reflection data along the Savannah River, including in the vicinity of VEGP Units 1 and 2, and crossing the projected trace of the Pen Branch fault. Henry (1995) concluded that the Pen Branch fault extended into possibly Eocene age (54.8 to 33.7 mya) sediments. The applicant summarized this information in SSAR Section 2.5.1.2.4.1.

In SSAR Section 2.5.3.8.2.1, the applicant indicated that an old garbage trench that crossed the trace of the Pen Branch fault in the ESP site area, mapped by Bechtel in 1994, contained only dissolution collapse features and no tectonic structures that resulted from displacement along the Pen Branch fault. The applicant interpreted these dissolution features to be older than Late Pleistocene (i.e., greater than 10,000 years old) based on stratigraphic units exposed in the trench, providing an upper age limit for deformation due to displacement along the Pen Branch fault. More recent investigations, as discussed in the following paragraph, indicate a minimum age for displacement along the Pen Branch fault greater than 33.7 mya.

Seismic Reflection and Refraction Data Collected for the ESP Application

The applicant discussed seismic reflection and refraction data collected for the ESP application in SSAR Section 2.5.1.2.4.2. The applicant defined orientation of the Pen Branch fault in the ESP site area and concluded that a monoclinal fold in the Blue Bluff Marl marks the up-section effects of the Pen Branch fault on stratigraphic units in the site area, indicating no displacement that is post-Eocene (i.e., older than 33.7 mya).

Geomorphic Mapping and Field Reconnaissance for the ESP Application

In SSAR Sections 2.5.1.2.4.3 and 2.5.3.6, the applicant indicated that geomorphic mapping and field reconnaissance performed for the ESP application as preparation for the terrace study showed no surface expression of Quaternary deformation along the Pen Branch fault in the site region.

Terrace Study Performed for the ESP Application

The applicant discussed results of its analysis of the Ellenton fluvial terrace (i.e., terrace Qte) at the SRS, which was performed to assess the capability of the Pen Branch fault in the site area, in detail in SSAR Section 2.5.1.2.4.3. The applicant concluded that no Quaternary deformation of the terrace is indicated due to displacement along the Pen Branch fault within a resolution limit of 1 meter (3 feet). RAIs described in SER Section 2.5.1.3.1 (i.e., RAI 2.5.1-1, RAI 2.5.1-2, and RAI 2.5.1-3) posed questions to address the conclusion that the applicant drew from the analysis of fluvial terrace Qte, since this analysis was cited by the applicant as the most important piece of evidence indicating no Quaternary displacement along the Pen Branch fault. The staff and its USGS advisors also visited the ESP site to gain firsthand knowledge about the accuracy of the terrace analysis, and observations made during the site visit added credence to the applicant's conclusion that this study indicates that the Pen Branch fault does not exhibit Quaternary displacement and is not a capable tectonic feature at the ESP site.

Orientation of the Pen Branch Fault in the Modern-Day Regional Stress Field

In SSAR Section 2.5.1.1.4.2, the applicant stated, based on information from Moos and Zoback (1992), that maximum horizontal regional compressive stress in the modern-day stress field is oriented N50° to 70°E in the upper 640-meter (2100-foot) depth range. Such an orientation of regional stress (the applicant used a reasonable average of N60°E in its response to RAI 2.5.1-18) is subparallel to the measured strike of the Pen Branch fault, even when the fault is divided into segments striking N45°E and N34°E as the applicant discussed in SSAR Section 2.5.1.2.4.1. Shear failure theory predicts that maximum shear stress occurs on a surface oriented at 45° to maximum principal compressive stress; consequently, the Pen Branch fault surface is not oriented as a favorable plane for shear failure and resulting fault displacement.

2.5.1.3.5 Site Area Geologic Hazard Evaluation—Faulting, Earthquakes, and Seismicity

In SSAR Section 2.5.1.2.5, the applicant stated that no geologic hazards, effectively including any related to faulting, earthquakes, and seismicity, occur within the ESP site area. The applicant provided detailed discussions on surface faulting in SSAR Section 2.5.3 and seismic hazards in SSAR Section 2.5.2. The applicant provided results of the detailed analysis of the Pen Branch fault specifically, which demonstrate that the Pen Branch is not a capable structure in the site area, in SSAR Section 2.5.1.2.4. In SSAR Section 2.5.1.2.6.4, the applicant also stated that extensive studies of alluvial terraces and floodplain deposits showed no evidence of post-Miocene (i.e., greater than 5.3 mya) earthquake activity as discussed in SSAR Section 2.5.1.2.4. Based on information presented in SSAR Sections 2.5.1.2.4, 2.5.1.2.5, and 2.5.1.2.6.4, the applicant concluded that the ESP site exhibits no geologic hazards resulting from faulting, earthquakes, or seismicity that occur in the site area. Consequently, the applicant considered the site suitable in regard to geologic hazards related to faulting, earthquakes, and seismicity, including the Pen Branch fault, in the site area. However, the applicant does incorporate new information from other investigators on source geometry and earthquake recurrence rate for the Charleston seismic source into PSHA source models for the ESP site, as discussed in SSAR Section 2.5.2.2.2.4. The staff's evaluation of SSAR Section 2.5.1.2.5 in regard to potential hazards due to faulting, earthquakes, and seismicity is presented below.

Based on its review of the information that the applicant presented in SSAR Sections 2.5.1.2.4, 2.5.1.2.5, and 2.5.1.2.6.4, the staff concludes that the applicant presented a thorough and accurate description of faulting, earthquakes, and seismicity in the site area in support of the

ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). The staff concurs with the applicant that the ESP site exhibits no geologic hazards resulting from faulting, earthquakes, or seismicity that occur in the site area.

2.5.1.3.6 Site Area Nontectonic Deformation Features

In SSAR Section 2.5.1.2.5, the applicant stated that nontectonic surface depressions associated with dissolution of the Utley Limestone member of the Clinchfield Formation which overlies the Blue Bluff Marl do not pose a geologic hazard at the ESP site. The applicant plans to remove this unit from the site excavation, and the Blue Bluff Marl will form the foundation-bearing layer. These units are discussed in SSAR Section 2.5.1.2.3.2, and the surface depressions are discussed in detail in SSAR Section 2.5.3.8.2.1. In SSAR Section 2.5.1.1.1, the applicant indicated that Carolina Bays, which occur in the site area, are related to eolian erosion resulting from strong, unidirectional, southwesterly winds and not from dissolution. The applicant also indicated in SSAR Section 2.5.1.2.5 that any structures founded above the Blue Bluff Marl will require subsurface exploration to define low bearing strength layers associated with dissolution in units overlying the Blue Bluff Marl. Based on information presented in SSAR Section 2.5.1.2.5, the applicant concluded that the ESP site exhibits no hazard resulting from nontectonic deformation features. Consequently, the applicant considered the site suitable in regard to geologic hazards related to these features in the site area. The staff's evaluation of SSAR Section 2.5.1.2.5 in regard to potential hazard from nontectonic deformation is presented below.

Based on its review of the information presented in SSAR Section 2.5.1.2.5 and the SSAR sections (i.e., Section 2.5.3.8.2.1 for dissolution features and 2.5.1.1.1 for Carolina Bays) in which the applicant discussed surface depressions in detail, the staff concludes that the applicant presented a thorough and accurate description of nontectonic deformation features in the ste area in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). The staff concurs with the applicant that the ESP site exhibits no geologic hazards resulting from nontectonic deformation features.

2.5.1.3.7 Human-Induced Effects on Site Area Geologic Conditions

In SSAR Section 2.5.1.2.6.5, the applicant stated that no mining operations other than borrow of surficial soils, excessive extraction of injection of ground water, or impoundment of water exists in the site area that will detrimentally affect geologic conditions. Based on information presented in SSAR Section 2.5.1.2.6.5, the applicant concluded that the ESP site exhibits no hazard resulting from human-induced effects on site geologic conditions. Consequently, the applicant considered the site suitable in regard to geologic hazards related to human-induced effects in the site area. The staff's evaluation of SSAR Section 2.5.1.2.6.5 is presented below.

Based on its review of the information presented in SSAR Section 2.5.1.2.6.5, the staff concludes that the applicant presented an accurate description of human-induced effects in the site area in support of the ESP application, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). The staff concurs with the applicant that the ESP site exhibits no hazard resulting from human-induced effects on site geologic conditions.

2.5.1.3.8 Site Area Engineering Geology Evaluation

In SSAR Section 2.5.1.2.6, the applicant addressed engineering soil properties and behavior of foundation materials (Section 2.5.1.2.6.1), zones of alteration, weathering, and structural weakness (Section 2.5.1.2.6.2), and deformational zones (Section 2.5.1.2.6.3). The applicant addressed ground water conditions in SSAR Section 2.5.1.2.7. Regarding engineering properties (including index properties, static and dynamic strength, and compressibility), the applicant indicated that this information is discussed in detail in SSAR Section 2.5.4. In regard to zones of alteration, weathering, and structural weakness, the applicant indicated that some desiccation of the Blue Bluff Marl is expected and that desiccation, weathered zones, and fractures will be mapped and evaluated. Regarding deformational zones, the applicant stated that none were reported from previous studies for VEGP Units 1 and 2, but the applicant will evaluate any such zones detected during excavation mapping. In regard to site ground water conditions, the applicant indicated that a detailed discussion of these conditions is provided in SSAR Section 2.4.12. The staff's evaluation of SSAR Section 2.5.1.6, including SSAR Sections 2.5.1.2.6.1, 2.5.1.2.6.2, 2.5.1.2.6.3, and 2.5.1.2.7, is presented below.

Based on its review of the information that the applicant presented in SSAR Sections 2.5.1.2.6 and 2.5.1.2.7, the staff concludes that the applicant presented an accurate description of site area engineering geology, as far as existing data will allow, in support of the ESP application, as required by 10 CFR 100.23(c). The staff's detailed analysis of engineering properties of soil and rock is presented in SER Section 2.5.4, and the analysis of site ground water conditions is presented in SER Section 2.4.12.

Based on its review of SSAR Section 2.5.1.2 and the applicant's responses to RAIs as set forth above, the staff concludes that the applicant identified and properly characterized all site area geologic features, including the Pen Branch fault. The staff also concludes that SSAR Section 2.5.1.2 provides an accurate and thorough description of site area geologic features, with an emphasis on the Quaternary Period, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d).

2.5.1.4 Conclusions

As discussed in SER Sections 2.5.1.1, 2.5.1.2, and 2.5.1.3, the staff carefully reviewed the basic geologic and seismic information submitted by the applicant in SSAR Section 2.5.1. The staff concurs that the data and analyses presented by the applicant in the SSAR provide an adequate basis to conclude that no capable tectonic faults exist in the plant site area that have the potential to generate surface or near-surface fault displacement.

In addition, the staff concludes that the applicant has identified and appropriately characterized all seismic sources significant for determining the SSE for the ESP site, in accordance with the guidance provided in RG 1.70, RG 1.165, and Section 2.5.1 of NUREG-0800. Because ground motion hazard at the ESP site is dominated by the Charleston seismic source, the staff concurs with the applicant's decision to update the EPRI (1986) source model for this seismic source in light of new information on source geometry and earthquake recurrence rate. No capable tectonic feature has as yet been linked to the Charleston seismic source. Based on information from the applicant's thorough review of the literature on regional geology, and the applicant's literature review and geologic, geophysical, and geotechnical investigations of the site vicinity and site area, the staff further concludes that the applicant has properly characterized regional and site lithology, stratigraphy, geologic and tectonic history, and structural geology, as well as subsurface soils and rock units at the site. The staff also concludes that there is no potential for the effects of human activity (i.e., mining activity or ground water injection or withdrawal) that will compromise the safety of the ESP site.

On the basis of the foregoing, the staff concludes that the applicant has provided a thorough and accurate characterization of the geologic and seismic characteristics of the site, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d).

2.5.2 Vibratory Ground Motion

2.5.2.1 Introduction/Overview/General

SSAR Section 2.5.2 describes the applicant’s determination of the ground motion response spectrum (GMRS) at the Early Site Permit (ESP) site from potential earthquakes in the site area and region. SSAR Section 2.5.2.1 describes the earthquake catalog used for the ESP site, SSAR Section 2.5.2.2 summarizes the geologic structures and tectonic activity that could potentially result in ground motion at the ESP site, and SSAR Section 2.5.2.3 describes the correlation of earthquake activity with geologic structures or tectonic provinces. SSAR Section 2.5.2.4 describes the earthquake potential for seismic sources in the region surrounding the ESP site, SSAR Section 2.5.2.5 describes the seismic wave transmission characteristics of the site, SSAR Section 2.5.2.6 provides the horizontal GMRS, SSAR Section 2.5.2.7 provides the vertical GMRS, SSAR Section 2.5.2.8 discusses the operating-basis earthquake ground motion spectrum, and SSAR Section 2.5.2.9 describes the results of site response sensitivity calculations.

The applicant stated that the information provided in SSAR Section 2.5.2 of the ESP application uses the procedures recommended in RG 1.165, “Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion,” issued March 1997, for performing the Probabilistic Seismic Hazard Analysis (PSHA) for the ESP site. However, rather than using the reference-probability approach described in Regulatory Guide (RG) 1.165 for determining the SSE, the applicant developed the GMRS using the performance-based method described in RG 1.208, A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion,” issued March 2007. According to RG 1.208, the GMRS represents the first part of the development of the safe-shutdown earthquake (SSE) for a site. In addition, the applicant used the 1986 EPRI [Electric Power Research Institute] Project (EPRI NP-4726) seismic source model for the Central and Eastern United States (CEUS) as an input for its seismic ground motion calculations. RG 1.165 indicates that applicants may use the seismic source interpretations developed by Lawrence Livermore National Laboratory (LLNL (1993) or EPRI as inputs for a site-specific analysis. RG 1.165 also recommends a review and update, if necessary, of both the seismic source and ground motion models used to develop the SSE ground motion for the ESP site.

To determine whether an update of the seismic source and ground motion models used in the 1989 EPRI PSHA (EPRI NP-6395-D) was necessary, the applicant reviewed the literature published since the mid-to-late 1980s. This literature review identified the need for changes to the source characterization parameters of the Charleston seismic zone. In addition, the applicant determined that the ground motion models used for the 1989 EPRI PSHA needed to be updated.

2.5.2.2 Summary of Application

2.5.2.2.1 Seismicity

SSAR Section 2.5.2.1 describes the development of a current earthquake catalog for the ESP site. The applicant started with the EPRI historical earthquake catalog (EPRI NP-4726-A 1988), which is complete through 1984. To update the earthquake catalog, the applicant used information from the Advanced National Seismic System (ANSS) and the South Eastern United States Seismic Network (SEUSS).

The EPRI catalog covers the time period from 1627 to 1984 and contains earthquakes that occurred within the CEUS. Earthquakes comprising the EPRI catalog are characterized by a variety of different size measures, including local magnitude (M_L), surface-wave magnitude (M_S), duration or coda magnitude (M_d or M_c), body-wave magnitude (m_{bLg}), felt area (FA), and epicentral Modified Mercalli (MM) intensity (I_o). Earthquake measures such as M_L, M_S, M_d, M_c, and m_{bLg} are based on characteristics of instrumentally recorded events. M_d and M_c are related to the duration of a recorded earthquake, while M_L, M_S, and m_{bLg} are related to the amplitude of a recorded earthquake. FA and I_o, are based on qualitative descriptions of the effects of the earthquake at a particular location (Kramer 1996).

All earthquakes comprising the EPRI catalog are described in terms of m_b. The applicant converted all earthquakes that were not originally characterized by m_b to best, or expected, estimates of m_b ($E[m_b]$) using conversion factors developed in EPRI NP-4726-A (1988). EPRI NP-4726-A (1988) developed these conversion factors from regression models relating m_b to M_L, M_S, M_d or M_c; FA; and I_o. In addition, the 1988 EPRI study calculated a uniform magnitude (m_b*) from Em_b and the variance of m_b (σ^2_{mb}) in order to account for the uncertainty in estimating m_b.

The applicant updated the EPRI historical seismicity catalog to incorporate earthquakes that have occurred within (and beyond) the site region (320-kilometer (km) or 200-mile (mi) radius) since 1984. To update the EPRI catalog, the applicant used a latitude-longitude window of 30° to 37°N, 78° to 86°, which incorporated the 320 km (200 mi) radius and all seismic sources contributing significantly to the ESP site seismic hazard. The applicant used information from the ANSS and the SEUSS for the update. Of these two catalogs, the applicant primarily used the SEUSS catalog for the period from 1985 to 2005. Events in the SEUSS and ANSS catalogs that have occurred since 1985 are primarily reported as m_{bLg}, M_L, M_c, and M_d. To be consistent with the m_b estimates provided in the EPRI catalog, the applicant converted the magnitudes given in both the SEUSS and ANSS catalogs to E[mb]. The applicant included a total of 61 events with $E[m_b]$ magnitude greater than 3.0 in the update of the EPRI NP-4726-A (1988) seismicity catalog. The applicant also calculated m_b* using $E[m_b]$ and σ^2_{mb} (estimated from the ANSS and SEUSS catalogs).

As shown in Figure 2.5.2-1 of this SER, a comparison of the geographic distribution of earthquakes contained in the EPRI catalog (1627–1984) and the earthquakes contained in the updated catalog (1985–2005) shows a very similar spatial distribution. The cluster of events along the coast of South Carolina is related to the Charleston Seismic Zone, while the cluster of events in eastern Tennessee is associated with the Eastern Tennessee Seismic Zone (ETSZ). The ETSZ extends from southwest Virginia to northeast Alabama.

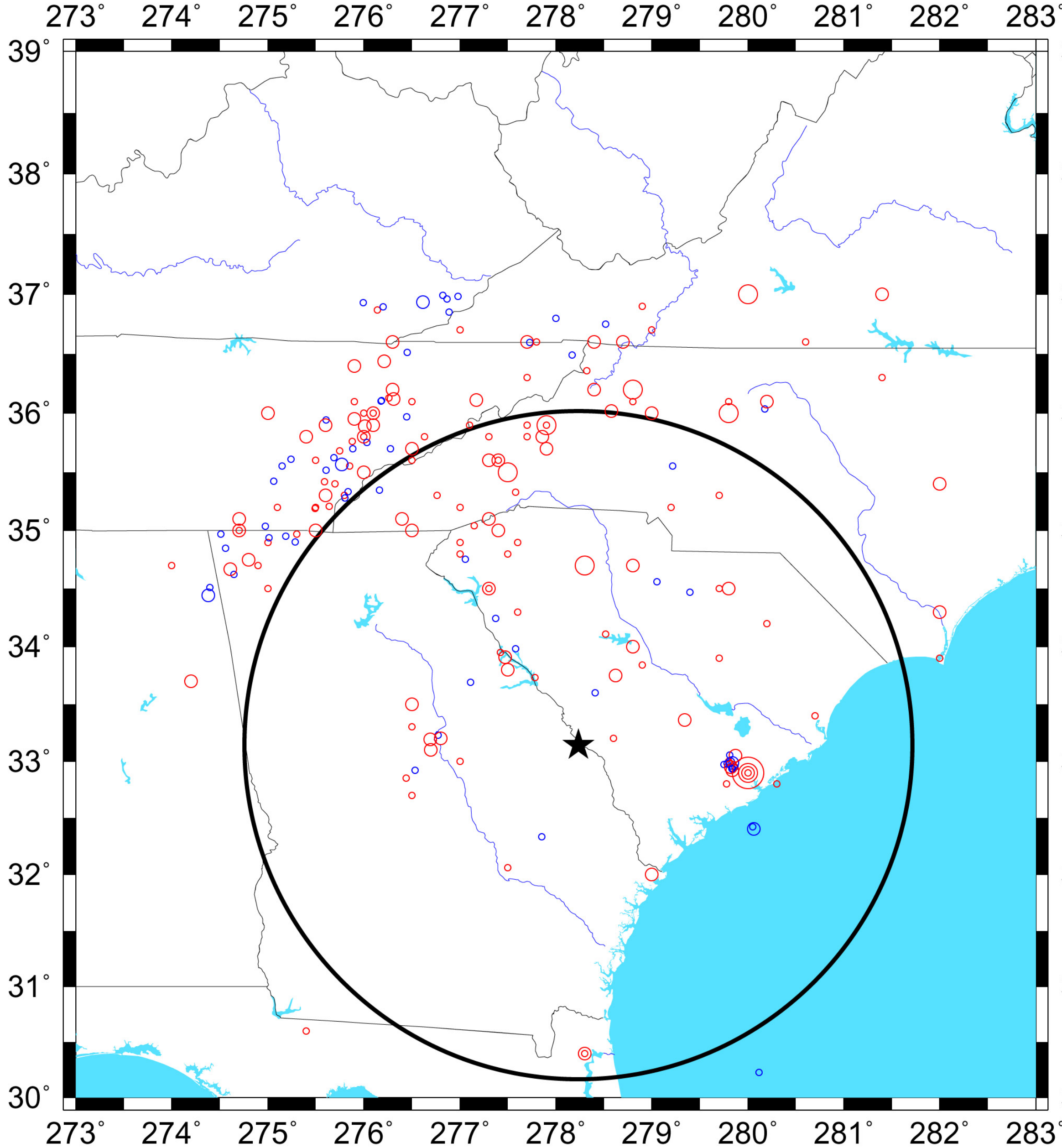


Figure 2.5.2-1 - A comparison of events (m_b greater than 3) from the EPRI historical catalog (depicted by blue circles) with events from the applicant's updated catalog (depicted by red circles). The star corresponds to the location of the ESP site and the large black circle corresponds to the 200-mi site radius.

2.5.2.2.2 Geologic and Tectonic Characteristics of the Site and Region

SSAR Section 2.5.2.2 describes the seismic sources and seismicity parameters that the applicant used to calculate the seismic ground motion hazard for the ESP site. Specifically, the applicant described the seismic source interpretations from the 1986 EPRI Project (EPRI NP-4726 1986), relevant post-EPRI seismic source characterization studies, and its updated EPRI seismic source zone for the Charleston area based on more recent data.

Summary of EPRI Seismic Sources

The applicant used the 1986 EPRI seismic source model for the CEUS as a starting point for its seismic ground motion calculations. The 1986 EPRI seismic source model is comprised of input from six independent earth science teams (ESTs), which included the Bechtel Group, Dames and Moore, Law Engineering, Rondout Associates, Weston Geophysical Corporation, and Woodward-Clyde Consultants. Each team evaluated geological, geophysical, and seismological data to develop a model of seismic sources in the CEUS. The 1989 EPRI PSHA study (EPRI NP-6395-D 1989) subsequently incorporated each of the EST models. SSAR Sections 2.5.2.2.1.1 through 2.5.2.2.1.6 provide a summary of the primary seismic sources developed by each of the six ESTs. As stated in SSAR Section 2.5.2.2.1, the 1989 EPRI seismic hazard calculations implemented screening criteria to include only those sources with a combined hazard that exceeded 99 percent of the total hazard from all sources for two ground-motion measures (EPRI NP-6395-D 1989).

Each EST representation of seismic source zones affecting the ESP site region differs significantly in terms of total number of source zones and source characterization parameters such as geometry and maximum magnitudes (and associated weights). For example, the total number of primary source zones identified by each EST ranged from 2 (Rondout Associates team) to 15 (Law Engineering team). However, all teams identified and characterized one or more seismic source zones or background sources that accounted for seismicity in the vicinity of the ESP site. In addition, all of the ESTs identified and characterized one or more seismic source zones to account for the occurrence of Charleston-type earthquakes.

SER Table 2.5.2-1 provides the sources that account for Charleston-type earthquakes. The largest maximum magnitudes (M_{max}) assigned to the Charleston source zone by each team ranged from m_b 6.8 (Law Engineering, with a weight of 1) to m_b 7.5 (Woodward-Clyde, with a weight of 0.33). This corresponds to a moment magnitude (M) range of 6.8 to 8.0.

Table 2.5.2-1 - Summary of EPRI EST Charleston Seismic Sources (Based on Information Provided in SSAR Tables 2.5.2-2 to 2.5.2-7)

EPRI EST	Source	Description	Probability of Activity	M_{max} (mb) and Weights
Bechtel	H	Charleston Area	0.50	6.8 [0.20] 7.1 [0.40] 7.4 [0.40]
	N3	Charleston Faults	0.53	6.8 [0.20] 7.1 [0.40] 7.4 [0.40]
Dames & Moore	54	Charleston Seismic Zone	1.00	6.6 [0.75] 7.2 [0.25]
Law Engineering	35	Charleston Seismic Zone	0.45	6.8 [1.0]
Rondout	24	Charleston	1.0	6.6 [0.20] 6.8 [0.60] 7.0 [0.20]
Weston	25	Charleston Seismic Zone	0.99	6.6 [0.90] 7.2 [0.10]
Woodward-Clyde	30	Charleston (includes NOTA)	0.573	6.8 [0.33] 7.3 [0.34] 7.5 [0.33]
	29	S. Carolina Gravity Saddle (Extended)	0.122	6.7 [0.33] 7.0 [0.34] 7.4 [0.33]
	29A	S. Carolina Gravity Saddle No. 2 (Combo C3)	0.305	6.7 [0.33] 7.0 [0.34] 7.4 [0.33]

Post-EPRI Seismic Source Characterization Studies

SSAR Section 2.5.2.2.2 focuses on the Charleston seismic source zone. The applicant described several PSHA studies that were completed after the 1989 EPRI PSHA, which involved the characterization of seismic sources within the ESP site region. These PSHA studies developed models of the Charleston seismic source that differed from those used in the 1989 EPRI PSHA study because they incorporated recent paleoliquefaction data. The applicant also provided its justification for not updating the EPRI seismic source parameters for the ETSZ, which is situated at the edge of the 320-km (200-mi) site region radius.

Charleston Seismic Source Zone. SSAR Section 2.5.2.2.2 describes three post-EPRI (1989) PSHA studies that characterized the seismic sources within the ESP site region. These studies include the USGS National Seismic Hazard Mapping Project (Frankel et al. 1996, 2002) and the South Carolina DOT (SCDOT) seismic hazard mapping project (Chapman and Talwani 2002). Unlike the EPRI study, these PSHA studies developed models of the Charleston seismic source that incorporated recent paleoliquefaction data.

The applicant stated that abundant soil liquefaction features induced by the 1886 Charleston earthquake, as well as other large prehistoric earthquakes that date back to the mid-Holocene (at least 5000 years), are preserved in geologic deposits at numerous locations within the 1886 meizoseismal area and along the South Carolina coast. In 2001, Talwani and Schaeffer (2001) reevaluated all of the liquefaction data previously compiled for the Charleston area and, based on recalibrated radiocarbon dates for liquefaction features, provided an estimate of earthquake recurrence for the region. Talwani and Schaeffer (2001) reinterpreted radiocarbon dates for previously published liquefaction features documented along the coast of South Carolina. Radiocarbon dates are useful in providing contemporary, minimum, and maximum limiting ages for liquefaction features. Talwani and Schaeffer (2001) recalculated previously compiled age data to account for fluctuations in atmospheric carbon-14 over time. They used the calibrated data to correlate ages of past individual earthquakes and then to estimate earthquake recurrence. Talwani and Schaeffer (2001) also identified individual earthquake episodes based on samples with a "contemporary" age constraint that had overlapping calibrated radiocarbon ages at the 68 percent (1-sigma) confidence interval. They calculated the estimated age of each earthquake from the weighted averages of overlapping contemporary ages. Talwani and Schaeffer (2001) identified a total of eight events from the paleoliquefaction record, including the 1886 Charleston event. These events are referred to as 1886, A, B, C, D, E, F, and G (in order of increasing age).

Talwani and Schaeffer (2001) proposed two scenarios to explain the distribution and timing of paleoliquefaction features (shown in SSAR Table 2.5.2-13). In Scenario 1, they interpreted events A, B, E, and G to be large Charleston-type events, while they interpreted events C, D, and F to be smaller, moderate magnitude (~**M** 6) events. In Scenario 2, Talwani and Schaeffer (2001) interpreted all events as large, Charleston-type events. In addition, they combined events C and D into a large event C' based on the observation that the calibrated radiocarbon ages that constrain the timing of Events C and D are indistinguishable at the 95 percent (2-sigma) confidence interval.

In 2002, the USGS updated the seismic hazard maps for the contiguous United States based on new seismological, geophysical, and geologic information (Frankel et al. 2002). The 2002 USGS update included modifications to the geometry, recurrence, and M_{max} of the Charleston seismic source zone. In its update, the USGS represented Charleston-type earthquakes by two equally weighted areal sources. One of these seismic source zones envelops most of the tectonic features and liquefaction data in the greater Charleston area, while the other source envelops the southern half of the southern segment of the East Coast Fault System (ECFS). Frankel et al. (2002) adopted a mean paleoliquefaction-based recurrence interval of 550 years for Charleston-type earthquakes which ranged from **M** 6.8 to 7.5.

The SCDOT model (Chapman and Talwani 2002) characterized Charleston-type earthquakes by using a combination of three equally weighted line and area sources. The SCDOT model comprises a coastal South Carolina areal source zone that includes most of the paleoliquefaction sites, a source that captures the intersection of the Woodstock and Ashley River faults, and a source that represents the southern ECFS source zone. For Charleston-type earthquakes, which ranged from **M** 7.1 to 7.5, Chapman and Talwani (2002) also adopted a mean paleoliquefaction-based recurrence interval of 550 years.

The applicant briefly mentioned the Trial Implementation Project (TIP) study in the SSAR. However, the applicant did not explicitly include the findings of this study in the SSAR because the TIP study primarily focused on the implementation of the Senior Seismic Hazard Advisory Committee (SSHAC) methodology, rather than the actual seismic hazard estimation.

Eastern Tennessee Seismic Zone. In SSAR Section 2.5.2.2.2.5, the applicant concluded that no new information regarding the ETSZ has been developed since 1986 that would require a significant revision to the original EPRI seismic source model. The applicant noted that despite being one of the most active seismic zones in Eastern North America, no evidence for larger prehistoric earthquakes, such as paleoliquefaction features, has been discovered. The largest earthquake recorded in the ETSZ was a magnitude 4.6 and occurred in 1973. The applicant also noted that a much higher degree of uncertainty is associated with the assignment of M_{max} for the ETSZ than for other CEUS seismic source zones where values of M_{max} are constrained by paleoliquefaction data.

The 1986 EPRI seismic source model (EPRI NP-4726 1986) included various source geometries and parameters to represent the seismicity of the ETSZ. All of the EPRI ESTs, except for the Law Engineering team, represented this area of seismicity with one or more local source zones. The Law Engineering team's Eastern Basement source zone included the ETSZ seismic source zone. With the exception of the Law Engineering team's Eastern Basement source, none of the other ETSZ sources contributed more than 1 percent to the site hazard, and thus were excluded from the final 1989 EPRI PSHA hazard calculations (EPRI NP-6452-D 1989).

Upper-bound $_{max}$imum values of M_{max} developed by the EPRI teams for the ETSZ ranged from **M** 4.8 to 7.5. The applicant found that M_{max} estimates for the ETSZ in more recent studies fall within the range of magnitudes captured by the EPRI model. Bollinger (1992) estimated an M_{max} of **M** 6.3, while the USGS hazard model (Frankel et al. 2002) assigned a single M_{max} value of **M** 7.5 for the ETSZ.

Updated EPRI Seismic Sources

Based on the results of several post-EPRI PSHA studies (Frankel et al. 2002; Chapman and Talwani 2002) and the availability of paleoliquefaction data (Talwani and Schaeffer 2001), the applicant updated the EPRI characterization of the Charleston seismic source zone as part of the ESP application. SSAR Section 2.5.2.2.2.4 describes how the applicant used post-EPRI information to recharacterize the source geometry, M_{max}, and magnitude recurrence for the Charleston seismic source zone. The applicant stated that it updated the Charleston seismic source zone using the guidelines provided in RG 1.165. Specifically, the applicant performed an SSHAC Level 2 study to incorporate current literature and data and the understanding of experts into an update of the Charleston seismic source model. The applicant referred to the updated model in the SSAR as the Updated Charlestown Seismic Source (UCSS) model. Bechtel (2006) describes the development of the UCSS model in greater detail.

UCSS Geometry. To represent the Charleston seismic source, the applicant developed four mutually exclusive source zone geometries. The applicant based the geometries of these four source zones, referred to as A, B, B', and C, on the following information:

- current understanding of geologic and tectonic features in the 1886 Charleston earthquake epicentral region
- the 1886 Charleston earthquake shaking intensity
- distribution of seismicity

- geographic distribution, age, and density of liquefaction features associated with both the 1886 and prehistoric earthquakes

SER Figure 2.5.2-2, reproduced from SSAR Figure 2.5.2-9, depicts the geometries of the applicant's four source zones. As shown in SER Figure 2.5.2-2, Geometry A is an approximately 100 x 50 km, northeast-oriented area centered on the 1886 Charleston meizoseismal area and envelops the following:

- the 1886 earthquake MMI X (severe damage) isoseismal (Bollinger 1977)
- the majority of identified Charleston-area tectonic features and inferred fault intersections
- the area of ongoing concentrated seismicity
- the area of greatest density for the 1886 and prehistoric liquefaction features

Based on the available geologic and seismologic evidence, the applicant concluded that Geometry A defines the area where future Charleston-type earthquakes will most likely occur. For this reason, the applicant assigned a weight of 0.70 to Geometry A in the UCSS model. However, in order to capture the uncertainty that future events may not be entirely restricted to Geometry A, the applicant developed three additional geometries, referred to as B, B', and C, that were each assigned a weight of 0.1.

As shown in SER Figure 2.5.2-2, Geometry B is a coast-parallel source, with an area of approximately 260 x 100 kilometers (161.6 x 62.1 miles), that incorporates all of Geometry A. The elongation and orientation of Geometry B roughly parallels both the regional structural grain as well as the elongation of the 1886 isoseismals (damage contours). Paleoliquefaction features mapped by Amick (1990), Amick et al. (1990a, 1990b), and Talwani and Schaeffer (2001) define the northeastern and southwestern extents of Geometry B. In addition, Geometry B extends to the southeast to include the offshore Helena Banks fault zone; offshore earthquakes in 2002 (mb 3.5 and 4.4) suggest a possible spatial association with the mapped trace of the Helena Banks fault zone. Multiple reflection profiles clearly show the Helena Banks fault, which demonstrates late Miocene (23.8 to 5.3 million years ago (mya)) offset (Behrendt and Yuan 1987).

Geometry B' is an approximately 260 x 50-km (161.6 x 31.1-mi) source area that is identical to Geometry B with the exception that Geometry B' does not include the offshore Helena Banks fault system. The applicant excluded the Helena Banks fault system from Geometry B' because the majority of data and evaluations (e.g., Behrendt and Yuan 1987) suggest that this fault system is no longer active.

Geometry C is an approximately 200 x 30-km (124.3 x 18.6-mi), north-northeast-oriented source area that envelops the southern segment of the ECFS as depicted by Marple and Talwani (2000). Both the U. S. Geological Survey (USGS) hazard model (Frankel et al. 2002) and the SCDOT hazard model (Chapman and Talwani 2002) explicitly incorporate the southern segment of the ECFS as a source zone. However, the USGS hazard model (Frankel et al. 2002) truncated the northern extent of the southern fault segment, while the SCDOT hazard model (Chapman and Talwani 2002) extended the southern segment to include, in part, the liquefaction features in southeastern South Carolina (Chapman 2005). The applicant concluded that the liquefaction features in southeastern South Carolina are captured in source zones B and B'. The applicant further concluded that the truncation of the northern extent of the southern fault segment of the ECFS in the USGS hazard model is not supported by any available data.

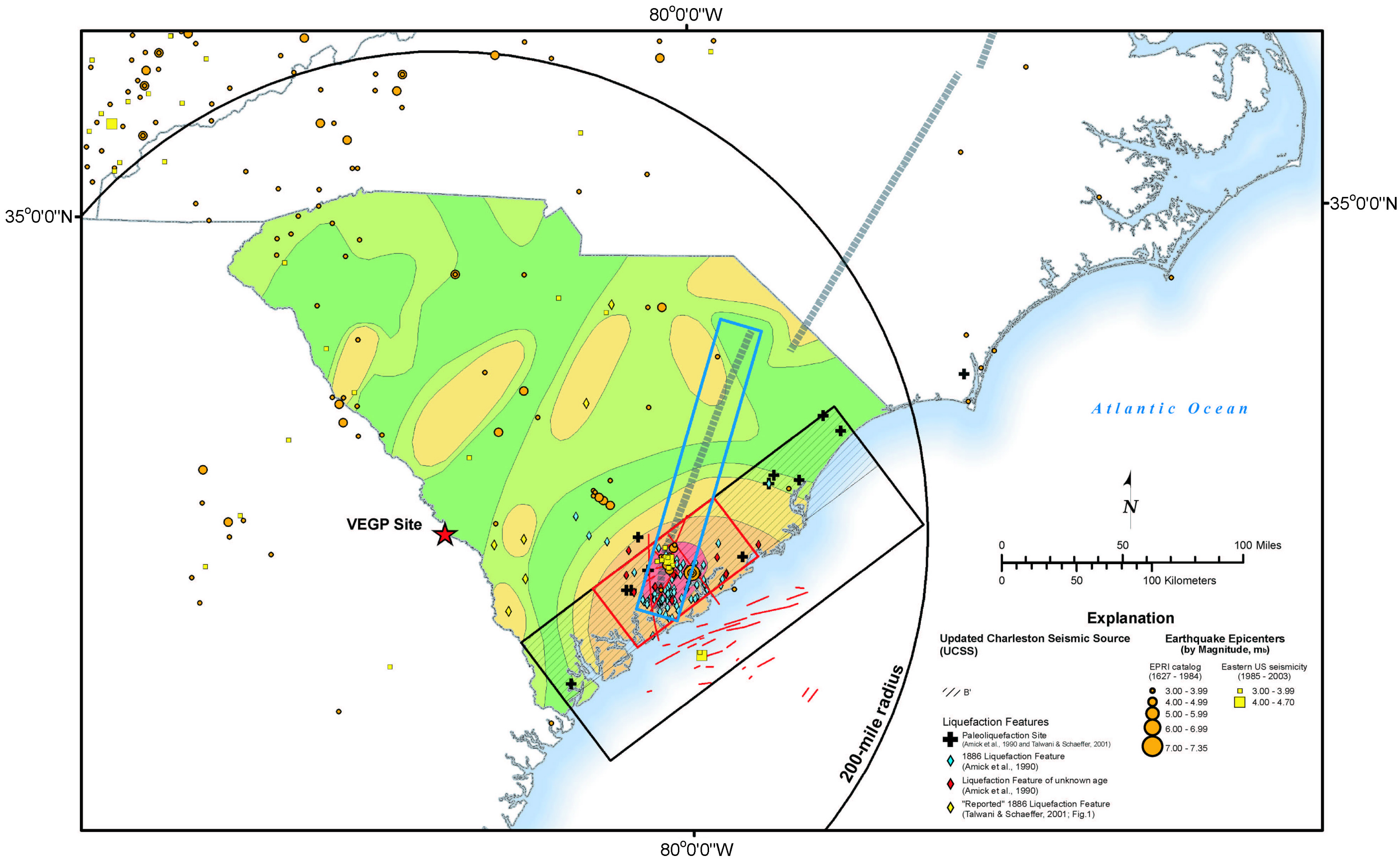


Figure 2.5.2-2 - Alternative geometries comprising the UCSS model updated Charleston seismic source (reproduced from SSAR Figure 2.5.2-9)

UCSS Maximum Magnitude. In order to define the largest earthquake that could be produced by the Charleston seismic source, the applicant stated that it developed a distribution for M_{max} based on several post-EPRI (1989) magnitude estimates for the 1886 Charleston earthquake. The applicant modified the USGS hazard model magnitude distribution (Frankel et al. 2002), shown in SER Table 2.5.2-2, to include a total of five discrete magnitude values, each separated by 0.2 M units. The applicant's M_{max} distribution included a discrete value of M 6.9 to represent the Bakun and Hopper (2004) best estimate of the 1886 Charleston earthquake magnitude, as well as a lower value of M 6.7 to capture the probability that the 1886 earthquake was smaller than the Bakun and Hopper (2004) mean estimate of M 6.9. In their study, Bakun and Hopper (2004) provide a 2-sigma range of M 6.4 to M 7.2.

Table 2.5.2-2 - Comparison of Maximum Magnitudes and Weights for the USGS and SCDOT Models with the Applicant's UCSS Model

M_{max} (M)	USGS Model Weight	SCDOT Model Weight	UCSS Model Weight
6.7	—	—	0.1
6.8	0.2	—	—
6.9	—	—	0.25
7.1	0.2	0.2	0.3
7.3	0.45	0.6	0.25
7.5	0.15	0.2	0.1

UCSS Recurrence Model. Most of the available geologic data pertaining to the recurrence of large earthquakes in the South Carolina region were published after 1990. In the absence of these data, the 1989 EPRI study (EPRI NP-6395-D) estimated the recurrence of large Charleston-type earthquakes using a truncated exponential model. The 1989 EPRI study estimated the parameters of this exponential model from historical seismicity. The recurrence of M_{max} earthquakes in the EPRI study was on the order of several thousand years, which is significantly greater than more recently published estimates of about 500 to 600 years that are based on paleoliquefaction data (Talwani and Schaeffer 2001).

To estimate recurrence for earthquakes with **M** less than 6.7, the applicant used an exponential magnitude distribution. The applicant estimated the parameters of this exponential distribution from the earthquake catalog. However, based on paleoliquefaction data, the applicant found that M_{max} earthquakes (**M** greater than 6.7) have occurred more frequently than would be implied by extrapolation of the recurrence of smaller magnitude (**M** less than 6.7) earthquakes within the UCSS. Thus, the applicant treated M_{max} events within the UCSS according to a characteristic earthquake model, which means that this source repeatedly generates earthquakes, known as characteristic earthquakes, similar in size to M_{max}. The applicant estimated the recurrence of these characteristic earthquakes from paleoliquefaction data.

The applicant stated that it further reevaluated the data presented by Talwani and Schaeffer (2001) and provided an updated estimate of earthquake recurrence. Talwani and Schaeffer (2001) used calibrated radiocarbon ages with 1-sigma error bands to define the timing of past liquefaction episodes in coastal South Carolina. However, the standard practice in paleoliquefaction studies is to use calibrated ages with 2-sigma error bands (e.g., Sieh et al. 1989; Grant and Sieh 1994; Tuttle 2001) to more accurately reflect uncertainties associated with radiocarbon dating. The applicant determined that the use of 1-sigma error bands by Talwani and Shaeffer (2001) may lead to overinterpretation of the paleoliquefaction record such that more episodes are interpreted than actually occurred. For this reason, the applicant recalibrated the radiocarbon ages presented in Talwani and Schaeffer (2001) and reported the newly recalibrated ages with 2-sigma error bands.

The applicant identified six individual paleoearthquakes, including the 1886 Charleston event, from the UCSS calibrated 2-sigma data. The applicant determined that two earthquake events (C and D) identified in the Talwani and Schaeffer (2001) 1-sigma analysis are not individually distinguishable at the 95 percent (2-sigma) confidence interval, and the applicant defined these two events as a single event, C'. The applicant also suggested that Talwani and Schaeffer (2001) events F and G likely represent a single large event, defined by the applicant as event F'. The applicant interpreted the six large paleoearthquakes (1886, A, B, C', E, and F') to represent Charleston-type events that occurred within the past ~5000 years. Furthermore, the applicant determined that results of the 2-sigma analysis suggest there have been four large earthquakes in the most recent ~2000-year (yr) portion of the earthquake record (1886, A, B, and C').

The applicant calculated two different average recurrence intervals, which represent two recurrence branches on the logic tree shown in SSAR Figure 2.5.2-11. The first average recurrence interval is based on the four events (1886, A, B, and C') that the applicant interpreted to have occurred within the past ~2000 years. The applicant concluded that this time period represents a complete portion of the paleoseismic record based on published literature (e.g., Talwani and Schaeffer 2001) and feedback from those researchers questioned (Talwani 2005; Obermeier 2005) by the applicant as part of the expert elicitation. The applicant assigned a weight of 0.8 to the logic tree branch representing the recurrence interval calculated for the 2000-yr record. The second average recurrence interval is based on events that the applicant interpreted to have occurred within the past ~5000 years and includes events 1886, A B, C', E, and F'. This time period represents the entire paleoseismic record based on available liquefaction data (Talwani and Schaeffer 2001). Published papers and researchers questioned suggest that the older part of the record (i.e., older than ~2000 years) may be incomplete. The applicant noted, however, that it may also be possible that the older record is complete but exhibits longer inter-event times. For this reason, the applicant assigned a weight of 0.2 to the logic tree branch representing the recurrence interval calculated for the 5000-yr record. The applicant indicated that the 0.80 and 0.20 weighting of the ~2000-yr and 5000-yr paleoliquefaction records, respectively, reflect the incomplete knowledge of both the short- and long-term recurrence behavior of the Charleston source.

The applicant used the methods of Savage (1991) and Cramer (2001) to calculate the mean recurrence interval for both the ~2000-yr and ~5000-yr records. According to the applicant, these methods describe the mean recurrence interval with best estimate mean Tave and an uncertainty described as a lognormal distribution with median T0.5 and parametric lognormal shape factor σ0.5. The average recurrence interval for the ~2000-yr record, based on the three most recent inter-event times (1886–A, A–B, B–C'), has a best estimate mean value of 548 years and an uncertainty distribution described by a median value of 531 years and a lognormal shape factor of 0.25. The average recurrence interval for the ~5000-yr record, based on five inter-event times (1886–A, A–B, B–C', C'–E, E–F'), has a best estimate mean value of 958 years and an uncertainty distribution described by a median value of 841 years and a lognormal shape factor of 0.51.

The applicant modeled earthquakes in the exponential part of the distribution as point sources uniformly distributed within the source area, with a constant depth fixed at 10 kilometers. For the characteristic model, the applicant represented source zone Geometries A, B, B', and C by a series of closely spaced, vertical, northeast-trending faults parallel to the long axis of each source zone.

2.5.2.2.3 Correlation of Earthquake Activity with Seismic Sources

SSAR Section 2.5.2.3 describes the correlation of updated seismicity with the EPRI seismic source model. The applicant compared the distribution of earthquake epicenters from both the original EPRI historical catalog (1627–1984) and the updated seismicity catalog (1985–2005) with the seismic sources characterized by each of the EPRI ESTs. Based on this comparison, the applicant concluded that there are no new earthquakes within the site region that can be associated with a known geologic structure. In addition, it concluded that there are no clusters of seismicity that would suggest a new seismic source not captured by the EPRI seismic source model. The applicant also concluded that the updated catalog does not show a pattern of seismicity that would require significant revision to the geometry of any of the EPRI seismic sources. The applicant further stated that the updated catalog does not show or suggest an increase in M_{max} or a significant change in seismicity parameters (activity rate, b-value) for any of the EPRI seismic sources.

2.5.2.2.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes

SSAR Section 2.5.2.4 presents the results of the applicant's PSHA for the ESP site. PSHA is an acceptable method to estimate the likelihood of earthquake ground motions occurring at a site (RG 1.165 and RG 1.208). The hazard curves generated by the applicant's PSHA represent generic hard rock conditions (characterized by a shear- (S-) wave velocity of 9200 feet per second (ft/s)). In SSAR Section 2.5.2.4, the applicant also described the earthquake potential for the site in terms of the most likely earthquake magnitudes and source-site distances, which are referred to as controlling earthquakes. The applicant determined the low-and high-frequency controlling earthquakes by deaggregating the PSHA at selected probability levels. Before determining the controlling earthquakes, the applicant updated the original 1989 EPRI PSHA (EPRI NP-6395 1989) using the seismic source zone adjustments, described in SER Section 2.5.2.1.2, and the new ground motion models described below.

PSHA Inputs

Before performing the PSHA, the applicant updated the original 1989 EPRI PSHA inputs using the seismic source zone adjustments described in SSAR Section 2.5.2.2. In addition, the applicant used the updated 2004 EPRI (EPRI 1009684) ground motion models instead of the EPRI NP-6395-D (1989) ground motion models, which were used in the original 1989 EPRI PSHA.

Seismic Source Model

To update the original EPRI model, the applicant removed all of the sources identified as a Charleston source from each of the six EPRI EST models. SER Table 2.5.2-1 lists these sources. The applicant then incorporated its four UCSS alternative source geometries, M_{max}, and recurrence distributions into each of the six EST models. The applicant explained that in most cases, this involved replacing a single Charleston source with four alternative Charleston sources.

The applicant used an exponential magnitude distribution to model smaller earthquakes (**M** less than 6.7) within the UCSS. To calculate the activity rate and b-value for this distribution, the applicant used the same methodology and smoothing assumptions that were used in the 1989 EPRI study. However, the applicant calculated these seismicity parameters using the new geometries of the UCSS along with the updated seismicity catalog (through April 2005). Because old and new source geometries are not coincident, the applicant allowed the portions of "old" EPRI sources that fell outside of the new UCSS source geometries to default to the existing EPRI background sources. According to the applicant, this ensured that no areas in the seismic hazard model were aseismic. For the unmodified sources of the 1989 EPRI PSHA, the applicant used the original seismicity rates from the 1988 EPRI (EPRI NP-4726-A 1988) earthquake catalog (through 1984) in its seismic hazard calculations.

To determine whether the seismicity rates used in the 1989 EPRI PSHA (EPRI NP-6395-D 1989) are appropriate for the assessment of the seismic hazard at the ESP site, the applicant assessed seismicity rates for two sources in the site region: 1) a small rectangular source around the Charleston seismicity; and (2) a triangular-shaped source representing seismicity in South Carolina and a strip of Georgia that incorporates the ESP site. The applicant stated that it selected these sources because they contribute the most to the seismic hazard at the ESP site.

The applicant investigated the seismicity rates in the two sources by running the program EQPARAM (from the EPRI EQHAZARD package) first for the original EPRI catalog and then for the updated EPRI catalog (through April 2005). The applicant used the a- and b-values obtained from EQPARAM to calculate the recurrence rates for different earthquake magnitudes. For the rectangular Charleston source, the applicant concluded that the seismicity rates remain the same when the seismicity from 1985 to April 2005 is added. For the triangular South Carolina source, the applicant concluded that the seismicity rates decrease when the seismicity from 1985 to April 2005 is added.

The applicant concluded that the seismicity recorded since 1984 does not indicate that seismic activity rates have increased in those sources contributing most to the hazard at the ESP site, under the assumptions of the 1989 EPRI PSHA. Based on the review of geological and seismological data published since the 1986 EPRI Project (EPRI NP-4726), presented in SSAR Section 2.5.2, the applicant concluded that, with the exception of the Charleston seismic source, there are no significant changes to the original EPRI M_{max} values. SSAR Section 2.5.2.2.2 discusses the applicant's modifications to M_{max} for the Charleston seismic source.

Ground Motion Models

The applicant used the ground-motion models developed by the 2004 EPRI-sponsored study (EPRI 1009684 2004) for the updated PSHA. For general area sources, the applicant combined 9 estimates of median ground motion with 4 estimates of aleatory uncertainty, which resulted in 36 combinations. For fault sources in rifted regions (which apply to the East Coast Fault System [ECFS] fault segments), the applicant combined 12 estimates of median ground motion with four estimates of aleatory uncertainty, resulting in 48 combinations.

The applicant compared the EPRI NP-6395 (1989) ground motion model with the EPRI 1009684 (2004) ground motion models. The differences between the two models are a function of magnitude, distance, and structural frequency. The applicant stated that in general, the median ground-motion amplitudes are similar at high frequencies. At low frequencies, the EPRI 1009684 (2004) models show lower median ground motions because these models incorporate the possibility of a double-corner source model. However, the applicant stated that the EPRI 1009684 standard deviations are universally higher than those of EPRI NP-6395.

PSHA Methodology and Calculation

For the PSHA calculation, the applicant used the Risk Engineering, Inc. FRISK88 seismic hazard code. The applicant first performed a PSHA using the original 1989 EPRI primary seismic sources and ground-motion models in order to validate FRISK88 against the EPRI software EQHAZARD. The applicant compared the results from FRISK88 with the original EPRI hard rock results. The applicant determined that a comparison of the mean hazard curves for peak ground acceleration (PGA) generally agrees to within 5.1 percent for amplitudes up to 1 g.

Using the updated EPRI seismic source characteristics and new ground-motion models as inputs, the applicant performed PSHA calculations for PGA and spectral acceleration at frequencies of 25, 10, 5, 2.5, 1, and 0.5 hertz (Hz). Following the guidance provided in RG 1.165, the applicant performed PSHA calculations assuming generic hard rock site conditions (i.e., an S-wave velocity of 9200 ft/s). The applicant incorporated the effects of the ESP site geology into its calculation of the SSE spectrum, which uses the hard rock PSHA results as a starting point.

PSHA Results

To determine the low- and high-frequency controlling earthquakes for the ESP site, the applicant followed the procedure outlined in Appendix C to RG 1.165. This procedure involves the deaggregation of the PSHA results at a target probability level to determine the controlling earthquake in terms of a magnitude and source-to-site distance. The applicant chose to perform the deaggregation of the mean 10^{-4}, 10^{-5}, and 10^{-6} PSHA hazard results. SER Figure 2.5.2-3 shows the results of the applicant's high-frequency (5 to 10 Hz) 10^{-4} hazard deaggregation, while SER Figure 2.5.2-4 shows the results of the low-frequency (1 to 2.5 Hz) 10^{-4} hazard deaggregation. The staff did not show the applicant's deaggregation plots for the 10^{-5} and 10^{-6} mean hazard levels because of their similarity to the 10^{-4} deaggregation plot shown in SER Figures 2.5.2-3 and 2.5.2-4.

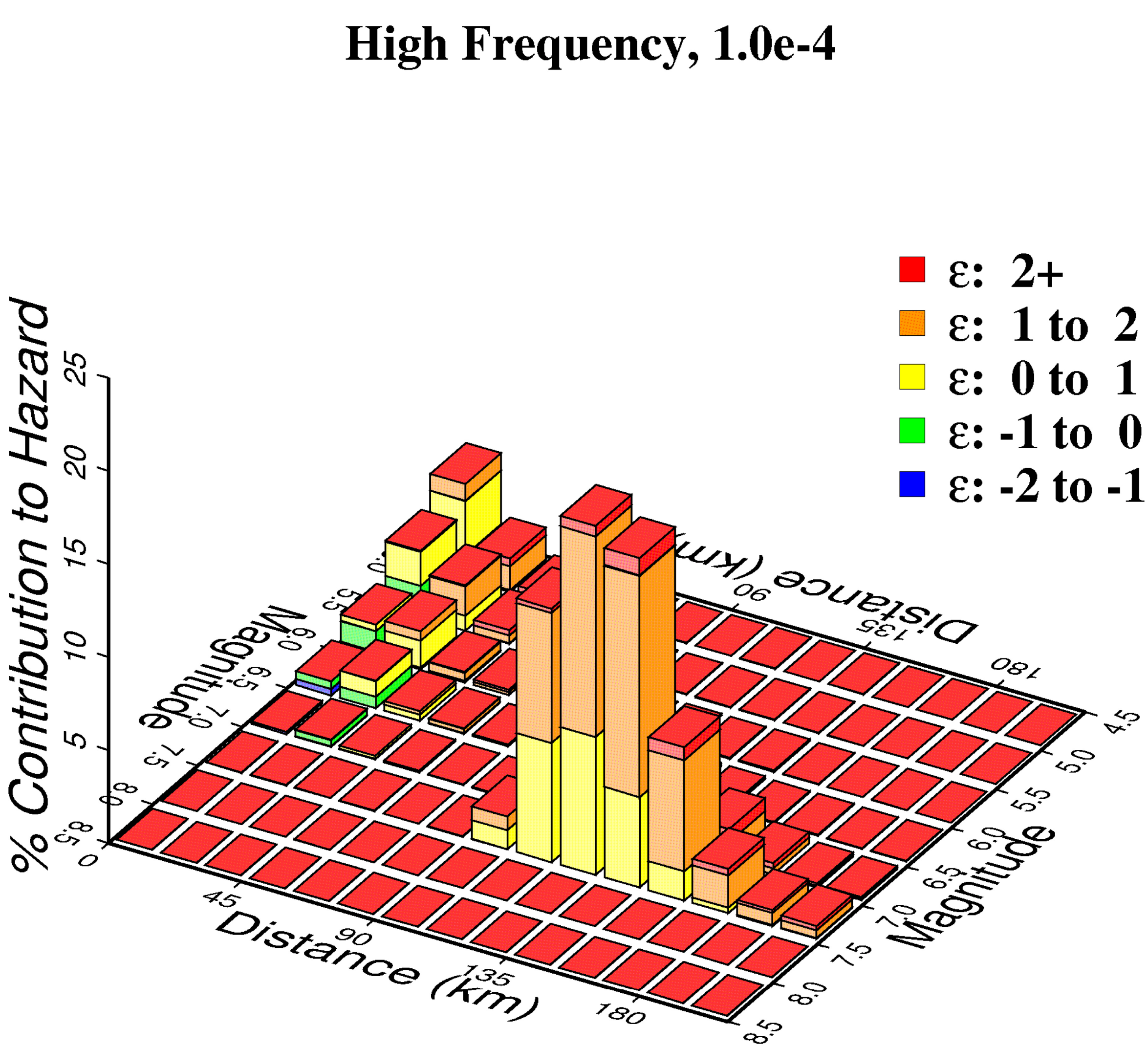


Figure 2.5.2-3 - High-frequency (5 to 10 Hz) 10^{-4} hazard deaggregation (reproduced from SSAR Figure 2.5.2-22)

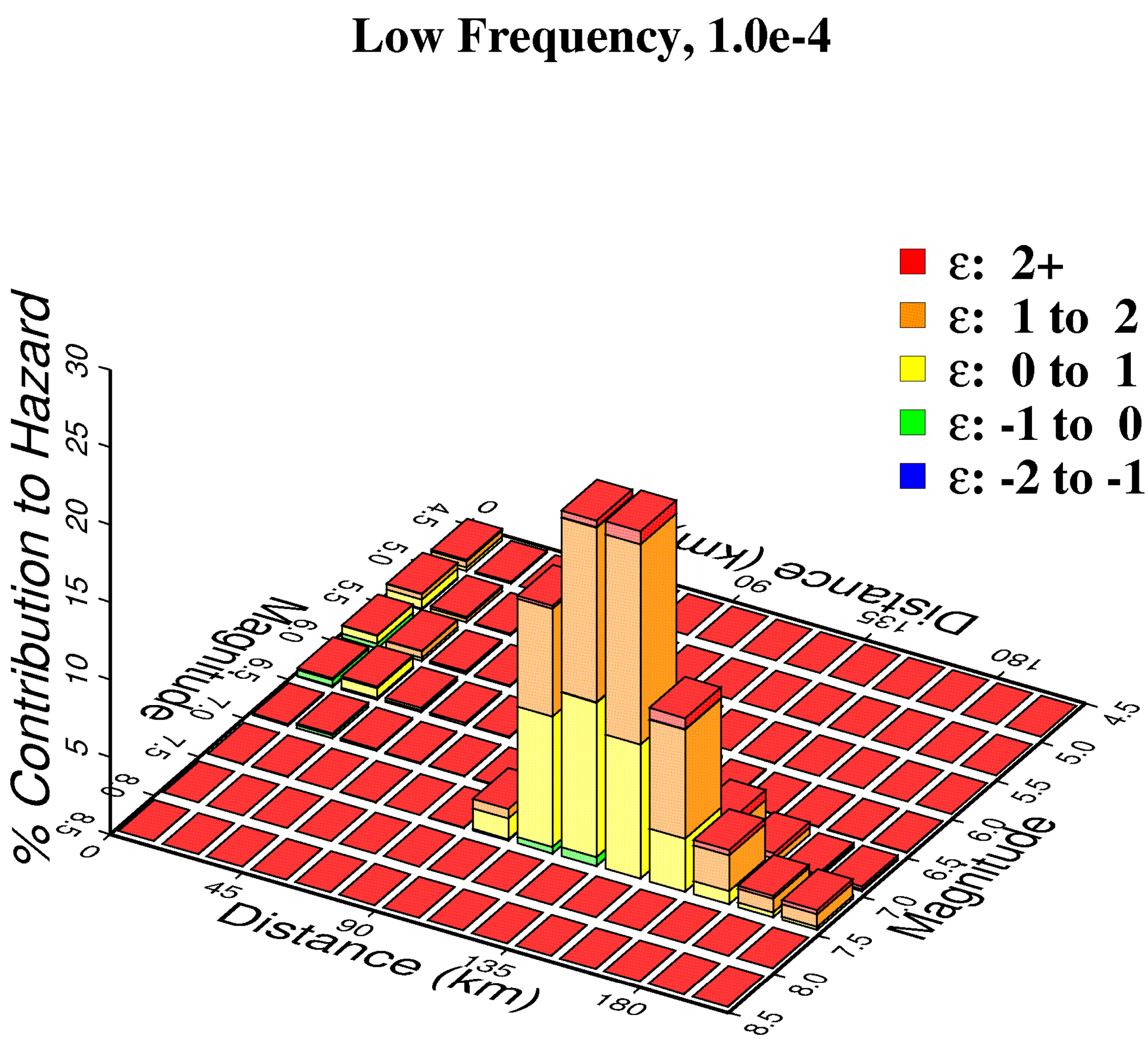


Figure 2.5.2-4 - Low-frequency (1 to 2.5 Hz) 10^{-4} hazard deaggregation (reproduced from SSAR Figure 2.5.2-23)

Because of the similarity of the mean magnitude (Mbar) and mean distance (Dbar) values for the three hazard levels, the applicant selected a single Mbar and Dbar value for each frequency range. SER Table 2.5.2-3 provides the Mbar and Dbar values for the high- and low-frequency controlling earthquakes corresponding to the 10^{-4}, 10^{-5}, and 10^{-6} hazard levels. SER Table 2.5.2-3 also provides the applicant's final Mbar and Dbar values for the high- and low-frequency controlling earthquakes. For the high-frequency mean 10^{-4}, 10^{-5}, and 10^{-6} hazard, the controlling earthquake, based on the final Mbar and Dbar pair, is an **M** 5.6 event occurring at a distance of 12 kilometers (7.5 miles), corresponding to an earthquake from a local seismic source zone. For the low-frequency mean 10^{-4}, 10^{-5}, and 10^{-6} hazard, the controlling earthquake is an **M** 7.2 event and occurs at a distance of 130 kilometers (80.8 miles). This earthquake corresponds to an event in the Charleston seismic zone.

Table 2.5.2-3 - Computed and Final Mbar and Dbar Values Used for Development of High- and Low-Frequency Target Spectra (Based on the Information Provided in SSAR Table 2.5.2-17)

High Frequency (5 to 10 Hz)				
Mean Hazard Level	10^{-4}	10^{-5}	10^{-6}	Final Values
Mbar (M)	5.5	5.6	5.6	5.6
Dbar	17.7 km (11 mi)	11.5 km (7.1 mi)	9.1 km (5.7 mi)	12 km (7.5 mi)
Low Frequency (1 to 2.5 Hz)				
Mean Hazard Level	10^{-4}	10^{-5}	10^{-6}	Final Values
Mbar (M)	7.2	7.2	7.2	7.2
Dbar	136.5 km (84.8 mi)	134.3 km (83.5 mi)	132.9 km (82.6 mi)	130 km (80.8 mi)

2.5.2.2.5 Seismic Wave Transmission Characteristics of the Site

SSAR Section 2.5.2.5 describes the method used by the applicant to develop the site free-field soil uniform hazard response spectrum (UHRS). The hazard curves generated by the PSHA are defined for generic hard rock conditions (characterized by an S-wave velocity of 9200 ft/s). According to the applicant, these hard rock conditions exist at a depth of more than 2000 feet below the ground surface at the ESP site. To determine the soil UHRS, the applicant: (1) developed soil/rock profile models for the ESP site; (2) selected seed earthquake time histories; and (3) performed the final site response analysis.

Site Response Model

According to the applicant, the soil profile to a depth of approximately 1049 feet at the ESP site consists of approximately 86 feet of predominantly sands, silty sands, and clayey sands, with occasional clay seams, referred to as the Upper Sand Stratum (Barnwell Group). At the base of this sand unit is a Shelly Limestone (Utley Limestone), which is characterized by solution channels, cracks, and discontinuities. Beneath the Utley limestone is the Blue Bluff Marl (Lisbon Formation), consisting of approximately 64 feet of slightly sandy, cemented calcareous clay. The Blue Bluff Marl is underlain by approximately 900 feet of fine-to-coarse sand with interbedded silty clay and clayey silt, referred to as the Lower Sand Stratum. The Lower Sand Stratum comprises the Still Branch, Congaree, Snapp, Black Mingo, Steel Creek, Gaillard/Black Creek, Pio Nono, and Cape Fear formations.

According to the applicant, the rock profile at the ESP site, below approximately 1049 feet, consists of the Dunbarton Triassic (206–24 mya) basin followed by Paleozoic (543–248 mya) crystalline rock. The Dunbarton Triassic basin rock comprises red sandstone, breccia, and mudstone and is characterized by a weathered zone in the upper 120 feet. The Paleozoic crystalline basement is characterized by a high S-wave velocity (greater than 9200 ft/s). The Pen Branch fault forms the boundary between the Dunbarton Triassic basin and the Paleozoic basement rock. As described in SSAR Section 2.5.1, the Pen Branch fault dips to the southeast at an angle of 45 degrees below the ESP site.

The soil/rock profile model used by the applicant for its site response analysis is shown in SSAR Figure 2.5.4-7 and SSAR Table 2.5.4-11. The uppermost competent in-situ layer is the Blue Bluff Marl, which is encountered at a depth of 86 feet and characterized by an average S-wave velocity of 2354 ft/sec. Note that SSAR Figure 2.5.4-7 and SSAR Table 2.5.4-11 do not show the Barnwell Group and Utley Limestone. The applicant intends to remove the incompetent Barnwell Group (and the underlying Utley Limestone) because it is susceptible to liquefaction and dissolution-related ground deformation. Furthermore, its S-wave velocity is generally below 1000 ft/s. Thus, in its site response calculations, the applicant assumes that these layers have been replaced with 86 feet of structural backfill.

SSAR Figure 2.5.4-7 shows S-wave velocities for each of the different soil and rock layers to a maximum depth of 2275 feet. The applicant based this S-wave velocity profile on the results of suspension primary and secondary (P-S) velocity and seismic cone penetrometer tests (CPTs) performed at the ESP site, as well as deep borehole S-wave velocity data from the Savannah River Site (SRS 2005). The applicant did not determine S-wave velocity for the compacted backfill as part of the ESP subsurface investigation. Instead, the applicant relied on data for existing Units 1 and 2. To represent the variability of the depth to the top of the Paleozoic crystalline basement, where the S-wave velocity is at least 9200 ft/s, the applicant developed six alternative site response profiles, which are provided in Part B of SER Table 2.5.4-11. For the six alternative profiles, the depth to the top of the Paleozoic crystalline rock ranged from 1525 feet to 2275 feet. According to the applicant, the six alternative site response profiles also accounted for the uncertainty of the S-wave velocity gradient between the top of the unweathered section of the Dunbarton Triassic basin to the top of the Paleozoic crystalline rock. In its site response model, the applicant used the PSHA rock motions at the top of the Paleozoic crystalline rock as input.

The applicant collected additional S-wave velocity data as part of the COL site investigation. This data is described in detail in SSAR Section 2.5.4.4 and is referred to as “COL” data by the applicant. The applicant used the SASW (Spectral Analysis of Surface Waves) and cross-hole methods, and the results of Resonant Column and Torsional Shear (RCTS) tests to determine the S-wave velocity of the proposed backfill. The applicant also determined the S-wave velocity of the Blue Bluff Marl and the Still Branch, Congaree, and Snapp Formations of the Lower Sand Stratum using down-hole seismic CPT tests and suspension P-S velocity tests, combined these data with two ESP profiles (located in the powerblock area of Units 3 and 4) and averaged the results. The applicant then developed an S-wave velocity profile for soil (i.e. to a depth of 1059 ft). The resulting S-wave velocity profile is presented in SSAR Table 2.5.4-11a and SSAR Figure 2.5.4-7a. Because the COL S-wave velocity measurements only extended to a maximum depth of 420 feet below ground surface, the applicant incorporated the S-wave velocity data from the ESP profile (provided in SSAR Table 2.5.4-11 and SSAR Figure 2.5.4-7) below this depth.

The applicant did not use the additional COL S-wave velocity profile as input to its site response calculations. Instead, the applicant provided justification that the use of only the ESP S-wave velocity profile is adequate. In SSAR Section 2.5.4.7.5, the applicant presented a comparison of the ESP and COL S-wave velocity profiles. Based on the comparison of the two S-wave velocity profiles shown in SSAR Figure 2.5.4-7a, the applicant concluded that there is good agreement between the two data sets. Furthermore, based on the results of site response sensitivity studies presented in SSAR Section 2.5.2.9, the applicant concluded that the difference in the amplification between the ESP and COL data is small.

The strain-dependent shear modulus and damping relationships used by the applicant for the soil units at the ESP site are based on EPRI TR-102293 (1993). The applicant also used the strain-dependent shear modulus and damping relationships developed for the nearby SRS by Lee (1996). For the Dunbarton Triassic basin and Paleozoic crystalline rocks, the applicant assumed linear behavior during earthquake shaking with 1-percent damping.

As part of the COL site investigation, the applicant also developed strain-dependent shear modulus and damping relationships based on RCTS tests performed on compacted backfill, Blue Bluff Marl, and Lower Sand samples. The resulting site-specific shear modulus reduction curves are provided in SSAR Table 2.5.4-12a and SSAR Figure 2.5.4-9a, while the site specific damping curves are provided in SSAR Table 2.5.4-12a and SSAR Figure 2.5.4-11a. Although the applicant relied only on the generic EPRI and SRS strain-dependent shear modulus and damping relationships as input to its site response calculations, the applicant presented a comparison with the site-specific relationships in SSAR Figures 2.5.4-19a through 2.5.4-20c. Specifically, SSAR Figures 2.5.4-19a, 19b, and 19c compare the normalized shear modulus reduction versus shear strain curves for the compacted backfill, Blue Bluff Marl, and Lower Sands, respectively. SSAR Figures 2.5.4-20a, 20b, and 20c compare damping versus shear strain for the same units. In SSAR Section 2.5.4.7.5, the applicant stated that generally, the figures suggest that the subsurface soils behave more linearly (i.e. provide a smaller reduction in shear modulus and less damping) than both the generic EPRI and SRS relationships. However, the applicant's site response sensitivity studies, described in SSAR Section 2.5.2.9, resulted in small differences in amplification between the ESP and COL data.

The applicant stated that once it determined the appropriate soil and rock dynamic properties, it modeled the variability present in the site data by randomizing the soil and rock S-wave velocity profiles, soil shear modulus reduction and damping relationships, and rock-damping values. For each family of degradation curves (i.e., EPRI or SRS), the applicant generated 60 randomized soil/rock profiles to account for the variability in the site properties. The applicant generated the 60 randomized soil/rock profiles using the stochastic model described in EPRI TR-102293 (1993) and Toro (1996). Inputs to the applicant's stochastic model include the base-case soil and rock profiles provided in SSAR Table 2.5.4-11, as well as the depth to bedrock, which the applicant randomized to account for the range of depths associated with the Pen Branch fault. For each randomized velocity profile, the applicant developed one set of randomized shear modulus reduction and damping curves from the EPRI family of curves and another set from the SRS family of curves.

To account for the variability in soil shear strain modulus and material-damping ratio with shearing strain amplitude, the applicant randomized the shear modulus reduction and damping curves used for the site response analysis. For each of the randomized velocity profiles, the applicant developed one set of randomized shear modulus reduction and damping curves for each family of degradation curve (i.e., EPRI or SRS). Inputs to the applicant's model include the base-case shear modulus reduction and damping curves provided in SSAR Tables 2.5.4-12 and 2.5.4-13 and shown in SSAR Figures 2.5.4-9 to 2.5.4-12. The applicant stated that it also accounted for the uncertainty in damping ratio for the Dunbarton Triassic basin rock, which is represented by a 5- to 95-percentile range of 0.7 to 1.5 percent.

Site Response Input Time Histories

The applicant developed target spectra for two different frequency ranges, high-frequency (5 to 10 Hz) and low-frequency (1 to 2.5 Hz), as defined in RG 1.165. These high- and low-frequency target response spectra represent the Mbar and Dbar values from the deaggregation of the 10^{-4}, 10^{-5}, and 10^{-6} hazard curves. For the high-frequency cases, the applicant considered only those sources within 105 kilometers of the site to compute the Mbar and Dbar values. To compute the low-frequency Mbar and Dbar values, the applicant only considered sources at distances greater than 105 kilometers from the site. The applicant noted that this distinction was made based on the dominance of the Charleston source for low frequencies and long return periods.

Because of the similarity of the calculated Mbar and Dbar values for the three hazard levels, the applicant selected a single Mbar and Dbar pair to represent the high-frequency controlling earthquake and a single Mbar and Dbar pair to represent the low-frequency controlling earthquake. SER Table 2.5.2-3 provides the final Mbar and Dbar values used for the development of the high- and low-frequency target spectra.

Using the final high- and low-frequency Mbar and Dbar values, described above, the applicant developed target response spectra using the log-average of the single and double corner CEUS spectral shape models of NUREG/CR-6728 (Technical Basis for Revision of Regulatory Guidance of Design Ground Motions: Hazard- and Risk- Consistent Ground Motion Spectra Guidelines). The applicant scaled the low-frequency spectral shape to the corresponding UHRS (i.e., 10^{-4}, 10^{-5} or 10^{-6}) at 1.75 and scaled the high-frequency spectral shape to the corresponding UHRS at 7.5 Hz. SER Figure 2.5.2-5 shows the resulting high- and low-frequency target response spectra for the 10^{-4} mean hazard level. The applicant also developed target response spectra for the 10^{-5} and 10^{-6} hazard levels.

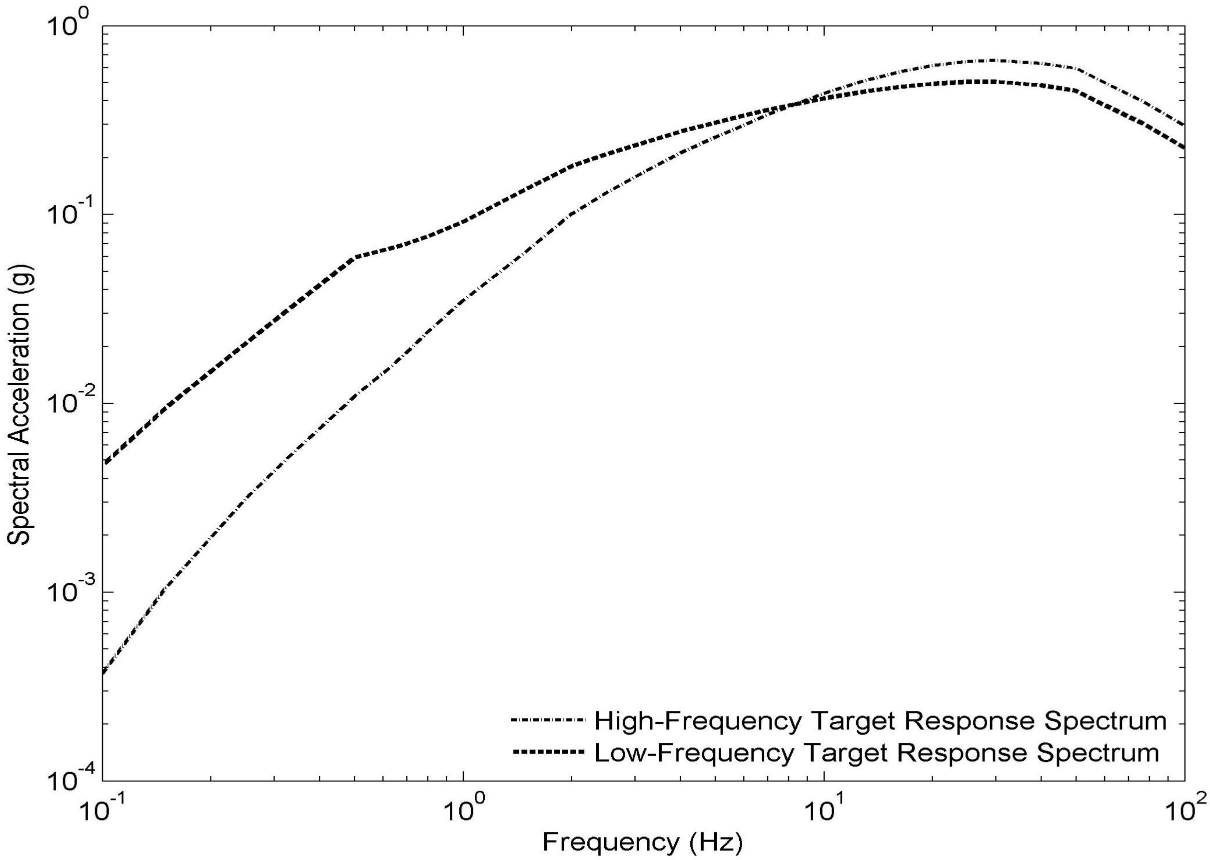


Figure 2.5.2-5 - Low- and high-frequency target response spectra representing the 10^{-4} hazard level (based on the information provided in SSAR Tables 2.5.2-20a, and 2.5.2-20b).

To determine the ESP dynamic site response, the applicant spectrally matched a suite of acceleration time histories to the six target response spectra described above. The applicant selected strong motion acceleration time histories that were recorded at rock-site locations in the Western United States (WUS), Eastern Canada, Turkey, and Japan. Specifically, the applicant selected time histories recorded at sites characterized by S-wave velocities greater than 600 meters per second (m/s) (1968.5 ft/s) in the upper 30 meters (98.4 feet) and similar magnitudes and distances to the final high- and low-frequency Mbar and Dbar values.

The applicant spectrally matched a total of 30 seed time histories to the low-frequency target response spectra corresponding to the 10^{-4}, 10^{-5}, and 10^{-6} mean hazard levels. The applicant spectrally matched a different group of 30 seed time histories to the high-frequency target response spectra representing the 10^{-4}, 10^{-5}, and 10^{-6} mean hazard levels. The applicant used the spectral matching criteria recommended in NUREG/CR-6728 to check the average spectrum from the 30 spectrally matched time histories for a given frequency range and mean hazard level.

Site Response Methodology and Calculation

To determine the final site response, the applicant used the program SHAKE to compute the site amplification functions (AFs) for each of the spectrally matched time histories. As shown in SER Table 2.5.2-4, for each hazard level (10^{-4}, 10^{-5}, and 10^{-6}) and for each deaggregation earthquake (high- and low-frequency), the applicant paired the 60 randomized soil profiles corresponding to the EPRI curves and the 60 randomized soil profiles representing the SRS curves with the 30 spectrally matched time histories. The applicant applied each time history to two of the randomized soil/rock profiles, which resulted in a total of 240 AFs for each of the three mean hazard levels.

Table 2.5.2-4 - Site Response Analyses Performed (Based on the Information Provided in SSAR Table 2.5.2-19)

Mean Hazard Level	10^{-4}		10^{-5}		10^{-6}		Total Number of Analyses
Deaggregation Earthquake	High Freq.	Low Freq.	High Freq.	Low Freq.	High Freq.	Low Freq.	
Number of Input Time Histories	30	30	30	30	30	30	
Number of Randomized Soil Profiles (EPRI)	60	60	60	60	60	60	360
Number of Randomized Soil Profiles (SRS)	60	60	60	60	60	60	360
							720

Site Response Results

To obtain the final site AFs, the applicant divided the output response spectrum (defined at the top of the backfill) by the hard rock input response spectrum for each of the cases shown in SER Table 2.5.2-4. For the 10^{-4} mean hazard level, the applicant computed the mean of the 60 individual AFs corresponding to the high-frequency input time histories and the EPRI-based randomized soil profiles. The applicant repeated this process for the SRS-based randomized soil profiles. The applicant's final high-frequency AF (shown in the lower plot of SER Figure 2.5.2-6) corresponds to the mean of these two results. The applicant developed the final low-frequency AF in a similar manner and this is also shown in SER Figure 2.5.2-6 (upper plot). According to the applicant's results, the ESP site subsurface amplifies the high-frequency input hard rock motion over the fairly wide frequency range of 0.1 to ~25 Hz, with the maximum amplification of 3.8 at a frequency of 0.6 Hz. The applicant's results also show that the low-frequency input hard rock motion is amplified over the frequency range of 0.1 to ~20 Hz, with the maximum amplification of 4.0 at a frequency of 0.6 Hz.

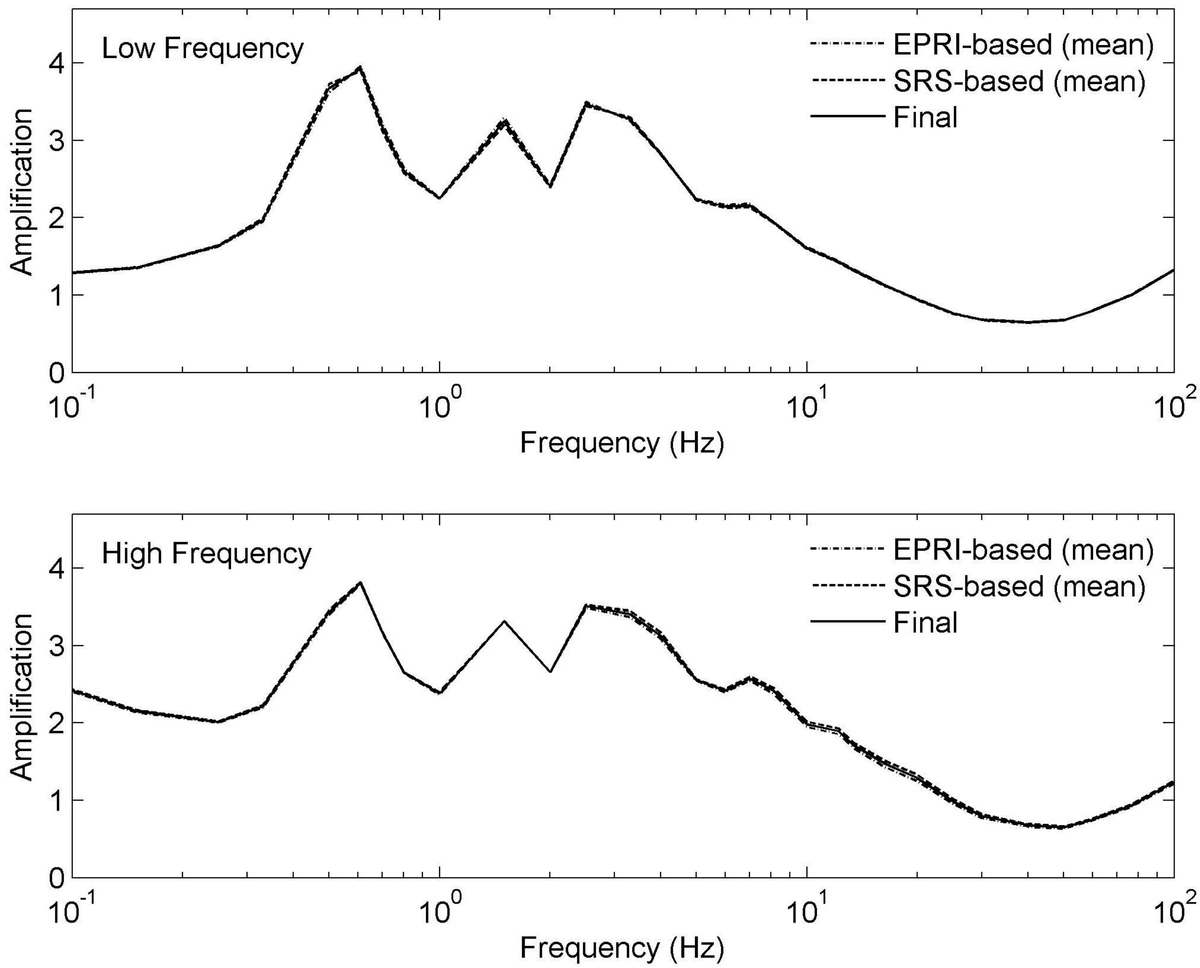


Figure 2.5.2-6 - Final EPRI and SRS high- and low-frequency AFs for the 10^{-4} hazard level (based on the information provided in SSAR Tables 2.5.2-20e and 2.5.2-20f)

The applicant determined the final 10-4 soil surface spectrum for the ESP site by scaling the hard rock UHRS (shown in SER Figure 2.5.2-5) by the final AFs (shown in SER Figure 2.5.2-6). The applicant defined each of the AFs at a total of 300 frequencies, but only defined the hard rock UHRS at 7 structural frequencies. For this reason, the applicant interpolated the hard rock UHRS at values between the 7 structural frequencies using the high- and low-frequency spectral shapes for hard rock from NUREG/CR-6728. The applicant's choice of the high- or low-frequency spectral shape for the interpolation depended on the envelope motion. The applicant defined the envelope motion as the envelope of the high- and low-frequency mean output response spectra (defined at the top of the soil column). The applicant noted that at frequencies above 8 Hz, this is always the HF motion and at frequencies below 2 Hz, this is always the LF motion. The applicant further noted that at frequencies between 2 and 8 Hz, the envelope motion depended on the frequency.

Next, the applicant multiplied the hard rock UHRS (now defined at 300 structural frequencies) by either the high- or low-frequency final amplification factors (shown in SER Figure 2.5.2-6). The applicant multiplied the hard rock UHRS by the low-frequency mean amplification factor if it used low-frequency spectral shape to interpolate the hazard rock UHRS at that structural frequency. If the applicant used the high-frequency spectral shape to interpolate the hard rock

UHRS at that frequency, then it multiplied the hard rock UHRS by the high-frequency mean AF. The applicant stated that at some intermediate frequencies between 2 and 8 Hz, the high- and low- frequency AFs are weighted in order to achieve a smooth transition between HF and LF spectra.

The applicant repeated the above process for the 10^{-5} hazard level to determine the final 10^{-5} soil UHRS. SER Figure 2.5.2-7 provides the final soil UHRS for the 10^{-4} and 10^{-5} hazard levels.

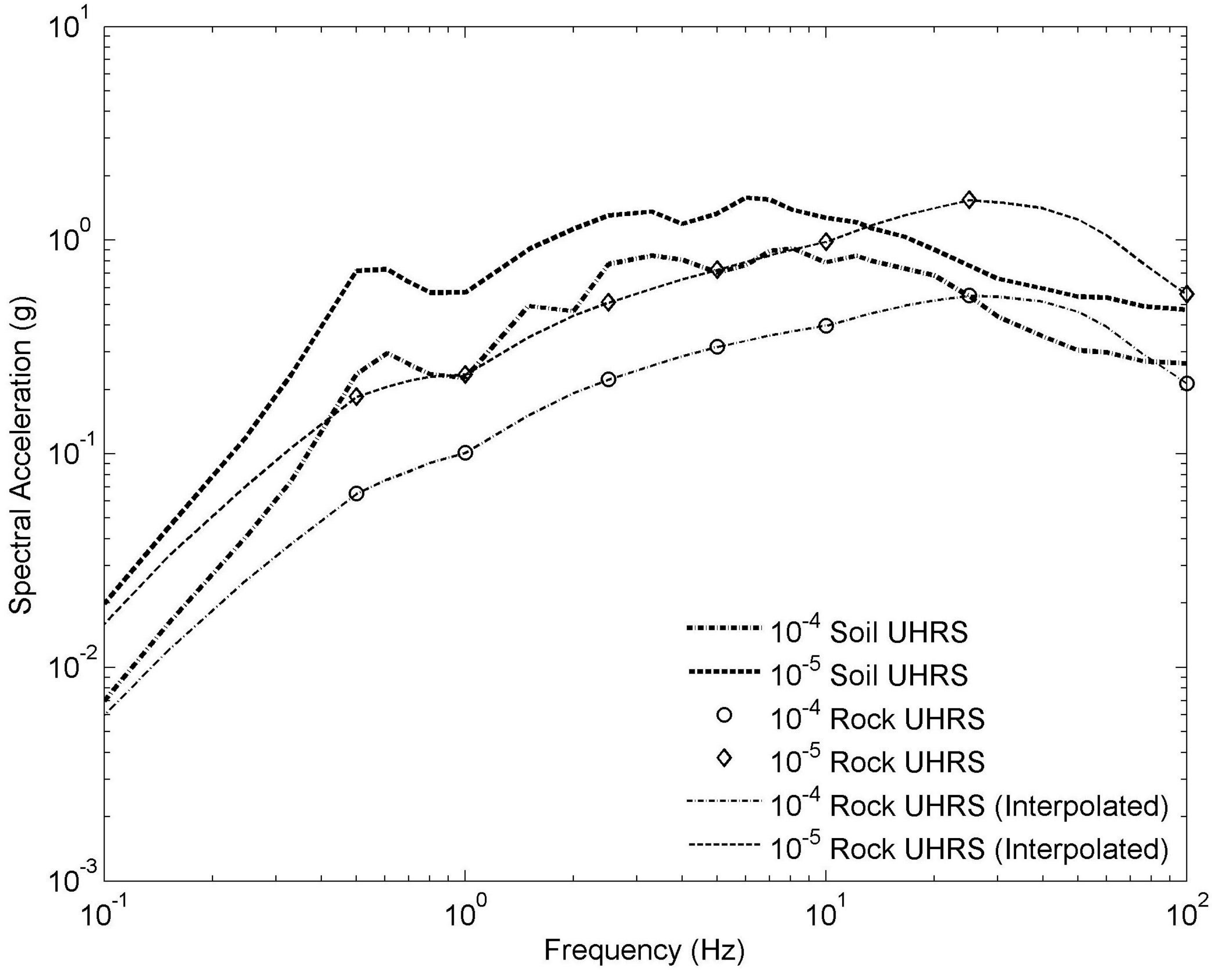


Figure 2.5.2-7 - Horizontal soil-based UHRS for the 10^{-4} and 10^{-5} hazard levels (based on the information provided in SSAR Tables 2.5.2-16 and 2.5.2-21b)

2.5.2.2.6 Ground Motion Response Spectra

SSAR Section 2.5.2.6 describes the method used by the applicant to develop the horizontal and vertical site-specific ground motion response spectra (GMRS). To obtain the horizontal GMRS, the applicant used the performance-based approach described in RG 1.208 and in ASCE/SEI Standard 43-05, “Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities and Commentary.” The applicant developed the vertical GMRS by applying vertical-to-horizontal response spectral (V/H) ratios, based on NUREG/CR-6728 and Lee (2001), to the horizontal GMRS.

Horizontal Ground Motion Response Spectrum

The applicant developed a horizontal, site-specific, performance-based GMRS using the method described in ASCE/SEI Standard 43-05 and RG 1.208. The performance-based method achieves the annual target performance goal (PF) of 10^{-5} per year for frequency of onset of significant inelastic deformation. This damage state represents a minimum structural damage state, or essentially elastic behavior, and falls well short of the damage state that would interfere with functionality. The horizontal GMRS, which meets the PF, is obtained by scaling the site-specific mean 10^{-4} UHRS by a design factor (DF):

$$DF = \max\left\{1.0, 0.6\left(A_R\right)^{0.8}\right\} \qquad \text{Equation (1)}$$

where the amplitude ratio, AR, is given by the ratio of the 10^{-5} UHRS and the 10^{-4} UHRS spectral accelerations for each spectral frequency.

The applicant determined the horizontal performance-based GMRS by scaling the 10^{-4} soil UHRS, shown in SER Figure 2.5.2-7, by the DF defined by Equation (1). The applicant's horizontal GMRS is shown in SER Figure 2.5.2-8, which is defined at the top of the structural backfill. The applicant smoothed the GMRS using a running average filter (above 1 Hz) constrained to go through the seven structural frequencies that define the original rock UHRS (SER Figure 2.5.2-5). The applicant made an exception for the 5-Hz structural frequency because of the trough observed in the 10^{-4} soil UHRS (refer to SER Figure 2.5.2-8) at this frequency. The smoothed 5-Hz GMRS value is based on amplitudes at adjacent frequencies. SER Figure 2.5.2-8 also shows the soil UHRS for both the 10^{-4} and 10^{-5} mean hazard levels for comparison.

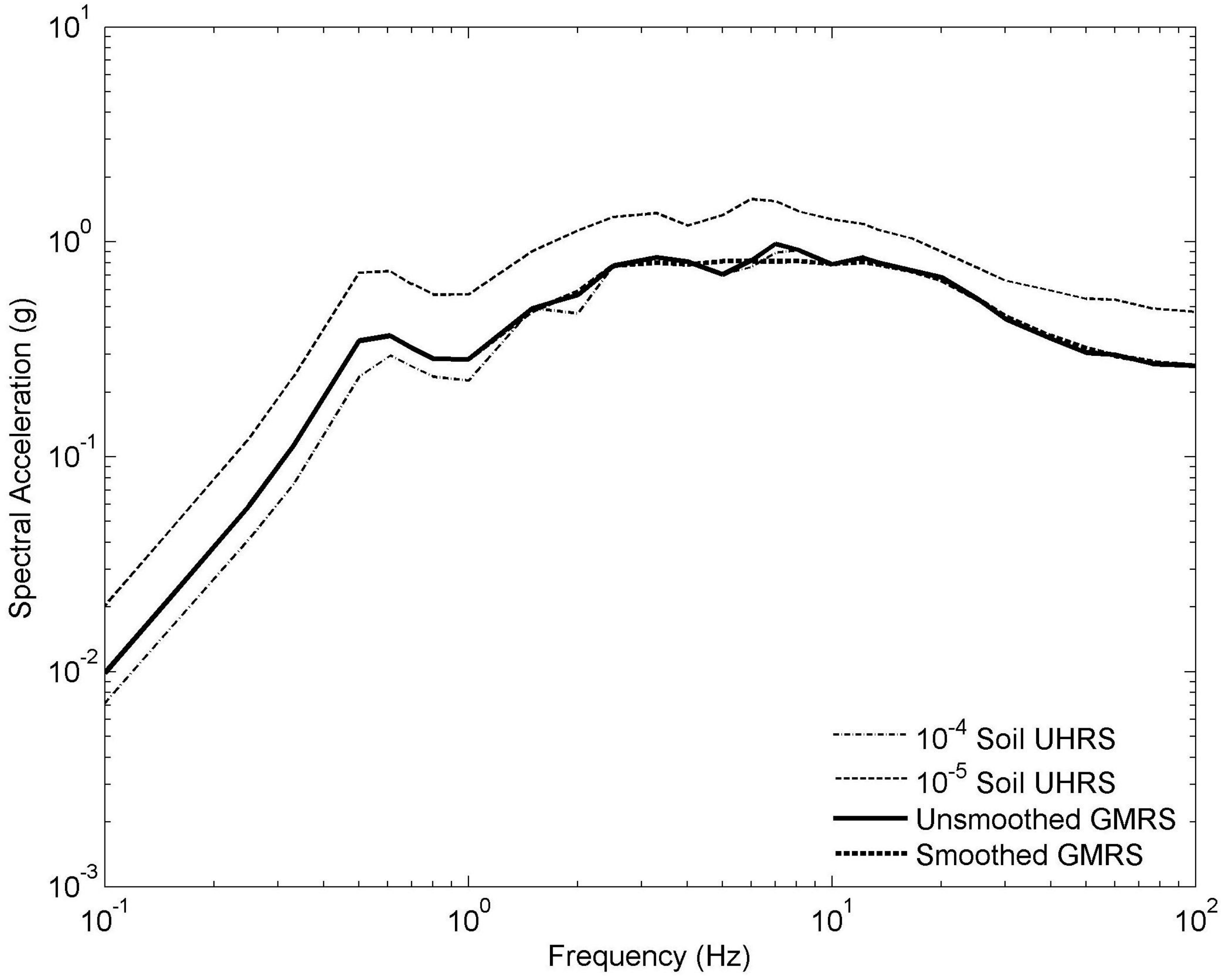


Figure 2.5.2-8 - Horizontal raw and smoothed GMRS (based on the information provided in SSAR Table 2.5.2-22b)

Vertical GMRS

To determine the vertical GMRS, the applicant applied V/H ratios, based on NUREG/CR-6728 and Lee (2001), to the horizontal smoothed GMRS shown in SER Figure 2.5.2-8. Since the V/H ratios presented in NUREG/CR-6728 and Lee (2001) are functions of magnitude, source distance, and local site conditions, the applicant developed V/H ratios corresponding to the final low- and high-frequency controlling earthquakes shown in SER Table 2.5.2-3. The low-frequency controlling earthquake corresponds to an **M** 5.6 event occurring at a distance of 12 kilometers (7.5 miles), while the high-frequency controlling earthquake is represented by an **M** 5.6 event occurring at a distance of 12 kilometers (7.5 miles).

NUREG/CR-6728 presents V/H ratios for soft rock WUS sites and hard rock CEUS sites. The WUS rock V/H ratios provided in NUREG/CR-6728 are based on an empirical database of WUS strong-motion records. Due to the limited number of available CEUS ground motion recordings, NUREG/CR-6728 uses the WUS ratios and modifies them based on the results of modeling studies to obtain CEUS rock ratios. In addition, Appendix J to NUREG/CR-6728 provides a formula to develop V/H ratios for CEUS soil sites:

$$V/H_{CEUS,Soil} = V/H_{WUS,Soil,Empirical} * \left[V/H_{CEUS,Soil,Model} / V/H_{WUS,Soil,Model} \right] \qquad \text{Equation 2}$$

Because the ESP site is a soil site, the applicant used Equation (2) to determine V/H ratios. The applicant obtained the first term of Equation (2), $V/H_{WUS,Soil,Empirical}$, from the ground motion model of Abrahamson and Silva (1997) which provides horizontal and vertical ground motion relationships for deep soil sites. In NUREG/CR-6728, generic soil columns were used to determine $V/H_{WUS,Soil,Model}$ and $V/H_{CEUS,Soil,Model}$ ratios, which provided results for **M** 6.5 and distances of 1, 5, 10, 20, and 40 kilometers. The applicant obtained the second term of Equation (2) using $V/H_{CEUS,Soil,Model}$ and $V/H_{WUS,Soil,Model}$ ratios corresponding to **M** 6.5 and 20 kilometers to represent the high-frequency (**M** 5.6, 12 km) controlling earthquake. In addition, the applicant used the $V/H_{CEUS,Soil,Model}$ and $V/H_{WUS,Soil,Model}$ ratios corresponding to **M** 6.5 and 40 kilometers to represent the low-frequency (**M** 7.2, 130 km) controlling earthquake. The applicant considered these magnitude and distance substitutions to be conservative because V/H ratios are observed to decrease with distance for a given magnitude. The applicant assigned a weight of approximately 1:3 to the results representing the high- and low-frequency controlling earthquakes, respectively.

Lee (2001) used the methodology outlined in NUREG/CR-6728 to develop V/H ratios for the MOX Fuel Fabrication Facility at the SRS. However, Lee (2001) developed $V/H_{CEUS,Soil,Model}$ ratios using a site-specific soil model for the SRS, rather than the generic CEUS profile used in Appendix J to NUREG/CR-6728. To obtain V/H ratios corresponding to the high-frequency controlling earthquake (**M** 5.6, 12 km), the applicant interpolated the results provided in Lee (2001) between **M** 5.5 at 10 kilometers and 20 kilometers and **M** 6.0 at 10 kilometers and 20 kilometers. Similarly, to obtain V/H ratios corresponding to the **M** 7.2, 130-km earthquake, the applicant interpolated the results provided in Lee (2001) between **M** 7.0 at 100 kilometers and **M** 7.2 at 100 kilometers. The distance of 100 kilometers was the largest distance considered in Lee (2001). However, the applicant considered the distance substitution of 100 kilometers for 130 kilometers to be conservative because V/H ratios are observed to decrease with distance for a given magnitude. The applicant assigned a weight of approximately 1:3 to the results representing the high- and low-frequency controlling earthquakes, respectively.

SER Figure 2.5.2-9 plots the resulting V/H ratios obtained from NUREG/CR-6728 and Lee (2001), as well as the final V/H ratios. The V/H ratios from Lee (2001) are higher than those derived from the NUREG/CR-6728 results for frequencies greater than about 0.7 Hz. To develop the final V/H ratios, the applicant used an approximate envelope of the two results. The applicant assigned a greater weight to the V/H ratios from Lee (2001) because this study used a site-specific soil model for the nearby SRS. SER Figure 2.5.2-7 also plots V/H ratios from RG 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Revision 1, issued December 1973. The final V/H ratios are slightly less than those provided in RG 1.60 at all frequencies.

To obtain the vertical GMRS, the applicant scaled the horizontal smoothed GMRS, shown in SER Figure 2.5.2-8, by the final V/H ratio (shown in SER Figure 2.5.2-9).

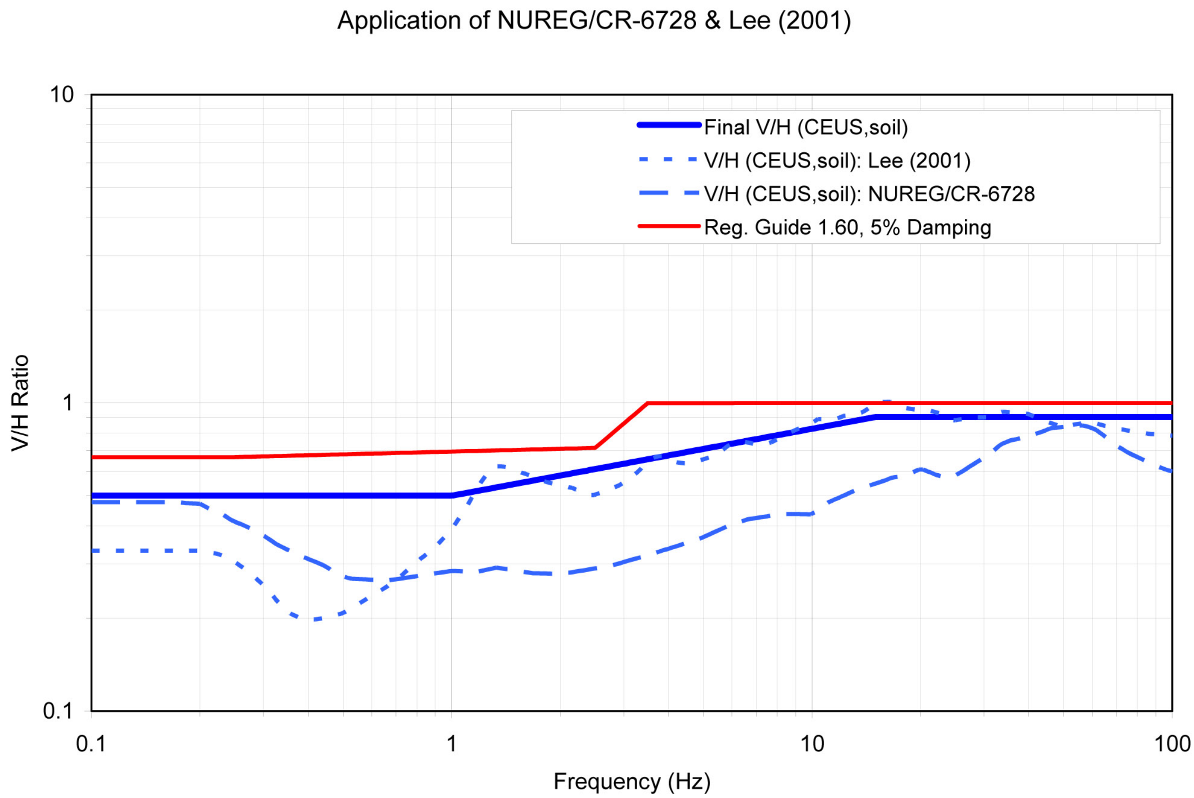


Figure 2.5.2-9 - Final V/HCEUS,Soil ratios (reproduced from SSAR Figure 2.5.2-43)

2.5.2.2.7 Operating Basis Ground Motion

The applicant did not determine the Operating Basis Earthquake (OBE) as part of the Vogtle ESP and stated that the OBE will be determined during the COL stage.

2.5.2.2.8 Sensitivity Studies

As part of its COL site investigation, the applicant collected additional S-wave velocity data and developed site-specific strain-dependent shear modulus and damping relationships based on RCTS test results. However, the applicant did not use any of this additional COL data as input to its site response calculations. Instead, the applicant relied on the SRS and generic EPRI strain-dependent shear modulus and damping curves and S-wave velocity profiles developed as part of the ESP. Rather than recalculating site amplification factors that also account for additional COL data, the applicant performed site response sensitivity calculations for a select number of cases in order to demonstrate that use of the ESP S-wave velocity data and SRS and generic EPRI strain-dependent shear modulus and damping curves is appropriate.

The applicant conducted three sets of sensitivity calculations in order to evaluate: (1) the sensitivity of the AP1000 nuclear island responses to changes in the backfill S-wave velocity; (2) the effects of the backfill geometry on the site response and on the SSI response of the nuclear island; and (3) the effects of additional COL data on site response.

In the first set of calculations, the applicant evaluated the effects of changes in the backfill S-wave velocity. A comparison of the ESP S-wave velocity profile (used for the GMRS and FIRS [foundation input response spectra] computation in SSAR Section 2.5.2.5.1.5) with the S-wave velocity profile used in the sensitivity study is provided in SSAR Figure 2.5.2-51. The staff notes that the S-wave velocity profile used in the sensitivity study did not correspond to the COL backfill data because the applicant performed the sensitivity study before conducting the Phase I test pad program. The S-wave velocity values of the sensitivity study median S-wave velocity profile are larger than both the ESP and COL profiles, which are provided in SSAR Tables 2.5.4-10 and 2.5.4-10a, respectively. The applicant's analysis involved the randomization of the entire soil column with new backfill properties and development of the new outcrop motion at the foundation level of the AP1000 nuclear island. The applicant then used the new time-history and associated strain-compatible soil properties in the SSI analysis of the AP1000. The results of this sensitivity study are provided in Appendix 2.5E (Vogtle Site Specific Seismic Evaluation Report) to the SSAR. The applicant concluded that, even with significant variation of the backfill S-wave velocity, the AP1000 design is applicable to the Vogtle site with a large margin.

In the second sensitivity study, the applicant evaluated the effects of the backfill geometry. Due to the large volume of excavation and the large lateral extent of the backfill at the Vogtle site, the applicant modeled the backfill layers as free-field soil layers for both the soil amplification for development of the ground motion (GMRS and FIRS) and the site-specific seismic SSI analysis of the AP1000. To confirm this assumption, the applicant performed a two-dimensional site response analysis (Part I) followed by a two-dimensional SSI analysis (Part II) of the AP1000 model in order to evaluate the extent of backfill on the site response and on the SSI response of the Nuclear Island. For the 2D analysis, the applicant used the cross section shown in the East-West direction provided in SSAR Figure 2.5.2-53. In Part I of the analysis, the applicant performed a 2D site response analysis. The applicant's 2D model for the site response analysis is provided in SSAR Figure 2.5.2-54, which is based on the cross section shown in SSAR Figure 2.5.2-53. The applicant used the same properties for backfill, Blue Bluff Marl, the lower sand layers and layers extending to the rock at the base as those that it used to develop the GMRS and FIRS. The computation of the GMRS and FIRS (described in SSAR Section 2.5.2.5), however, involved 60 randomized soil profiles, 30 high-frequency and 30 low-frequency input time histories. Thus, for its 2D analysis, the applicant only considered a subset of the soil profiles (i.e. the upper, mean, and lower bound soil profiles) and input time histories (i.e. three high-frequency and three low-frequency input time histories). The applicant compared the resulting site amplification factors with those calculated from the 1D SHAKE results for the same set of input motions and soil properties, which are shown in SSAR Figures 2.5.2-55, 2.5.2-56, and 2.5.2-57 for locations (presented as "in-column" motions) at depths of 0 ft (GMRS), 40 ft (FIRS horizon), and at 86 ft depth (Top of Blue Bluff Marl), respectively, at the centerline of the backfill (shown in SSAR Figure 2.5.2-54). The applicant concluded that the differences are very small. The applicant further concluded that the geometry of the backfill has an insignificant effect on GMRS and FIRS. In addition, the applicant compared transfer functions for the 1D SHAKE and 2D SASSI analyses, which determine how the soil profile amplifies or deamplifies each frequency in the input motion (Kramer, 1996). In SSAR Figure 2.5.2-55a, the applicant compared the transfer function that relates the motion at a depth of 0 ft to the bedrock input motion, while the transfer function that relates the motion at a depth of 40 ft to the bedrock input motion is shown in SSAR Figure 2.5.2-56a. In both cases the applicant used one high-frequency input motion and the mean soil profile. The applicant stated that this additional comparison also confirmed that the use of a 1D SHAKE analysis is adequate given the geometry of the backfill at the site.

In Part II, the applicant developed a Vogtle 2D SASSI model of the nuclear island (NI) to include the backfill as part of the structural model shown in Figure 2.5.2-58. This model is similar to the model in Part I except that the applicant included the AP1000 NI model using only the mean soil profile and a single time history from the analysis performed in Part I (i.e. the input motions for the two SSI analyses are obtained from the respective 1D SHAKE analysis in Part I). The applicant compared the SSI responses for the 2D SASSI NI model (referred to as Bathtub Model-d5) at key locations in the NI are compared with the SSI results of the 2D SASSI (referred to as 2D-AP-d5) that assumes backfill extends to infinity in lateral directions. These comparisons are shown in SSAR Figure 2.5.2-59 through 2.5.2-64. The applicant concluded that the response spectra are similar and it considered the differences to be negligible. The applicant also plotted the generic AP1000 standard design response spectra for comparison for the purpose of demonstrating that a significant margin exists between the AP1000 generic response and the Vogtle 2D results. The applicant stated that a detailed discussion of the 2D SASSI NI model and a comparison of transfer functions are documented in more detail in Appendix A of Appendix 2.5E.

Finally, the applicant performed sensitivity studies to evaluate the effects of the additional COL S-wave velocity and the strain dependent shear modulus and damping relationships based on RCTS test results. As input, the applicant selected three high-frequency and three low-frequency rock time histories representing the 10^{-4} annual exceedance frequency level from the suite of motions used for the GMRS computation in SSAR Section 2.5.2.5. The applicant also used three soil profiles representing the best estimate COL velocity profile (shown in SSAR Figure 2.5.4-7a) as well as the upper and lower bounds. In addition, the applicant used the associated COL strain-dependent soil properties presented in SSAR Figures 2.5.4-9a and 2.5.4-11a and in SSAR Table 2.5.4-12a. The applicant performed two sets of analyses in order to consider the high and low PI (Plasticity Index) cases of the Blue Bluff Marl as illustrated in SSAR Figures 2.5.4-9a and 2.5.4-11a. The applicant then averaged the results using the three high-frequency input time histories, three soil profiles, and the high and low PI cases of the Blue Bluff Marl, then divided this average response spectrum (corresponding to a depth of 40 ft) by the 10^{-4} high-frequency input response spectrum to obtain site amplification factors. The applicant repeated this process for the low-frequency input time histories. The applicant then enveloped the resulting high-frequency and low-frequency amplification factors, which is represented by the green dashed curve in SSAR Figure 2.5.2-65c. The blue solid curve in SSAR Figure 2.5.2-65c corresponds to the amplification factors based on a limited number of ESP soil profiles. From the ESP set of runs described in SSAR Section 2.5.2.5.1, the applicant used the strain compatible velocity and damping profiles to obtain the median and upper bound profiles (using one standard deviation as the variation) to use as input to the analysis. The applicant used the same three high-frequency and three low-frequency time histories used for the analysis of the COL data above. In SSAR Figure 2.5.2-65c, the applicant also plotted (depicted by the red dashed curve) the amplification factors resulting from the fully randomized ESP soil profiles and entire group of input time histories (described in SSAR Section 2.5.2.5). The applicant concluded that the comparison of the two sets of results based on the ESP data shows good agreement and thus that the limited number of profiles and time histories are adequate for the purpose of the evaluation of the inpact of the COL data. Furthermore, the applicant concluded that the difference in amplification between the ESP and COL data is small.

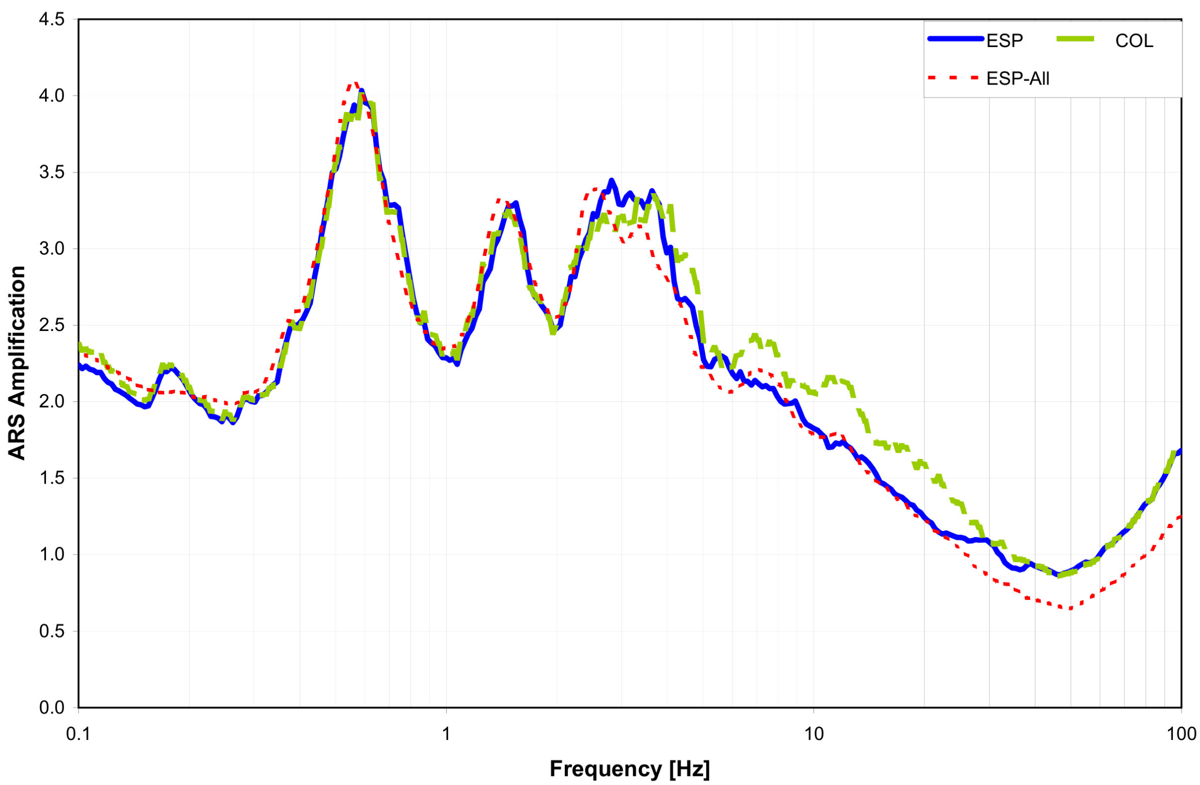


Figure 2.5.2-10 – Comparison of Amplification Factors from Sensitivity Analyses (reproduced from SSAR Figure 2.5.2-65c)

2.5.2.3 Regulatory Basis

SSAR Section 2.5.2 presents the applicant's determination of ground motion at the ESP site from possible earthquakes that might occur in the site region and beyond. In SSAR Section 1.8, the applicant stated that it had developed the geological and seismological information used to determine the seismic hazard in accordance with regulations listed in SSAR Table 1-2, which includes 10 CFR 50.34; Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50; and 10 CFR 100.23. The applicant further stated in SSAR Table 1-2 that it developed this information in accordance with the guidance presented in Section 2.5.2 of Revision 3 of NUREG-0800 and RG 1.165. The staff reviewed this portion of the application for conformance with the regulatory requirements and guidance applicable to the determination of the SSE ground motion for the ESP site, as identified below. 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 application 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 ground motion 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 ground motion for the site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface. Section 2.5.2 of Revision 3 of NUREG-0800 and RG 1.208 provide guidance concerning the evaluation of the proposed SSE ground motion, and RGs 1.165 and 1.208 provide guidance regarding the use of PSHA to address the uncertainties inherent in the estimation of ground motion at the ESP site.

2.5.2.4 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 GMRS 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 distance to the ESP site decreases. The GMRS is based upon a detailed evaluation of earthquake potential, taking into account regional and local geology, Quaternary (1.8 mya–present) 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 from possible earthquakes that might occur in the site region and beyond to determine the site GMRS. According to RG 1.208, applicants may develop the GMRS for a new nuclear power plant using either the EPRI or LLNL PSHAs for the CEUS. However, RG 1.208 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.

2.5.2.4.1 Seismicity

SSAR Section 2.5.2.1 describes the development of a current earthquake catalog for the ESP site. The applicant started with the EPRI historical earthquake catalog (EPRI NP-4726-A 1988), which is complete though 1984. To update the earthquake catalog, the applicant used information from the ANSS and SEUSS.

The staff focused its review of SSAR Section 2.5.2.1 on the adequacy of the applicant's description of the historical record of earthquakes in the site region. In Request for Additional Information (RAI) 2.5.2-1, the staff asked the applicant to provide electronic versions of the EPRI seismicity catalog (EPRI NP-4726-A 1988) for the region of interest (30 degrees to 37 degrees N, 78 degrees to 86 degrees W), as well as its updated EPRI seismicity catalog. The staff used the catalog data that the applicant provided in response to RAI 2.5.2-1 to compare with its own compilation of recent earthquakes for the site region. The applicant's updated catalog consisted of a total of 61 events. Of these 61 events, there were 56 m_b 3 events and 5 mb 4 events. In comparison, the staff's list of earthquakes, based entirely on the ANSS earthquake catalog, consisted of 50 m_b 3 events and 3 m_b 4 events.

Because the applicant used the EPRI historical earthquake catalog (EPRI NP-4726-A 1988), which is part of the 1989 EPRI seismic hazard study that the NRC endorsed in RG 1.165, the staff concludes that the seismicity catalog used by the applicant is complete and accurate for the time period 1777–1985. The staff compared the applicant's update of the regional seismicity catalog with its own listing of recent earthquakes and, as a result, concludes that the earthquake catalog used by the applicant is complete and provides a conservative estimate of earthquake magnitudes and locations for the ESP site region.

To determine whether the seismicity rates used in the EPRI study (EPRI NP-6395-D 1989) are appropriate for the assessment of the seismic hazard at the ESP site, the applicant used two areas in the site region: (1) a small rectangular area around the Charleston seismicity; and (2) a triangular-shaped area that envelops the seismicity in South Carolina and a strip of Georgia. The applicant concluded that, for the rectangular Charleston source, the updated catalog indicates that the seismicity rates are the same. For the triangular South Carolina source, the updated catalog indicated that seismicity rates decreased when the seismicity from 1985 to April 2005 was added. In RAI 2.5.2-18, the staff asked the applicant to provide a justification for the selection of the geometries used to represent the Charleston source and the South Carolina source. In response to RAI 2.5.2-18, the applicant assessed the seismicity in two additional areas within the site region. The applicant concluded that any region in South Carolina that would affect the seismic hazard at the ESP site would have estimated activity rates that stay constant or decrease, if the new regional earthquake catalog were added to the analysis.

Based on the applicant's evaluation of multiple areas and its determination that seismicity rates in the region have not increased since 1985 for any of these selected areas, the staff concludes that the applicant's use of the EPRI seismicity rates is appropriate and that these rates are appropriate for the assessment of the seismic hazard at the ESP site.

2.5.2.4.2 Geologic and Tectonic Characteristics of the Site and Region

SSAR Section 2.5.2.2 describes the seismic sources and seismicity parameters used by the applicant to calculate the seismic ground motion hazard for the ESP site. Specifically, the applicant described the seismic source interpretations from the 1986 EPRI Project (EPRI

NP-4726), relevant post-EPRI seismic source characterization studies, and its updated EPRI seismic source zone for the Charleston area. The staff focused its review of SSAR Section 2.5.2.2 on the applicant's update of the Charleston seismic source zone. The staff also reviewed the applicant's basis for not updating the other EPRI source zones that contribute to the seismic hazard at the ESP site.

Summary of EPRI Seismic Sources

Section 2.5.2.2.1 summarizes the seismic sources and seismicity parameters used in the 1986 EPRI Project and subsequently implemented in the 1989 PSHA (EPRI NP-D 1989). The 1989 EPRI PSHA study expressed M_{max} values in terms of m_b. The applicant noted that most modern seismic hazard analyses describe M_{max} in terms of **M** and used the arithmetic average of the conversion relations presented in Atkinson and Boore (1995), Frankel et al. (1996), and EPRI TR-102293 (1993) to convert from mb to **M**. In RAI 2.5.2-5, the staff asked the applicant to provide its converted **M** values. In response to RAI 2.5.2-5, the applicant provided a table that listed a range of m_b values and the corresponding converted **M** values.

To confirm the applicant's magnitude conversions, the staff compared the applicant's converted **M** values with the **M** values it obtained using the conversion relations of Frankel et al. (1996) and Johnston (1994), which were provided in Chapman and Talwani (2002). The staff found that the conversion provided in Chapman and Talwani (2002) yields slightly larger **M** values in the m_b 4.0 to 7.5 range. However, based on the uncertainties associated with magnitude conversions and the applicant's use of the average of three different conversion relations to account for this uncertainty, the staff concludes that the applicant's converted **M** values are adequate.

SSAR Sections 2.5.2.2.1.1 through 2.5.2.2.1.6 provide a summary of the primary seismic sources developed in the 1980s by each of the six EPRI ESTs. Each EST described its set of seismic source zones for the CEUS in terms of source geometry, probability of activity, recurrence, and M_{max}. Each EPRI EST identified one or more seismic source zones that include the ESP site. Although some of the ERPI ESTs assigned M_{max} values as high as **M** 7.5 for the source zones that make up the Atlantic coastal region, the M_{max} values for the seismic source zones that include the site have a weighted mean of about **M** 6.0. In RAI 2.5.2-6, the staff asked the applicant to explain whether it considered more recent studies on large worldwide earthquakes by Johnston (1994) and Kanter (1994) as possible updates of the earlier EPRI seismic source models.

In response to RAI 2.5.2-6, the applicant stated that the final versions of the Johnston (1994) and Kanter (1994) assessments (included in Volume 1 of the Johnston et al. 1994 study) do not constitute new information that would require an update of the M_{max} values used for the EPRI seismic source models. In its response, the applicant stated that the initial results of the Johnston et al. (1994) study were available to the EPRI ESTs, and that the final results of the Johnston et al. (1994) study generally support the initial findings of the study.

The staff reviewed the applicant's response to RAI 2.5.2-6 and concluded that, although many of the EPRI ESTs assigned M_{max} values that reflect the studies of Johnston and Kanter, the applicant did not provide an adequate justification to support the low weights for some of the larger M_{max} values. In particular, the Dames and Moore EST gave fairly low weights to some of its seismic source zones. For example, the two M_{max} values assigned by the Dames and Moore EST for the "Southern Appalachian Mobile Belt" are mb 5.6 with a weight of 0.8 and 7.2 with a weight of 0.2. These two M_{max} values and weights are similar to those for the other ESTs for the

Atlantic coastal margin; however, the Dames and Moore EST also assigned a probability of activity of only 0.26 for this source. Similarly, for its "Southern Cratonic Margin," the Dames and Moore EST assigned a probability of activity of only 0.12. The combined effect of these low probabilities of activity and low weights for the larger magnitudes results in a lower hazard for the ESP site. This result is shown in SER Figures 2.5.2-17 and 2.5.2-18, which are plots of the 1- and 10-Hz PSHA hazard curves for each of the EPRI ESTs. As shown in these two figures, the Dames and Moore seismic hazard curves are substantially lower than those for the other ESTs.

In response to RAI 2.5.2-6, the applicant also stated that the North Anna site is located within Kanter's (1994) Piedmont domain 223 in nonextended crust and, as a result, large magnitude earthquakes are not expected in this domain. The staff, however, notes that the Vogtle ESP site is located within the Mesozoic passive margin. Specifically, the site is on the hanging wall of the southeast-dipping Pen Branch fault (SSAR Figures 2.5.1-2, 2.5.1-29, and 2.5.1-34), which is the main border fault of the Dunbarton Triassic basin (SSAR Figures 2.5.1-2 and 2.5.1-10). In turn, the Dunbarton Triassic basin is a subbasin within the much larger South Georgia basin complex (SSAR Figures 2.5.1-2 and 2.5.1-7). Therefore, the site is in Kanter's Eastern Seaboard domain 218. The rocks beneath the site are Triassic strata of domain 218's rift basins (SSAR Figures 2.5.1-34 and 2.5.1-38). Beneath the Triassic rocks is the Piedmont domain, but the Piedmont rocks have been cut by the Mesozoic extensional faults that bound the rifts. The distinction between the Eastern Seaboard and Piedmont domains depends on the presence or absence of Mesozoic extensional faults, rather than the age of the rocks cut by those faults. Accordingly, the staff believes that the site is subject to the higher M_{max} of the Eastern Seaboard domain of Kanter (1994). The site is in one of the regions that Johnston et al. (1994) found to have hosted all earthquakes of **M** 7.0 and larger in the world's stable continental regions (SCRs).

SER Figure 2.5.2-11 shows a histogram of magnitudes of the 30 earthquakes that had **M** 6.5 and larger in the world's extended margin, which is based on the compilation of the largest earthquakes in the world's SCRs by Johnston et al. (1994). The histogram has a large peak at **M** 6.6 and 6.7. The earthquakes making up the peak come from various SCRs, continents, and plate tectonic settings, indicating that values of 6.6 and 6.7 occur widely in diverse geologic and tectonic settings. This implies that M_{max} is unlikely to be less than these values anywhere in the extended margin of North America. As such, the low weights and low probability of activities assigned by the Dames and Moore EST to larger M_{max} values do not reflect worldwide earthquake activity in extended margins.

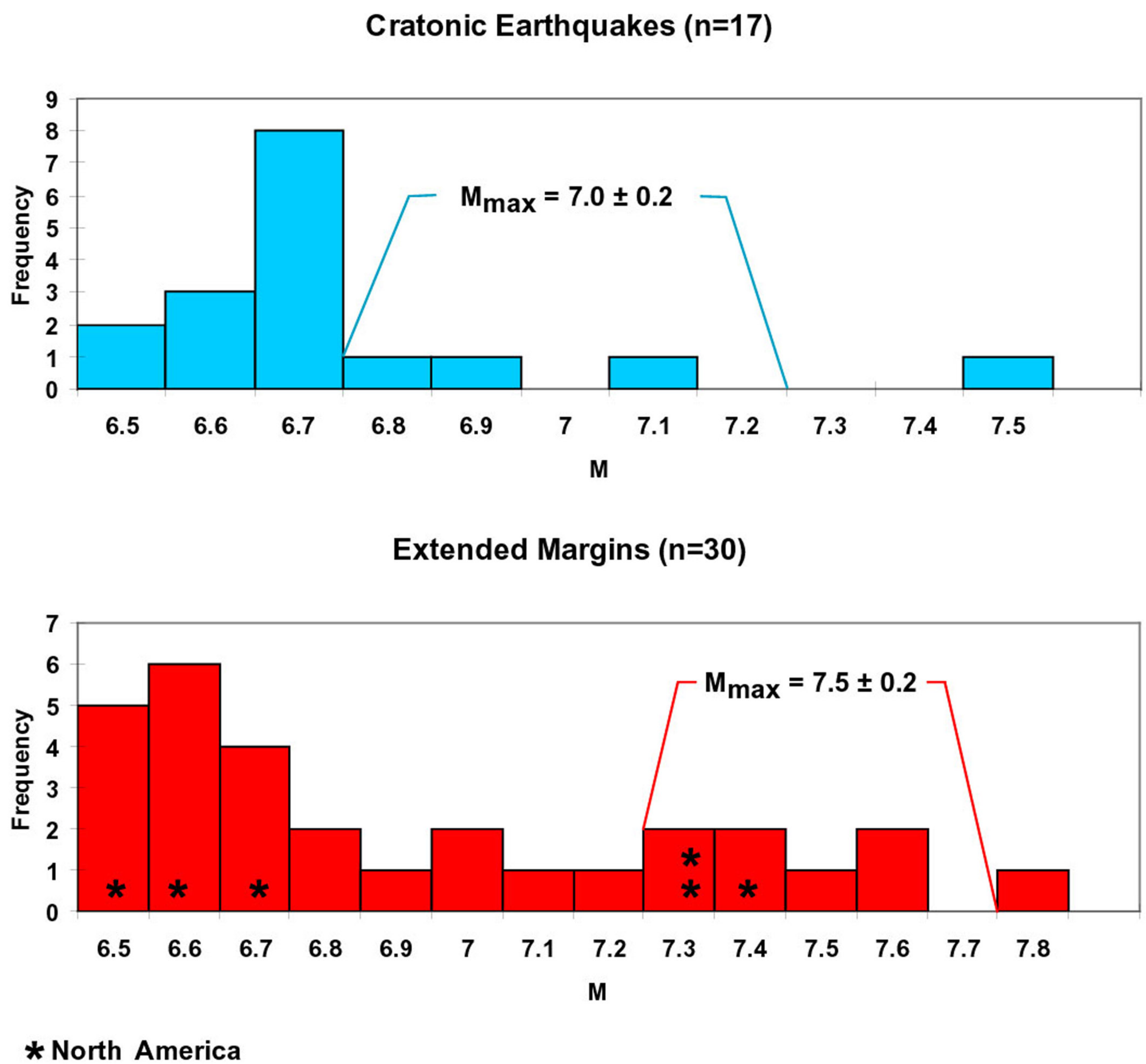


Figure 2.5.2-11 - Histogram showing magnitudes of the 30 earthquakes that had M 6.5 and larger in the world's extended margins (Source: USGS)

In summary, the staff concluded that the applicant did not provide an adequate justification to support the low weights for the larger M_{max} values for the EPRI source zones that include the site. In particular, the staff was concerned that the low weights and low probability of activities assigned by the Dames and Moore EST to some of its seismic source zones result in hazard curves for the ESP site that may not adequately characterize the regional seismic hazard. In addition, the staff concluded that the site is located within the Mesozoic passive margin, rather than the Piedmont unextended province as stated in the applicant's response. Accordingly, in the SER with open items, this issue was identified as Open Item 2.5-1.

As noted above, Open Item 2.5-1 related to the staff's concern that the low weights and low probability of activities assigned by the Dames and Moore EST to some of its seismic source zones resulted in hazard curves for the ESP site that may not adequately characterize regional seismic hazard. In response to Open Item 2.5-1, the applicant stated the following:

> As pointed out in the DSER, the Dames & Moore team assigned low probabilities of activity (PA) to some of its sources, such as source zones 41 and 53. Zone 53 (Southern Appalachian Mobile Belt) is a default zone for several Triassic rift basin sources, represents a host zone for the Vogtle site, and has a PA = 0.26. The lack of a background zone beneath the region covered by source 53 results in a source-less area when 53 is "turned off." While the implementation of this aspect of the Dames & Moore source model has been the subject of debate, this is not an "error" or misinterpretation in their model. Statements in both the Dames & Moore EPRI report (1986) as well as recent discussions with James McWhorter, an original member of the Dames & Moore EST, indicate that Dames & Moore intended to represent the earthquake process in this fashion.

The applicant provided the following discussion from page 5-3 of the Dames and Moore report (1986, Volume 6), which indicates that Dames and Moore believes earthquake occurrence can be explained by tectonic reasons and that they do not use background zones as in other traditional seismic hazard assessments:

> "In our model, uniform seismicity is a consequence of a reasonable tectonic explanation for earthquake occurrence in the zone. To avoid muddling the tectonic aspect, our team does not use backgrounds. There is either a tectonic reason for a block of the earth's crust to be seismically active or there is not. So what we formerly called a "global background" no longer exists; the sources replacing it have a PA reflecting our confidence in a tectonic reason for earthquake activity there."

The applicant stated that although the Dames and Moore seismic source zone implementation is different from the other ESTs, it still represents the range of expert opinion in the EPRI SSHAC Level 4 study. The applicant further stated that "from a process standpoint, it is not the responsibility of the applicant to defend the original rationale or implementation of the EPRI study, which has been approved by the NRC in Regulatory Guide 1.165 and forms the basis for evaluating sites across the CEUS. The individual teams were given latitude as to how to model seismic hazard in order to capture the full range of opinion for the poorly understood earthquake process in the CEUS. Without new data to invalidate the model, an individual team or model should not be reinterpreted or disregarded simply because their resultant hazard is less than the other EST source models."

In addition, the applicant subsequently provided supplemental information regarding Open Item 2.5-1 in a letter dated December 11, 2007. This letter addressed additional concerns that the staff had about the Dames and Moore model regarding a quotation in the 1992 DOE Standard "Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites for Department of Energy Facilities" (DOE-STD-1024-92). The purpose of the DOE Standard was to provide guidance in the use of the seismic hazard curves developed by the LLNL and the EPRI. The Standard based its recommendations on the evaluations of the LLNL and EPRI seismic hazard method performed by LLNL, Jack Benjamin and Associates, and Risk Engineering Inc. The following quotation is from one of the issues identified by Risk Engineering, Inc.:

> "Risk Engineering, Inc. has also found that the EPRI team of Dames and Moore does not fully account for historic seismicity near the Savannah River Site (SRS). One reason for this is the fact that the SRS host source zone was given a low

probability of activity. Risk Engineering, Inc. recommended that the Dames and Moore seismic source input not be used to calculate the seismic hazard at SRS."

The applicant's December 11, 2007 supplemental information contained a letter enclosure from Dr. Robin K. McGuire of Risk Engineering, Inc., which provided additional background regarding the above quotation. In his letter, Dr. McGuire stated that "the quote from my 1991 report was taken from a study that had the purpose of reconciling hazard curves from the EPRI and LLNL reports. In my role as a seismic-hazard analyst in that project (rather than an expert in seismic source characterization), I achieved the project goal by giving credibility only to those interpretations that were consistent with historical seismicity at all magnitude levels. Interpretations that were high or low relative to historical seismicity were given zero weight. The remaining interpretations gave hazard that was relatively consistent (as one would expect), which achieved the purpose of the study. Thus the down-weighting of the Dames & Moore source model was not made on the basis of its geologic or technical merits."

With respect to the quotation in the DOE report, Dr. McGuire stated the following:

> "Examining historical earthquakes from the EPRI catalog in Dames & Moore source 53, one event occurred in 1966 with m_b=4.7, and all other historical earthquakes had $m_b \leq 4.3$. A search of the PDE and ISC catalogs indicates that the 1966 event was an offshore explosion, and if so the largest historical earthquake in source 53 was $m_b \sim 4.3$. In any case the quotation in the 1st paragraph is accurate relative to historical earthquakes with $m_b \leq 4.7$, but the Dames & Moore interpretation is not inconsistent with the occurrence of earthquakes with $m_b > 5$. Stated another way, no earthquakes with $m_b > 5$ have occurred historically in the Dames & Moore source 53, and Dames & Moore said there is a 26 percent chance that earthquakes with $m_b > 5$ will occur there in the future."

In its supplemental response, the applicant also provided a letter from Dr. Robert Kennedy, which demonstrated that the Dames and Moore model contribution is not significant at the Vogtle ESP site. Dr. Kennedy looked at the 10 Hz total mean hazard curve together with the contributing mean hazard curves from the updated Charleston source and each of the six ESTs source models. He noted that at any spectral acceleration, the total mean annual frequency of exceedance, H, is given by combining the Charleston source mean annual frequency of exceedance with the mean of the 6 ESTs mean annual frequency of exceedance:

$$H = H_C + \left(H_R + H_{WC} + H_{We} + H_L + H_B + H_{DM}\right)/6 \qquad \text{Equation (3)}$$

Where HC is the mean annual frequency of exceedance from the updated Charleston source, and HR, HWC, HWe, HL, HB, HDM, are the mean annual frequencies of exceedance from the Rondout, Woodward-Clyde, Weston, Law, Bechtel, and Dames and Moore teams, respectively. At a spectral acceleration of 0.42 g, Dr. Kennedy found that deleting the Dames and Moore input (HDM) increased the total mean annual frequency of exceedance by only approximately 5 percent. He further concluded that similar results exist at a spectral acceleration corresponding to a mean annual frequency of exceedance of 10^{-5}.

In reviewing the response to Open Item 2.5-1 and supplemental information provided by the applicant, the staff concluded that the applicant did not provide adequate justification for the low probabilities of activity that Dames and Moore team assigned to several of its source zones.

The staff is concerned because the Dames and Moore model states that there is only a 26 percent and 12 percent chance that earthquakes larger than mb 5.0 can occur in source zones 53 and 42, respectively. The Dames and Moore team's interpretation differs significantly from the other ESTs interpretations as well as other recent seismic hazard studies including USGS, SCDOT, and TIP studies. The staff, however, agrees with the applicant's determination that the Dames and Moore team does not contribute significantly to the hazard at the Vogtle site. The staff performed a similar comparison to the one performed by Dr. Kennedy, but instead compared percentage changes in spectral acceleration rather than annual exceedance frequency. The results showed that the percentage increase in the 10 Hz total mean hazard spectral acceleration at the 10^{-4} annual exceedance frequency is 2.07 percent if the Dames and Moore team's contribution is removed. At the 10^{-5} annual exceedance frequency, the percentage increase in spectral acceleration is 3.44 percent. The staff concludes that the percentage increase is even less for the 1 Hz hazard curve. The percentage increase in spectral acceleration at the 10^{-4} annual exceedance frequency is 0.39 percent when the Dames and Moore team's contribution is removed. At the 10^{-5} annual exceedance frequency, the percentage increase in spectral acceleration is 0.38 percent. Thus, in spite of the staff's concerns that the Dames and Moore team did not adequately characterize the regional seismic hazard, the staff considers open Item 2.5-1 to be resolved because the Dames and Moore team's contribution to the total mean hazard at the Vogtle ESP site is not significant.

Post-EPRI Seismic Source Characterization Studies

SSAR Section 2.5.2.2.2 describes three PSHA studies that were completed after the 1989 EPRI PSHA and which involved the characterization of seismic sources within the ESP site region. These three studies include the USGS National Seismic Hazard Mapping Project (Frankel et al. 1996, 2002), the SCDOT seismic hazard mapping project (Chapman and Talwani 2002), and the NRC TIP study (NUREG/CR-6607, "Guidance for Performing Probabilistic Seismic Hazard Analysis for a Nuclear Plant Site: Example Application to the Southeastern United States"). The applicant provided a description of both the USGS and SCDOT [South Carolina Department of Transportation] models, as well as the impact of these more recent studies on the EPRI PSHA models. The applicant did not, however, consider the TIP study to be a relevant source of information. The TIP study implemented the PSHA guidelines developed by the SSHAC (NUREG/CR-6372, "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts") and focused on the development of seismic zonation and earthquake recurrence models for the Watts Bar (Tennessee), and Vogtle sites. The applicant stated that it did not explicitly incorporate the results of the TIP study into the SSAR because "the study was more of a test of the methodology rather than a real estimate of the seismic hazard." Because part of the TIP study focused on the Vogtle site, the staff, in RAI 2.5.2-7, asked the applicant to explain why it concluded that the TIP study was more of a test of the methodology rather than a real estimate of the seismic hazard and why it did not use the TIP study results. In response, the applicant stated the following:

> The TIP study focuses primarily on implementing the Senior Seismic Hazard Advisory Committee (SSHAC) PSHA methodology (SSHAC 1997), however, and was designed to be as much of a test of the methodology as a calculation of seismic hazard. For example, as part of the test of the methodology, Committee members were asked to present opposing arguments, regardless of whether they agreed with the position they were asked to present. As a disclaimer, Kevin Coppersmith prefaced his discussion of the Pen Branch fault with the following statement:

> The following white paper—much like a lawyers (sic) legal argument—presents a particular position and seeks only to support that position. I have intentionally tried to present an unbalanced case, giving only lip service to counter arguments…Further, I have done a poor job of citing references and providing supporting data to many of my arguments (p. A-51).
>
> The TIP study provides useful discussions, including speculations regarding the Charleston seismic source, seismic hazards of the South Carolina–Georgia region, and Eastern Tennessee. However, the TIP study focuses primarily on methodology. The process-oriented focus of the TIP study is also illustrated in the report presentation, which is very thorough on methodology, but significantly lacking in presenting a summary of seismic source model parameters. For these reasons, the TIP study results are not explicitly incorporated into the VEGP ESP application.

The staff reviewed the applicant's response to RAI 2.5.2-7, as well as the TIP report, and disagrees with the applicant's conclusion that the TIP report was more of a test of the methodology rather than a real estimate of the seismic hazard.

The disclaimer provided in the applicant's response to RAI 2.5.2-7 accompanied a white paper titled, "Include the Pen Branch and Other Local Faults in the PSHA," written by Kevin Coppersmith after the first TIP workshop, which involved a panel of five expert evaluators, the technical facilitator/integrator (TFI) team, and expert proponents and presenters. The workshop comprised a series of technical sessions, which included presentations of recent research and interpretations by the presenters. Each of the technical sessions was followed by a discussion moderated by the TFI team in which key outstanding technical issues were defined. These key issues were then assigned to evaluators as the topics of "white papers" to be written after the workshop. For example, Kevin Coppersmith was assigned to write the white paper in support of "Discrete local fault sources for Vogtle," while Pradeep Talwani was assigned to present a case against "Discrete local fault sources for Vogtle." The TIP report states that "the objective of these papers is to clarify the arguments for and against key interpretations having direct bearing on seismic source characterization in a way that will stimulate interaction among the evaluators." The TIP report also states that "the experts were asked to act as proponents of a certain scientific position and since the issues selected involved dichotomous positions they had to argue for a position that they do not necessarily defend. This has an advantage of forcing the experts, and all the participants, into discovering the positive aspects of scientific concepts other than their own." Thus, Kevin Coppersmith's disclaimer that accompanied his white paper merely reflects his assigned role to provide supporting arguments for a key workshop issue.

The staff concludes that, while the primary objective of the TIP study was to implement the SSHAC PSHA methodology, there is nothing to suggest that the project's final hazard results are not valid. In fact, the seismic hazard results from the TIP triggered a followup NRC-sponsored study, documented in Appendix G to NUREG/CR-6607, which involved a comparison of the TIP hazard results with NUREG-1488, "Revised Livermore Seismic Hazard Estimates for 69 Sites East of the Rocky Mountains." Therefore, although portions of the TIP report may have been focused on implementing the SSHAC methodology, much of the data and results contained in the report are applicable to the ESP site. Thus, in the SER with open items, the staff did not concur with the applicant's disposition of the TIP study. The staff requested that the applicant provide an evaluation of any information contained in the TIP study that is relevant to the seismic source characterization of the ESP site. The staff considered this information necessary in order to determine whether the applicant provided a thorough characterization of the seismic sources surrounding the site, as required by 10 CFR 100.23. Accordingly, in the SER with open items, this issue was identified as Open Item 2.5-2.

In response to Open Item 2.5-2, the applicant reiterated its position that the Trial Implementation Project (TIP) study was primarily an exercise in implementation of the SSHAC process. The applicant also stated the following:

> The fact that all final seismic source model parameters and weights are not presented in the TIP report also support that this study focused primarily on implementation of the SSHAC process as opposed to the development and publication of a new source model for the southeastern US. The absence of a complete set of parameters and weights in the TIP study also makes it difficult to replicate the entire source model and directly compare with some of the specific EPRI model parameters. The TIP report provides tables and figures that illustrate how the individual EVA's (experts) evaluated or weighted certain issues or parameters, but the report does not provide a final tabulation of all source parameters and weights that were used in the computation of hazard in the TIP study.

The applicant noted, however, that "the TIP report does present logic trees, tables, and plots that summarize different aspects of their seismic source characterization and uncertainty in several key parameters". The applicant also stated the following in support of the TIP study:

> However, the TIP study does address some key issues and provides assessments of these issues by the five experts assembled (Bollinger, Chapman, Coppersmith, Jacob, and Talwani) that can be evaluated and compared, in a more general sense, to the EPRI EST source model parameters. The TIP study included multiple workshops to define, clarify, and elicit expert opinion on several critical issues relating to the source characterization process and specific technical questions on seismic sources that were judged to be significant to the hazard at the Vogtle and Watts Bar sites.

As requested by the staff in Open Item 2.5-2, the applicant also presented an evaluation of information in the TIP study relevant to the seismic source characterization of the ESP site, including the ETSZ. The applicant stated that "Several of the key issues addressed in the TIP study support the wide range of uncertainty expressed in the EPRI EST seismic source characterizations for the ESP site."

In summary, the applicant acknowledged that the TIP study is a valid study and also provided an evaluation of information relevant to the seismic source characterization of the ESP site (see Open Item 2.5-3 for the applicant's discussion of the TIP study report with respect to the ETSZ). Therefore, the staff considers Open Item 2.5-2 to be closed.

Northwest of the ESP site, at a distance just beyond 200 miles, is the ETSZ zone. As shown in SER Figure 2.5.2-1, the ETSZ covers a cluster of earthquakes in eastern Tennessee. In SSAR Section 2.5.2.2.2.5, the applicant stated that, despite being one of the most active seismic zones in Eastern North America, the largest recorded earthquake recorded in the ETSZ is a magnitude 4.6, and no evidence for larger prehistoric earthquakes, such as paleoliquefaction features, has been discovered. The applicant also stated that, with the exception of the Law source 17 (Eastern Basement), none of the EPRI EST sources that included the ETSZ contributed more than 1 percent of the total hazard at the ESP site. For this reason, the applicant's hazard calculations did not include the sources that accounted for ETSZ seismicity, with the exception of Law source 17. The applicant also concluded that no new information regarding the ETSZ has been developed since 1986 that would require a significant revision to the original EPRI seismic source model, specifically with regards to M_{max} for the ETSZ.

In RAI 2.5.2-16, the staff asked the applicant to provide the M_{max} distributions and geographic coordinates defining the geometry of each EST-identified ETSZ. In response to RAI 2.5.2-16, the applicant provided the staff with the requested information and also stated the following:

> None of the EPRI-SOG teams specifically defined a zone identified as "Eastern Tennessee Seismic Zone." Each EPRI-SOG team did define one or more zones that encompass seismicity in eastern Tennessee and, in most cases, the surrounding regions.

The staff concludes that the information provided by the applicant, in response to RAI 2.5.2-16, is complete. SER Table 2.5.2-5 shows the M_{max} distributions for the EPRI EST seismic sources that encompass seismicity in eastern Tennessee, provided by the applicant in its response to RAI 2.5.2-16.

Table 2.5.2-5 - M_{max} Values Corresponding to the EPRI EST Seismic Source Zones That Encompass Seismicity in Eastern Tennessee (Provided by the Applicant In Response to RAI 2.5.2-5)

EPRI EST	Source	Description	Probability of Activity	M_{max} (M) and Weights
Bechtel	24	Bristol Trends	0.25	5.31 [0.10] 5.66 [0.40] 6.06 [0.40] 6.49 [0.10]
	25	NY-AL Lineament	0.3	4.97 [0.10] 5.31 [0.40] 5.66 [0.40] 6.49 [0.10]
	25A	NY-AL Lineament (Alternative)	0.45	4.97 [0.10] 5.31 [0.40] 5.66 [0.40] 6.49 [0.10]
Dames & Moore	4	Appalachian Fold Belt	0.35	5.66 [0.80] 7.51 [0.20]
	4A	Kinks in Appalachian Fold Belt	0.65	6.82 [0.80] 7.51 [0.20]
Law Engineering	17	Eastern Basement	0.62	5.31 [0.20] 6.82 [0.80]
Rondout	13	Southern NY-AL Lineament	1	4.78 [0.30] 6.06 [0.55] 6.34 [0.15]
	24	Southern Appalachians	0.99	6.49 [0.30] 6.82 [0.60] 7.16 [0.10]
	27	TN-VA Border	0.99	4.78 [0.30] 6.06 [0.55] 6.34 [0.15]
Weston	24	NY-AL Clingman	0.9	4.97 [0.26] 5.66 [0.58] 6.49 [0.16]
Woodward-Clyde	31	Blue Ridge Combo	0.024	5.54 [0.33] 6.06 [0.34] 7.16 [0.33]
	31A	Blue Ridge Combo (Alternative)	0.211	5.54 [0.33] 6.06 [0.34] 7.16 [0.33]

In RAI 2.5.2-17, the staff asked the applicant to justify its rationale for not updating the ETSZ as characterized by the EPRI ESTs and to discuss how the M_{max} distributions developed by each EST compare with more recent M_{max} estimates for the ETSZ included in the USGS hazard model (Frankel et al. 2002) and Bollinger (1992). In addition, the staff asked the applicant to explain whether the contribution to the hazard would change if the EST source zones representing the ETSZ were assigned a single M_{max} of M 7.5, or alternatively, to explain why it believes an M_{max} value of M 7.5 with a weight of 0.5 or higher is not warranted for the ETSZ.

In response, the applicant concluded that the majority of the seismicity that defines the ETSZ is beyond the 200-mi site region. The applicant also noted that its update of the Charleston seismic source model (based on recent paleoliquefaction studies) has increased the relative contribution of the Charleston source to the ESP site and thus served to decrease the relative contribution of more distant sources such as the ETSZ. Furthermore, the applicant stated that there is no historic or prehistoric evidence for large magnitude events occurring in the eastern Tennessee area. In support of the low weights assigned by the EPRI ESTs for this region, the applicant stated the following:

> While the lack of evidence for past large events in ETSZ does not preclude large events from occurring in the future, this fact should influence the weighting of the M_{max} distribution. It is therefore logical that the M_{max} distribution for the ETSZ should have lower weights assigned to the largest magnitudes, in contrast to the Charleston and New Madrid sources, where there is a high confidence that those sources are capable of producing large events since they have occurred in the past.

In response to RAI 2.5.2-17, the applicant concluded that the EPRI EST maximum magnitude distributions for the ETSZ span the range of more recent assessments. The applicant's discussion focused on Bollinger's (1992) source model for the SRS. The applicant stated that Bollinger's (1992) M_{max} of **M** 6.3, which was given a weight of 95 percent, is close to the mean $_{max}$imum magnitude of ~**M** 6.2 of the EPRI study. The applicant also noted that Bollinger (1992) assigned a low weight of 5 percent to an M_{max} of **M** 7.8, which was calculated based on a low probability that the dimensions of seismogenic structures within the zone may extend along the entire 300-km northeast-trending axis of the zone. The applicant also concluded that the TIP study (NUREG/CR-6607) provided a similarly broad M_{max} magnitude distribution as did the EPRI distribution of M 4.8 to M 7.5 for the ETSZ. The applicant stated that the magnitude distributions for all TIP Study ETSZ source zone representations ranged from as low as **M** 4.5 to as high as **M** 7.5, with the mode of about **M** 6.5 for almost each distribution (NUREG/CR-6607, pages F-12 to F-19 of Appendix F).

In summary, the applicant concluded the following in its response to RAI 2.5.2-17:

> The ETSZ is characterized by abundant seismicity, but has yet to produce a recorded event greater than **M** 5, which is about the minimum magnitude used to characterize seismic sources in modern PSHA studies. In our opinion, we believe that there is sufficient uncertainty in the M_{max} potential of the ETSZ that a broad range of magnitudes is appropriate and that the EPRI model sufficiently captures the range of more recent M_{max} distributions for this source. While the ETSZ may be capable of producing a **M** 7.5, we do not believe that a weight of 0.5 to 1.0 for this magnitude represents the range of expert opinion reflected in the post-EPRI studies by Bollinger (1992) and Savy et al. (2002). The exception, of course, is the USGS model that assigns a single magnitude of **M** 7.5.

The staff reviewed the applicant's response to RAI 2.5.2-17 and disagrees with the applicant that the ETSZ EPRI EST M_{max} values adequately represent the ETSZ. Rather, the staff concludes that even though these EPRI EST sources have M_{max} values as large as **M** 7.5, the corresponding weights are very low. In addition, the probabilities of activities of many of the ETSZ EPRI EST sources are also low. For example, in SER Table 2.5.2-5, the Dames and Moore Appalachian Fold Belt source has an M_{max} value of **M** 7.5 and a weight of 0.20, and the probability of activity of this source is only 0.35.

SER Table 2.5.2-6 shows recent M_{max} values for the ETSZ including Frankel et al. (2002), Chapman and Talwani (2002), and Bollinger (1992). A comparison of the two results shows that the EPRI M_{max} values shown in SER Table 2.5.2-5 are significantly lower than more recent studies, as shown in SER Table 2.5.2-6. For example, Chapman and Talwani (2002) assigned a single M_{max} of **M** 7.0 to the ETSZ. They noted that epicentral locations of the earthquakes define a major northeast-trending seismic zone, over 300 kilometers in length, suggesting the possibility of a major shock, if the zone is viewed as defining a through-going basement fault. Chapman and Talwani (2002) also stated that "focal mechanisms and the spatial locations of seismicity have revealed much information concerning this important issue, but the seismic hazard posed by this seismic zone remains uncertain."

Table 2.5.2-6 - M_{max} Values for the ETSZ for Recent Studies

Study	M_{max} (M) and Weights
Bollinger (1989)	6.2 [1.0]
Johnston and Chiu (1989)	7.2 [1.0]
Bollinger (1992)	5.7 [0.158] 6.1 [0.158] 6.2 [0.317] 6.5 [0.158] 7.2 [0.158] 7.8 [0.050]
Frankel et al. (2002)	7.5 [1.0]
Chapman and Talwani (2002)	7.0 [1.0]

Furthermore, as stated in the applicant's response above, none of the EPRI ESTs specifically defined a zone identified as the "Eastern Tennessee Seismic Zone." Each EPRI EST did define one or more zones that encompass seismicity in eastern Tennessee and, in most cases, the surrounding regions. In more recent studies, the seismicity within the ETSZ is explicitly developed into source geometries to account for the ETSZ (e.g., Frankel et al. 2002; Chapman and Talwani 2002; Bollinger 1992; and NUREG/CR-6607).

To validate the applicant's claim that the ETSZ hazard results are insignificant compared to the Charleston seismic source, the staff did a confirmatory analysis. The staff performed hazard calculations using maximum magnitudes for the ETSZ that ranged from **M** 6.0 to **M** 7.8. This magnitude range reflects more recent M_{max} values assigned to the ETSZ, as shown in SER Table 2.2.5-6. SER Figure 2.5.2-12 shows the staff's 1-Hz hazard curves for the ETSZ using this range of M_{max} values. SER Figure 2.5.2-12 also shows the applicant's total mean hazard curve and the Charleston seismic source zone contribution for comparison. The staff's results show that, although the Charleston seismic source zone clearly dominates the 1-Hz hazard, the contribution from the ETSZ for some of the larger M_{max} values (greater than 7.0) may contribute significantly more than 1 percent to the total hazard for the ESP site.

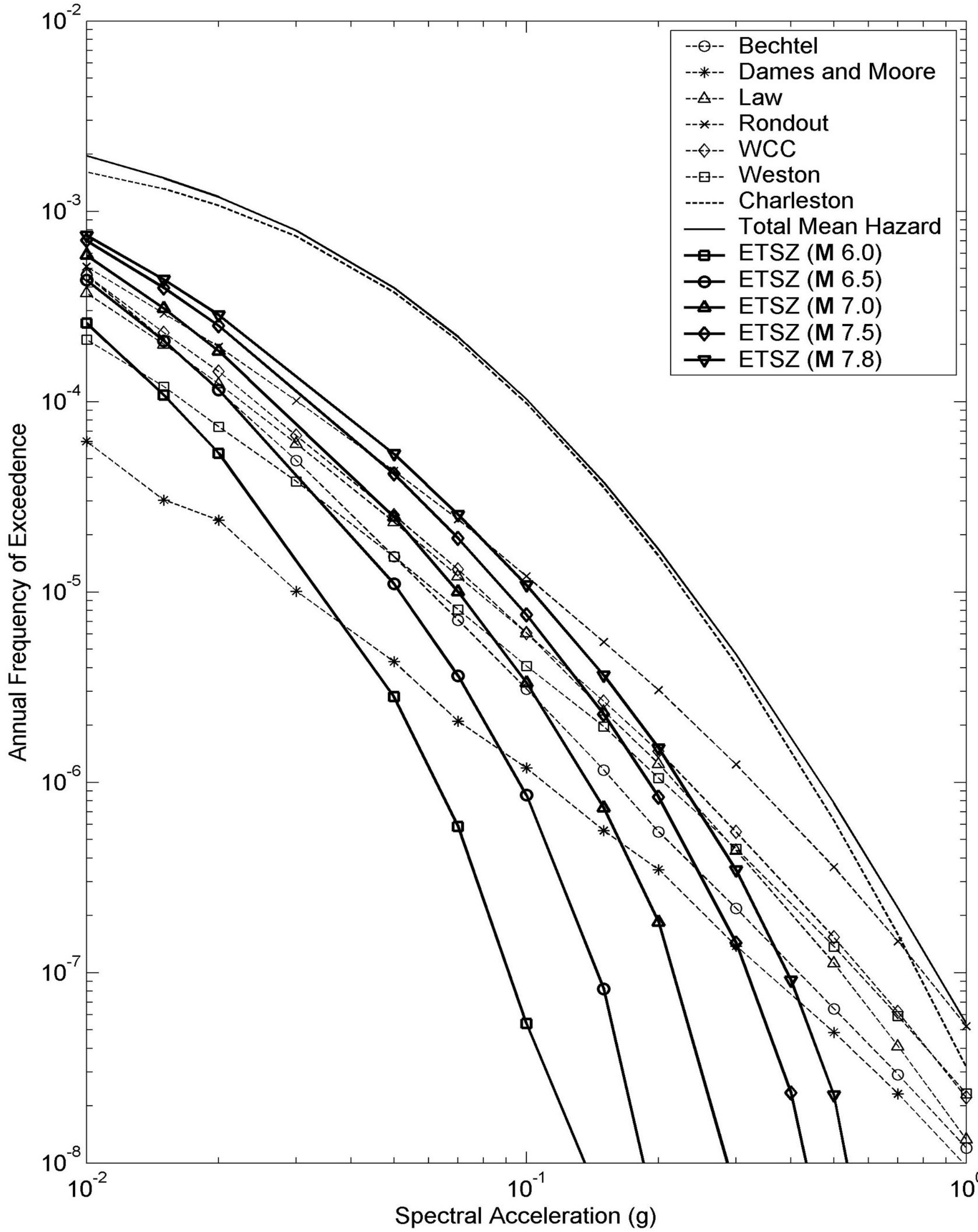


Figure 2.5.2-12 - Comparison of the staff's 1-Hz hazard curves for the ETSZ for magnitudes ranging from M 6.0 to M 7.8

The staff concluded that, despite the uncertainty regarding the potential for large earthquakes within the ETSZ, the results of post-EPRI source characterizations for the ETSZ suggest that the EPRI EST characterization of the ETSZ needs to be updated. The results of the staff's confirmatory analysis confirmed the applicant's assertion that the Charleston seismic source dominates the 1-Hz hazard. However, the staff concluded in the SER with open items that the contribution of the ETSZ at the ESP site may be significant enough to warrant inclusion in the applicant's PSHA, if larger M_{max} values are considered. Accordingly, in the SER with open items, this issue was identified as Open Item 2.5-3.

In response to Open Item 2.5-3, the applicant stated the following:

> The Eastern Tennessee seismic zone (ETSZ) lies between the New York-Alabama and Ocoee aeromagnetic anomalies in what Kanter (1994) has classified as non-extended crust. Wheeler (1995; 1996) has defined this region associated with Eastern Tennessee seismicity as Late Proterozoic/early Paleozoic Iapetan extended crust. Based on the Johnston et al. (1994) study of stable continental cratons, the global seismicity database indicates that the largest historic earthquakes (**M**>7) are limited to Mesozoic extended crust. The Johnston et al. (1994) data base shows that Paleozoic non-extended crust has a mean M_{max} of **M**6.4. Therefore, based on the global database, there is no analog to suggest that the ETSZ portion of the crust should fail in large (**M**>7) events.

As requested by the staff in Open Item 2.5-2, the applicant also provided an evaluation of the TIP study relevant to the seismic source characterization of the ESP site. In response to Open Item 2.5-3 (as well as in response to the staff's request in Open Item 2.5-2) the applicant provided the following evaluation of the ETSZ based on the TIP study:

> The Trial Implementation Project (TIP) study (Savy et al., 2002) identified the ETSZ as a key issue in assessing hazard for the Watts Bar site in Tennessee. While this study was primarily a trial implementation of the SSHAC process, the NRC has requested in Open Item 2.5-2 that we more closely examine information contained in the TIP study that is relevant to the seismic source characterization of the ESP site. The TIP study defined eight source zones to represent uncertainty in the geometry of the ETSZ and defined composite M_{max} distributions for each source zone using the weighting schemes from each of the five experts. The composite M_{max} distributions are presented graphically (pages F-12 through F-19 of the TIP study) for each of the ETSZ source zones, and are summarized in the table below with values of the minimum, maximum, and mode of the distributions.

Source Zone	Min	Mode	Max
4a1	4.5	6.5	7.5
4a1+2	5.0	6.5	7.5
4a1+2+3	5.0	6.5	7.5
4b1	5.0	6.5	7.5
4b2	5.0	6.5	7.5
4c	5.0	6.5	7.5
4d	5.0	6.5	7.5
4e	5.0	6.5	7.5

The magnitude distributions for all ETSZ source zone representations in the TIP study ranged from as low as **M**4.5 to as high as **M**7.5, with a mode of either **M**6.3 or **M**6.5 for each distribution. The modal values represent the greatest weight of the distributions, indicating that the experts participating in the trial implementation of the SSHAC Level 4 process felt that the majority of the weight belonged in the moderate magnitude events as opposed to the largest magnitudes. The broad distribution of the TIP study is similar to the distribution of **M**4.8 to **M**7.5 in the EPRI source zones.

The modal M_{max} value for each of the TIP characterizations of the ETSZ is either **M**6.3 or **M**6.5. Even though the TIP study does not present discrete magnitudes and weights, the modal magnitudes suggest a mean magnitude on the order of ~**M**6.5 or less for the ETSZ.

In summary, the applicant concluded that "Since no new data or evidence has been developed to imply large magnitude earthquakes in the ETSZ since the EPRI study, there is no basis for rejecting the M_{max} interpretations of the EPRI teams, which cover the range of M_{max} employed in more recent seismic source characterizations. Therefore additional calculations of seismic hazard with larger M_{max} values for the ETSZ would be purely speculative and could not form a basis for conclusions."

The staff disagrees with the applicant's conclusions that additional calculations of seismic hazard with larger M_{max} for the ETSZ are not warranted. The staff notes that there are more recent seismic hazard studies, such as the LLNL TIP study and the Geomatrix TVA Dam safety study, which provide new information on the seismic hazard of the area. Furthermore, the staff does not agree with the applicant's conclusion that the EPRI team's M_{max} composite distribution for the ESTZ is similar to that of more recent studies. The applicant only compared the range of the M_{max} values of the EPRI study rather than the actual weighted values. SER Figure 2.5.2-13 clearly shows that more recent studies place a significantly higher probability on larger maximum magnitude earthquakes than the EPRI study. The mean M_{max} for the TIP (i.e. Savy et al., 2002) and Geomatrix studies are approximately **M**6.55 and **M**6.58, respectively.

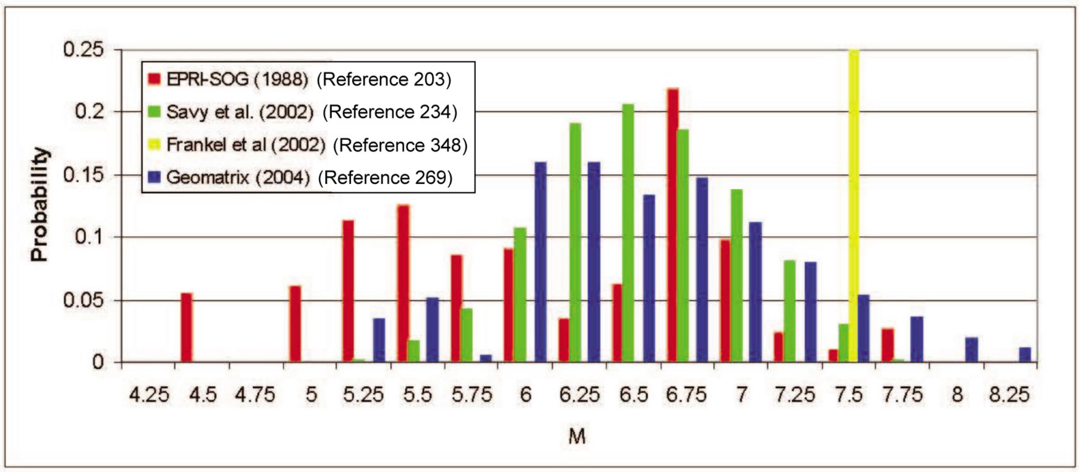


Figure 2.5.2-13. Composite EPRI-SOG distribution in terms of M compared to more recent assessments (reproduced from the Bellefonte RCOL application)

The staff concludes, however, that the contribution of the ESTZ at the Vogtle ESP site is insignificant, even when M_{max} values comparable to the mean M_{max} values for the TIP and Geomatrix studies are considered. Based on the staff's sensitivity study, presented in SER Figure 2.5.2-12, a mean magnitude of **M**6.5 for the ETSZ contributes to less than 1 percent of the total hazard at 1 Hz for ground motions critical for design levels (0.1 g and higher). Therefore, the staff considers Open Item 2.5-3 to be resolved.

<u>**Updated EPRI Seismic Sources**</u>

Based on the results of several post-EPRI PSHA studies (Frankel et al. 2002; Chapman and Talwani 2002) and the recent availability of paleoliquefaction data (Talwani and Schaeffer 2001) for the Charleston source zone, the applicant updated the EPRI characterization of the Charleston seismic source zone as part of the ESP application. The applicant referred to its update as the UCSS model. The staff focused its review on the applicant's UCSS geometry, M_{max} values, and recurrence model. The staff also reviewed the methodology that the applicant used to perform this update.

<u>SSHAC Update of the Charleston Seismic Source</u>. In SSAR Section 2.5.2.2.2.4, the applicant noted that the UCSS model is described in detail in a 2006 Bechtel engineering study report. In order to review the applicant's UCSS model, the staff, in RAI 2.5.2-2, requested a copy of the Bechtel (2006) report. In response to RAI 2.5.2-2, the applicant provided the staff with a copy of Bechtel (2006). Based on its review of the Bechtel (2006) report, the staff gained additional insight regarding the applicant's UCSS model.

As described in Bechtel (2006), the applicant performed an SSHAC Level 2 study to incorporate current literature and data, as well as the understanding of experts, into an update of the Charleston seismic source model. An SSHAC Level 2 study uses an individual, team, or company to act as a Technical Integrator (TI), who is responsible for reviewing data and literature and contacting experts who have developed interpretations of or who have specific knowledge about the seismic source. The TI for the update of the Charleston seismic source model consisted of a team of six William Lettis & Associates, Inc. (WLA) personnel (Scott

Lindvall, Ross Hartleb, William Lettis, Jeff Unruh, Keith Kelson, and Steve Thompson). The WLA TI team first compiled and reviewed all new information developed since 1986 regarding the 1886 Charleston earthquake and the seismic source that may have produced this earthquake and then compared this new information with the 1986 EPRI EST assessments of the Charleston seismic source. Following the literature review, the TI conducted interviews with experts and researchers familiar with geologic/seismologic data and recent characterizations of the Charleston seismic source. The TI consulted the following seismic and geologic experts:

- Dr. David Amick, Science Applications International Corporation
- Dr. Martin Chapman, Virginia Polytechnic Institute
- Dr. Chris Cramer, U.S. Geological Survey
- Dr. Art Frankel, U.S. Geological Survey
- Dr. Arch Johnston, Center for Earthquake Research and Information, University of Memphis
- Dr. Richard Lee, Los Alamos National Laboratory
- Dr. Joe Litehiser, Bechtel Corporation (original team leader of the 1986 Bechtel EST)
- Dr. Stephen Obermeier, U.S. Geological Survey (retired)
- Dr. Pradeep Talwani, University of South Carolina
- Dr. Robert Weems, U.S. Geological Survey

The TI next integrated this information to develop an updated characterization of the Charleston seismic source that captures the composite representation of the informed technical community.

In RAI 2.5.2-4, the staff asked the applicant to justify its rationale for selecting an SSHAC Level 2 methodology for the UCSS update, as opposed to a higher level update. To support its rationale for using the SSHAC Level 2 methodology, the applicant stated the following:

> SSHAC (1997) describes four levels of study (Levels 1 through 4), in increasing order of sophistication and effort. The choice of the level of a PSHA is driven by two factors: (1) the degree of uncertainty and contention associated with the particular project, and (2) the amount of resources available for the study (SSHAC 1997). SSHAC (1997, Table 3-1) suggests that a Level 2 study is appropriate for issues with "significant uncertainty and diversity," and for issues that are "controversial" and "complex." In a SSHAC Level 2 study, a Technical Integrator (TI) is responsible for reviewing data and literature and contacting experts who have developed interpretations or who have specific knowledge of the seismic source. The TI interacts with experts to identify issues and interpretations, and to assess the range of informed expert opinion. In Level 3 studies, the TI goes a step further by bringing together experts and focusing dialog and interaction between them in order to evaluate relevant issues. In Level 4 studies, a Technical Facilitator/Integrator (TFI) is responsible for aggregating the judgments of a panel of experts to develop a composite distribution of the informed technical community. In a meeting held on July 7, 2005, VEGP ESP Technical Advisory Group (TAG) members Dr. Martin Chapman, Dr. Robert Kennedy, Dr. Carl Stepp, and Dr. Robert Youngs agreed that a Level 2 study is appropriate for updating the Charleston seismic source model.

In RAI 2.5.2-4, the staff also asked the applicant to describe its implementation of the SSHAC Level 2 methodology. Specifically, the staff asked the applicant to describe in more detail how the expert's opinions were integrated into the development of the final UCSS model, how any conflicting opinions between the experts were dealt with, and how the final source model represents the informed consensus of the community beyond those queried for the UCSS update. In response, the applicant stated that, as part of the SSHAC process, the TI contacted 10 experts and researchers familiar with geologic/seismologic data and recent characterizations of the Charleston seismic source. The applicant stated the following:

> These experts were asked a series of questions pertaining to key issues regarding the Charleston seismic source. This was not a formal process of expert interrogation to obtain from each expert all of the specific parameters and weights to be used in the model. Instead, we allowed the experts to speak to their own areas of expertise. It was then the TI's responsibility to combine these responses with data from the published literature to capture the range of expert opinion and judgment regarding parameters and weights to be used in the UCSS model.

Regarding the TI integration of the expert's opinion into the development of the final UCSS model, the applicant provided the following information:

> This activity included a two-day workshop held on September 13–14, 2005 to develop the UCSS model at the WLA office in Valencia, California after several weeks of literature and data review. The workshop included the TI team, who integrated Charleston area data and expert interpretations, discussed uncertainties and conflicting expert interpretations, and developed UCSS geometries and the logic tree.

The applicant also stated the following regarding the review of the UCSS model by the TAG panel:

> A Technical Advisory Group (TAG) panel was convened in April 2006 in Frederick, Maryland to critically review the UCSS model and to provide feedback regarding the process and the results of the study. TAG members Chapman, Kennedy, Stepp, and Youngs were in attendance. In addition, Dr. Carl Stepp and Dr. Martin Chapman reviewed written copies of the Engineering Report describing the UCSS and provided written comments on, and approval of, the document.

With regard to how the final source model represents the informed consensus of the community beyond those queried for the UCSS update, the applicant stated, "for the VEGP ESP study, a Senior Seismic Hazard Analysis Committee (SSHAC) Level 2 study was performed to incorporate current literature and data and the understanding of experts into an update of the Charleston seismic source model," and that "the intent of the SSHAC process is to represent the range of current understanding of seismic source parameters by the informed technical community."

Based on its review of SSHAC (1997) and the Bechtel (2006) report provided by the applicant in response to RAI 2.5.2-2, as well as the applicant's response to RAI 2.5.2-4, the staff concludes that the applicant's overall implementation of the SSHAC Level 2 process is adequate. In accordance with an SSHAC Level 2 study, the applicant established a TI, comprising six WLA personnel, to conduct a literature review and contact experts and researchers familiar with geologic/seismologic data and recent characterizations of the Charleston seismic source. As defined in the SSHAC report, a TI is "a single entity (individual, team, or company, etc.) who is responsible for ultimately developing the composite representation of the informed technical community." Also in accordance with SSHAC, the applicant selected a peer review panel to "critically review the UCSS model and to provide feedback regarding the process and results of the study." The applicant referred to its peer review panel as the VEGP ESP TAG. The TAG consisted of Dr. Martin Chapman, Dr. Robert Kennedy, Dr. Carl Stepp, and Dr. Robert Youngs. According to the 1997 SSHAC report, the purpose of the peer review panel is to "assure that the process followed was adequate and to ensure that the results provide a reasonable representation of the diversity of views of the technical community."

The staff also concludes that the applicant's selection of an SSHAC Level 2 study is appropriate for the update of the Charleston seismic source zone. As shown in SER Table 2.5.2-7 (reproduced from Table 3-1 of the 1997 SSHAC report), the SSHAC criteria for deciding on the level of the study is rather subjective. The 1997 SSHAC report suggests that Level 2 studies are appropriate for issues with "significant uncertainty and diversity," and for issues that are "controversial" and "complex," while Level 3 and 4 studies are appropriate for issues that are "highly contentious; significant to hazard; and highly complex." SSHAC (1997) also states that Level 3 and 4 studies "are resource-intensive and are, therefore, most appropriate for large-scale studies for critical facilities." Thus, based on the guidance provided in SSHAC (1997), and because the applicant's study involved the update of a single seismic source zone, the staff agrees with the applicant's decision to use an SSHAC Level 2 study.

Table 2.5.2-7 - Degrees of PSHA Issues and Levels of Study (from SSHAC (1997), Table 3-1, p. 23)

ISSUE DEGREE	DECISION FACTORS	STUDY LEVEL
A Noncontroversial and/or insignificant to hazard		1 TI evaluates/weights models based on literature review and experience; estimates community distribution
B Significant uncertainty and diversity; controversial; and complex		2 TI interacts with proponents and resource experts to identify issues and interpretations; estimates community distribution
C Highly contentious; significant to hazard; and highly complex	Regulatory concern Resources available Public perception	3 TI brings together proponents and resource experts for debate and interaction; TI focuses debate and evaluates alternative interpretations; estimates community distribution
		4 TFI organizes panel of experts to interpret and evaluate; focuses discussions; avoids inappropriate behavior on part of evaluators; draws picture of evaluators' estimate of the community's composite distribution; has ultimate responsibility for project

Although the staff concurs with the applicant's selection and overall implementation of an SSHAC Level 2 method to update the Charleston seismic source model, its review of Bechtel (2006) resulted in several additional questions. For example, the staff was unable to determine the actual questions that each of the experts involved in the SSHAC Level 2 study were asked, the range of expert opinions related to key aspects of the UCSS model (i.e., recurrence, geometry, and maximum magnitude), or the specific process used to combine the expert's opinions and resolve any differing opinions. On June 18, 2007, the applicant supplemented its response to RAI 2.5.2-4 with additional information regarding its SSHAC Level 2 study. Because the staff received this information late in the review process, the staff identified this as Open Item 2.5-4 in the SER with open items, to allow additional time to complete the review. The staff also requested the applicant to explain why only two of the four members of the TAG panel reviewed and approved written copies of the engineering report describing the UCSS, as stated in response to RAI 2.5.2-4.

In its supplemental response to RAI 2.5.2-4, the applicant provided the staff with the list of questions that the technical integrator developed and used as its basis for communicating with researchers by telephone. These questions covered the main issues involving the Charleston earthquake process, geometry, maximum magnitude (M_{max}), and recurrence. The applicant also provided the responses given by each of the experts. The applicant noted that some of the experts limited their responses to their own specific area of expertise. For example, Stephen Obermeier (USGS, retired) provided comments and insight on paleoliquefaction data, but did not wish to comment on specific questions regarding source geometry modeling and other parameters. In addition, the applicant also stated that in some interviews, selected questions were not asked if the topic was outside the expert's research area or if the interview was limited on time.

The applicant's supplemental response to RAI 2.5.2-4 also describes how the expert's opinions were integrated into the development of the final UCSS model, and how any conflicting opinions between the experts were dealt with. The applicant stated that "because the SSHAC Level 2 process does not involve bringing the experts together, there was not a forum for experts to directly question or challenge each other's assumptions or results and formally resolve any conflicting opinions." The applicant noted that "in the compilation of literature and expert opinions, there were instances where one expert's opinions differed from others." The applicant further noted that "in these cases, it is the responsibility of the Technical Integrator (TI) to "evaluate the viability and credibility of the various hypotheses with an eye toward capturing the range of interpretations, their credibilities, and uncertainties" (SSHAC 1997). The applicant stated that "conflicting opinions were included in the model parameters in an effort to capture the range of opinion and uncertainty."

In Open Item 2.5-4, the staff also requested the applicant to explain why only two of the four members of the Technical Advisory Group (TAG) panel reviewed and approved written copies of the engineering report describing the Updated Charleston Seismic Source (UCSS), as stated in its response to RAI 2.5.2-4. In response to Open Item 2.5-4, the applicant stated the following:

> The Updated Charleston Seismic Source (UCSS) model was presented to the entire Technical Advisory Group (TAG) panel in meetings on April 12-13, 2006. As such, the TAG performed participatory peer review of the UCSS, including reviewing the approach (i.e., SSHAC Level 2), data, and results of the updated model. The TAG panel consisted of three seismologists and one structural engineer. It was decided that it would be in the best interest of the project to also have a detailed review of UCSS engineering report by members of the TAG. The two seismologists most familiar with the tectonics and seismicity of the southeastern US, Dr. Martin Chapman and Dr. Carl Stepp, were requested to review written copies of the engineering report and provide comments.

The staff reviewed the applicant's responses to RAI 2.5.2-4 and Open Item 2.5-4. Based on its review, the staff concludes that the applicant adequately performed a SSHAC Level 2 study to update the Charleston seismic source zone. The staff concludes that the list of questions that the TI asked the experts generally addressed the key aspects of the UCSS model, and that the applicant's UCSS adequately captured the range of expert's input, when provided. The staff further concludes that the TI adequately integrated the range of expert's responses, where appropriate, into the final UCSS along with its findings based on its review of current literature and paleoliquefaction data. In addition, the staff considers it appropriate that only two of the TAG panel members performed a detailed review the final UCSS because these members had the most familiarity with the tectonics and seismicity of the southeastern US.

<u>Paleoliquefaction features of the Charleston seismic source zone</u>. Abundant soil liquefaction features induced by the 1886 Charleston earthquake, in addition to other large prehistoric earthquakes (dating back to the mid-Holocene), are preserved in geologic deposits at numerous

locations within the 1886 meizoseismal area and along the South Carolina coast. SSAR Section 2.5.2.2.2.4.1 states that the characteristics of the 1886 Charleston earthquake, combined with the greatest density of prehistoric liquefaction features, "show that future earthquakes having magnitudes comparable to the Charleston earthquake of 1886 most likely will occur within the area defined by Geometry A. A weight of 0.7 is assigned to Geometry A". Additionally, SSAR Figure 2.5.2-9 indicates no likelihood that an 1886-sized earthquake has occurred inland from the coastal region, except along Geometry C, and then only with a probability of 0.1. In RAI 2.5.2-8, the staff asked the applicant to summarize the age, liquefaction susceptibility, and geographic distribution of liquefiable deposits in the zone that is 50 to 150 kilometers (31 to 93 miles) inland from the coast and explain whether this information supports a negligible probability of large inland earthquakes. In addition, in RAI 2.5.2-8, the staff requested that the applicant reconcile the negligible probability of large inland earthquakes, as indicated in SSAR Figure 2.5.2-9, with the discovery of prehistoric liquefaction features as much as 100 kilometers (62 miles) inland in fluvial deposits of the Edisto River (Obermeier 1996). In response to RAI 2.5.2-8, the applicant stated the following:

> Liquefaction susceptibility is a function of numerous variables including, but not limited, to, sediment grain size and sorting, degree of compaction and/or cementation, deposit thickness, depth below ground surface, degree of saturation, and sediment age. Obermeier (1996) suggested that South Carolina Coastal Plain deposits older than about 250 ka have negligible potential for liquefaction due to the effects of chemical weathering. Obermeier (1996) observed that, in general, the region within 30 mi (~50 km) of the coast is highly susceptible to liquefaction. The liquefiable deposits of the about 100 ka Princess Anne Formation, however, are mapped greater than 65 mi inland (McCartan et al. 1984).
>
> Numerous liquefaction features caused by the 1886 Charleston earthquake and paleoliquefaction features from prehistoric Events A, B, C', E and F' are distributed along a 115 mi stretch of coastal South Carolina from Bluffton in the south to Georgetown in the north. The inland extent of 1886 liquefaction is less well-constrained.
>
> There is no structural, geomorphic, paleoseismic (other than the cited sparse liquefaction data), or historic (i.e., 1886) evidence to suggest a source zone geometry that trends northwest-southeast or extends significantly inland from the 1886 meizoseismal area. The sparse liquefaction features along the Edisto River cited by Seeber and Armbruster (1981), Amick et al. (1990), and Obermeier (1996) likely reflect strong ground shaking in deposits susceptible to liquefaction, and not a localized, inland source.

The staff agrees that the applicant's response adequately summarized the age, liquefaction susceptibility, and geographic distribution of liquefiable deposits in the zone 50–150 kilometers (31–93 miles) inland from the South Carolina coast. However, it is the staff's opinion that the applicant, in its RAI response, did not provide substantial evidence to rule out the occurrence of large inland earthquakes, especially given the presence of liquefiable deposits greater than 100 kilometers (65 miles) inland from the coast. The occurrence of a large earthquake inland from the coast would necessitate a different Charleston source zone model. Accordingly, in the SER with open items, the staff identified this issue as Open Item 2.5-5. In Open Item 2.5-5, the staff asked the applicant to provide supporting evidence to rule out the occurrence of large inland earthquakes.

In response to Open Item 2.5-5, the applicant explained that it would be difficult to provide direct evidence that large earthquakes have not occurred inland from Charleston. The applicant described liquefaction and paleoliquefaction features that have been documented by a number of researchers along the Edisto River as far as 70 km (45 mi) inland from the coast. The applicant considered these sites to represent liquefaction and paleoliquefaction features documented farthest inland from the coast. The applicant explained that most researchers do not document negative findings for inland liquefaction features and provided the following statement:

> Various researchers (e.g., Amick et al. 1990, Obermeier 1996) have published maps depicting the geographic distribution of 1886 liquefaction and paleoliquefaction sites in coastal South Carolina and along the eastern seaboard. These researchers do not, however, thoroughly document their reconnaissance of the rivers and drainage ditches that lack features indicative of strong ground shaking inland from the Charleston meizoseismal area, other than to say none was observed inland.

The applicant also provided additional supporting information in the form of documented expert opinion regarding the likelihood of large inland earthquakes. The following statement by the applicant details the opinions of Stephen Obermeier (U.S. Geological Survey, retired), an expert in eastern U.S. liquefaction and paleoliquefaction:

> Obermeier discussed the areas reconnoitered as part of his and others' research into South Carolina coastal plain liquefaction sites. There are no published maps that show in detail those areas studied but in which no liquefaction features were recognized. According to Obermeier, Figure 7.6 from Obermeier (1996) represents the best published approximation of the areas of investigation. This figure indicates that, with the exception of the Edisto River, the search for liquefaction features extended roughly 12 to 30 mi (20 to 50 km) inland throughout South Carolina. Reconnaissance along the Edisto River extended to roughly 45 mi (70 km) from the coast and represents the inland-most extent of the search for liquefaction features. Reconnaissance was conducted inland along the Edisto River in part because the banks of this river and its associated drainage ditches, more so than most in South Carolina, provide relatively good geologic exposure in which liquefaction features may be recognized.

The applicant compared the geographic distribution of the inland Edisto River liquefaction features to those found along the coast and made the following statement:

> It is instructive to note that these Edisto River liquefaction sites are closer to the Charleston meizoseismal area (<40 miles) than are the liquefaction sites up and down the coast that experienced liquefaction during the 1886 event (~100 miles). These observations indicate that the local Charleston source is capable of producing the observed inland liquefaction features along the Edisto River.

The applicant also provided the following statement contained in the TIP study (Savy et al., 2002) to further support a local Charleston source rather than an inland source for producing large earthquakes:

> The hazard at the Vogtle plant will be sensitive to the northwestern and western extents of the Charleston source. There appears to be no compelling reason to extend the source to the northwest from the 1886 epicentral area by connecting the Summerville-Middleton Place and Bowman zones of microseismicity. Dave Amick has found no paleoliquefaction evidence for strong ground shaking in the Bowman area, and the microseismicity there is much shallower than in the epicentral area. (p.19)

The applicant stated that while it is difficult to provide conclusive evidence that a large earthquake would not occur inland from the coast, many large areal source zones contained in the EPRI source model allow for potential large earthquakes to occur throughout the southeastern U.S. and thus would account for the possibility of a large inland earthquake outside of the local Charleston source.

While the applicant's position for supporting a negligible probability of large inland earthquakes does not rule out the potential for large inland earthquakes to occur, the staff believes that the applicant provided adequate documentation to support the likelihood of a local Charleston source rather than a source inland from the coast. The staff found the applicant's submittal of expert opinion regarding previous documentation of inland historic and prehistoric liquefaction features to be sufficient to support the applicant's evaluation. Only a handful of sites inland from Charleston along the Edisto River provide evidence for earthquake-induced liquefaction and most researchers do not document a lack of evidence in their observations. While numerous factors contribute to the liquefaction susceptibility at a site, liquefiable sediments are known to be present greater than 100 km (65 mi) inland from the coast, with minimal evidence for liquefaction observed.

The lack of more abundant earthquake-induced liquefaction features observed farther inland coupled with the presence of features extending more than 100 miles along the coast, and mostly equidistant from Charleston, does not prove large inland earthquakes have not occurred but rather suggests a more likely centralized earthquake source closer to Charleston. The staff concurs with the applicant that it would be difficult to provide direct evidence against the occurrence of large inland earthquakes. Furthermore, the staff concludes that the information provided by the applicant in support of a localized Charleston earthquake source, rather than an inland earthquake source, is adequate based on evidence in the existing literature as well as expert opinion regarding actual observed liquefaction features. Therefore, the staff considers Open Item 2.5-5 to be resolved.

With regard to the size and quantity of earthquakes that produced the Charleston area liquefaction features, SSAR Section 2.5.2.2.2.4.3 suggests that the liquefaction features attributed by researchers to a single large, prehistoric earthquake might actually have been produced by several moderate magnitude earthquakes that are closely spaced in time (SSAR, page 2.5.2-26). In RAI 2.5.2-9, the staff asked the applicant to determine whether Talwani or Obermeier, two recognized experts, have data on the sizes of prehistoric liquefaction craters and whether these or any related data might constrain the possible magnitudes of the prehistoric earthquakes.

In response to RAI 2.5.2-9, the applicant explained that it is possible to compare the 1886 earthquake liquefaction features with liquefaction features attributed to pre-1886 events. The applicant further explained that some pre-1886 features suggest an earthquake magnitude similar to the 1886 Charleston earthquake. The applicant provided the following evidence:

> Obermeier (1996) noted "almost all craters that predate 1886 have a morphology and size comparable to the 1886 craters" (p.345). Moreover, the sizes of individual craters formed during the 600 and 1,250 years BP events are at least as large as those formed during the 1886 earthquake, both in the vicinity of Charleston and farther away (Obermeier 1996). These observations suggest that some prehistoric earthquakes have been at least as large as the 1886 earthquake.

The applicant cited a number of references, including Talwani and Schaeffer (2001), Hu et al. (2002a, 2002b), Leon (2003), and Leon et al. (2005), each of which attempted in some degree to estimate earthquake magnitudes associated with liquefaction features over the extended, as well as more limited, areas in the Charleston vicinity. According to the applicant, the magnitude estimates based on these studies vary widely, from **M** 7+ (Talwani and Schaeffer 2001) to **M** 6.8–7.8 (Hu et al. 2002b) to M 6.9–7.1 and **M** 5.6–7.2 (Leon et al. 2005) for earthquakes associated with widespread liquefaction features. Magnitude estimates for earthquakes producing liquefaction features over more limited areas vary similarly from M 6+ (Talwani and Schaeffer 2001) to **M** 5.5–7.0 (Hu et al. 2002b) to **M** 5.7–6.3 and **M** 4.3–6.4.

The applicant concluded that, even with the large uncertainties attached to estimating magnitudes from paleoliquefaction data, and in turn reflecting broad magnitude estimates for prehistoric earthquake events, the studies cited suggest that at least some of the prehistoric earthquakes have been similar in magnitude to the 1886 Charleston earthquake. Specifically, the applicant's response indicates that pre-1886 liquefaction craters "have a morphology and size comparable to the 1886 craters." This statement indicates that 1886 and pre-1886 liquefaction craters have similar maximum sizes, with ground conditions and hypocentral depths being similar, which implies similar historic and prehistoric earthquake magnitudes.

While the applicant's reasoning does not rule out the occurrence of numerous smaller earthquakes, the staff believes that the applicant made an accurate assumption that earthquake magnitudes for pre-1886 earthquakes in the Charleston area are similar to the magnitude range attributed to the 1886 event based on the documentation of large liquefaction craters induced by both 1886 and pre-1886 earthquakes. As such, the staff concludes that the applicant conservatively assumed that the pre-1886 earthquakes were similar in magnitude to the 1886 event.

In RAI 2.5.2-10, the staff asked the applicant to summarize, for each of the pre-1886 events, the number of liquefaction features and sites that have been documented, the areal extent of liquefaction (i.e., the number of square kilometers affected), the number of dates that have been collected, and how well the features correlate from one site to the next.

In response to RAI 2.5.2-10, the applicant summarized the methods used in the application to constrain the timing of liquefaction-inducing earthquakes and referenced SSAR Table 2.5.2-13 to provide an age comparison of Charleston liquefaction events (Talwani and Schaeffer 2001). The applicant provided the following background information:

> Talwani and Schaeffer (2001) used calibrated radiocarbon ages with 1-sigma error bands in order to define the timing of past liquefaction episodes in coastal South Carolina. The standard in paleoseismology, however, is to use calibrated ages with 2-sigma (95.4 percent confidence interval) error bands (e.g., Sieh et al. 1989; Grant and Sieh 1994). Likewise, in paleoliquefaction studies, in order to more accurately reflect the uncertainties in radiocarbon dating, the use of

> radiocarbon dates with 2-sigma error bands (as opposed to narrower 1-sigma error bands) is advisable (Tuttle 2001).

Because Talwani and Schaeffer used calibrated ages with 1-sigma error bands, the applicant recalibrated Talwani and Schaeffer's (2001) radiocarbon data using 2-sigma error bands and presented the new data in the application. The applicant stated that the use of 1-sigma error bands by Talwani and Schaeffer (2001) possibly led to an overinterpretation of the paleoliquefaction record such that Talwani and Shaeffer (2001) may have interpreted more episodes than what actually occurred. The applicant used the 2-sigma recalibrated data to obtain broader age ranges for pre-1886 earthquake-induced liquefaction events. The applicant provided the following additional information:

> Paleoearthquakes were distinguished based on grouping paleoliquefaction features that have contemporary radiocarbon samples with overlapping calibrated ages. The event ages were then defined by selecting the age range common to each of the samples. For example, an event defined by overlapping 2-sigma sample ages of 100 to 200 cal yr BP and 50 to 150 cal yr BP would have an event age of 100 to 150 cal yr BP. We consider the "trimmed" ages to represent the ~ 95 percent confidence interval, with a "best estimate" event age as the midpoint between the ~ 95 percent age range.
>
> The 2-sigma analysis identified six earthquakes (including 1886) in the data presented by Talwani and Schaeffer (2001). As noted by that study, events C and D are indistinguishable at the 95 percent confidence interval, and together they compose Event C'. Additionally, our 2-sigma analysis suggests that Talwani and Schaeffer's (2001) events F and G may have been a single, large event, which we name Event F'.

The applicant provided a summary of the approximate number of documented liquefaction features, the areal extent of those features, and the number of radiocarbon dates collected for each of the prehistoric earthquake events (A, B, C', E, F') as well as for the 1886 event. SER Figure 2.5.1-11, in response to RAI 2.5.1-10, provides a means of visually correlating liquefaction features from one site location to the next and from one event to another.

Based on its review of the applicant's response to RAI 2.5.1-10, the staff concludes that the applicant adequately summarized the documented liquefaction features associated with 1886 and pre-1886 earthquake events. The data provided by the applicant are useful in evaluating the uncertainty associated with each of the prehistoric earthquake events and in correlating similarities between events in order to better estimate possible magnitudes and source location.

SSAR Section 2.5.2.2.2.4.3 states that paleoliquefaction Event C is defined by features north of Charleston, while Event D is defined by sites south of Charleston. Events C and D are combined into a single large event, C'. In RAI 2.5.2-11, the staff requested the applicant to provide any information on liquefaction features, geographically located between these two areas, that have similar radiocarbon ages, which would support the characterization of these events as a single large event rather than two separate events. The staff also asked the applicant to provide justification that there is enough paleoliquefaction data to support a single large event C' from a single source.

In response to RAI 2.5.2-11, the applicant stated that using 2-sigma calibration for evaluating radiocarbon dates associated with Talwani and Schaeffer (2001) events C and D, based on timing alone, provides evidence that these events are indistinguishable at the 95 percent confidence interval. The applicant combined the two events into a single event, C'. Talwani and Schaeffer (2001) themselves interpreted an alternate scenario for these two events, also based on 2-sigma calibration of the data, and referred to a possible single event, C'.

The applicant provided a visual depiction of this information (SER Figure 2.5.2-14) to allow a comparison of liquefaction features associated with Talwani and Schaeffer (2001) events C and D to determine any overlap that could provide further evidence that these two events should be combined into a single event, C'. The applicant stated that liquefaction features associated with events C and D are localized and do not show any spatial overlap and "therefore do not provide definitive geographic evidence for combining these events into a single, large event C'." However, the applicant chose to include a single, large event C' (as opposed to two smaller events C and D) into the updated Charleston seismic source model based on the following three reasons:

1. The two-sigma reanalysis of Talwani and Schaeffer's (2001) age data performed for the VEGP ESP application indicates that the age data constraining the timing of Events C and D overlap one another and therefore the two events are indistinguishable. This observation is consistent with the interpretation of a single, large Event C'.

2. The incorporation of a single, large Event C' into the updated Charleston seismic source model is, in effect, a conservative approach. In developing a recurrence interval for large, characteristic earthquakes in the updated Charleston seismic source model, it was desirable to include the possibility that Events C and D represent a single, large earthquake. Talwani and Schaeffer's (2001) moderate-magnitude (~M 6) earthquakes C and D would be eliminated from the record of large (M_{max}) earthquakes in the updated Charleston seismic source model, thereby increasing the calculated M_{max} recurrence interval and lowering the hazard without sufficient justification.

3. The distribution of paleoliquefaction sites for Event C' is very similar to the coastal extent of liquefaction features from the 1886 earthquake. Moreover, the distribution and number of paleoliquefaction sites for Event C' are very similar to those for Events A and B, the two best documented prehistoric events (SER Figure 2.5.2-15).

Based on its review of the applicant's response to RAI 2.5.2-11, the staff acknowledges that recalibration of radiocarbon ages shows that the ages of events C and D are indistinguishable at a 95.4 percent confidence interval and that the applicant's decision to combine the two events into a single larger event, C', is justified. Geographic distribution of liquefaction features associated with a single large event C' is comparable to distribution of features associated with the 1886 Charleston earthquake and prehistoric earthquake events A, B, E and F'. The effect is to decrease the average recurrence interval of 1886-sized earthquakes from what the interval would be if events C and D were two moderate earthquakes. Thus, combining C and D is conservative with respect to seismic hazard.

<u>Charleston Seismic Source Zone Geometries</u>. For its update of the Charleston seismic source zone, the applicant developed new source zone boundaries. Specifically, as described in SSAR Section 2.5.2.2.4, the applicant developed four, mutually exclusive source zone geometries, referred to as A, B, B', and C, to represent the Charleston seismic source. These four source zones are shown in SER Figure 2.5.2-2 (reproduced from SSAR Figure 2.5.2-9). SSAR Section 2.5.2.2.2.4.1 states that the width of Geometry B is 80 kilometers (50 miles). However, SSAR Figure 2.5.2-9 (and SER Figure 2.5.2-2) show that the width of Geometry B is

100 kilometers (62 miles). In RAI 2.5.2-14, the staff asked the applicant to provide the actual dimensions of Geometry B used for the UCSS. In response, the applicant stated that the width of UCSS Geometry B is 100 kilometers and not 80 kilometers, as stated in SSAR Section 2.5.2.2.2.4.1. Based on the applicant's clarification of the width of source zone B, the staff concludes that the source referred to as Geometry B in SSAR Figure 2.5.2-9 is accurate.

SSAR Section 2.5.2.4.4 states that "the new interpretation of the Charleston source indicates that a source of the large earthquakes in the Charleston area exists with weight 1.0…." Although the UCSS update of the Charleston source zone covers a fairly large area, the weighting and source geometries give the largest hazard only inside Zone A (either 0.9 (A, B, B') or 1.0 (A, B, B', C)), which is a relatively small zone. In view of this result, the staff asked the applicant, in RAI 2.5.2-13, to provide justification for the UCSS source geometries and weighting scheme and define what is meant by the "Charleston area." In its response, the applicant concluded that the Charleston source area is "stationary in space and is confined to a relatively restricted area," which it referred to as Geometry A. The applicant provided the following information to support its conclusion that the source area that produced 1886 Charleston-type large magnitude earthquakes is likely relatively restricted in area:

> The updated Charleston seismic source model includes four potential geometries (A, B, B', and C) to represent the source area for the Charleston seismic source zone. The greatest weight is given to a localized zone (Geometry A) that completely incorporates the 1886 earthquake Modified Mercalli Intensity (MMI) X isoseismal (Bollinger 1977), the majority of identified Charleston meizoseismal-area tectonic features and inferred fault intersections, and the majority of reported 1886 liquefaction features. Outlying liquefaction features are excluded because liquefaction occurs as a result of strong ground shaking that may extend well beyond the areal extent of the tectonic source. Data describing the size and spatial distribution of paleoliquefaction features suggest prehistoric earthquakes (Events A, B, C', E, and F') were of similar magnitude and location to the 1886 Charleston earthquake, which produced liquefaction at significant distances northeast and southwest from the meizoseismal area. Lower weights are given for source geometries that envelop specific postulated tectonic features (i.e., Geometry C for the southern segment of the East Coast fault system), or for broader areal distributions that also envelop the localized zone to allow for greater uncertainty in the location and lateral extent of a fault that may have produced the 1886 Charleston earthquake.

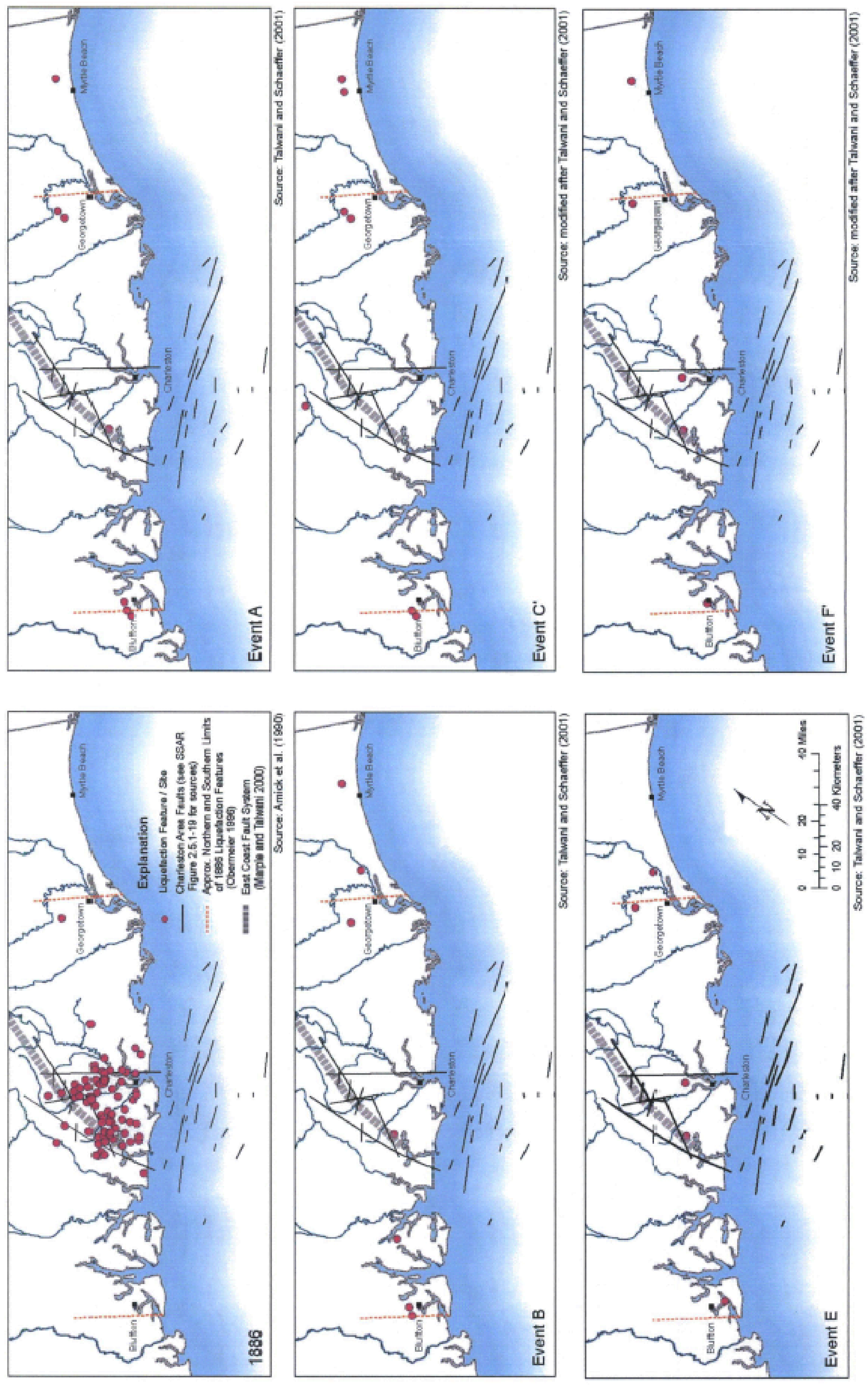


Figure 2.5.2-14 – Geographic Distribution of Liquefaction Features Associated with Charleston Earthquakes (SSAR Figure 2.5.2-12a)

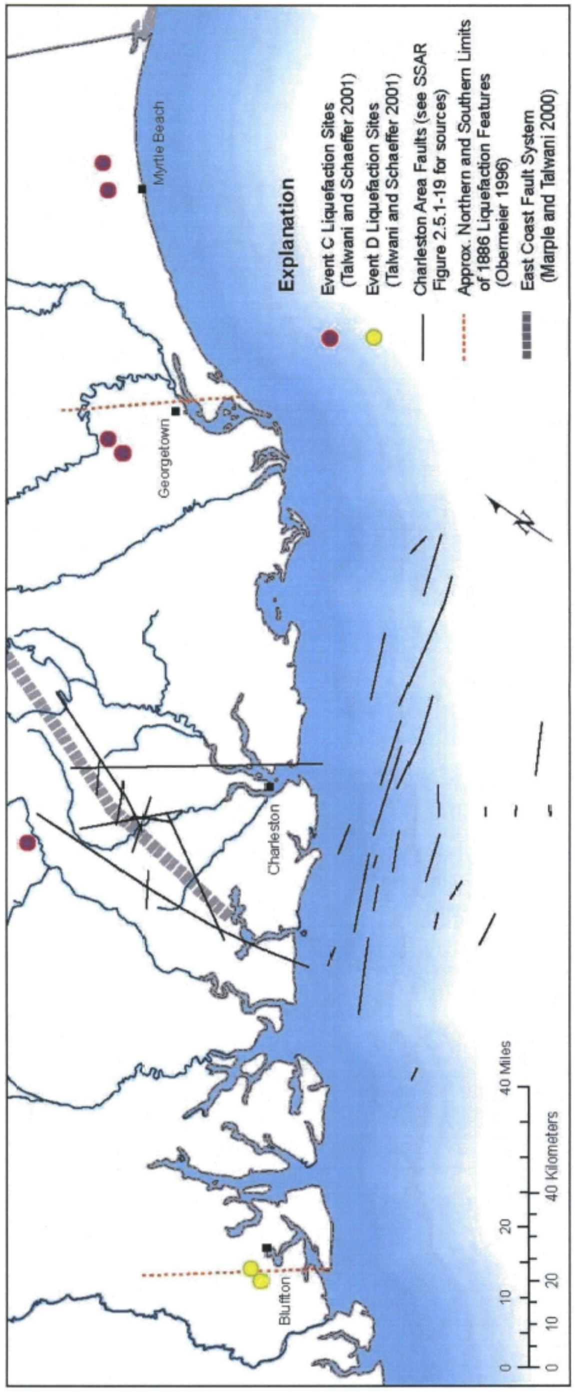


Figure 2.5.2-15 – Liquefaction Sites for Events C, C, and D (Applicant Response to RAI 2.5.2-11, Figure 2.5.2-11)

The applicant provided the following revision for the term “Charleston area” as used in the third sentence of the first paragraph of SSAR Section 2.5.2.4.4:

> The new interpretation of the Charleston source (see Section 2.5.2.2.2) indicates that a unique source of large earthquakes exists with weight 1.0 and that large magnitude events occur with a rate of occurrence unrelated to the rate of smaller magnitudes.

The applicant's response states that the SSHAC Level 2 TI concluded that the Charleston source area is stationary in space and is confined to a relatively restricted area. Geometry A represents the preferred small source area and it is given a high weight of 0.7 (SSAR 2.5.2.2.2.4.1). According to the applicant geometry A is based on (1) the 1886 meizoseismal area and greatest density of liquefaction features; (2) the concentration of known and hypothesized tectonic features, mainly faults; (3) the concentration of historical seismicity, chiefly in the Middleton Place-Summerville seismic zone; and (4) the greatest density of prehistoric liquefaction features.

The staff focused its review on the density of prehistoric liquefaction features in relation to Geometry A because the use of a small source area to represent the sources of the 1886 and all previous large earthquakes depends crucially on a demonstration that the largest liquefaction craters of all ages concentrate near Charleston. The staff also reviewed the information presented in Bechtel (2006). Bechtel (2006) briefly references recent studies regarding the geographic distribution, density, and size of liquefaction features produced by the 1886 and prehistoric earthquakes in the Charleston region, specifically Obermeier et al. (1989, 1990, 2001) and Amick et al. (1990).

The staff also reviewed the study of Obermeier et al. (1989). Obermeier et al. (1989) conclude that, "Both the size and relative abundance of pre-1886 craters are greater in the vicinity of Charleston (particularly in the 1886 meizoseismal zone) than elsewhere, even though the susceptibility to earthquake-induced liquefaction is approximately the same at many places throughout this coastal region." Figure 4 of Obermeier et al. (1989), reproduced as SER Figure 2.5.2-16, depicts the sizes of various prehistoric liquefaction features and demonstrates that the largest craters of all ages concentrate near Charleston. The staff notes that the figure cannot exclude the possibility that one (or more) of the large prehistoric earthquakes created its (or their) largest liquefaction features elsewhere. However, Obermeier's (1989) figure shows four size classes of craters, with the largest prehistoric craters (wider than 3 meters) present only in the 1886 meizoseismal area. Only smaller craters are known farther south and north. Obermeier (1989) favors attributing some of these distant, small-to-medium-sized craters to infrequent moderate earthquakes at two separate sources far north and south of Charleston. The epicentral regions of 1886-sized earthquakes should have abundant craters wider than 3 meters, and they have been found only near Charleston. Sparse exposures preclude saying much about crater sizes between Beaufort and the Edisto River, south of Charleston (Obermeier et al. 1989) and south of Geometry A. Thus, it is unlikely, but possible, that the paleoliquefaction record of a large earthquake's meizoseismal region could be concealed south of Geometry A. However, this small probability is accounted for by Geometries B and B', which span most of the length of South Carolina's coast. The absence of known abundant paleoliquefaction features in North Carolina and Georgia, despite searches there (Amick and Gelinas 1991), suggests that Geometries B and B' need not extend beyond South Carolina.

Accordingly, the staff concludes that the applicant's use of a small area to represent the sources of the 1886 and all previous large earthquakes is adequate. Available evidence suggests it is likely that 1886-sized earthquakes occurred mostly or entirely within a small area like Geometry A. Evidence provided by the applicant in response to previous Open Item 2.5-5, further supports a localized source contained within Geometry A.

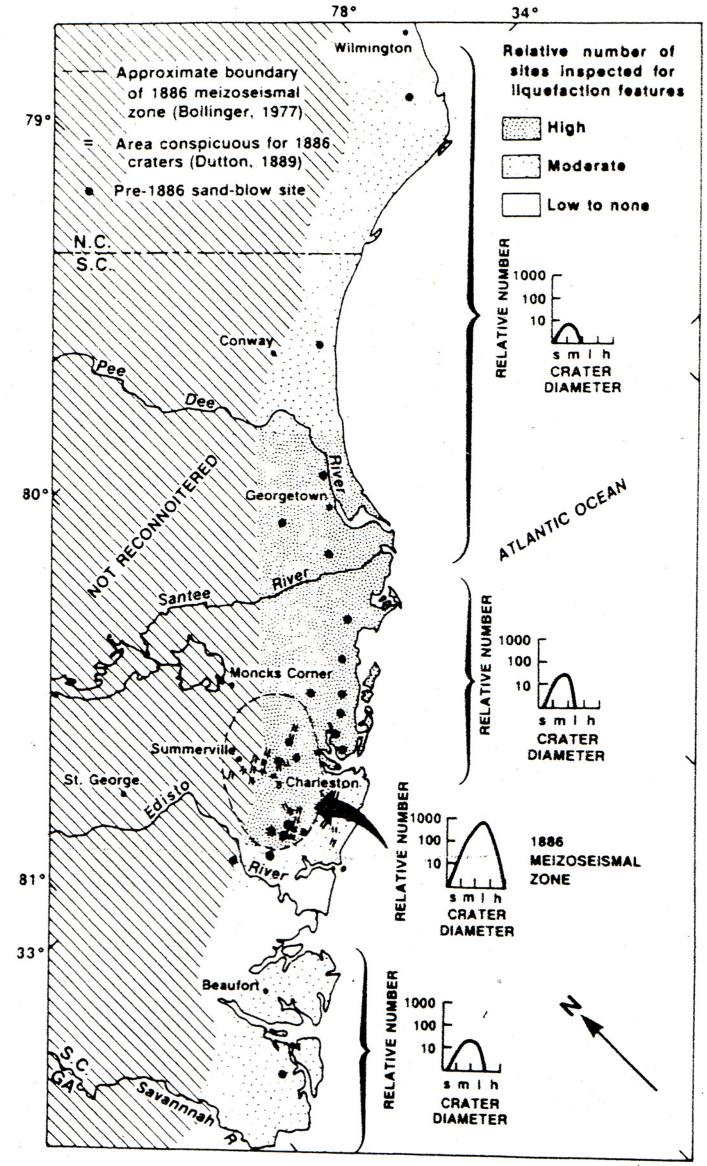


Figure 2.5.2-16 - Relative number of filled craters and crater diameters for pre-1886 sand blows at sites on marine-related sediments. The relative number is a scaling based on comparison with the abundance of craters in the 1886 meizoseismal zone, which has an arbitrary value of 1000. Crater diameters are small (s, less than 1 m), medium (m, 1–2 m), large (l, greater than 3 m) (reproduced from Obermeier et al. 1989).

Offshore of the South Carolina coast in the Charleston area there are several smaller faults (SER Figure 2.5.2-2). These faults correspond to the Helena Banks fault zone. In SSAR Section 2.5.2.2.2.4.1, the applicant concluded that, although the Helena Banks fault zone is clearly shown by multiple seismic reflection profiles and has demonstrable Late Miocene offset (Behrendt and Yuan 1987), there is no evidence to demonstrate the activity of this fault zone. In RAI 2.5.2-15, the staff asked the applicant to explain why the two seismic events (mb 3.5 and 4.4) in 2002, which occurred in the vicinity of the Helena Bank fault zone, cannot be positively correlated with the fault zone. The association of these two events with the Helena Banks fault zone would indicate that this fault zone is currently active. In response, the applicant stated that it could not positively correlate the two earthquakes with the Helena Banks fault zone for the following reasons:

The lack of detailed information on these two 2002 offshore earthquakes (poor location, no focal mechanisms) and the lack of additional seismic activity in this offshore area, make it difficult to assign the Helena Banks fault zone as the causative fault. It is possible that the two 2002 earthquakes indicate reactivation of the Helena Banks fault zone, but the fact that these events cannot be positively correlated to the fault suggests otherwise. There are numerous faults in the central and eastern United States located close to a few or more poorly located, small earthquakes, but this simple and very limited spatial association has not typically led researchers to positively correlate them to specific faults and classify these faults as reactivated seismogenic structures.

Based on its review of the applicant's response to RAI 2.5.2-15, the staff concurs with the applicant's conclusion that it could not positively correlate the recent offshore earthquakes with the Helena Banks fault zone because of the uncertainties regarding the exact locations of these two events. However, even though these two events cannot be directly correlated with the Helena Banks fault zone, the applicant's UCSS source zone Geometry B encompasses both the Helena Banks fault zone and the epicenters of these two events.

Recurrence intervals for the Charleston seismic source. In SSAR Section 2.5.2.2.2.4.3, the applicant describes its calculation of recurrence intervals for the updated Charleston seismic source, which is largely based on paleoliquefaction data compiled by Talwani and Schaeffer (2001). The applicant calculated two different average recurrence intervals, which represent two recurrence branches on the logic tree. The first average recurrence interval is based on the four events (1886, A, B, and C') that the applicant interpreted to have occurred within the past ~2000 years. The applicant considered this time period to represent a complete portion of the paleoseismic record based on published literature (e.g., Talwani and Schaeffer 2001) and feedback from those researchers questioned (Talwani 2005; Obermeier 2005) by the applicant as part of its expert elicitation. This branch of the logic tree was given a weight of 0.8. The applicant's second average recurrence interval is based on events that the applicant interpreted to have occurred within the past ~5000 years and includes events 1886, A, B, C', E, and F'. This time period represents the entire paleoseismic record based on available liquefaction data (Talwani and Schaeffer 2001). Published papers and researchers questioned by the applicant suggest that the older part of the record (i.e., older than ~2000 years) may be incomplete. The applicant noted, however, that it may also be possible that the older record is complete and exhibits longer inter-event times. For this reason, the average recurrence interval calculated for the ~5000-yr record (six events) is given a weight of 0.20 on the logic tree.

In RAI 2.5.2-12, the staff asked the applicant to provide more detail regarding its rationale for the weighting of the two recurrence branches on the logic tree. The staff also asked the applicant to justify its use of these two scenarios rather than another case study (e.g., 10 large-magnitude earthquakes occurring at approximately regular intervals during the past 5000 years), including its impact on the hazard calculation. The applicant provided the following response to justify its weighting of the 2000-yr and 5000-yr logic tree branches:

> The relative weighting of these two branches of the logic tree is based on a SSHAC level 2 assessment of completeness of the geologic record of paleoliquefaction events over these two time intervals. Earthquakes in the paleoliquefaction record do not occur at regular intervals, and this may be the result of "temporal clustering of seismicity, fluctuation of water levels, or their

evidence having been obliterated” (Talwani and Schaeffer 2001; p. 6640). Talwani and Schaeffer (2001) consider the paleoliquefaction record to be complete for the past 2,000 yrs. Moreover, Prof. Pradeep Talwani (University of South Carolina, pers. comm. 9/8/05) and Dr. Steve Obermeier (U.S. Geological Survey [retired], pers. comm. 9/2/05) consider the 2,000-yr record to represent a complete portion of the paleoseismic record. For these reasons, the average recurrence interval calculated for the most-recent ~2,000 yr portion of the paleoseismologic record is given a relatively high weight of 0.80.

> The degree of completeness for the entire ~5,000-yr record of paleoliquefaction events is uncertain. It is possible that all paleoliquefaction events in this time period have been preserved and recognized in the geologic record. Alternatively, it is possible that events are missing from the ~5,000-yr record. Average M_{max} recurrence interval calculated from the entire ~5,000-yr record is greater (i.e., larger average interevent time) than that calculated for the ~2,000-yr record. The decision to give less weight (0.20) to this recurrence estimate is therefore conservative.

Regarding its use of these two scenarios rather than another case study (e.g., 10 large-magnitude earthquakes occurring at approximately regular intervals during the past 5000 years), the applicant stated the following:

> We also considered other scenarios from which to calculate earthquake recurrence, but ultimately decided not to incorporate those that included non-conservative assumptions. For example, Talwani and Schaeffer (2001) include a scenario in which their events C and D are moderate-magnitude, local earthquakes. These moderate-magnitude earthquakes would be eliminated from the record of large (M_{max}) earthquakes, thereby increasing the calculated recurrence interval. This and other permutations of the paleoliquefaction record (and resulting recurrence intervals) could be included, but, if based on nonconservative assumptions, would increase the recurrence interval and lower the hazard without sufficient justification. The given example of “ten large-magnitude earthquakes occurring at approximately regular intervals during the past 5,000 years” was not included in the model because: (1) it is permissible only if events are assumed to be missing from the geologic record; and (2) the resulting recurrence interval would be very similar to the branch of the logic tree using the ~2,000-yr paleoliquefaction record.

In summary, the applicant assigned the largest weight of 0.8 to the average recurrence interval calculated for the most recent ~2000-yr portion of the paleoseismologic record. The applicant considered this time period to represent a complete portion of the paleoseismic record based on published literature (e.g., Talwani and Schaeffer 2001) and feedback from those researchers questioned (Talwani 2005; Obermeier 2005) by the applicant as part of the expert elicitation. The applicant stated that the 5000-yr time period represents the entire paleoseismic record based on available liquefaction data (Talwani and Schaeffer 2001). However, the applicant only assigned a weight of 0.2 to the 5000-yr branch of the logic tree because the completeness of the ~5000-yr paleoseismic record is uncertain.

Based on its review of the applicant’s response to RAI 2.5.2-12, and the information presented by the applicant in SSAR Section 2.5.2.2, the staff concurs with the applicant’s logic tree weighting for earthquake recurrence because it reflects all of the available data and uncertainties. Specifically, the applicant assigned the largest weight of 0.8 to the 2000-yr logic tree branch because there is a greater certainty that this portion of the paleoseismologic record is complete. The applicant also used the entire ~5000-yr record to calculate earthquake recurrence. The applicant calculated a recurrence interval of 958 years from the ~5000-yr record. This value is less conservative than the mean recurrence interval of 548 years calculated from the ~2000-yr record. However, the applicant assigned a significantly lower weight of 0.2 to this logic tree branch because there is a greater uncertainty that the ~5000-yr record is complete.

In summary, the staff focused its review of SSAR Section 2.5.2.2 on the applicant's update of the Charleston seismic source model and its basis for not updating the other EPRI seismic source zones that contribute to the seismic hazard at the ESP site. The staff concludes that the applicant's update of the 1986 EPRI PSHA sources adequately characterizes the seismic hazard in the region surrounding the site.

2.5.2.4.3 Correlation of Earthquake Activity with Seismic Sources

SSAR Section 2.5.2.3 describes the correlation of updated seismicity with the EPRI seismic source model. The applicant compared the distribution of earthquake epicenters from both the original EPRI historical catalog (1627–1984) and the updated seismicity catalog (1985–2005) with the seismic sources characterized by each of the EPRI ESTs. The applicant concluded that there are no new earthquakes within the site region that can be associated with a known geologic structure and that there are no clusters of seismicity suggesting a new seismic source not captured by the EPRI seismic source model. The applicant also concluded that the updated catalog does not show a pattern of seismicity that would require significant revision to the geometry of any of the EPRI seismic sources. The applicant further concluded that the updated catalog does not show or suggest an increase in M_{max} or a significant change in seismicity parameters (activity rate, b-value) for any of the EPRI seismic sources. The applicant based its conclusions on a comparison of the distribution of earthquake epicenters from both the original EPRI historical catalog and from its updated seismicity catalog with the seismic sources characterized by each of the EPRI ESTs.

In Parts A and B of RAI 2.5.2-1, the staff requested electronic versions of the EPRI seismicity catalog and the applicant's updated EPRI seismicity catalog for the region of interest. In Part C of RAI 2.5.2-1, the staff requested the geographic coordinates of the primary source zones developed by each of the six EPRI ESTs. The staff used the information provided in response to Parts A and B of RAI 2.5.2-1 to compare the applicant's update of the regional seismicity catalog with its own listing of recent earthquakes. Based on this comparison, the staff concurs with the applicant's assertion that the rate of seismic activity has not increased in the ESP region since 1985. Using the information provided in response to Part C of RAI 2.5.2-1, the staff compared the updated earthquake catalog with each of the primary seismic sources developed by each EPRI EST. Based on the comparision of earthquakes in the updated catalog with each of the EPRI EST seismic sources, the staff concurs with the applicant's conclusion that revisions to the existing EPRI sources are not warranted. However, additional worldwide earthquake data may indicate the need for an update of some of the EPRI seismic source models. In addition, recent paleoliquefaction studies predict shorter recurrence intervals for large Charleston-type earthquakes compared to predictions based on the historical seismicity catalog. These paleoliquefaction data also provide information regarding the locations of large prehistoric Charleston-type earthquakes. SER Section 2.5.2.3.2 describes the staff's conclusions with respect to the applicant's update of the Charleston seismic source.

2.5.2.4.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes

SSAR Section 2.5.2.4 presents the earthquake potential for the ESP site in terms of the controlling earthquakes. The applicant determined the high- and low-frequency controlling earthquakes by deaggregating the PSHA results at selected probability levels. Before determining the controlling earthquakes, the applicant updated the 1989 EPRI PSHA using the seismic source zone adjustments described in SER Section 2.5.2.1.2 and the new ground motion models described in SER Section 2.5.2.1.4.

The staff focused its review of SSAR Section 2.5.2.4 on the applicant's updated PSHA and the ESP site controlling earthquakes determined by the applicant after completion of its PSHA. While the staff's review of the applicant's update of the EPRI seismic source model is described in SER Section 2.5.2.3.2, this SER section focuses on the review of the application of the updated seismic source model to the hazard calculation at the ESP site.

PSHA Inputs

As input to its PSHA, the applicant used its updated version of the 1989 EPRI seismic source model. The staff's evaluation of the applicant's update is described in SER Section 2.5.2.3.2. The applicant also used the ground motion models developed by the 2004 EPRI-sponsored study (EPRI 1009684 2004) as input to its PSHA. The ESP applications for the Clinton (Illinois), Grand Gulf (Mississippi) and North Anna (Virginia) sites also used the updated EPRI ground motion models. The staff's final SERs for Clinton (ADAMS Accession No. ML0612204890), Grand Gulf (ADAMS Accession No. ML061070443), and North Anna (ADAMS Accession No. ML063170371) provide an extensive review of the EPRI 2004 ground motion models. Thus, the staff considers the applicant's use of the EPRI 2004 ground motion model to be appropriate.

PSHA Results

In order to determine the adequacy of the PSHA results, the staff, in RAI 2.5.2-1, requested that the applicant to provide the 1- and 10-Hz mean hazard curves for each of the six EPRI ESTs, as well as the 1- and 10-Hz mean hazard curves for the UCSS model. In response to RAI 2.5.2-1, the applicant provided the requested hazard curves. SER Figures 2.5.2-17 and 2.5.2-18 show the applicant's 1-Hz and 10-Hz total mean hazard curves, as well as the hazard curves corresponding to each of the six EPRI EST seismic source model inputs. Both figures also show the hazard curves corresponding to the applicant's UCSS model.

The total mean hazard curves, shown in SER Figures 2.5.2-17 and 2.5.2-18, comprise the mean of the six EPRI EST total hazard curves plus the contribution of the UCSS.

As shown in SER Figure 2.5.2-17, for the 1-Hz hazard curves, the Charleston source dominates the overall hazard at the ESP site. In SER Figure 2.5.2-18, for the 10-Hz hazard curves, the contributions from each of the six ERPI seismic source models have a more significant contribution to the overall hazard.

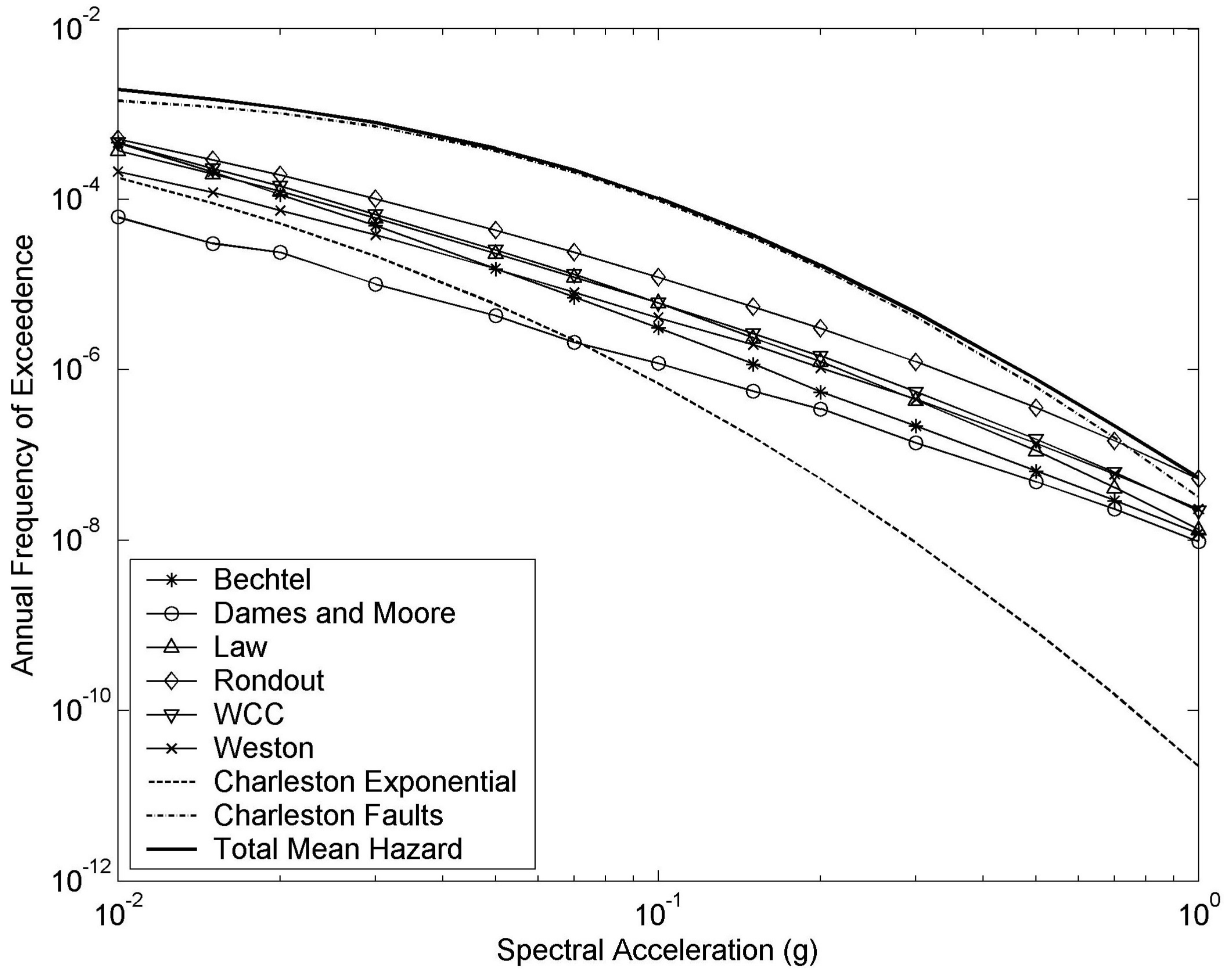


Figure 2.5.2-17 - Plot showing the applicant's 1-Hz total mean hazard curve for the ESP site. This figure also shows the contributions of the applicant's UCSS model, which consists of "Charleston Faults" and "Charleston Exponential," as well as the contributions from each of the six EPRI EST seismic source models.

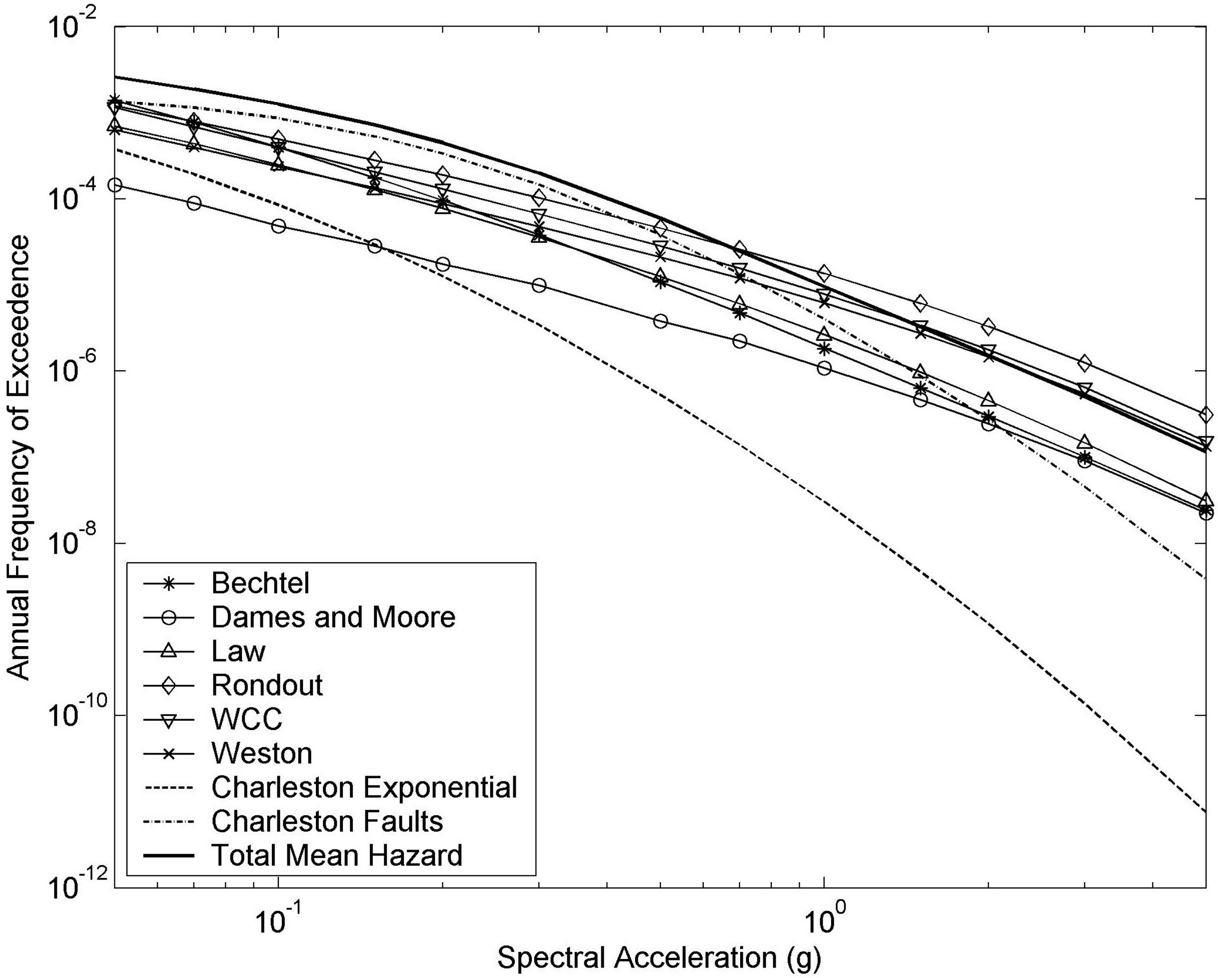


Figure 2.5.2-18 - Plot showing the applicant's 10-Hz total mean hazard curve for the ESP site. This figure also shows the contributions of the applicant's UCSS model, which consists of "Charleston Faults" and "Charleston Exponential," as well as the contributions from each of the six EPRI EST seismic source models.

Controlling Earthquakes. To determine the low- and high-frequency controlling earthquakes for the ESP site, the applicant followed the procedure outlined in Appendix C to RG 1.165. This procedure involves the deaggregation of the PSHA results at a target probability level to determine the controlling earthquakes in terms of magnitude and source-to-site distance. The applicant chose to perform the deaggregation of the mean 10^{-4}, 10^{-5}, and 10^{-6} PSHA results. SER Table 2.5.2-8 shows the low- and high-frequency controlling earthquakes. Because of the similarity of Mbar and Dbar values for the three hazard levels, the applicant selected a single recommended Mbar and Dbar value for each frequency range. For the high-frequency mean 10^{-4} and 10^{-5} and 10^{-6} hazard levels, the controlling earthquake has a magnitude of M 5.6 event occurring at a distance of 9.0 kilometers (5.6 miles), corresponding to an earthquake from a local seismic source zone. In contrast, for the low-frequency mean 10^{-4} and 10^{-5} and 10^{-6} hazard levels, the controlling earthquake has a magnitude of M 7.2 at a distance of 130 kilometers (80.8 miles). This controlling earthquake corresponds to an event in the Charleston seismic source zone.

Table 2.5.2-8 - Computed and Final Mbar and Dbar Values Used for Development of High-and Low-Frequency Target Spectra (Based on Information Provided In SSAR Table 2.5.2-17)

High Frequency (5 to 10 Hz)				
Mean Hazard Level	**10^{-4}**	**10^{-5}**	**10^{-6}**	**Final Values**
Mbar (M)	5.6	5.6	5.7	5.6
Dbar	17.6 km (10.9 mi)	11.4 km (7.1 mi)	9.0 km (5.6 mi)	9.0 km (5.6 mi)
Low Frequency (1 to 2.5 Hz)				
Mean Hazard Level	**10^{-4}**	**10^{-5}**	**10^{-6}**	**Final Values**
Mbar (M)	7.2	7.2	7.2	7.2
Dbar	136.5 km (84.8 mi)	134.3 km (83.5 mi)	133.0 km (82.6)	130 km (80.8 mi)

In RAI 2.5.2-21, the staff asked the applicant to explain how it calculated the final Dbar and Mbar values. In its response to RAI 2.5.2-21, the applicant stated that the final low-frequency distance value of 130 kilometers (80.8 miles) is based on the source-to-site distance for the Charleston source, while the final high-frequency value of 9 kilometers (5.6 miles) is equal to the log-average of the three computed values rounded to the nearest kilometer. The applicant also stated that the final magnitude values for the respective high- and low-frequency cases are equal to the linear average of the three magnitude values rounded to the nearest tenth of a magnitude unit. In addition, the applicant provided a comparison between the high-frequency spectral shape using the final magnitude and distance values and the computed magnitude and distance values. The applicant also provided a comparison between the low-frequency spectral shape using the final magnitude and distance values and the computed magnitude and distance values. Based on its comparison, the applicant concluded that the use of the recommended magnitude and distance values in place of the computed magnitude and distance values for each of the three annual probability levels would not significantly change the results of the site response analysis.

The staff concurs with the applicant's final high- and low-frequency Mbar and Dbar values because these final values, and the corresponding spectral shapes, are very similar to the calculated values for the three annual probability levels.

Based on its review of the ESP site controlling earthquake magnitudes and distances as discussed above, the staff concludes that the applicant's PSHA adequately characterized the overall seismic hazard of the ESP site. The staff also concludes that the applicant's controlling earthquakes for the ESP site (**M** 5.6 at 9 km (5.6 miles), **M** 7.2 at 130 km (80.8 miles)) are generally consistent with both the historical earthquake record and paleoliquefaction studies in the Charleston seismic source zone. In addition, the staff finds that the ground motions developed by the applicant from the controlling earthquakes are consistent with the most recent CEUS ground motion evaluations. Accordingly, the staff concludes that the applicant followed the guidance in RG 1.165 and RG 1.208 for evaluating regional earthquake potential and determining the ground motion resulting from controlling earthquakes.

2.5.2.4.5 Seismic Wave Transmission Characteristics of the Site

SSAR Section 2.5.2.5 describes the method used by the applicant to develop the ESP site free-field ground motion spectrum. The seismic hazard curves generated by the applicant's

PSHA are defined for generic hard rock conditions (characterized by a S-wave velocity of 9200 ft/s). According to the applicant, these hard rock conditions exist at a depth of more than 2000 feet below the ground surface at the ESP site. To determine the site free-field ground motion, the applicant performed a site response analysis. The output of the applicant's site response analysis is site AFs, which are then used to determine the UHRS for three hazard levels (10^{-4}, 10^{-5}, and 10^{-6}). The 10^{-4} and 10^{-5} UHRS are then used to calculate the GMRS for the site.

In SSAR Section 2.5.2.5.1.1, the applicant describes the methodology it used to develop the soil UHRS for the 10^{-4}, 10^{-5}, and 10^{-6} hazard levels. The applicant's site free-field soil UHRS is defined at the top of the Blue Bluff Marl. According to the applicant, the top of the Blue Bluff Marl is characterized by an average S-wave velocity of 2354 ft/s. In RAI 2.5.2-19, the staff asked the applicant to provide a detailed step-by-step description of the methodology it used to develop the site AFs and the 10^{-4} and 10^{-5} soil UHRS. In response to RAI 2.5.2-19, the applicant more completely explained Steps 1 through 6. However, after reviewing the applicant's response, the staff concluded that the applicant's description of Steps 5 and 6 did not provide sufficient detail for the staff to completely evaluate the site response method. In particular, the staff was not clear on the enveloping motion used in Step 5, and the applicant's description in Step 6 appeared to differ from that described in SSAR Section 2.5.2.5.1.1. On June 18, 2007, the applicant supplemented its RAI response with additional detail on each of the steps used in the site response analysis; however, the staff had not been able to completely evaluate the applicant's supplemental information. As such, the staff was not able to reach a conclusion in the SER with open items on the adequacy of the applicant's methodology. Accordingly, in the SER with open items, the staff identified Open Item 2.5-6 to reflect the additional review time needed by the staff to review the applicant's supplemental response to RAI 2.5.2-19, as well as the staff's request for further clarification of Step 6 of the applicant's site response methodology.

Based on the applicant's response to RAI 2.5.2-19 and Open Item 2.5-6, a summary of the applicant's site response methodology is provided below:

The applicant determined the final 10^{-4} soil surface spectrum for the ESP site by scaling the hard rock UHRS (shown in SER Figure 2.5.2-5) by the final AFs (shown in SER Figure 2.5.2-6). The applicant defined each of the AFs at a total of 300 frequencies, but only defined the hard rock UHRS at 7 structural frequencies. For this reason, the applicant interpolated the hard rock UHRS at values between the 7 structural frequencies using the high- and low-frequency spectral shapes (from NUREG/CR-6728) for hard rock. This resulted in two rock spectra: a high-frequency spectrum and a low-frequency spectrum that are both constrained to equal the spectral amplitudes for the 7 PSHA structural frequencies at which the PSHA was calculated. From the high-frequency and low-frequency rock spectra, a single spectrum was then derived using the high-frequency rock spectrum for high frequencies and the low-frequency rock spectrum for low frequencies.

In order to determine the 10^{-4} soil spectrum (UHRS), the applicant multiplied the hard rock UHRS (now defined at 300 structural frequencies) by either the high- or low-frequency final amplification factors, which are shown in SER Figure 2.5.2-6. The applicant multiplied the hard rock UHRS by the high-frequency final amplification factors for frequencies above 8 Hz. For frequencies below 5 Hz, the applicant multiplied the hard rock UHRS by the low-frequency final amplification factors. In between 8 Hz and 5 Hz, the applicant interpolated the soil spectrum to achieve a smooth transition between the high-frequency and low-frequency controlled parts.

The applicant repeated the above process for the 10^{-5} hazard level to determine the final 10^{-5} soil UHRS. SER Figure 2.5.2-7 provides the final soil UHRS for the 10^{-4} and 10^{-5} hazard levels.

Upon completing its review of the supplemental response to RAI 2.5.2-19 as well as the applicant's additional response to Open Item 2.5-6, summarized above, the staff concludes that the applicant provided sufficient information for the staff to perform its review of the methodology. The staff also concludes that the supplemental information is generally consistent with what the applicant provided in SSAR Section 2.5.2.5. Furthermore, the staff concludes that the applicant's site response methodology is adequate because it follows the guidance provided in RG 1.208.

SSAR Section 2.5.2.5.1.3 describes the development of low- and high-frequency target spectra based on the low- and high-frequency controlling earthquake magnitudes and distances. To determine the target low- and high-frequency spectra, the applicant used the average of the single and double corner source models provided in NUREG/CR-6728. In RAI 2.5.2-20, the staff asked the applicant why it did not use the EPRI ground motion models (EPRI 1009684 2004) to develop the high- and low-frequency target response spectra since the applicant used these ground motion models for its PSHA. In response to RAI 2.5.2-20, the applicant provided the following information:

> The 2004 EPRI ground motion report (EPRI 1009684) gives equations to estimate spectral acceleration at 7 structural frequencies (100, 25, 10, 5, 2.5, 1, and 0.5 Hz). To properly represent rock motion for input to a site response analysis, it is necessary to interpolate between these 7 structural frequencies to obtain a realistic spectral shape, rather than using linear interpolation. For this task, NUREG/CR-6728 was used, because one of its goals was specifically to develop realistic spectral shapes for the eastern U.S. to use in earthquake ground motion analyses.

The staff concurs with the applicant's use of NUREG/CR-6728 spectral models for the CEUS, since the EPRI 2004 ground motion models only provide 7 structural frequencies. Because the applicant used the NUREG/CR-6728 source models, it was able to avoid using linear interpolation and, subsequently, obtained a more accurate estimate of the site response.

A key step in the site response analysis is the selection of actual earthquake records that closely match the low- and high-frequency controlling earthquake magnitude and distance values. The response spectra from these earthquake records, which are generally from the WUS, are matched to the CEUS spectral shapes described in the preceding paragraph. SSAR Section 2.5.2.5.1.4 describes the spectral matching of the selected seed time histories to the target response spectra and states that "the spectral matching criteria given in NUREG/CR-6728 were used to check the average spectrum from the 30 time histories for a given frequency range (high- or low-frequency) and annual probability level. This is the recommended procedure in NUREG/CR-6728 when multiple time histories are being generated and used." In RAI 2.5.2-22, the staff asked the applicant to verify that it satisfied the NUREG/CR-6728 matching criteria for each individual earthquake time history. In response to RAI 2.5.2-22, the applicant pointed out that item (e) of the NUREG/CR-6728 matching criteria provides guidance for the use of a suite of ground motion records as well as for an individual record. In addition, the applicant stated that it matched the other relevant criteria for both the low-frequency and high-frequency spectra. Since the applicant followed the guidance specified in NUREG/CR-6728 for multiple time histories and also matched the other relevant criteria, the staff concludes that the applicant adequately matched the seed time histories to the CEUS spectral shapes.

In addition to the seed time histories, another important part of the site response analysis is the model of the site subsurface soil and rock properties. In particular, the applicant's site response analysis should incorporate the uncertainty in these properties. Key properties include the shear wave velocities, material damping, and the strain-dependent behavior of each of the soil layers underlying the site. To model the strain-dependent behavior of the soil, the applicant used shear modulus and damping curves developed by EPRI (EPRI TR-102293 1993), as well as curves developed for the SRS (Lee 1996). Besides these soil properties, in RAI 2.5.2-23, the staff asked the applicant to discuss results of its site response calculations in terms of the following:

1. the effects of the six alternative site response profiles in terms of the different depths to the top of the Paleozoic crystalline rocks
2. the possible effects of the Pen Branch fault zone (i.e., as a low-velocity zone or weak zone)
3. the effects of the low-velocity zones within the Blue Bluff Marl and Lower Sand Stratum

In response to RAI 2.5.2-23, the applicant performed additional sensitivity calculations to examine the effects of the different depths to the top of the Paleozoic crystalline rocks using the six base case profiles shown in SSAR Table 2.5.4-11, Part B. In order to represent the Pen Branch fault as a low-velocity zone, the applicant modified the rock S-wave velocities of the six base profiles to include a low-velocity zone and to represent the Pen Branch fault. The applicant concluded that the depth to the Pen Branch fault, and a lower velocity layer for the Pen Branch, does not affect the site response. The applicant observed very small differences between the results. Regarding the effects of the low-velocity zones within the Blue Bluff Marl and Lower Sand Stratum, the applicant stated the following:

> The low velocity zones in the Blue Bluff Marl and in the Lower Sand Stratum were incorporated in the site response calculations, i.e., the site response calculation results inherently reflect the inclusion of these low velocity zones. The calculations were performed using the base case shear wave velocity profile that is based on field measurements, and randomized profiles.

The staff reviewed the applicant's response to RAI 2.5.2-23, as well as the results of its sensitivity calculations, and concludes that the applicant adequately captured the site variability in its site response calculations. The applicant generated randomized soil and rock S-wave velocity profiles and randomly paired them with 60 sets of shear modulus degradation and damping curves. According to RG 1.208, the use of 60 randomized profiles is generally adequate to determine a reliable estimate of the mean and standard deviation of the site response.

To determine the adequacy of the applicant's site response calculations, the staff performed its own confirmatory site response calculations. The staff used a site response methodology similar to that used by the applicant and, like the applicant, the staff used the program SHAKE. The main difference between the two sets of calculations is that the staff did not use as many input time histories as the applicant used for its analysis. In addition, the staff did not use randomized soil and rock S-wave velocity profiles, soil shear modulus reduction and damping relationships, and rock damping values. Instead, as inputs to its confirmatory analysis, the staff used the applicant's base case S-wave velocity profiles (given in SSAR Table 2.5.4-11) and shear modulus reduction and damping relationships (given in SSAR Tables 2.5.4-12 and 2.5.4-13).

SER Figures 2.5.2-19 to 2.5.2-22 show the mean AFs resulting from the staff's confirmatory site response calculations. Each figure plots the mean results of the six alternative subsurface profiles for both the EPRI and SRS shear modulus and damping curves. SER Figures 2.5.2-19 and 2.5.2-20 show the results corresponding to the 10^{-4} hazard levels for the respective high- and low-frequency input motions, while SER Figures 2.5.2-21 and 2.5.2-22 plot the results corresponding to the 10^{-5} hazard levels for the respective high- and low-frequency input motions. SER Figures 2.5.2-18 to 2.5.2-22 also show the applicant's mean AFs for comparison. The applicant's results are similar overall. For each case, the amplification peaks are very similar, and in all cases, the peaks occur at approximately 0.6 Hz. The differences between the results are likely due to the greater variability that the applicant incorporated into its model through the use of randomized profiles and material properties, as well as the use of multiple time histories. This variability is illustrated in SER Figure 2.5.2-23 (reproduced from SSAR Figure 2.5.2-37). As a result of its analysis, the staff was able to confirm the applicant's overall site response results.

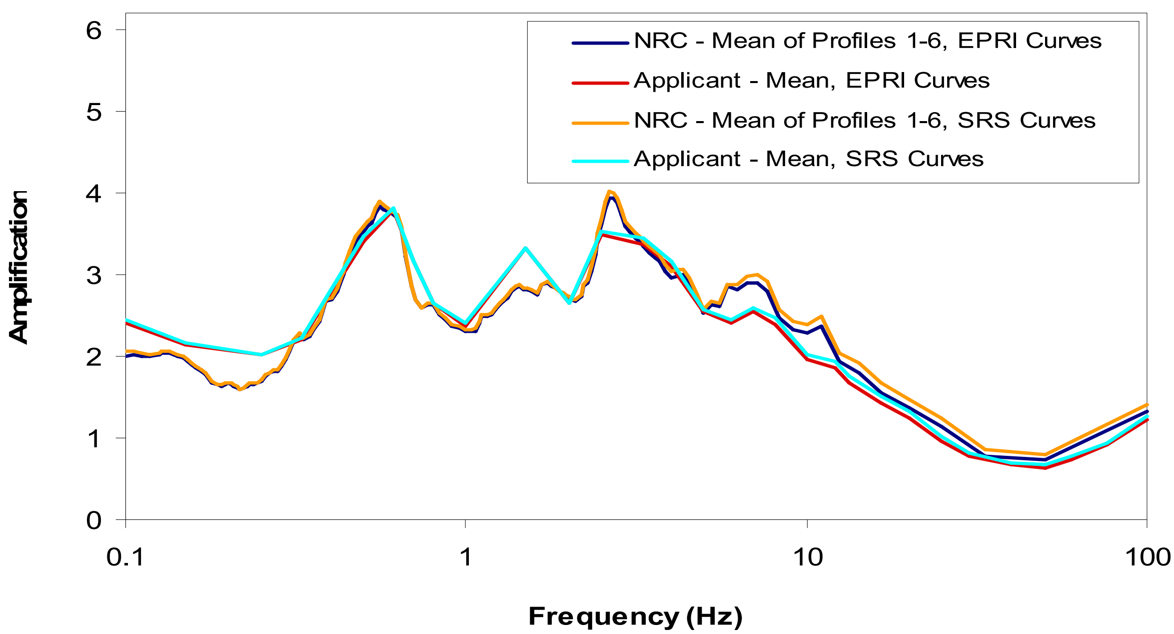


Figure 2.5.2-19 - Results of the staff's site response calculations for high-frequency rock motions for the 10^{-4} hazard level. The applicant's mean results are shown for comparison.

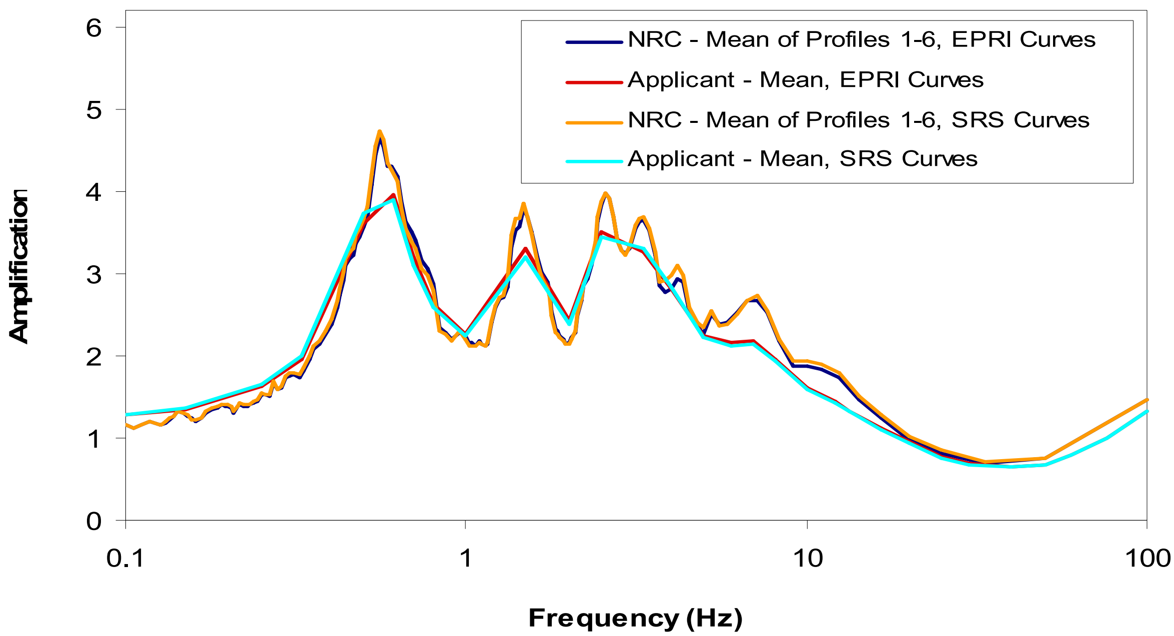


Figure 2.5.2-20 - Results of the staff's site response calculations for low-frequency rock motions for the 10^{-4} hazard level. The applicant's mean results are shown for comparison.

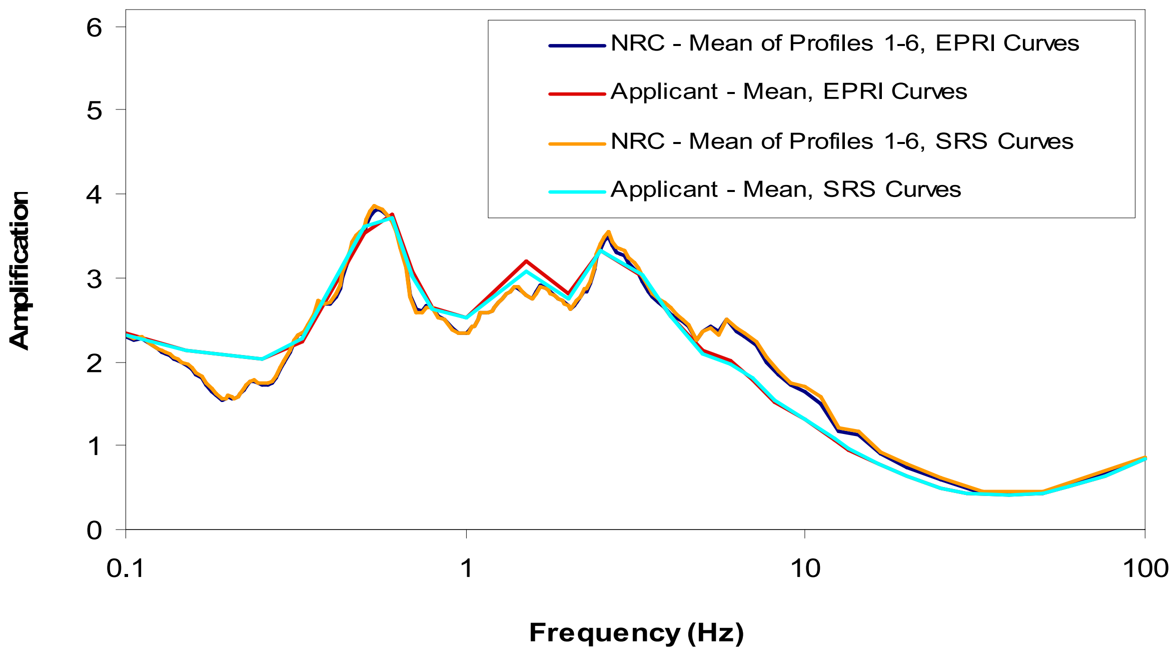


Figure 2.5.2-21 - Results of the staff's site response calculations for high-frequency rock motions for the 10^{-5} hazard level. The applicant's mean results are shown for comparison.

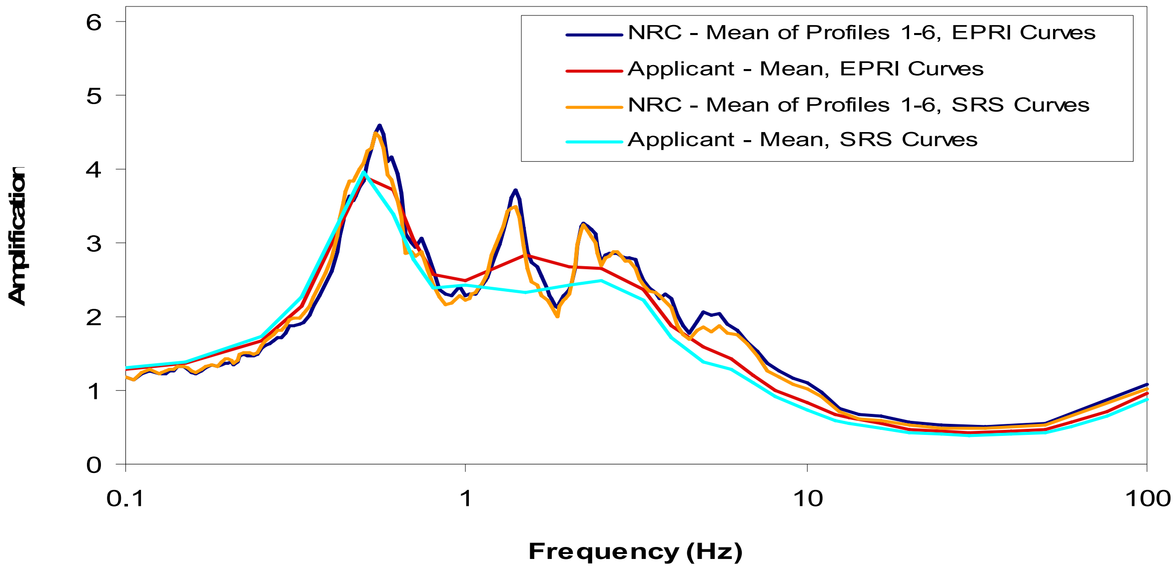


Figure 2.5.2-22 - Results of the staff's site response calculations for low-frequency rock motions for the 10^{-5} hazard level. The applicant's mean results are shown for comparison.

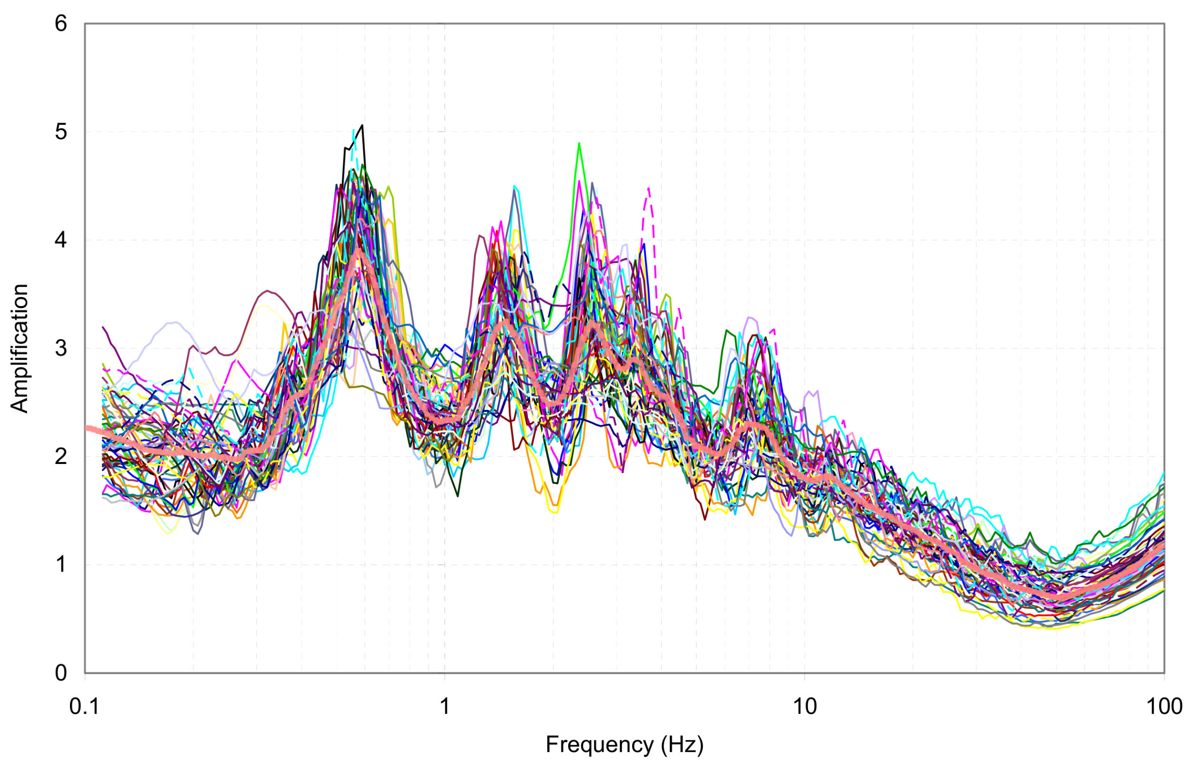


Figure 2.5.2-23 - Results of the applicant's site response calculations for high-frequency rock motions for the 10^{-4} hazard level using the EPRI degradation curves (reproduced from SSAR Figure 2.5.2-37).

In RAI 2.5.2-23, the staff asked the applicant to justify its use of an equivalent-linear approach rather than a nonlinear approach to model the soil nonlinearity at the ESP site. In response, the applicant provided a table containing the maximum shear strains obtained from its SHAKE analyses of the randomized profiles. The applicant's table is reproduced as SER Table 2.5.2-9. In reference to SER Table 2.5.2-9, the applicant stated, "The table shows that the maximum soil strain remained below 0.6 percent. The equivalent-linear approach is adequate for this low level of soil strain."

Table 2.5.2-9 - Applicant's Maximum Shear Strain Values Provided In Response to RAI 2.5.2-23

Earthquake Probability Level	EPRI Randomized Profiles		SRS Randomized Profiles	
	Low-Frequency Earthquake	High-Frequency Earthquake	Low-Frequency Earthquake	High-Frequency Earthquake
10^{-4}	0.078 percent	0.067 percent	0.082 percent	0.068 percent
10^{-5}	0.592 percent	0.300 percent	0.287 percent	0.353 percent

The staff believed that further justification was necessary in order for it to concur with the applicant's assertion that the equivalent-linear approach is suitable for strain levels as high as those for the 10^{-5} probability level. The equivalent-linear modeling approach produces a systematic shift in resonance peaks toward lower frequencies as the level of strain increases and also may predict a more dramatic reduction in AFs at higher frequencies. Accordingly, in the SER with open items, the staff identified Open Item 2.5-7, which requested that the applicant provide further justification for its claim that the equivalent-linear approach is suitable for higher strain levels.

In response to Open Item 2.5-7, the applicant referred to the 1993 EPRI study (EPRI TR102293), which presents a comprehensive study comparing the equivalent-linear method with nonlinear methods for seismic site response analysis. The applicant stated that the study involved a comparison using the equivalent-linear method using RASCAL/SHAKE and nonlinear methods with the programs SUMDES and TESS for three sites (Gilroy 2, Treasure Island, and Lotung, Taiwan). The study compared the actual recorded motion at each of the three sites with the solution from each method of analysis. The sites included soil layers ranging from sands and gravels to soft silts and stiff clays and had both high- and low- strain ground motion recordings. A comparison of the results showed reasonably good agreement between the different methods. In addition, the study analyzed higher ground motions (maximum input accelerations ranged from 0.5 g to 1.25 g) using a generic soil profile for Eastern North America using the same three programs. The applicant noted that the study also confirmed that the amplification factors obtained from the equivalent-linear method are in general agreement with those of the fully nonlinear methods. Furthermore, according to the EPRI study, the predicted peaks at the resonance frequency tend to be conservative using the equivalent-linear method.

With respect to the Vogtle site, the applicant stated that "the input motion is low compared to the range of motions used in the EPRI study and the site is generally stiffer. Therefore, the conclusion of the EPRI study applies, confirming the equivalent-linear method is adequate for the site response analysis at the Vogtle site."

The staff concludes that the applicant, in its response to Open Item 2.5-7, provided an adequate justification for using the equivalent-linear approach to perform site response calculations for the Vogtle ESP site. The applicant referred to the 1993 EPRI study (EPRI TR-102293), which showed that equivalent-linear method is in general agreement with fully nonlinear methods for the case studies considered. The EPRI study is also applicable to the Vogtle site because the study considered a generic soil profile for Eastern North America. In addition, the maximum input peak accelerations ranged from 0.5 g to 1.25 g, which are larger than the expected ground motions at the Vogtle site. Futhermore, since the expected ground motions at the Vogtle site are less than, and the soil profile is generally stiffer than, the soil profiles considered in the EPRI study, the resulting soil nonlinearity is expected to be less at the Vogtle site.

In addition to Open Items 2.5-6 and 2.5-7, the staff noted in the SER with open items that the applicant did not perform any laboratory dynamic testing of the ESP soils, as specified in RG 1.138, "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants," Revision 2, issued December 2003. Instead, as inputs to its site response calculations, the applicant relied on the EPRI and SRS shear modulus degradation and damping curves and assigned equal weights to the results for both sets of curves. This issue is discussed in greater detail in SER Section 2.5.4.4. Accordingly, in the SER with open items, the staff identified Open Item 2.5-19, in which the staff requested that the applicant justify its use of the EPRI and SRS shear modulus and damping curves in the absence of any dynamic testing of the ESP soils. In response to Open Item 2.5-19, the applicant submitted this information as Revision 4 of the SSAR. As part of its COL site investigation, the applicant developed site-specific strain-dependent shear modulus and damping relationships based on RCTS test results (performed on compacted backfill, Blue Bluff Marl, and Lower Sand samples), which are described in SSAR Section 2.5.4.7.5. Rather than recalculating site amplification factors using the site-specific strain-dependent shear modulus reduction and damping relationships, the applicant performed site response sensitivity calculations for a select number of cases in order to demonstrate that use of the SRS and generic EPRI strain-dependent shear modulus and damping curves are appropriate. The results of the applicant's sensitivity calculations are described in SSAR Section 2.5.2.9.3. The applicant evaluated the effects of the additional COL S-wave velocity and the strain dependent shear modulus and damping relationships based on RCTS test results, and compared these results to similar calculations performed using only ESP S-wave velocity data as well as the EPRI and SRS shear modulus degradation and damping curves. SER Figure 2.5.2-10 shows the applicant's results. The applicant concluded that the difference in amplification between the ESP and COL data is small.

In SSAR Section 2.5.2.9, the applicant conducted three sets of sensitivity calculations in order to evaluate: (1) the sensitivity of the AP1000 nuclear island responses to changes in the backfill S-wave velocity; (2) the effects of the backfill geometry on the site response and on the SSI response of the Nuclear Island; and (3) the effects of additional COL data on site response. In SER Section 2.5.2, the staff focused its review on the applicant's evaluation of the effects of the additional COL data on site response, which is described in SSAR Section 2.5.2.9.3. The staff reviewed the applicant's calculations to evaluate the sensitivity of the AP1000 nuclear island responses to changes in backfill S-wave velocity and the effects of the backfill geometry on the site response and on the SSI response of the Nuclear Island as part of SER Section 3.8.5.

The staff reviewed the results of the applicant's site response sensitivity calculations described in SSAR Section 2.5.2.9.3 and agrees with the applicant's conclusion that the differences between the applicant's original analysis using the ESP data and its analysis incorporating the additional COL data are insignificant. Thus, the staff concludes that the applicant's use of the

SRS and generic EPRI strain-dependent shear modulus and damping curves is appropriate. Therefore, the staff considers Open Item 2.5-19 to be resolved.

For the reasons stated above, the staff concludes that, overall, the applicant's site response methodology and results are acceptable. The applicant followed the general guidance provided in RG 1.208, and the results of the confirmatory site response calculations performed by the staff are similar to the applicant's results.

2.5.2.4.6 Ground Motion Response Spectra

SSAR Section 2.5.2.6 describes the method used by the applicant to develop the horizontal and vertical site-specific GMRS. To obtain the horizontal GMRS, the applicant used the performance-based approach described in RG 1.208 and ASCE/SEI Standard 43-05. The applicant developed the vertical GMRS by applying V/H ratios to the horizontal GMRS. The applicant based these V/H ratios on the information provided in NUREG/CR-6728 and Lee (2001).

Following the guidance in RG 1.208, the staff has recently adopted new terminology to differentiate between the different types of site and design ground motion response spectra. The staff now refers to the performance-based SSE as the site-specific GMRS. The GMRS represents the first part of the development of the SSE for a site as a characterization of the regional and local seismic hazard and must satisfy the requirements of 10 CFR 100.23. In accordance with Appendix S to 10 CFR Part 50, during the combined license phase, an additional check of the ground motion is required at the foundation level. Specifically, Appendix S to 10 CFR Part 50 states that the free-field foundation level ground motion must be represented by an appropriate response spectrum with a peak acceleration of at least 0.1 g. The GMRS becomes the site SSE if it exceeds the minimum requirements of Appendix S to 10 CFR Part 50. Otherwise, if any portion of the GMRS falls below the minimum response spectrum, then the site SSE becomes the ground motion spectrum that envelops the GMRS and the minimum response spectrum. As such, the final SSE must satisfy the requirements of both 10 CFR 100.23 and Appendix S to 10 CFR Part 50.

The staff reviewed the applicant's GMRS in terms of meeting the requirements of 10 CFR 100.23 with respect to the development of the SSE.

Horizontal GMRS

The ESP applicant for the Clinton, Illinois, site also used the performance-based approach to determine the horizontal GMRS. The staff's final SER for Clinton (ADAMS Accession No.ML0612204890) provides an extensive review and derivation of the performance-based approach. As described in RG 1.208, the performance-based approach combines a conservative characterization of the ground motion hazard with equipment/structure performance (fragility characteristics) to establish a risk-consistent GMRS. The performance-based GMRS is obtained by modifying the 10^{-4} UHRS at the free-field ground surface by a DF. The resulting GMRS meets the target performance goal of 10^{-5} per year for the mean annual probability of systems, structures, and components reaching the limit state of inelastic response. The performance-based approach achieves a relatively consistent annual probability of plant component failure across the range of plant locations and structural frequencies. It does this by accounting for the slope of the seismic hazard curve, which changes with structural frequency and site location.

To verify the adequacy of the applicant's GMRS, the staff, in RAI 2.5.2-3, requested six PSHA hazard curves (1, 2.5, 5, 10, 25, and 100 Hz). The staff received the requested information from the applicant on June 18, 2007 (as supplemental information to RAI 2.5.2-3). Because the information was provided late in the review process, the staff identified this as Open Item 2.5-8 in the SER with open items. This was done to allow the staff additional time to complete its review of the applicant's response to RAI 2.5.2-3.

In response to RAI 2.5.2-3, the applicant provided the staff with soil hazard curves (corresponding to the top of the Blue Bluff Marl) at annual exceedance frequency levels of 10^{-4}, 10^{-5}, and 10^{-6}. The applicant obtained these hazard curves from its site response analysis described in SSAR Section 2.5.2.5. The applicant defined each hazard curve at a total of seven frequencies (0.5, 1, 2.5, 5, 10, 25, and 100 Hz). The applicant also obtained hazard curves at intermediate annual exceedance frequencies by performing interpolation. For each of the seven frequencies, the applicant fit a quadratic equation to the log (base 10) of the spectral ratios as a function of annual exceedance frequency.

Since the issuance of the SER with open items, the applicant changed the location of its GMRS from the top of the Blue Bluff Marl to the top of the structural backfill. At a public meeting on February 28, 2008, it was brought to the attention of the staff that the applicant's GMRS accounted for the effects of the material above the Blue Bluff Marl, which is contrary to the definition of the GMRS in RG 1.208. The applicant subsequently re-defined its GMRS and provided the updated soil hazard curves that corresponded to the top of the structural backfill.

The staff performed a confirmatory analysis in order determine the GMRS via the risk equation (Equation 1) as opposed to the direct convolution of the risk integral (Equation 3). The staff performed this confirmatory analysis in order to verify the acceptability of assuming a linear hazard curve in log-log space.

$$P_{FT} = \int_0^\infty H(a) f_a(a) da$$

Equation (4)

Since the seismic hazard curves have a slight downward curvature, assuming a linear fit results in slightly higher exceedance values and, as a result, slightly higher GMRS values, as illustrated in Table 2.5.2-10. Therefore, the staff concludes that the applicant's use of the approximate power law hazard curve is slightly conservative and therefore acceptable.

Table 2.5.2-10. Comparison of Site-Specific GMRS Values

Natural Frequency (Hz)	GMRS	
	Risk Integral (g)	Risk Equation (g)
1.0	0.276	0.285
2.5	0.714	0.775
5.0	0.693	0.709
10.0	0.702	0.789

The DF recommended in ASCE/SEI 43-05 (Equation 1) is slightly unconservative for β=0.3 and conservative for β of 0.4 to 0.6. To evaluate the significance of the range of β values on the DF, the staff determined the unacceptable performance frequency values (PFT) for the GMRS values for four natural frequency values 1, 2.5, 5, and 10 Hz. The applicant determined the four GMRS values shown in Table 2.5.2-10 using the performance-based approach as described in ASCE/SEI 43-05, which assumes a β value of 0.4 and a target performance goal of $1x10^{-5}$/yr. The staff used the four hazard curves provided by the applicant to determine PFT via direct integration of the risk integral (Equation 3) for β ranging from 0.3 to 0.6. As shown below in Table 2.5.2-11, the PFT values for β=0.3 are only slightly larger than the target value of $1x10^{-5}$/yr (with the exception of frequencies of 2.5 and 10 Hz, which are less than the target value of $1x10^{-5}$/yr). Since the PFT values for β=0.3 are only slightly larger (at frequencies of 1.0 and 5.0 Hz) than the target performance goal of 10^{-5}/yr and fragility β values of 0.3 are not common for SSCs, the staff concludes that the applicant's assumption that β=0.4 for determining the GMRS is acceptable.

Table 2.5.2-11. Unacceptable Performance Frequency Values for β Ranging from 0.3 to 0.6

Frequency (Hz)	GMRS (g)	PFT*10^{-5}/yr			
		β = 0.3	β = 0.4	β = 0.5	β = 0.6
1.0	0.285	1.073	0.925	0.661	0.506
2.5	0.775	0.689	0.706	0.539	0.500
5.0	0.709	0.950	0.920	0.668	0.539
10.0	0.789	0.518	0.579	0.500	0.500

As determined by the staff in its final SER for the Clinton Early Site Permit, essentially elastic behavior (or OSID (onset of significant inelastic deformation)) is just beyond the occurrence of insignificant (or localized) inelastic deformation, and in this way corresponds to essentially elastic behavior. As such, OSID of an SSC can be expected to occur well before seismically-induced core damage, resulting in much larger frequencies of OSID than seismic core damage frequency (SCDF (seismic core damage frequencies)) values. To further demonstrate that the frequency of OSID is larger than the SCDF, the staff used the four Vogtle ESP hazard curves (1, 2.5, 5, and 10 Hz) to calculate SCDF values each of the GMRS values. In performing this calculation of SCDF, the staff used the risk integral (Equation 3) with the complete range of β values (0.3 to 0.6) and assumed that the seismic margin (Ms) against core damage is 1.67 for new standard plant designs as specified in the staff requirements memorandum (SRM), dated July 21, 1993, on SECY 93-087. As shown in Table 2.5.2-12 below, SCDF values for the four natural frequencies and β values vary from $0.022x10^{-5}$/yr to $0.318x10^{-5}$/yr.

Table 2.5.2-12. SCDF Values for Vogtle GMRS

Frequency (Hz)	GMRS (g)	SCDF*10^{-5}/yr			
		β = 0.3	β = 0.4	β = 0.5	β = 0.6
1.0	0.285	0.318	0.210	0.152	0.120
2.5	0.775	0.072	0.055	0.052	0.055
5.0	0.709	0.156	0.105	0.086	0.079
10.0	0.789	0.022	0.027	0.033	0.040

For comparison, NUREG-1742 shows, based on the results of seismic PRAs of 25 nuclear power plants, that the median value for mean core damage frequency is $1.2x10^{-5}$/yr. Therefore, by setting the target performance goal, PFT, to be a frequency of onset of inelastic deformation

(FOSID) value of $1x10^{-5}$/yr, the resulting GMRS computed using the ASCE/SEI 43-05 methodology provides SCDF values that are substantially lower than those for most of the 25 nuclear power plants provided in NUREG-1742. For the natural frequencies of 5 and 10 Hz and for β values of 0.4 and 0.5, SCDF is about $1x10^{-6}$/yr to $3x10^{-7}$/yr for the Vogtle ESP performance-based SSE, which is about 12 to 40 times lower than the median of the mean SCDF for the 25 nuclear power plants considered in NUREG-1742.

In summary, the staff concludes that the applicant provided sufficient information in response to RAI 2.5.2-3 in order for the staff to verify the adequacy of the applicant's GMRS. Based on the results of the confirmatory analyses described above, the staff concludes that the applicant's use of the approximate power law hazard curve to determine the GMRS is slightly conservative and therefore acceptable. In addition, the staff concludes that the applicant's assumption that β=0.4 for determining the GMRS is acceptable. Furthermore, the staff concludes that the applicant targeted a sufficiently low structural performance frequency value ($1x10^{-5}$/yr), which is set equivalent to FOSID (frequency of onset of significant inelastic deformation), such that the resulting performance-based GMRS achieves an SCDF which is approximately 12 to 40 times smaller than the median of the mean SCDF for the 25 nuclear power plants considered in NUREG-1742. Therefore, the staff considers Open Item 2.5.2-8 to be resolved.

Vertical GMRS

To compute the vertical GMRS, the applicant used a combination of V/H ratios obtained from NUREG/CR-6728 and Lee (2001). Since the V/H ratios presented in NUREG/CR-6728 and Lee (2001) are functions of magnitude, source distance, and local site conditions, the applicant developed V/H ratios corresponding to the final high-frequency (**M** 7.2, 130 km) and low-frequency (**M** 5.6, 12 km) controlling earthquakes described in SSAR Section 2.5.2.4. The applicant referred to these high- and low-frequency controlling earthquakes as "near" and "far" events, respectively.

In Part A of RAI 2.5.2-24, the staff asked the applicant to justify its rationale for assigning the approximate weights of 1:3 to the V/H ratios corresponding to the respective "near" and "far" events. In response to Part A of RAI 2.5.2-24, the applicant concluded that it developed this weighting based on a review of the high- and low-frequency distance deaggregations as well as the relative contributions of the 10^{-4} and 10^{-5} hazard levels to the GMRS. Based on its review of the high-frequency distance deaggregation at the 10^{-4} hazard level (shown in SSAR Figure 2.5.2-30), the applicant concluded that approximately three-fourths of the area under the 10^{-4} hazard probability density curve corresponds to the "far" event, while about one-fourth of the area under the curve corresponds to the "near" event. In comparison, the applicant found that the relative contribution of the "near" and "far" events at the 10^{-5} hazard level is approximately the same. The applicant also reviewed the low-frequency distance deaggregation (shown in SSAR Figure 2.5.2-31) at both the 10^{-4} and 10^{-5} hazard levels and concluded that the hazard is dominated by the "far" event.

As stated in its response to Part A of RAI 2.5.2-24, the applicant focused on the 10^{-4} high-frequency distance deaggregation and the associated weights of 1:3 to determine the relative contributions of the respective "near" and "far" events because the GMRS is generally only slightly higher than the 10^{-4} ground motion. The applicant used the high-frequency distance deaggregation, rather than the low-frequency distance deaggregation, because it concluded "the low-frequency end of the spectrum is not as sensitive to magnitude and distance nor, therefore, to the distinction between 'near' and 'far' events."

The staff concludes that the applicant's use of NUREG/CR-6728 to develop V/H ratios is acceptable because the report considers the effects of magnitude and distance on spectral ratios and is applicable to CEUS soil sites. Previous regulatory guidance (RG 1.60 and NUREG/CR-0098, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants") recommended that the V/H ratio be fixed at two-thirds, independent of ground motion frequency, earthquake magnitude, distance, and local site conditions. More recent regulatory guidance (RG 1.208) recommends the use of V/H ratios that incorporate magnitude, distance, and local site conditions, such as those found in NUREG/CR-6728. Because of the observed similarity between the GMRS to the 10^{-4} soil UHRS, and because V/H ratios are observed to be higher in the near-field region and in the high-frequency range of the response spectrum (e.g., NUREG/CR-6728), the staff concurs with the applicant's rationale for weighting the relative contributions of the "near" and "far" events based on the 10^{-4} high-frequency distance deaggregation.

In Part B of RAI 2.5.2-24, the staff asked the applicant to discuss the similarities and differences between the site-specific soil profile used by Lee (2001) and the VEGP soil profile. In response to Part B of RAI 2.5.2-24, the applicant stated that the SRS site-specific soil profile is not published in Lee (2001) so that a comparison with the ESP profile could not be made. The applicant also stated that given the proximity of the ESP site to the SRS, it assumed that the site conditions at the SRS are more comparable to those at the ESP site than to the generic CEUS profile used in NUREG/CR-6728.

In Part C of RAI 2.5.2-24, the staff asked the applicant to provide justification for the relative weights assigned to the NUREG/CR-6728 and Lee (2001) results and final smoothing to develop the final V/H ratios for the ESP site. In response, the applicant stated that it used an approximate envelope of the two results. For frequencies between 1 and 100 Hz, the applicant approximated the V/H ratios of Lee (2001) by two log-log line segments. For frequencies less than 1 Hz, the applicant used a constant ratio of 0.5, which is greater than both Lee (2001) and NUREG/CR-6728, and more closely resembles the V/H values in RG 1.60.

For CEUS soil sites, RG 1.208 endorses the procedure provided in NUREG/CR-6728 to determine a WUS-to-CEUS transfer function to modify the WUS V/H ratios. The staff, therefore, concludes that the applicant's use of the formula provided in Appendix J to NUREG/CR-6728 to determine the ESP site V/H ratios is acceptable. However, the formula in Appendix J, shown in Equation (2) in SER Section 2.5.2.6, requires the input of site-specific V/H ratios, V/HCEUS,Soil,Model, based on ground motion modeling. For this site-specific V/H ratio, the applicant used the results of Lee (2001), which are applicable to the SRS soil profile, and NUREG/CR-6728, based on a generic CEUS soil profile. SER Figure 2.5.2-9 shows the applicant's final V/H ratios as a function of frequency. At frequencies above approximately 1 Hz, the applicant estimated the V/H ratios of Lee (2001) by two log-log line segments. At frequencies between 1–2 Hz and 10–20 Hz, this log-log line segment is less that the V/H ratios of Lee (2001). In the SER with open items, the staff concluded that the applicant did not provide adequate justification to support the applicability of either the Lee (2001) or the NUREG/CR-6728 soil V/H ratios at the ESP site. The staff further concluded that the applicant's approximate envelope was arbitrary. For example, the applicant did not provide its rationale for excluding the peaks observed in the Lee (2001) V/H ratios in the 1–2 Hz and 10-20 Hz frequency ranges. Accordingly, in Open Item 2.5-9, in the SER with open items, the staff requested that the applicant provide more detail regarding the applicability of the Lee (2001) and the NUREG/CR-6728 V/H ratios to the ESP site. In addition, the staff requested that the applicant provide its justification for the use of an approximate envelope of the Lee (2001) and NUREG/CR-6728 V/H ratios.

In response to the staff's request to provide more detail regarding the applicability of the Lee (2001) and the NUREG/CR-6728 V/H ratios to the ESP site, the applicant stated that it considered the implementation of the NUREG/CR-6728 approach in two cases as a guide for recommending a V/H for the Vogtle ESP site. In the first case, the applicant relied on the transfer functions presented in Appendix J to NUREG/CR-6728, where the CEUS soil model corresponds to a generic "deep soil" (500 ft) site. In the second case, the applicant relied on an evaluation of V/H for the nearby SRS (Lee, 2001), which also followed the NUREG/CR-6728 approach. The applicant stated that the subsurface S-wave velocity profiles and depths to water table are similar at Vogtle and at the SRS. The applicant also stated that "while the results from the SRS (first case) may seem arguably the most applicable for the Vogtle site, the generic nature of the first case is consistent with the generic character of the rock V/H recommendation of the NUREG. Therefore both results are considered in the SSAR."

Regarding additional justification for the use of an approximate envelope of the Lee (2001) and NUREG/CR-6728 V/H ratios, the applicant stated that, similar to the RG 1.60 V/H ratios and the recommended V/H functions for rock sites in NUREG/CR-6728, it intended to derive a V/H (based on both Lee and NUREG/CR-6728 soil) that is relatively simple and smooth, yet also reflects the following general features:

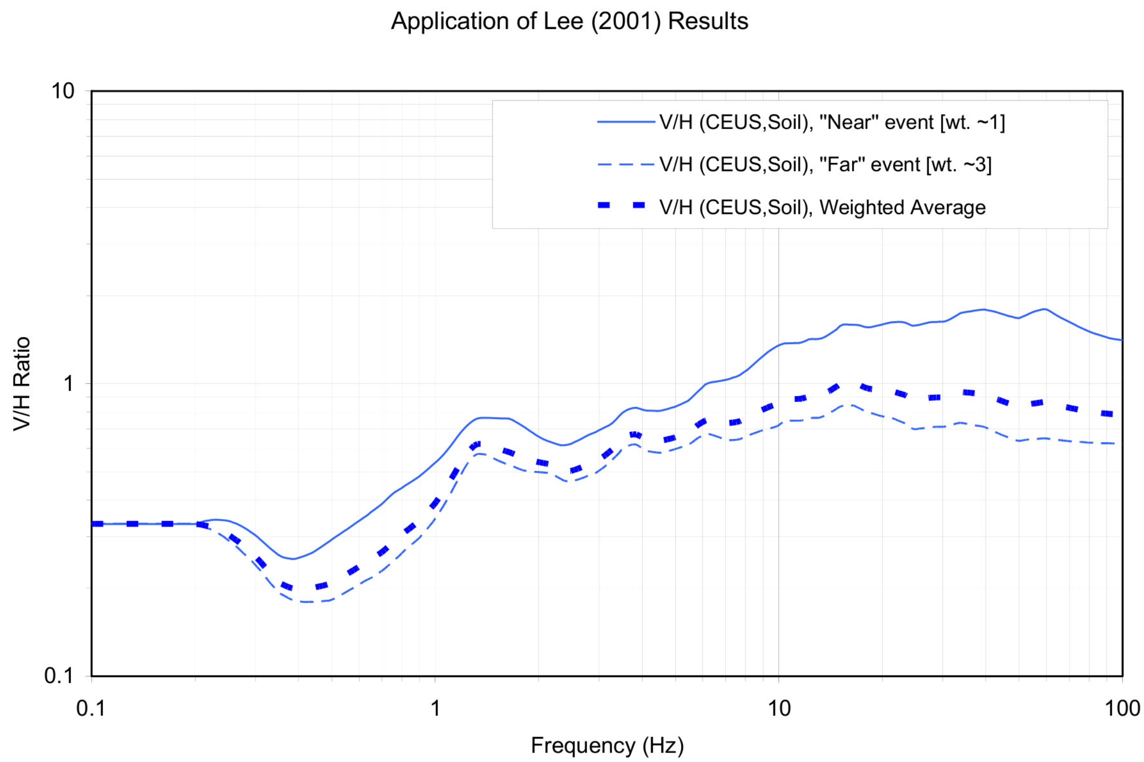
- Similar to RG 1.60 and the NUREG/CR-6728 V/H for rock, V/H is higher at high frequencies than at low frequencies;
- The two cases evaluated suggest that a relatively flat V/H value at high frequencies, slightly lower (~0.9) than that given by RG 1.60 (1.0);
- both cases suggest a lower V/H value (0.5) than that given by RG 1.60 (2/3) in the lowest frequencies;
- the envelope of the two cases suggests that the transition between the higher V/H at high frequencies and the lower V/H at low frequencies is more gradual than the relatively abrupt transition in Reg. Guide 1.60; and
- the V/H at high frequencies is sustained at its high value longer toward lower frequencies (flatter) than suggested by CEUS rock V/H from the NUREG/CR-6728.

In Open Item 2.5.2-9, the staff also requested that the applicant provide its rationale for excluding the peaks observed in the Lee (2001) V/H ratios in the 1–2 Hz and 10–20 Hz frequency ranges. In response, the applicant stated that given the complexities, assumptions, and uncertainties of developing CEUS, deep soil V/H for the Vogtle site, as well as the desire to develop a smooth function, it developed a conservative envelope of the V/H for the two cases. The applicant further stated that three discrete acceleration intervals (≤0.2g, 0.2 – 0.5 g, and >0.5 g) for which the rock V/H is defined in NUREG/CR-6728 also suggests approximate evaluations of V/H. For this reason, some peaks are cut (e.g., 1.3 Hz) and valleys are filled (e.g., 2.5 Hz) by the applicant. However, the applicant stated that it did not consider this to be significant relative to other uncertainties in ground motion evaluations.

Based on the applicant's response to Open Item 2.5-9, the staff concludes that the applicant's use of the generic CEUS soil profile V/H ratios provided in Appendix J is acceptable because the applicant also considered the V/H ratios developed for the adjacent SRS, which has a similar S-wave velocity profile to the Vogtle site and is therefore more applicable. Furthermore, the V/H ratios for the SRS soil profile are always larger than the generic CEUS soil profile, and the applicant used an approximate envelope of the two results, with the exception of the peaks excluded in the 1–2 Hz and 10–20 Hz frequency ranges. The staff, however, concludes that the applicant's exclusion of the peaks observed in the Lee (2001) V/H ratios in the 1–2 Hz and 10-20 Hz frequency ranges is not significant. As observed in SER Figure 2.5.2-9, the peak excluded in the 10–20 Hz frequency range is approximately 10 percent larger than the approximate envelope, while the peak in the narrow 1–2 Hz frequency range is less than 20 percent larger. Furthermore, the valleys on either side of the narrow peak at 1–2 Hz have also been filled. The staff notes that the applicant's final vertical GMRS is not changed significantly as a result of this smoothing. In addition, the staff notes that the applicant's use of 100 km instead of 130 km distance to obtain V/H corresponding to the **M** 7.2, 130-km earthquake from the Lee (2001) results is conservative because V/H decreases with distance for a given magnitude. This would effectively increase the final V/H based on the Lee (2001) results for the SRS shown in SER Figure 2.5.2-9. Therefore, the staff considers Open Item 2.5-9 to be resolved.

Based on its review of SSAR Section 2.5.2.6, the staff thus concludes that, overall, the applicant's horizontal and vertical GMRS, which are shown in SSAR Figure 2.5.2-44b, are acceptable. The applicant followed the general guidance provided in RG 1.208 to develop both the horizontal and vertical GMRS for the Vogtle site. In SSAR Table 1-1, the applicant identified the GMRS as an ESP site characteristic[11]. For the reasons set forth above, the staff agrees with the applicant's GMRS as a site characteristic, which appears as SER figure 2.5.2-25 and in Appendix A of the SER.

[11] The staff notes that this site characteristic for the GMRS is not bounded by the AP1000 certified design response spectrum (CSDRS). However, the staff considers the GMRS value determined for the Vogtle site to be within the range of values that new reactor designs generally are engineered to withstand. Accordingly, the staff considers the approval of this site characteristic to be consistent with the staff's determination that, from a geologic and seismologic perspective, the ESP site is suitable and meets the applicable requirements of Part 52 and Part 100. Whether the reactor design ultimately chosen for the site bounds the GMRS site characteristic will be determined at the COL stage.



Note: Considering the relative contribution of the "near" and "far" events to the horizontal SSE design response spectrum, the approximately 1:3 weighted average is shown.

Figure 2.5.2-24. Plots of recommended V/H CEUS,Soil ratios using the results from Lee (2001) for the SRS (reproduced from SSAR Figure 2.5.2-41).

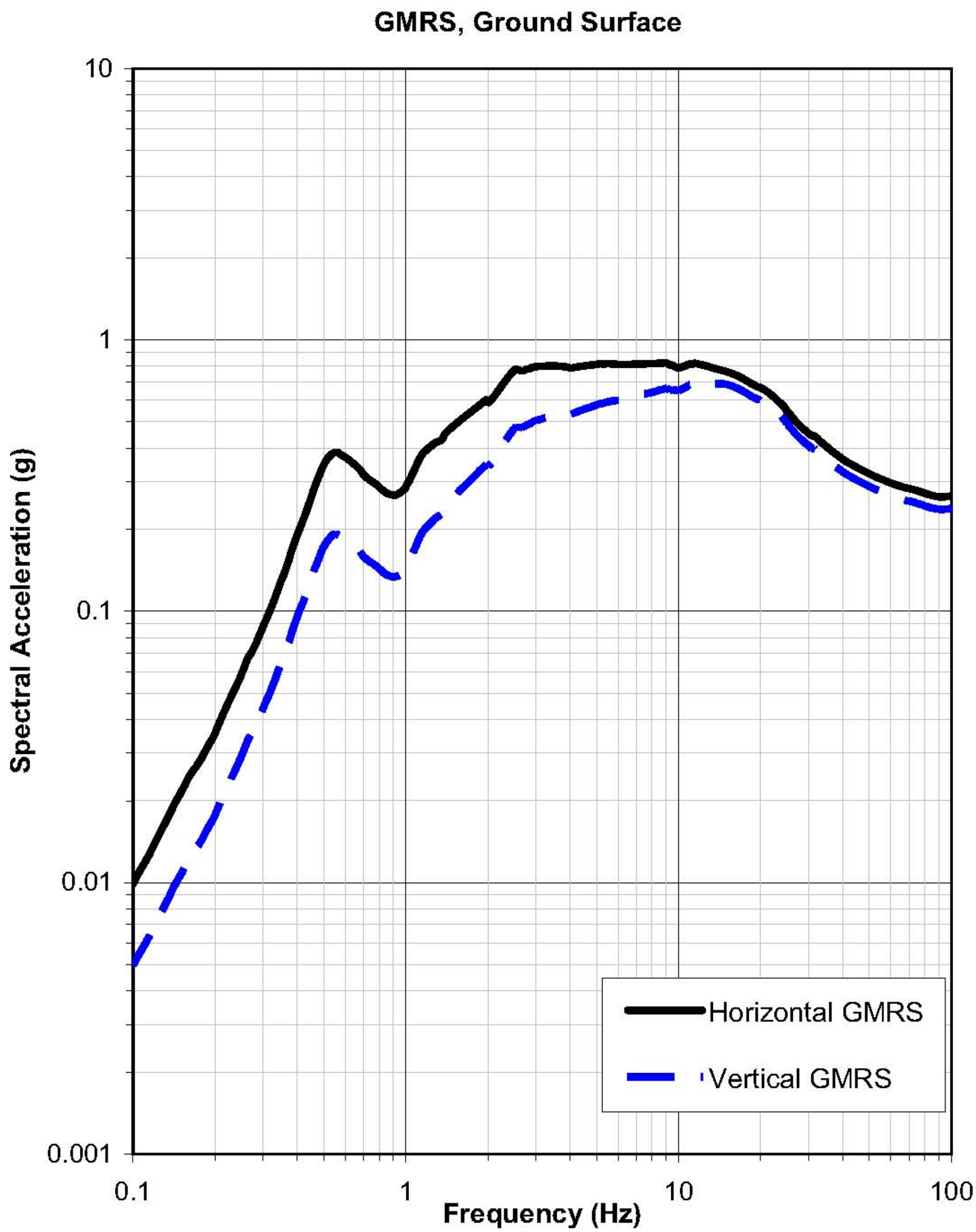


Figure 2.5.2-25. Plots of the horizontal and vertical GMRS (reproduced from SSAR Figure 2.5.2-44b).

2.5.2.5 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, 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 this PSHA follows the guidance provided in RGs 1.165 and 1.208. The staff concludes that the controlling earthquakes and associated ground motion derived from the applicant's PSHA are consistent with the seismogenic region surrounding the ESP site. In addition, the staff finds that the applicant's GMRS, which was developed using the performance-based approach, adequately represents the regional and local seismic hazards and accurately includes the effects of the local ESP subsurface properties. The staff concludes that the proposed ESP site is suitable with respect to the vibratory ground motion criteria for new nuclear power plants and meets the applicable requirements of 10 CFR 100.23.

2.5.3 Surface Faulting

In SSAR Section 2.5.3, the applicant evaluated the potential for tectonic and nontectonic surface and near-surface deformation at the VEGP ESP site. The applicant included a review of geologic, seismic, and geophysical investigations in SSAR Section 2.5.3.1.1 to assess the potential for surface deformation that could impact the ESP site. In SSAR Sections 2.5.3.1.2 and 2.5.3.1.4, the applicant assessed geologic evidence, or the absence of evidence, for surface deformation by evaluating known geologic structures in the VEGP site vicinity. SSAR Section 2.5.3.3 provides a review of seismicity within the site vicinity (a 40 km (25 mi) radius of the VEGP site) and addresses any correlation between the seismicity and capable tectonic structures. SSAR Sections 2.5.3.1.4 and 2.5.3.1.5 evaluate the tectonic structures in the site area, how these structures relate to the regional tectonics, and any ages of deformation associated with these structures. The applicant discussed the potential for tectonic and/or nontectonic deformation at the VEGP site in SSAR Section 2.5.3.1.8. On the basis of this evaluation, the applicant concluded that: (1) no capable tectonic sources exist within the VEGP site area (within an 8 km (5 mi) radius); (2) the potential for tectonic fault displacement is negligible; (3) only limited potential exists for nontectonic surface deformation within the site area; and (4) the potential for nontectonic surface deformation can be mitigated by excavation of materials.

2.5.3.1 Technical Information in the Application

2.5.3.1.1 Geologic, Seismic, and Geophysical Investigations

In SSAR Section 2.5.3.1, the applicant described the geologic, seismic, and geophysical investigations performed to assess the potential for tectonic and nontectonic surface and near-surface deformation at and within an 8 km (5 mi) radius of the VEGP site. The applicant reviewed previous VEGP site investigations, published geologic mapping, previous SRS investigations, previous seismicity data, previous seismic reflection data, current seismic reflection studies, and current aerial and field reconnaissance. The applicant stated that geologic and geomorphic investigations within and beyond the site vicinity (a 40 km (25 mi) radius) and interpretation of aerial photographs taken within the site area (an 8 km (5 mi) radius) were used to supplement existing information for documenting the presence or absence of features indicative of potential Quaternary (1.8 million years ago (mya) to present) fault activity at or near the site.

Data from Previous Investigations

SSAR Section 2.5.3.1.1 describes previous site area investigations conducted for VEGP Units 1 and 2. Section 2.5.3.1.2 describes the applicant's review of published geologic maps for analyzing surface deformation within the site area. The applicant reviewed previous SRS investigations (SSAR Section 2.5.3.1.3), including geologic, seismic, hydrologic, and geophysical investigations, and concluded that the Pen Branch fault does not exhibit surface deformation, is not a capable tectonic structure, and is not favorably oriented in the modern-day stress regime to experience displacement. In SSAR Section 2.5.3.1.4, the applicant reviewed historical seismicity and microseismicity data for the site vicinity (within a 40 km (25 mi) radius) and the site area (within an 8 km (5 mi) radius). The applicant stated that no recent earthquake activity has occurred within the site area and that the closest microearthquake to the ESP site is located on the SRS, about 11 km (7 mi) to the northeast of the VEGP. In SSAR Section 2.5.3.1.5, the applicant discussed previous seismic reflection studies and again concluded that the Pen Branch fault is not a capable tectonic structure.

Data from Current Investigations

The applicant described current seismic reflection studies in SSAR Section 2.5.3.1.6 and current aerial and field reconnaissance studies in SSAR Section 2.5.3.1.7. These investigations were performed for the ESP application in order to image the Pen Branch fault beneath the surface and to check for evidence of surface faulting within the ESP site vicinity. The applicant stated that the Pen Branch fault was clearly imaged beneath the ESP site area in the seismic reflection data. The applicant concluded that, based on aerial and field reconnaissance data, no geomorphic features within the site vicinity display evidence for surface rupture, surface warping, or fault offset.

2.5.3.1.2 Geologic Evidence, or Absence of Evidence, for Surface Deformation

In SSAR Section 2.5.3.2, the applicant stated that four bedrock faults are mapped within a 5-mile radius of the VEGP ESP site. These faults, interpreted from seismic reflection, borehole, gravity, and magnetic and/or ground water data, include the Pen Branch, Ellenton, Steel Creek, and Upper Three Runs faults. Of these four faults, only the Pen Branch fault is interpreted to extend beneath the VEGP ESP site area, motivating the applicant to perform a detailed investigation of the Pen Branch fault as it relates to the ESP site. A complete description of the applicant's investigation of the Pen Branch fault is included in SSAR Section 2.5.1.2.4.1. The remaining three faults, mapped in relation to the SRS, are located within a 5-mile radius of the VEGP site, but are not interpreted to extend beneath the site. The applicant concluded that none of the four faults mapped within the site area displays evidence of surface rupture and that none of these faults is a capable tectonic structure.

Pen Branch Fault

The applicant presented its conclusions regarding the Pen Branch fault in SSAR Sections 2.5.3.2.1 and 2.5.3.5.1. The Pen Branch fault is more than 30 km (greater than 20 mi) in length along its northeastern strike direction and forms the northwest boundary of the Dunbarton Triassic basin. The fault initially accommodated regional crustal extension during the Mesozoic (248 to 65 mya) by normal slip during the Triassic (248 to 206 mya) period to form the

Dunbarton Basin, and was reactivated in the Cretaceous (144 to 65 mya) and Tertiary (65 to 2 mya) as a reverse fault. The applicant stated that the Pen Branch fault is not exposed or geomorphically expressed at the surface, and borehole and seismic reflection data collected at the SRS show no evidence for post-Eocene slip on the fault. According to the applicant, the Ellenton Quaternary terrace (Qte) at the SRS, dated between 350,000 and 1 mya in age, was evaluated for the ESP application and demonstrates no Quaternary tectonic deformation of the terrace surface within a resolution of about 1 m (3 ft). The applicant stated that both previous and more recent investigations to define the presence or absence of surface deformation related to displacement on the Pen Branch fault indicate no evidence of Quaternary (1.8 mya to present) deformation. Based on these findings, the applicant concluded that the Pen Branch fault is not interpreted as a capable tectonic source.

Ellenton Fault

In SSAR Sections 2.5.3.2.2 and 2.5.3.5.2, the applicant summarized geologic evidence for the absence of surface deformation due to slip on the Ellenton fault, located about 7.4 km (4.6 mi) from the VEGP site. As initially mapped by Stieve and Stephenson (1995), the Ellenton fault was a north-northwest striking fault located in the Dunbarton Basin between the Upper Three Runs and Pen Branch faults. The applicant stated that the Ellenton fault likely does not exist because the data used to suggest the existence of this potential structure were acknowledged to be of poor quality, there is no geomorphic expression of this fault at the surface, and the fault does not appear on the most recent SRS fault maps by Cumbest et al. (2000). Therefore, the applicant concluded that this fault could not represent a capable tectonic structure within the site area.

Steel Creek Fault

In SSAR Sections 2.5.3.2.3 and 2.5.3.5.3, the applicant summarized geologic evidence for the absence of surface deformation due to slip on the Steel Creek fault, located about 4.8 km (3 mi) from the VEGP site. This fault is interpreted to be more than 17.7 km (greater than 11 mi) in length, with a northeast strike and a northwest dip, and exhibits reverse slip movement. The Steel Creek fault cuts upward into Cretaceous units, but its uppermost extension remains unresolved. According to the applicant, longitudinal profiles along Quaternary fluvial terraces overlying the surface projection of the fault, with a resolution of 2-3 m (7-10 ft), show no evidence of warping or faulting of the terrace surfaces and therefore provides no evidence for Quaternary (1.8 mya) deformation. Based on a lack of geomorphic surface expression, the applicant concluded that the Steel Creek fault is not a capable tectonic structure within the site area.

Upper Three Runs Fault

In SSAR Sections 2.5.3.2.4 and 2.5.3.5.4, the applicant summarized geologic evidence for the absence of surface deformation due to slip on the Upper Three Runs fault, located about 8 km (5 mi) from the VEGP site. The fault is not included on the more recent fault map of the SRS by Cumbest et al. (2000), but its northernmost trace is roughly parallel to the Tinker Creek fault that is shown on the Cumbest et al. (2000) fault map. According to the applicant, seismic profiles show that Coastal Plain sediments are not offset or deformed by this structure, and the fault is interpreted to be confined to basement rocks. Based on these findings and the fact that there is no geomorphic surface expression of this fault, the applicant concluded that it is not a capable tectonic structure within the site area.

2.5.3.1.3 Correlation of Earthquakes with Capable Tectonic Sources

The applicant summarized seismicity data for the VEGP ESP site vicinity in SSAR Sections 2.5.3.3 and 2.5.3.1.4 in order to determine whether any correlation exists between seismicity and capable tectonic structures. Figure 2.5.3-1 of this SER, taken from SSAR Figure 2.5.1-16, shows diffuse microseismic activity recorded by the SRS seismic recording network since 1976 within a 40 km (25 mi) radius of the VEGP site.

Based on the data shown in this figure, the applicant concluded that there is no spatial correlation of earthquake epicenters with known or postulated faults. The applicant reviewed published literature to further conclude that there are no known historical earthquake epicenters associated with bedrock faults or known tectonic structures in the site vicinity. The EPRI catalog of historical seismicity demonstrates that no known earthquake greater than body wave magnitude (mb) 3 has occurred within the site vicinity, while the SRS seismic recording network documents no recent microseismic activity (mb less than 3) within an 8 km (5 mi) radius of the VEGP site since 1976. The applicant stated that the nearest microearthquake event to the VEGP ESP site was located about 11 km (7 mi) northeast of the VEGP site on the SRS.

The applicant described three small earthquakes that occurred between 1985 and 1997 with magnitudes ranging between 2.0 and 2.6 and depths ranging from 2.5 to 6 km (1.5 to 3.5 mi). In addition to these events, the applicant described a magnitude 3.2 event located north of the SRS in Aiken, South Carolina, and a series of several small events (magnitudes less than or equal to 2.6) that occurred in 2001–2002 within the SRS boundaries. The applicant reviewed the locations of these events with respect to mapped faults in the ESP site vicinity, as well as previous studies of these events by Stevenson and Talwani (2004), Talwani et al. (1985), and Crone and Wheeler (2000), and concluded that there is no spatial correlation of seismicity with known or postulated faults or geomorphic features.

2.5.3.1.4 Ages of Most Recent Deformations

In SSAR Section 2.5.3.4, the applicant stated that, based on information presented in SSAR Section 2.5.3.2, none of the four faults (Pen Branch, Ellenton, Steel Creek, or Upper Three Runs) exhibits Quaternary (1.8 mya to present) displacement. Thus, the applicant concluded that none is considered a capable tectonic structure. In particular, the applicant stated that the Pen Branch fault exhibits no post-Eocene (33.7 mya to present) displacement.

2.5.3.1.5 Relationship of Site Area Tectonic Structures to Regional Tectonic Structures

SSAR Section 2.5.3.5 discusses the four faults identified within the site area and previously discussed in SER Section 2.5.3.1.2. Of these four faults, the applicant stated that only the Pen Branch fault occurs west of the SRS and within the ESP site area. The applicant concluded that, based on a review of all available data, none of these four faults is considered a capable tectonic structure and none is associated with any capable regional tectonic structure.

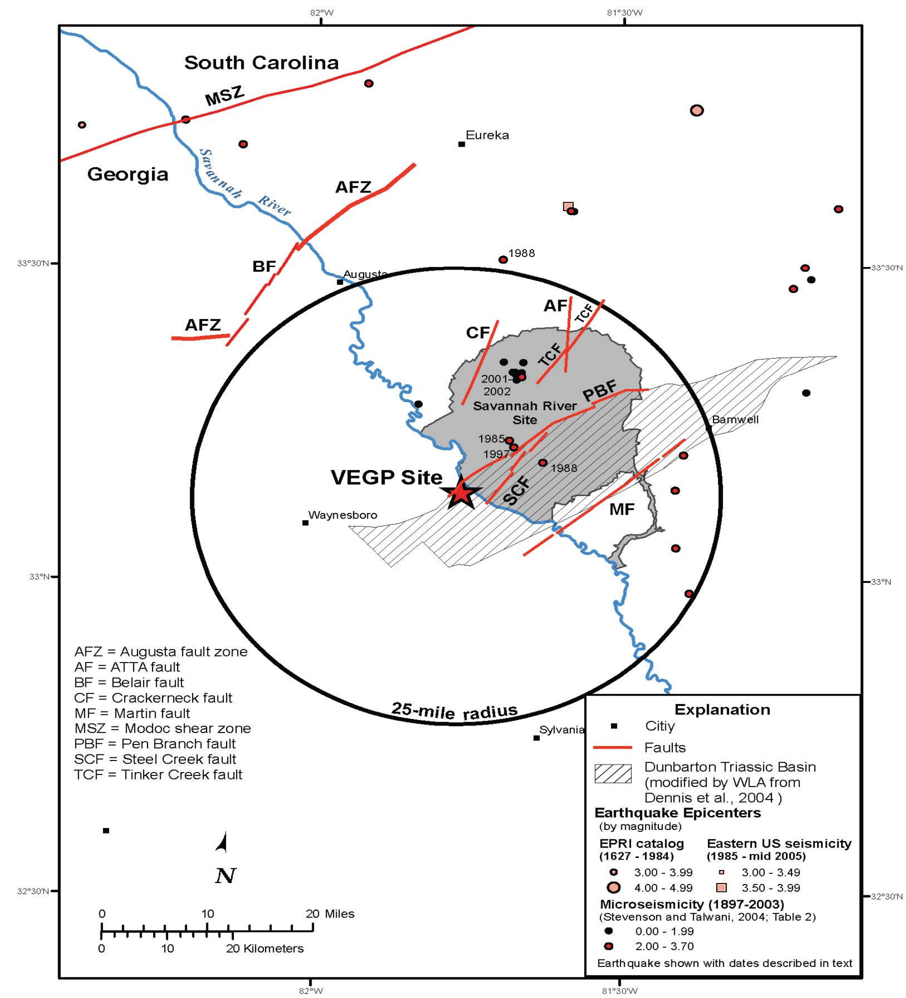


Figure 2.5.3-1 - Site Vicinity Tectonic Features and Seismicity (Reproduced from SSAR Figure 2.5.1-16)

2.5.3.1.6 Characterization of Capable Tectonic Sources

The applicant described characterization of capable tectonic sources in SSAR Section 2.5.3.6 and reiterated that no capable tectonic structures occur within 8 km (5 mi) of the VEGP site based on the following geologic evidence:

1. The Pen Branch fault is not exposed or expressed at the surface. Field reconnaissance and aerial photograph interpretations performed for the ESP study confirmed that there is no surface exposure of the fault or geomorphic expression indicative of Quaternary deformation.

2. Snipes et al. (1993) indicated that there was no displacement of a Quaternary soil horizon overlying the projected trace of the Pen Branch at the SRS, and the youngest horizon offset by fault displacement on the Pen Branch was the Dry Branch Formation of late Eocene age.

3. Geomatrix (1993) evaluated longitudinal profiles of Quaternary fluvial river terraces on the SRS and concluded that no evidence for warping or faulting of the terraces existed within a resolution limit of 2 to 3 m (7 to 10 ft).

4. Longitudinal terrace profiles across the now well-located Pen Branch fault also indicated no deformation of the Ellenton terrace (estimated to be 350,000 to 1 million years old) within a resolution limit of 1 m (3 ft).

5. Also as part of the ESP study, geomorphic analysis of the Ellenton terrace, which overlies the surface projection of the Pen Branch, demonstrates a lack of tectonic deformation of this Quaternary surface within a resolution limit of 1 m (3 ft). Details of this ESP study are presented in SSAR Section 2.5.1.2.4.3.

2.5.3.1.7 Designation of Quaternary Deformation Zones Requiring Detailed Investigation

In SSAR Section 2.5.3.7, the applicant concluded that no zones of Quaternary deformation requiring detailed fault investigation exist within the VEGP site area based on the absence of any Quaternary deformation features in the ESP site area.

2.5.3.1.8 Potential for Tectonic or Nontectonic Deformation at the Site

In SSAR Section 2.5.3.8.1, the applicant concluded that the potential for tectonic deformation at the ESP site is negligible and stated that no new information has been reported since the original site studies for VEGP Units 1 and 2 in the early 1970s to suggest the existence of Quaternary surface deformation. Also in SSAR Section 2.5.3.8, the applicant addressed the potential for nontectonic deformation features at the VEGP ESP site, including dissolution collapse features and clastic dikes.

In SSAR Section 2.5.3.8.2, the applicant specifically discussed the potential for nontectonic surface deformation at the ESP site, including interpretation of dissolution collapse features and clastic dikes. Regarding dissolution collapse features, which are discussed in SSAR Section 2.5.3.8.2.1, the applicant indicated that small-scale structures, including warped bedding, fractures, joints, minor fault offsets, and injected sand dikes, identified in the walls of a trench at the VEGP site were local features related to dissolution of the Utley Limestone and subsequent collapse of overlying Tertiary sediments. Age of these features was interpreted to be younger than Eocene-Miocene host sediments and older than the overlying late-Pleistocene Pinehurst Formation. The applicant stated that no late Pleistocene or Holocene dissolution features were identified at the site. The applicant indicated that mitigation of collapse due to dissolution of the Utley Limestone, which overlies the Blue Bluff Marl (BBM) at the site, could be accomplished by planned excavation and removal of the Utley Limestone to establish the foundation grade of the plant atop the BBM.

In SSAR Section 2.5.3.8.2.2, the applicant addressed clastic dikes, described as relatively planar, narrow (centimeter-to-decimeter wide) clay-filled features that flare upwards and are decimeters to meters in length. The applicant stated that Bechtel (1984) distinguished two types of clastic dikes in the walls of the trench on the VEGP site where dissolution collapse features were found. The first type of clastic dikes was interpreted to be sand dikes that resulted from injection of poorly consolidated fine sand into overlying sediments; the second type was clastic dikes produced by weathering and soil formation processes that were enhanced along fractures that formed during dissolution collapse. Bechtel (1984) concluded that the dikes were primarily a weathering phenomenon controlled by depth of weathering and paleosol development in Coastal Plain sediments and subsequent erosion of the land surface. According to the applicant, clastic dike features identified by Bartholomew et al. (2002) within the site area were observed during the ESP field reconnaissance. The applicant interpreted these features to be nontectonic in origin, although Bartholomew et al. (2002) suggested that they might be evidence for paleoearthquakes associated with late-Eocene to late-Miocene faulting, possibly along the Pen Branch fault.

2.5.3.2 Regulatory Evaluation

The acceptance criteria for evaluating the potential for surface or near-surface tectonic and nontectonic deformation are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100.23. The staff considered the following regulatory requirements in reviewing the applicant's discussion of information on surface faulting:

1. 10 CFR 53.17(a)(1)(vi), which requires that an ESP application contain a description of the geologic and seismic characteristics of the proposed site.

2. 10 CFR 100.23(c), which requires an ESP applicant to investigate geologic, seismic, and engineering characteristics of a site and its environs in sufficient scope and detail to permit an adequate evaluation of the proposed site, to provide sufficient information to support evaluations performed to determine the SSE Ground Motion, and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site.

3. 10 CFR 100.23(d), which requires that geologic and seismic siting factors considered for design include a determination of the SSE Ground Motion for the site, the potential for surface tectonic and non-tectonic deformation, the design bases for seismically-induced floods and water waves, and other design conditions including soil and rock stability, liquefaction potential, and natural and artificial slope stability. Siting factors and potential causes of failure to be evaluated include physical properties of materials underlying the site, ground disruption, and effects of vibratory ground motion that may affect design and operation of the proposed power plant.

The basic geologic and seismic information assembled by the applicant in compliance with the above regulatory requirements should also be sufficient to allow a determination at the COL stage of whether the proposed facility complies with the following requirements in Appendix A to 10 CFR Part 50:

1. 10 CFR Part 50, Appendix A, GDC 2, which requires that SSCs important to safety be designed to withstand the effects of natural phenomena such as earthquakes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

2. 10 CFR Part 50, Appendix S - IV, "Application to Engineered Design", which requires that vibratory ground motion (including the Safe Shutdown Earthquake Ground Motion and the Operating Basis Earthquake Ground Motion) and surface deformation be considered in the design of a nuclear power plant.

To the extent applicable in the regulatory requirements cited above, and in accordance with RS-002, the staff applied NRC-endorsed methodologies and approaches (specified in Section 2.5.3 of NUREG-0800) for evaluation of information characterizing the potential for surface or near-surface tectonic and nontectonic deformation at the proposed site as recommended in RG 1.165.

Section 2.5.3 of NUREG-0800 and RG 1.165 provide specific guidance concerning the evaluation of information characterizing the potential for surface and near-surface deformation, including the geologic, seismic, and geophysical data that the applicant needs to provide to establish the potential for surface deformation.

2.5.3.3 Technical Evaluation

This SER section presents the staff's evaluation of the geologic, seismic, and geophysical information submitted by the applicant in SSAR Section 2.5.3 to address the potential for surface or near-surface tectonic and nontectonic deformation within an 8 km (5 mi) radius of the ESP site (i.e., the "site area" as defined in RG 1.165). The technical information presented in SSAR Section 2.5.3 resulted from the applicant's surface and subsurface geologic, seismic, and geophysical investigations performed within the site area, supplemented by aerial and field reconnaissance studies undertaken within a 40 km (25 mi) radius of the site (i.e., the "site vicinity" as defined in RG 1.165). Through its review, the staff determined whether the applicant complied with the applicable regulations and conducted its investigations with an appropriate level of detail in accordance with RG 1.165.

To thoroughly evaluate the geologic, seismic, and geophysical information presented by the applicant, the staff obtained the assistance of the USGS. The staff and its USGS advisors visited the ESP site to confirm interpretations, assumptions, and conclusions presented by the applicant and related to the potential for surface or near-surface faulting and nontectonic deformation.

2.5.3.3.1 Geologic, Seismic, and Geophysical Investigations

In SSAR Sections 2.5.3.1.1 through 2.5.3.1.7, the applicant reviewed and summarized information related to previous VEGP site investigations (Section 2.5.3.1.1), published geologic mapping (Section 2.5.3.1.2), previous SRS investigations (Section 2.5.3.1.3), previous seismicity data (Section 2.5.3.1.4), previous seismic reflection data (Section 2.5.3.1.5), current seismic reflection studies (Section 2.5.3.1.6), and current aerial and field reconnaissance (Section 2.5.3.1.7).

Based on the information presented in SSAR Sections 2.5.3.1.1 through 2.5.3.1.7, the applicant concluded that no capable tectonic sources occur within the site area and that there is negligible potential for surface or near-surface fault rupture. Consequently, the applicant considered the site to be suitable in regard to the potential for surface or near-surface faulting. The staff's review of SSAR Sections 2.5.3.1.1 through 2.5.3.1.7 is presented below.

Data from Previous Investigations

The staff focused its review of SSAR Sections 2.5.3.1.1 through 2.5.3.1.5 on the applicant's descriptions of previous studies and data collected within the site area in order to assess the potential for surface tectonic deformation at the ESP site. In SSAR Section 2.5.3.1.1, the applicant described the results of previous investigations conducted for VEGP Units 1 and 2, which support the concepts that the Pen Branch fault (known to underlie the ESP site) exhibits no surface displacement and is a noncapable tectonic structure and that nontectonic deformation features occur in the site area. In SSAR Section 2.5.3.1.2, the applicant discussed information from published geologic maps documenting the existence of nontectonic deformation features in the site area. SER Section 2.5.3.3.9 provides a more detailed discussion of nontectonic features in the site area. The applicant also stated in SSAR Section 2.5.3.1.2 that Crone and Wheeler (2000) and Wheeler (2005) classified the Pen Branch fault as a Class C feature based on insufficient geologic evidence to document Quaternary displacement along the fault. In SSAR Section 2.5.3.1.3, the applicant cited evidence collected from the SRS that the Pen Branch fault does not exhibit surface displacement, is not a capable tectonic structure, and is not favorably oriented in the modern-day stress field to experience displacement. In SSAR Section 2.5.3.1.4, the applicant stated that no recent earthquake activity has occurred within the site area based on microseismicity data. In SSAR Section 2.5.3.1.5, the applicant discussed previous seismic reflection studies supporting the interpretation that the Pen Branch fault is not a capable tectonic structure.

Based on a review of SSAR Sections 2.5.3.1.1 through 2.5.3.1.5, the staff concludes that the applicant presented thorough and accurate descriptions of previous studies and data collected within the site area. The applicant used this information to assess the potential for tectonic deformation at the ESP site, which is required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). These five SSAR sections present well-documented geologic information that the applicant derived from published sources. The applicant provided an extensive list of references for these sources, which the staff examined in order to ensure the accuracy of the information presented by the applicant in the SSAR.

Data from Current Investigations

The staff focused its review of SSAR Sections 2.5.3.1.6 and 2.5.3.1.7 on the applicant's descriptions of the investigations performed to image the Pen Branch fault at the ESP site using seismic reflection and to look for evidence of surface faulting in the site vicinity using field and aerial reconnaissance. In SSAR Section 2.5.3.1.6, the applicant stated that the Pen Branch fault is clearly imaged beneath the ESP site in the seismic reflection data. In SSAR Section 2.5.3.1.7, the applicant indicated that no geomorphic evidence exists for surface rupture, surface warping, or fault offset. The applicant also reported its reinterpretation of features observed within the site vicinity and initially considered as possible evidence for tectonic activity. The applicant reinterpreted these features as nontectonic in origin.

Based on its review of SSAR Sections 2.5.3.1.6 and 2.5.3.1.7, the staff concludes that the applicant presented thorough and accurate descriptions of data from current investigations within the site area in order to assess the potential for tectonic deformation at the ESP site. This information supports the requirements set forth in 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). The staff further concludes that the applicant presented adequate evidence to support the conclusions that the Pen Branch fault underlies the ESP site. The staff believes that the applicant also provided adequate evidence that no surface rupture due to displacement along the Pen Branch fault exists in the site area or site vicinity. SER Section 2.5.1.3.4 presents the staff's evaluations and conclusions regarding all new information that was collected by the applicant to assess the Pen Branch fault. This information was used to support the applicant's conclusions that the Pen Branch fault does not exhibit surface rupture or Quaternary (1.8 mya to present) displacement and is not a capable tectonic feature at the ESP site.

2.5.3.3.2 Geologic Evidence for Surface Deformation

In SSAR Section 2.5.3.2, the applicant described four bedrock faults identified within the site area. These structures include the Pen Branch, Ellenton, Steel Creek, and Upper Three Runs faults, which the applicant discussed in SSAR Sections 2.5.3.2.1, 2.5.3.2.2, 2.5.3.2.3, and 2.5.3.2.4, respectively. Based on information presented in SSAR Sections 2.5.3.2 and 2.5.1.2.4, the applicant concluded that none of the four faults mapped within the site area shows any evidence of surface rupture and that none of the faults is a capable tectonic source. The staff's evaluation of SSAR Section 2.5.3.2, including Sections 2.5.3.2.1, 2.5.3.2.2, 2.5.3.2.3, and 2.5.3.2.4, is presented below.

The staff focused its review of SSAR Section 2.5.3.2 on the applicant's descriptions of the four bedrock faults mapped within the site area. The staff concludes that the applicant presented accurate descriptions of these four faults to enable assessment of the potential for tectonic surface deformation within the site area. This assessment is required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Based on a review of the information presented by the applicant in SSAR Section 2.5.3.2, as well as information discussed in SSAR Section 2.5.1.2.4, the staff concurs with the applicant that none of these four faults exhibits surface displacement and none is a capable tectonic feature.

The rationale for the staff's conclusions in regard to the existence of surface faulting in the site vicinity and at the site, particularly in relation to the Pen Branch fault, is presented in detail in SER Section 2.5.1.3.4, which discusses geology of the site area. Also in SER section 2.5.1.3.4, the staff presents a summary of the lines of evidence cited by the applicant in the SSAR to indicate that the Pen Branch fault does not exhibit Quaternary displacement and is not a capable tectonic feature.

2.5.3.3.3 Correlation of Earthquakes with Capable Tectonic Sources

In SSAR Section 2.5.3.3, the applicant described the distribution of epicenters for instrumentally recorded earthquakes that have occurred in the site vicinity (within an 8-km (5-mi) radius). The applicant stated that neither historical nor instrumentally recorded earthquake epicenters show a correlation with known or postulated faults in the site vicinity. Based on information presented in

SSAR Section 2.5.3.3, as well as in SSAR Section 2.5.1.1.4.3 and SSAR Figure 2.5.1-16, the applicant concluded that no spatial correlation exists between earthquake epicenters and known or postulated faults in the site vicinity or site area. The staff's evaluation of SSAR Section 2.5.3.3 is presented below.

The staff focused its review of SSAR Section 2.5.3.3 on the applicant's description of historical and instrumentally recorded earthquake epicenters and faults that have occurred within the site vicinity. The staff concludes that the applicant presented convincing data and logical interpretations related to a lack of correlation between earthquakes and tectonic sources in support of the ESP application and as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Based on a review of the information presented by the applicant in SSAR Section 2.5.3.3, as well as information presented by the applicant in SSAR Section 2.5.1.1.4.3 and SSAR Figure 2.5.1-16, the staff concurs with the applicant's conclusion that no spatial correlation exists between earthquake epicenters and faults in the site vicinity or site area.

2.5.3.3.4 Ages of Most Recent Deformations

In SSAR Section 2.5.3.4, the applicant discussed information related to ages of the most recent deformations indicated for the four bedrock faults identified within the site area (i.e., the Pen Branch, Ellenton, Steel Creek, and Upper Three Runs faults). Based on information presented in SSAR Sections 2.5.3.4 and 2.5.1.2.4, the applicant concluded that none of these four faults exhibits Quaternary displacement and none is considered a capable tectonic structures. For the Pen Branch fault, the applicant stated that there is no evidence indicating this fault has experienced displacement younger than Eocene (i.e., less than 33.7 mya). The Pen Branch fault is of particular interest to the staff because it underlies the ESP site. The staff's evaluation of SSAR Section 2.5.3.4 is presented below.

The staff focused its review of SSAR Section 2.5.3.4 on the applicant's discussion of the ages of most recent deformations indicated for the four bedrock faults mapped within the site area. The staff concludes that the applicant presented accurate descriptions of the ages of deformation for these four faults in order to enable an accurate assessment of Quaternary displacement along faults within the ESP site area and at the ESP site. This assessment is required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Based on a review of the information presented by the applicant in SSAR Section 2.5.3.4, as well as information discussed in SSAR Section 2.5.1.2.4, the staff concurs with the applicant's conclusion that none of these four faults exhibits Quaternary displacement.

The rationale for the staff's conclusions in regard to the ages of most recent deformation, specifically for the Pen Branch fault, is presented in detail in SER Section 2.5.1.3.4. Also in SER Section 2.5.1.3.4, the staff presents a summary of the lines of evidence used by the applicant in the SSAR indicating that the Pen Branch fault does not exhibit Quaternary displacement and is not a capable tectonic feature.

2.5.3.3.5 Relationship of Site Area Tectonic Features to Regional Tectonic Structures

In SSAR Section 2.5.3.5, the applicant discussed the four faults identified within the site area. These structures include the Pen Branch, Ellenton, Steel Creek, and Upper Three Runs faults, which the applicant discussed in SSAR Sections 2.5.3.5.1, 2.5.3.5.2, 2.5.3.5.3, and 2.5.3.5.4, respectively. Of these four faults, the applicant indicated that only the Pen Branch fault occurs west of the SRS on the ESP site. Based on information presented in SSAR Section 2.5.3.5, the applicant concluded that none of the four faults is considered a capable tectonic feature within the site area, effectively concluding that none is linked with any capable regional tectonic structure. The staff's evaluation of SSAR Section 2.5.3.5 is presented below.

The staff focused its review of SSAR Section 2.5.3.5 on the applicant's descriptions of these four faults identified within the site area. The staff concludes that the applicant presented accurate descriptions of these four faults to enable assessment of possible linkage with regional tectonic structures in support of the ESP application and as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Based on a review of the information presented by the applicant in SSAR Section 2.5.3.5, as well as information discussed in SSAR Section 2.5.1.2.4, the staff concurs with the conclusions of the applicant that none of the four faults is a capable tectonic feature and none is linked with a capable regional tectonic structure.

2.5.3.3.6 Characterization of Capable Tectonic Sources

In SSAR Section 2.5.3.6, the applicant stated that no capable tectonic sources occur within the site area. The applicant summarized the data supporting a noncapable status for the Pen Branch fault. Based on information presented in SSAR Section 2.5.3.6, the applicant concluded that no capable tectonic sources exist in the site area that would require characterization. The staff's evaluation of SSAR Section 2.5.3.6 is presented below.

The staff focused its review of SSAR Section 2.5.3.6 on the applicant's description of the Pen Branch fault. The staff concludes that the applicant presented an accurate summary to enable assessment of the capability of the Pen Branch fault in support of the ESP application and as required by 10 CFR 52.17(a)(1)(vi), and 10 CFR 100.23(c), 10 CFR 100.23(d). Based on a review of the information presented by the applicant in SSAR Section 2.5.3.6, as well as information discussed in SSAR Section 2.5.1.2.4, the staff concurs with the applicant's conclusion that no capable tectonic sources exist in the site area requiring characterization, including the Pen Branch fault.

The rationale for the staff's conclusions in regard to the noncapability of the Pen Branch fault is presented in detail in SER Section 2.5.1.2.4. Also in SER Section 2.5.1.3.4, the staff presents a summary of the lines of evidence used by the applicant in the SSAR indicating that the Pen Branch fault does not exhibit Quaternary displacement and is not a capable tectonic feature.

2.5.3.3.7 Designation of Zones of Quaternary Deformation for Detailed Investigation

In SSAR Section 2.5.3.7, the applicant concluded that there are no zones of Quaternary deformation within the site area which require detailed investigation. The applicant based its conclusion on data presented in SSAR Sections 2.5.1.2.4, 2.5.3.2, 2.5.3.4, and 2.5.3.5. The staff's evaluation of SSAR Section 2.5.3.7 is presented below.

The staff focused its review of SSAR Section 2.5.3.7 on the applicant's descriptions of faults identified in the site area and discussed in SSAR Sections 2.5.1.2.4, 2.5.3.2, 2.5.3.4, and 2.5.3.5. The staff concludes that the applicant presented accurate descriptions of faults identified in the site area to enable an assessment of Quaternary deformation within the site area and at the ESP site in support of the ESP application and as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Based on a review of this information, the staff concurs with the applicant's conclusion that there are no zones of Quaternary deformation within the site area that require a detailed investigation.

The rationale for the staff's conclusions in regard to a lack of Quaternary deformation in the site area is presented in detail in SER Section 2.5.1.3.4. Also in SER Section 2.5.1.3.4, the staff presents a summary of the lines of evidence cited by the applicant in the SSAR to indicate that the Pen Branch fault does not exhibit Quaternary displacement and is not a capable tectonic feature.

2.5.3.3.8 Potential for Surface Tectonic Deformation

In SSAR Section 2.5.3.8.1, the applicant stated that the Pen Branch fault is noncapable and will not cause surface rupture in the future. The applicant also stated that the nonbrittle folding of the Blue Bluff Marl, interpreted to result from displacement along the Pen Branch fault, indicates near-surface tectonic deformation that is not younger than Eocene (i.e., less than 33.7 mya). Based on information summarized in SSAR Section 2.5.3.8.1, which is discussed in more detail by the applicant in SSAR Section 2.5.1.2.4.2, the applicant concluded that the potential for tectonic deformation at the site is negligible. The staff's evaluation of SSAR Section 2.5.3.8.1 is presented below.

The staff focused its review of SSAR Section 2.5.3.8.1 on the applicant's discussion of near-surface tectonic deformation interpreted by the applicant to result from displacement along the Pen Branch fault more than 33.7 mya. The staff concludes that the applicant presented an accurate discussion of the field data indicating no displacement younger than Eocene along the Pen Branch fault in the site area. This assessment is required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Based on a review of the information presented by the applicant in SSAR Sections 2.5.3.8.1 and 2.5.1.2.4.2, the staff concurs with the conclusion of the applicant that the potential for tectonic deformation at the site is negligible.

2.5.3.3.9 Potential for Nontectonic Deformation

In SSAR Section 2.5.3.8.2, the applicant discussed dissolution collapse features (SSAR Section 2.5.3.8.2.1) and "clastic" dikes (SSAR Section 2.5.3.8.2.2). Based on information presented in SSAR Section 2.5.3.8.2.1, the applicant stated that dissolution collapse features are not considered to be tectonic structures or paleoseismic features, and concluded that they do not represent a safety issue for the ESP site in regard to nontectonic surface deformation. Based on information presented in SSAR Section 2.5.3.8.2.2, the applicant indicated that two types of so-called "clastic" dikes occur in the site area: (1) sand dikes that resulted from injection of poorly-consolidated, liquefied fine sand into overlying sediments; and (2) pedogenic clastic dikes related to weathering and soil formation (i.e., pedogenic) processes that were enhanced along fractures. The applicant stated that these two types of dikes are also not tectonic structures or paleoseismic features and likewise concluded that they do not represent a safety issue for the ESP site in regard to nontectonic surface deformation. The staff's evaluation of SSAR Section 2.5.3.8.2 is presented below.

The staff focused its review of SSAR Section 2.5.3.8.2 on the applicant's descriptions of the modes of formation of the dissolution collapse features and "clastic" dikes (i.e., both the injection type and the pedogenic clastic type) because the applicant used this descriptive information to conclude that these features resulted from nontectonic deformation. The applicant also referred to "small-scale deformation features" in SSAR Sections 2.5.3.1.2 and 2.5.3.1.7, considered by

McDowell and Houser (1983) and Bartholomew et al. (2002) to be possible evidence of tectonic activity. The applicant stated in SSAR Sections 2.5.3.1.2, 2.5.3.1.7, and 2.5.3.8.2.2 that these small-scale features are considered to be nontectonic in origin based on observations made by the applicant during field reconnaissance studies performed for the ESP application. However, the applicant did not fully discuss the field observations and reasoning used to conclude that these small-scale deformation features are nontectonic in origin, and did not provide adequate information about the origin of the injection sand dikes or the pedogenic clastic dikes.

In RAI 2.5.3-1, the staff asked the applicant to more clearly describe its logic for concluding that the deformation features mapped and described by McDowell and Houser (1983) and Bartholomew et al. (2002) are nontectonic in origin. In RAI 2.5.3-2, the staff asked the applicant for additional information on field data used by the applicant to conclude that both the injection sand dikes and the pedogenic clastic dikes are nontectonic in origin. This clarification is important because paleoliquefaction features related to the 1886 Charleston earthquake or other previous seismic events are known to occur in the region, and the staff must ensure that none of the features described by the applicant in SSAR Sections 2.5.3.1.2, 2.5.3.1.7, and 2.5.3.8.2.2 are related to Quaternary tectonic deformation.

In response to RAI 2.5.3-1, the applicant stated that, based on reconnaissance of exposures in the site area, certain primary characteristics of the pedogenic type of clastic dikes suggested an origin consistent with weathering and soil forming processes for these features. Specifically, (1) the dikes are widely distributed in deeply weathered clayey and silty sands of the Hawthorne Formation and the Barnwell Group formations; (2) the dikes occur in nearly all exposures of the weathered profile, but are generally absent in exposures of stratigraphically lower, less weathered sedimentary units; (3) the dikes contain a central zone of bleached host rock bounded by a cemented zone of iron oxide and may contain a clay core; (4) grain-size analyses indicate that the dikes contain the same grain-size distribution as the host sediment, but with more silt and clay; and (5) the dikes decrease downward in width and density, usually tapering and pinching out over a distance of 5 to 15 feet. The applicant indicated that the “clastic” dikes identified by Bartholomew et al. (2002) are syndepositional, as indicated by the presence of marine animal burrows crossing the dikes, and that they developed in a subaqueous marine environment during the Late Eocene (i.e., more than 33.7 mya). Based on these lines of evidence, the applicant concluded that the clastic dikes observed in the site area are pedogenic, and not tectonic, in origin. The applicant also concluded that the clastic dikes described by Bartholomew et al. (2002), whether their origin is tectonic or nontectonic, developed more than 33.7 mya.

Based on its review of the applicant’s response to RAI 2.5.3-1, the staff concurs with the applicant’s conclusion that the clastic dikes described by Bartholomew et al. (2002) are older than 33.7 mya. The staff further concludes, in agreement with the applicant, that the clastic dikes observed in the site area are the result of pedogenic processes and are nontectonic in origin.

In response to RAI 2.5.3-2, the applicant indicated that the deformation features (i.e., warped bedding, fractures, small-scale faults, injection sand dikes, and clastic dikes), interpreted by the applicant to be nontectonic in origin, occurred in a garbage trench on the VEGP site mapped by the Bechtel staff in 1984. The trench (now filled but illustrated in SSAR Figures 2.5.3-1 and 2.5.3-2, as well as in Figure 2.5.3-2A accompanying the applicant’s RAI response) contained a monocline in the Blue Bluff Marl that is interpreted by the applicant as related to Eocene displacement along the Pen Branch fault. The monocline is positioned above the subsurface line of intersection of the Pen Branch fault with the contact of basement rock and Coastal Plain sediments.

In response to RAI 2.5.3-2, the applicant also stated that the local spatial relationships of warped bedding, fractures, and small-scale faults with the margins of dissolution depressions clearly demonstrate a nontectonic, dissolution collapse origin for these features. The applicant cited the trench map produced by Bechtel (1984), illustrated in Figure 2.5.3-2A, which accompanied its response to RAI 2.5.3-2, as conclusive evidence for this statement. The applicant reiterated the five primary characteristics of clastic dikes presented in its response to RAI 2.5.3-1, which suggested an origin consistent with a pedogenic origin for these features. In response to RAI 2.5.3-2, the applicant further indicated that the injection sand dikes likely were formed by fluid or plastic injection of an underlying source sand and that the close spatial association of the injection dikes with the sides of dissolution collapse depressions suggests that this type of dike is also related to a nontectonic, dissolution collapse origin. The applicant also stated that the injection sand dikes likely formed prior to an erosional event that occurred at the end of the Miocene (i.e., more than 5.3 mya), but did not discuss the basis for this statement in detail in the RAI response. The applicant stated that clastic dikes developed during a weathering event that is older than Late Pleistocene (i.e., more than 10,000 years ago). Based on its review of the applicant's response to RAI 2.5.3-1, the staff concurs with the applicant that the clastic dikes described by Bartholomew et al. (2002) are older than 33.7 mya. The staff further concludes, in agreement with the applicant, that the clastic dikes observed in the site area are the result of pedogenic processes and are nontectonic in origin. Based on its review of the applicant's response to RAI 2.5.3-2, the staff concludes that the response qualifies timing of the development of warped bedding, fractures, small-scale faults, clastic dikes, and injection sand dikes. The timing of that development as suggested by information presented by the applicant is as follows:

1. Deposition of Tertiary (i.e., a range of 65 to 1.8 mya in age) sedimentary units, including at least Eocene (54.8 to 33.7 mya) and Miocene (23.8 to 5.3 mya) sediments, with some periods of subaerial (i.e., above water in open air) erosion.

2. Initiation of dissolution of the Utley Limestone (Late Eocene in age) at the base of the Eocene Barnwell Group, with development of incipient depressions and formation of injected sand dikes in Barnwell Unit "D" above the Utley Limestone as illustrated in Figure 2.5.3-2A of the applicant's response to RAI 2.5.3-2. The initiation of dissolution and development of the injected sand dikes occurred after deposition of the sedimentary units in which they are found, and the applicant reported Late Pleistocene (more than 10,000 years in age) to Holocene (less than 10,000 years in age) sands that do not appear to be deformed overlying the warped bedding, fractures, small-scale faults, clastic dikes, and injection sand dikes in the trench mapped by Bechtel (1984).

3. Continued and increasing dissolution of the Utley Limestone, with numerous nontectonic dissolution collapse features developed in overlying units, including collapse-generated faults that cut, and consequently postdate, the injected sand dikes. Consequently, the injected sand dikes are the oldest of the deformation features mapped that the applicant equated with a response to nontectonic near-surface deformation.

4. Development of nontectonic clastic dikes above the sedimentary units that experienced dissolution collapse, many in the Miocene-age Hawthorne Formation based on Figure 2.5.3-2A of the applicant's response to RAI 2.5.3-2. The clastic dikes do not extend into

Late Pleistocene to Holocene-age sands, indicating that the clastic dikes are at least 10,000 years old.

The staff concludes that the evidence presented by the applicant in the response to RAI 2.5.3-2 clearly documents a nontectonic origin for the warped bedding, fractures, small-scale faults, and clastic dikes.

In regard to the origin of the injection sand dikes, the applicant made the case that these features are the oldest structures generated by nontectonic deformation in the site area. That is, the applicant considered that the injection sand dikes are not related to paleoliquifaction resulting from Quaternary tectonic deformation and seismic shaking in the site area. From information presented by the applicant in the SSAR and its response to RAI 2.5.3-2, the staff concludes that the injection sand dikes are the oldest of the observed features, and the age constraints discussed by the applicant appear to limit the youngest timing for development of these features to earlier than Late Pleistocene (i.e., more than 10,000 years in age) and possibly Pliocene (5.3 to 1.8 mya). This upper age limit for the injection sand dikes is supported by information provided by the applicant in the response to RAI 2.5.3-2, suggesting that the dikes pre-date an erosional event at or near the end of the Miocene (23.8 to 5.3 mya). Consequently, even if the injection sand dikes were the result of seismically-induced paleoliquefaction, the features are not Holocene (10,000 years to present) in age. However, a Pleistocene age (1.8 mya to 10,000 years) is not precluded for the injection sand dikes based on information provided by the applicant in the response to RAI 2.5.3-2.

The staff concurs with the applicant that no evidence exists to indicate that any of these features represent a safety issue for the ESP site in regard to nontectonic surface or near-surface deformation. However, in developing the SER with open items, the staff considered that the applicant's response to RAI 2.5.3-2 in regard to the injection sand dikes did not provide adequate information to bracket the pre-Miocene upper age limit for development of this feature as suggested by the applicant. Furthermore, the staff considered that the applicant did not clearly show that the injection sand dikes are spatially related to what must have been incipient dissolution depressions (i.e., much of the dissolution must have occurred after development of the injection sand dikes since, as the applicant pointed out, nontectonic small-scale faults associated with dissolution collapse cross-cut the injection dikes). Since the mechanism described by the applicant as responsible for the sand injection (i.e., fluid or plastic injection of the liquefied source sand) could be associated with seismic shaking and liquefaction of the sand materials, the staff formulated Open Item 2.5-10 to request that the applicant provide a more detailed description of geometry and physical characteristics of the injection sand dikes and their spatial association with dissolution depressions. The applicant's response and the staff's evaluation in regard to this open item are presented below.

In response to Open Item 2.5-10, the applicant cited all available field evidence used to interpret the injection sand dikes as nontectonic in origin (i.e., unrelated to seismic shaking and resultant liquefaction of materials) and pre-Quaternary in age. The applicant presented the following field evidence and logic to support its conclusions in regard to the injection sand dikes:

1. All injection sand dikes were found at a single location at the site and occurred within stratigraphic horizon "Unit D" of the Upper Eocene (more than 33.7 mya) Barnwell Group in the Coastal Plain sedimentary sequence.

2. The dikes registered upward movement of liquefied sands from a sand source in stratigraphic Unit C of the Barnwell Group, which directly underlies Unit D. The dikes,

which penetrated and were confined to Unit D, clearly flattened along the base of Barnwell stratigraphic Unit E, which directly overlies Unit D. Since Units C, D, and E are Upper Eocene Barnwell Group stratigraphic horizons that sequentially overlie each other from C to E, all units involved are older than 33.7 mya.

3. The injection sand dikes appear to be spatially related to areas of localized dissolution at depth in the Utley Limestone, as shown by location of the sand dikes in relation to surface morphology of Unit F (Upper Eocene Barnwell Group) in Figure 2.5-10B which accompanied the applicant's response to Open Item 2.5-10. The surface of Unit F clearly reflects a dissolution-related morphology of generally circular to elongated depressions due to the collapse of overlying sediments as dissolution of the underlying Utley Limestone occurred.

4. Based on the three field observations stated above, the applicant proposed a sand injection mechanism related to the response of sands in Unit C to increased overburden pressure associated with an early phase of collapse of sedimentary units overlying dissolution depressions in the Utley Limestone.

5. The Hawthorne Formation (Miocene, 23.8 to 5.3 mya) is the youngest unit showing effects of dissolution at depth (i.e., the "dissolution-related morphology" described above in Item 3). An erosion surface/relict paleosol (i.e., an earlier soil horizon that has persisted without major alteration of its morphology) overlying the Hawthorne does not show these effects. The applicant interpreted the erosion surface/paleosol to be Late Miocene to Pliocene in age (i.e., Late Tertiary, more than 1.8 mya, and therefore pre-Quaternary).

6. The erosion surface/paleosol is in turn overlain by Pleistocene-Holocene (less than 1.8 mya) eolian sands, which the applicant also reported showed no morphological effects of dissolution at depth.

7. Based on stratigraphic ages of units reflecting the dissolution-related morphology, the applicant interpreted the dissolution to be no younger than Late Miocene-Pliocene (i.e., more than 1.8 mya). By association, the injected sand dikes are also interpreted by the applicant to be no younger than Late Miocene-Pliocene.

The staff considers that the applicant used all available field evidence as cited above to conclude that the injected sand dikes formed in response to movement of liquefied sands resulting from collapse of overlying sediments related to dissolution at depth, rather than in response to liquefaction of saturated sands resulting from seismic shaking, and are most likely no younger than Late Miocene-Pliocene (i.e., more than 1.8 mya, so pre-Quaternary). Although the staff was not able to examine the injected sand dikes in the field because the trench in which they occurred is now filled, the applicant did show that the dikes are spatially related to areas of localized dissolution at depth in the Utley Limestone. Furthermore, the dikes are wholly confined to Upper Eocene sediments that are older than 33.7 mya, and it is not likely that such features would have been produced in units this old by historical seismicity and associated liquefaction. The applicant used stratigraphic constraints to suggest relative timing of dike formation (i.e., the applicant presented relative ages, rather than absolute age dates derived from radiometric dating methods). Use of stratigraphic data to determine relative age of a geologic feature is a standard method that is often applied when radiometric age dates are not available, and staff agrees that use of this method is appropriate in this case. In light of the information presented in the applicant's detailed response to Open Item 2.5-10, the staff agrees with the conclusions drawn by the applicant that the injection sand dikes are nontectonic in nature and pre-Quaternary in age. Therefore, Open Item 2.5-10 is resolved.

Based on a review of information presented by the applicant in SSAR Section 2.5.3.8.2 and the responses to RAI 2.5.3-1, RAI 2.5.3-2, and Open Item 2.5-10, the staff concurs with the applicant's conclusion that warped bedding, fractures, small-scale faults, clastic dikes, and injection sand dikes represent nontectonic deformation. The staff concludes that the applicant presented thorough descriptions of these features to enable assessment of nontectonic surface or near-surface deformation within the site area and at the ESP site in support of the ESP application as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). Based on review of SSAR Section 2.5.3 and the applicant's responses to RAIs and Open Item 2.5-10 as set forth above, the staff concludes that the applicant properly characterized the potential for surface and near-surface tectonic and nontectonic deformation at the ESP site, including the possibility of Quaternary tectonic deformation along the Pen Branch fault. The staff also concludes that SSAR Section 2.5.3 provides accurate and thorough descriptions of the potential for surface and near-surface tectonic and nontectonic deformation at the ESP site, with emphasis on the Quaternary Period, as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d).

2.5.3.4 Conclusions

As set forth in SER Sections 2.5.3.1, 2.5.3.2, and 2.5.3.3, the staff carefully reviewed the information on surface faulting submitted by the applicant in SSAR Section 2.5.3. On the basis of its detailed review, as fully described in the above SER sections, the staff concludes that the applicant provided a thorough and accurate characterization of surface and near-surface faulting and nontectonic deformation at the site as required by 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d). The staff concurs that data and analyses presented by the applicant in the SSAR provide an adequate basis to conclude that there is no evidence to indicate that surface or near-surface faulting or nontectonic deformation presents a hazard for the site area.

Based on information from the applicant's thorough review of the literature on site area geology in regard to surface expression of faulting, and the applicant's literature review and geologic, seismic, and geophysical investigations of the site vicinity and site area, the staff further concludes that the applicant has properly characterized the potential for surface or near-surface faulting and nontectonic deformation at the ESP site.available, and staff agrees that use of this method is appropriate in this case. In light of the information presented in the applicant's detailed response to Open Item 2.5-10, the staff agrees with the conclusions drawn by the applicant that the injection sand dikes are nontectonic in nature and pre-Quaternary in age. Therefore, Open Item 2.5-10 is resolved.

2.5.4 Stability of Subsurface Materials and Foundations

Section 2.5.4 of this SER evaluates the stability of subsurface materials and foundations at the site of Vogtle Electric Generating Plant (VEGP) Units 3 and 4. Section 2.5.4.1 of this SER provides a summary of the relevant geologic and seismic information contained in Section 2.5.4 of the Site Safety Analysis Report (SSAR) of the VEGP Units 3 and 4 Early Site Permit (ESP) application and LWA request. SER Section 2.5.4.3 provides the staff's evaluation of SSAR Section 2.5.4, including with respect to the applicant's responses to any requests for additional information, the resolution of open items, and the results of confirmatory analyses performed by the staff. SER Section 2.5.4.4 summarizes the applicant's conclusions as well as the staff's conclusions, and confirms that the applicable regulations have been met by the applicant.

2.5.4.1 Summary of Application

With respect to the stability of subsurface materials and foundations, the SSAR addresses information items contained in the AP1000 Standard Plant Design, Design Control Document (DCD), Revision 15. The applicant developed geological, geophysical, geotechnical, and seismological information to be used as the basis for the evaluation of the stability of the subsurface materials and foundations at the proposed site. The applicant initially reviewed analyses and reports prepared for the existing VEGP Units 1 and 2 as well as the readily available geotechnical literature. The applicant then conducted field investigations and performed field and laboratory testing during the initial phase of the ESP site subsurface investigation. These subsequent investigations were conducted with the intent of obtaining additional site information to further the understanding of the VEGP site and to complement the existing geotechnical data from the previous investigations completed for VEGP Units 1 and 2.

The applicant augmented the ESP field and laboratory test data with field and laboratory data from an investigation it performed in support of a Limited Work Authorization (LWA) request, which the applicant submitted on August 16, 2007. In addition to performing this investigation to support the LWA request, the applicant conducted comprehensive site geotechnical field and laboratory investigations to enhance the existing ESP geotechnical data as well as to support the COL application that the applicant submitted to the NRC on March 31, 2008. This additional data allowed the applicant to further develop and understand the geotechnical data at the specific locations proposed for the VEGP Units 3 and 4 site structures and at the locations of the proposed borrow sources for the structural backfill materials. Because the staff determined that this additional information was necessary only to the staff's finding associated with the LWA request, the staff has summarized and evaluated these additional data and analyses separately from the ESP information in this section and Section 2.5.4.3, respectively. Finally, the applicant conducted a test pad program in support of the LWA request to establish site-specific design properties for the structural backfill and to verify that the proposed backfill materials would meet the AP1000 standard design siting criteria.

2.5.4.1.1 Geologic Features

SSAR Section 2.5.4.1 refers to SSAR Sections 2.5.1.1 and 2.5.1.2 for detailed descriptions of the regional and site geology, including structural geology, physiography, geomorphology, geologic history, stratigraphy, structures, and hazards.

2.5.4.1.2 Properties of Subsurface Materials

SSAR Section 2.5.4.2 describes the static and dynamic engineering properties of the subsurface materials at the ESP site. In this section, the applicant described the subsurface materials, field investigations, laboratory tests, and the engineering properties it determined for the subsurface materials. The applicant also described the ESP and COL investigations and results for each stratum.

In support of the ESP application, the applicant submitted the following information:

Description of Subsurface Materials

SSAR Section 2.5.4.2.2 provides an overview of the subsurface profile and materials, including detailed descriptions of the underlying strata. The applicant categorized the soils underlying the ESP site into three groups based on their stability for geotechnical purposes. Group 1 soils include sands with silt and clay, Group 2 is the Blue Bluff clay marl layer, and Group 3 is made up of coarse-to-fine sand with interbedded thin seams of silt or clay. The applicant stated that the Group 1 soils would be completely removed and replaced with compacted backfill prior to construction of VEGP Units 3 and 4. In addition to grouping the soils, the applicant divided the VEGP site soils and bedrock into five strata:

1. Upper Sand Stratum (Group 1: Barnwell Group)
2. Marl Bearing Stratum (Group 2: Blue Bluff Marl or Lisbon Formation)
3. Lower Sand Stratum (Group 3)
4. Dunbarton Triassic Basin Bedrock
5. Paleozoic Crystalline Bedrock

The applicant developed the static design and engineering properties of the five strata from field and laboratory tests that it performed during the ESP and COL subsurface investigations, the results of which are summarized in Table 2.5.4-1 of this SSAR. A brief description of each stratum is provided below, including the soil and rock constituents and their ranges of thickness at the site. The applicant determined this information from 14 borings and 10 cone penetrometer tests (CPT) that it performed during the ESP subsurface investigation, and from 70 borings and 8 CPTs performed during the COL investigation. SSAR Figure 2.5.4-1a (Figure 2.5.4-1 of this SER) shows the locations of most of the ESP and COL borings. The applicant also provided cross-sectional profiles of subsurface conditions across the site and the nuclear island (SSAR Figures 2.5.4-3 through 2.5.4-5b; Figure 2.5.4-2 of this SER).

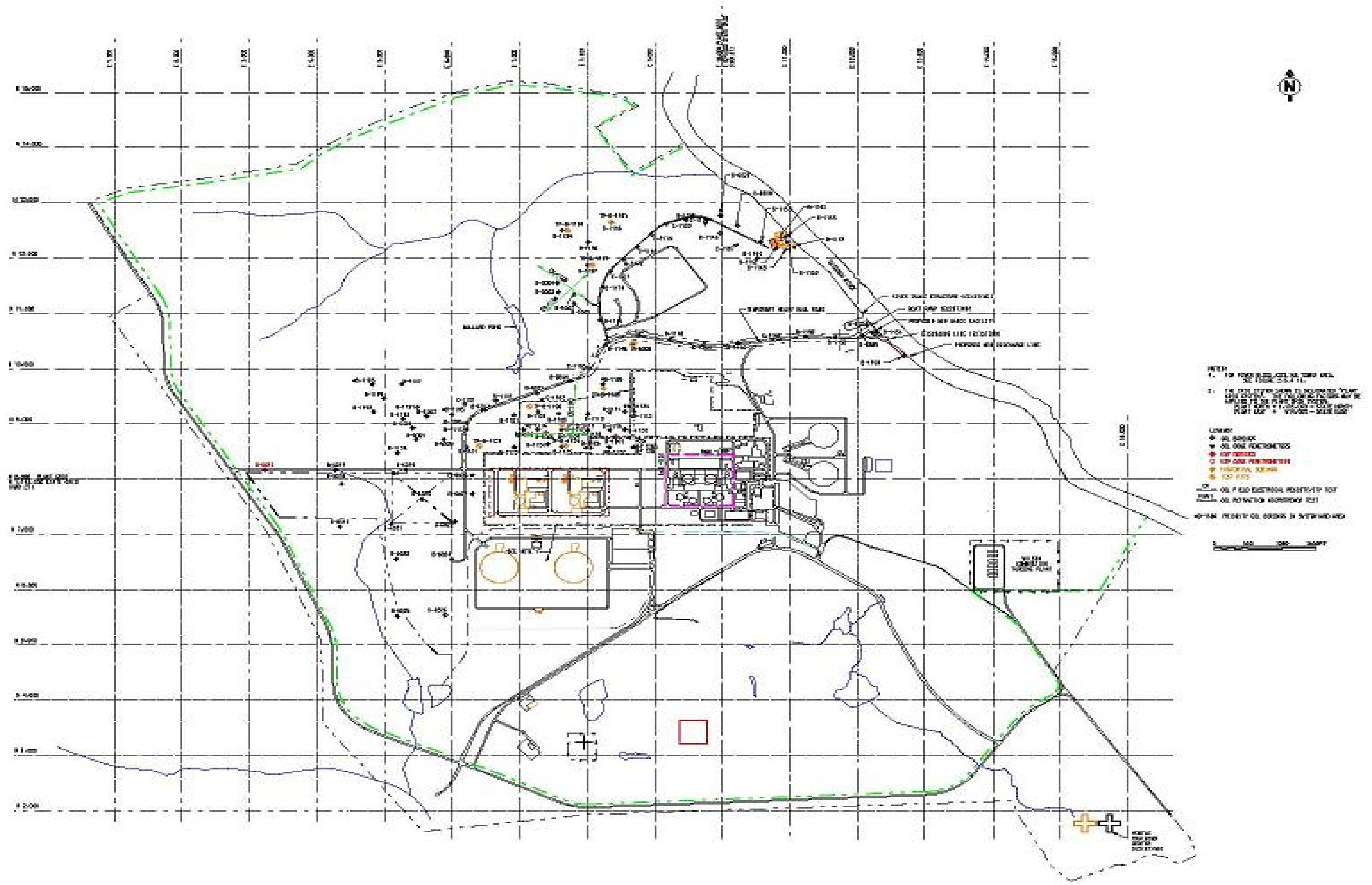


Figure 2.5.4-1 COL Site Boring Plan, Including Locations of ESP and Units 1 and 2 Borings (SSAR Figure 2.5.4-1a)

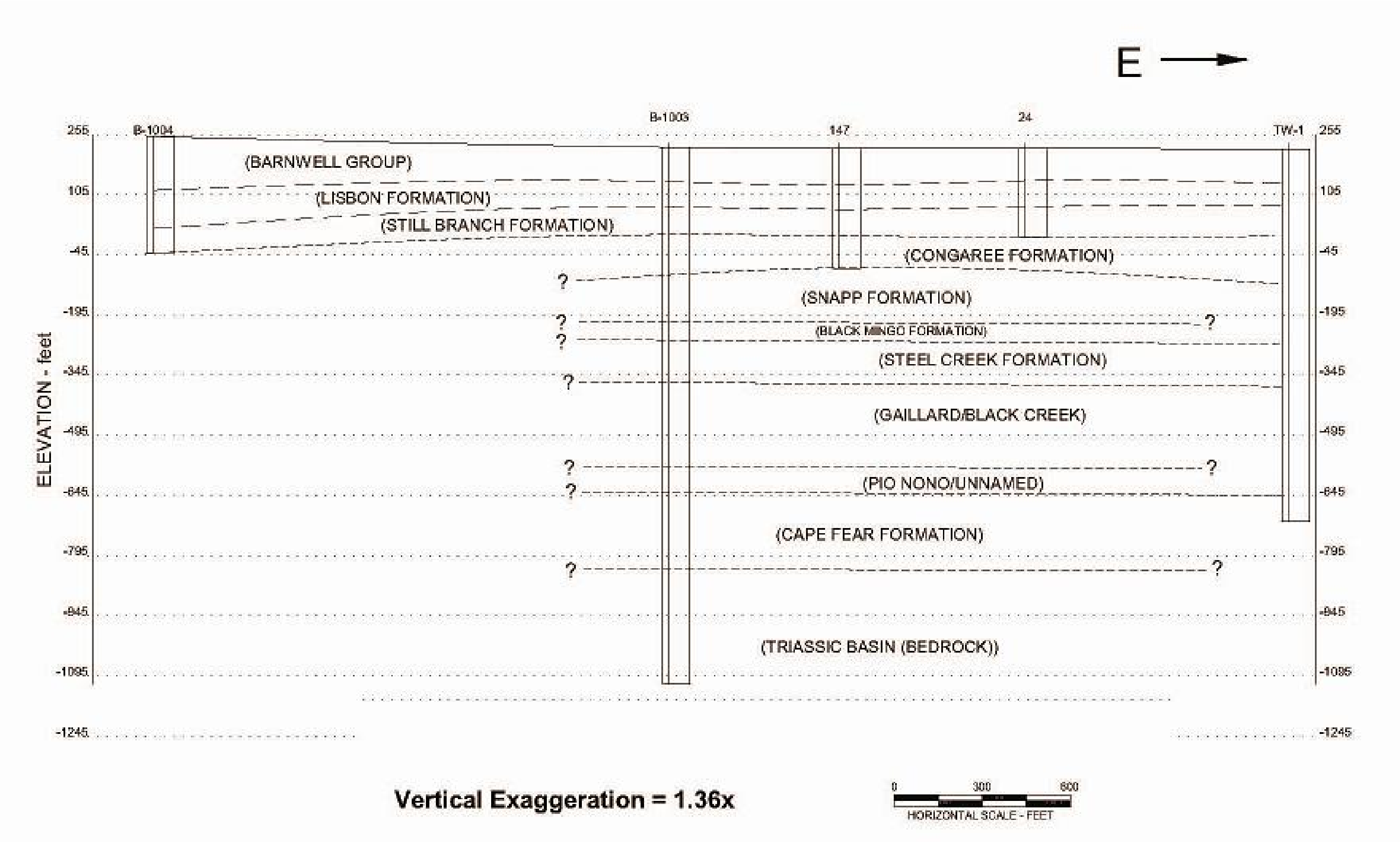


Figure 2.5.4-2 Subsurface Profile B-B' from SSAR Figure 2.5.4-1 (SSAR Figure 2.5.4-4)

1. Upper Sand Stratum (Barnwell Group). SSAR Subsection 2.5.4.2.2.1 describes the Upper Sand Stratum, or Barnwell Group, as consisting of predominantly sands, silty sands, and clayey sands with occasional clay seams, soft zones, and shell zones. The applicant encountered a shelly limestone layer, the Utley limestone, which contains significant solution channels, cracks, and other discontinuities, and observed severe fluid loss in the stratum while drilling. The applicant also determined that the stratum ranged in thickness from 24 to 48 meters (m) (78 to 157 feet (ft)), and attributed the large range to the westerly to northwesterly dip of the underlying Blue Bluff Marl. Based on its review of previous investigations for Units 1 and 2, the applicant determined that the Upper Sand Stratum is susceptible to liquefaction during seismic ground motion equivalent to the safe shutdown earthquake (SSE). The applicant found that the relative density of the stratum is highly variable, ranging from very loose to dense with clay lenses within the stratum ranging from soft to medium stiff. Therefore, the applicant concluded that the entirety of the Upper Sand Stratum, including the limestone layer, would need to be completely removed before it begins construction for VEGP Units 3 and 4.

   The applicant performed field Standard Penetration Tests (SPT) within the Upper Sand Stratum and obtained very high blow count values indicative of the previously observed shelly limestone and shell hash (mixture or pieces of shell) zones. Samples were recovered by the applicant at varying depths within the stratum and submitted for laboratory testing, including percent fines, moisture content, and Atterberg Limits (a measure of the relationship between percentage of fines and water content that affects the ability of a soil to remain plastic). The applicant indicated that the test results for percent fines ranged from 3 to 60 percent and 5 to 96 percent for the ESP and COL investigations, respectively, suggesting the stratum was made up of very fine grained sands, silts, and clay particles. From the results of the Atterberg Limits tests, the applicant determined a liquid limit of 43 to 97 for ESP investigations and an average of 72 for COL investigations. The applicant also determined a range of plasticity index from 21 to 67 for ESP investigations and an average index of 39 for COL investigations, indicating that the stratum's materials were inorganic and organic silts and clays of high plasticity. The natural moisture content of samples the applicant tested for Atterberg Limits ranged from 20 to 93 percent for the ESP investigations and again indicated the highly variable and fine grained nature of the sand, silt, and clay materials. The applicant calculated moist unit weights from 1,505 to 1,986 kilograms per cubic meter (kg/m^3; 94 to 124 pounds per cubic feet (pcf)) for fifteen samples, and specific gravities of 2.7 and 2.8 for two samples.

2. Blue Bluff Marl (Lisbon Formation). SSAR Subsection 2.5.4.2.2.2 describes the Blue Bluff Marl, which underlies the Upper Sand Stratum, in much greater detail because it is the load-bearing stratum at the proposed site of VEGP Units 3 and 4. The applicant stated that the Blue Bluff Marl consists of hard, slightly sandy, cemented, overconsolidated, calcareous clay with some shells and partially cemented, well-hardened layers varying between 19 to 29 m (63 to 95 ft) in thickness, with an average thickness of 23 m (76 ft) and a design ground water level at a depth of 16.7 m (55 ft). The top of the Blue Bluff Marl was mapped by the applicant between Elevation 37 and 42 m (122 and 140 ft) dipping downward towards the west side of the VEGP site. The applicant relied on 70 soil borings as part of its COL subsurface investigations to confirm its earlier ESP investigations of the Blue Bluff Marl. This reliance is especially important in the immediate area of the nuclear island, where 42 of the applicant's 70 borings penetrated into the Blue Bluff Marl layer. The applicant also considered the previous investigations completed for Units 1 and 2 to further determine the subsurface properties of the Blue Bluff Marl.

The applicant conducted a series of standard penetration tests (SPTs) within the marl layer at the VEGP site. The results of SPTs are reported as the total blows summed over the distance to give blows per meter (or per foot), a measure commonly referred to as the N-value. The average N-values from the SPTs conducted as part of the ESP and COL investigations were high, 272 and 233 blows per meter (bpm) (83 and 71 blows per foot (bpf)), respectively, which the applicant attributed to the hard to very hard consistency of the fossiliferous limestone, and cemented layers and nodules of the marl. As expected, the applicant noted that the SPT N-values increased with depth. Finally, although the applicant noted the presence of soft zones (N-values below 16 bpm (5 bpf)) in the marl at the adjacent Savannah River Site (SRS), none of the SPTs conducted on the marl underlying the VEGP site yielded N-values less than 30.48 bpm (10 bpf): therefore, the applicant concluded that soft zones were not present in the marl beneath the site of VEGP Units 3 and 4.

The applicant recovered samples from within the Blue Bluff Marl during the ESP and COL subsurface investigations and submitted these samples for laboratory testing of percent fines, moisture content, and Atterberg Limits. SSAR Tables 2.5.4-1 thru 2.5.4-4 provide a summary of these laboratory tests. The applicant also provided the average values from both the ESP and COL laboratory tests, which included: 48 and 74 percent fines; plastic limits of 29 and 34 percent; liquid limits of 51 and 67 percent; and a Plasticity Index of 22 and 33 percent, respectively. The natural moisture content of the samples the applicant tested ranged from 14 to 67 percent and 14 to 62 percent for the ESP and COL investigations, respectively, with an average of 35 percent for the ESP investigations and 33 percent for the COL investigations. The applicant also calculated moist unit weights from 1,521 to 2,130 kg/m^3 (95 to 133 pcf) for 69 COL samples, and specific gravities of 2.61 and 2.66 for eight COL samples.

As part of its ESP investigations, the applicant also performed 15 one-point unconsolidated undrained triaxial shear tests on marl stratum samples. From these tests the applicant found that the undrained shear strength of the marl ranged from 7 to 205 kilopascals (kPa) (150 to 4,300 pounds per square foot (psf)), far lower than the undrained shear strength measured by Southern for Units 1 and 2, which was between 12.5 and 23,900 kPa (260 to 500,000 psf). The applicant stated that the disagreement between the two results stems from “severe sample disturbance due to sampling technique (pitcher sampler) and preparation of testing specimen.” During the COL investigation, the applicant performed several additional laboratory strength tests on relatively undisturbed marl stratum samples. Specifically, these tests included 27 unconfined compression, 11 UU triaxial, and 27 consolidated undrained (CU) triaxial tests. The applicant reported that the average undrained shear strength from the UU and CU tests was 564 kPa (11,800 psf), which supported the design value of 478 kPa (10,000 psf) obtained for Units 1 and 2.

The applicant monitored the average heave during excavation for Units 1 and 2 and observed an average heave of 3.75 cm (1.25 in.), which corresponded to an undrained Young’s modulus value of 478,000 kPa (10,000,000 psf). Using the average value of shear strength results that failed at 2,394 kPa (50,000 psf), which was 766 kPa (16,000 psf), the applicant used the ratio of undrained shear strength to effective overburden pressure to calculate the preconsolidation pressure of 3,830 kPa (80,000 psf) and the overconsolidation ratio of 8. Due to this high preconsolidation pressure and the small foundation settlements measured by Southern during its VEGP Units 1 and 2 settlement monitoring program (less than 9.14 cm (3.6 in.), the applicant concluded that settlements due to new structures would be small. The applicant also measured the in-situ shear wave velocity which was used to calculate the dynamic shear modulus.

3. Lower Sand Stratum. SSAR Subsection 2.5.4.2.2.3 describes the Lower Sand Stratum, the top of which was mapped at a depth of about 50 m (165 ft) below the ground surface beneath the Blue Bluff Marl and underlain by the Dunbarton Triassic Basin rock. The applicant described the units of the stratum collectively as fine to coarse sands with interbedded silty clay and clayey silt, which, from top to bottom were identified as the Still Branch, Congaree, Snapp, Black Mingo, Steel Creek, Gaillard/Black Creek, Pio Nono/Unnamed, and Cape Fear formations. From the ESP subsurface investigations, the applicant determined that the Lower Sand Stratum was 275 m (900 ft) thick at the location of the one borehole (B-1003) that fully penetrated the stratum. Figure 2.5.4-4 of the SSAR illustrates the typical depths of the stratum as observed in B-1003.

   The applicant performed field SPTs during the ESP investigations and obtained an average N-value of 194 bpm (59 bpf). During the COL investigations, the applicant obtained SPT N-values for the Lower Sand in 42 penetrations as deep as 80 m (263 ft) into the unit, which averaged 230 bpm (70 bpf). The applicant observed that for the COL N-values, nearly all were above 98 bpm (30 bpf), indicative of very dense material. Furthermore, as was expected, both the ESP and COL investigation SPT N-values increased with depth. The applicant noted that the only evidence suggesting the presence of soft zones or loose material, a low N-value and lack of sample recovery, was an anomalous condition attributable to disturbed soil conditions at the bottom of the borehole caused by an imbalance between borehole and in-situ hydrostatic pressures.

   During the course of both the ESP and COL investigations, the applicant selected and submitted samples recovered from within the stratum for laboratory testing. The test results for percent fines and Atterberg Limits can be found in SSAR Table 2.5.4-1. The applicant reported that percent fines averaged 23.6 and 23 percent for the ESP and COL investigations, respectively. Atterberg Limit tests were performed as part of the ESP investigation and resulted in an average liquid limit percent of 47 percent, a plastic limit of 30 percent, a moisture content of 30 percent, and an average Plasticity Index of 17 percent. The applicant determined that samples with the higher percent fines and plasticity were from the silty clay and clayey silt layers. As part of the COL investigation, the applicant determined the moist unit weight of sixteen samples ranged from 1,810 to 2,178 kg/m^3 (113 to 136 pcf), with an average specific gravity of 2.67 for four samples.

4. Dunbarton Triassic Basin Rock. SSAR Subsection 2.5.4.2.2.4 describes the Dunbarton Triassic Basin rock as red sandstone, breccia, and mudstone, weathered through the upper 37 m (120 ft). The applicant drilled only one borehole deep enough to encounter the Dunbarton during the ESP investigation, B-1003. The applicant measured shear wave velocity in the upper 84 m (274 ft) of the rock profile and used the results to develop the shear wave velocity profile for site amplification. Finally, the applicant concluded that the rock was too deep to be of any interest to foundation design, and therefore performed no laboratory tests.

5. Paleozoic Crystalline Rock. SSAR Subsection 2.5.4.2.2.5 states that at a depth of 320 m (1,049 ft) below the surface, the applicant encountered the top portion of the weathered Dunbarton Triassic Basin rock. Beneath the adjacent SRS, the southeast dipping non-capable Pen Branch fault separates the Dunbarton Triassic Basin rock from Paleozoic crystalline rock to the northwest, a relationship the applicant suggested may occur at some depth below the VEGP site as well. According to the applicant, the results of a seismic

reflection survey at the VEGP site supported the continuation of the Pen Branch fault beneath the VEGP site, and therefore the presence of Paleozoic crystalline rock as well.

6. Subsurface Profiles. SSAR Figures 2.5.4-3, -4, and -5 present the typical subsurface profiles across the power block areas as determined from the ESP borings. The applicant presented the subsurface profiles across the power block area based on the COL borings in SSAR Figures 2.5.4-3a, -4a, and -5a.

Field Investigations

The applicant presented its field and subsurface investigation programs in SSAR Section 2.5.4.2.3. While the locations of borings completed for Units 1 and 2 were shown on site investigation maps and were referenced by the applicant, the applicant did not include boring logs from these previous investigations. The applicant utilized borings, geophysical surveys, CPTs, seismic CPTs, and test pits as part of the ESP and COL field investigations.

Laboratory Testing

SSAR Section 2.5.4.2.4 describes the laboratory testing of soil samples completed as part of the ESP and COL investigations. The applicant stated that laboratory testing was completed in accordance with the guidance presented in Regulatory Guide 1.138, was performed under an approved quality assurance program with work procedures developed specifically for the ESP and COL applications, and the soil samples were shipped from the onsite storage area to the testing laboratory under Chain-of-Custody procedures. The applicant focused the ESP laboratory test on verifying basic properties of the Upper Sand Stratum, the Blue Bluff Marl and the upper formations of the Lower Sand Stratum. The types and number of tests performed for the ESP investigations are listed in SSAR Table 2.5.4-3, while SSAR Table 2.5.4-4 presents the results. For the COL investigations, the applicant presented the types and number of tests in SSAR Table 2.5.4-3a and the results in Appendix 2.5C. The applicant also performed Resonant Column Torsional Shear (RCTS) testing on samples from the COL investigation and as a part of Phase 1 of the backfill test pad program at the Fugro facility in Houston, TX. The applicant presented the RCTS results for the COL investigation in Appendix 2.5C, Attachment G, while it presented the results for the test Pad program in Appendix 2.5D.

Engineering Properties

SSAR Section 2.5.4.2.5 describes the engineering properties for the soil and rock strata obtained during the ESP and COL subsurface investigations, and the chemical properties deduced as part of the COL investigation. The applicant used data from the COL borings in the immediate vicinity of the VEGP Units 3 and 4 nuclear island power block excavation areas as the basis for the determination of engineering properties. The engineering properties determined during the ESP investigations were derived from both the ESP subsurface and laboratory investigations and the data available from Units 1 and 2. The applicant determined the engineering properties of backfill from the COL and Test Pad program investigations. The applicant compared the properties from the ESP, COL and Test Pad Program to those developed during the previous field and laboratory testing programs conducted for Units 1 and 2 and concluded that the results were similar.

1. Rock Properties. SSAR Subsection 2.5.4.2.5.1 describes the engineering properties of rock at the VEGP Units 3 and 4 site. The applicant based Recovery and Rock Quality Designations (RQD) on results obtained from borehole B-1003, the deepest borehole drilled

during the ESP subsurface investigation, which extended 88 m (290 ft) into the bedrock. Although the applicant did not perform any laboratory strength testing of rock cores due to the extreme depth, suspension P-S velocity seismic testing in the borehole was performed to determine shear and compressional wave velocities.

2. Soil Properties. In SSAR Subsection 2.5.4.2.5.2, the applicant described the properties of the soil as determined from ESP and COL investigations, reviews of previous investigations for VEGP Units 1 and 2, and the Phase I test pad program results. To that end, the applicant performed sieve analyses, natural moisture content, and Atterberg Limits tests on Upper Sand Stratum, Blue Bluff Marl, and Lower Sand Stratum samples as part of the ESP and COL investigations, and made specific gravity measurements on Upper Sand Stratum, Blue Bluff Marl, and Lower Sand Stratum samples as part of the COL program. The applicant selected design values using the average of the test results for the respective soil strata.

Laboratory test data, SPT N-values, and shear wave velocity measurements from the ESP and COL investigations were used by the applicant to determine the undrained shear strength of the Blue Bluff Marl stratum. This data included UU and CU test results, in addition to laboratory strength testing data from the previous subsurface investigations and construction of VEGP Units 1 and 2. During the ESP investigation, the applicant correlated the average SPT N-value to an internal angle of friction of 34 and 41 degrees for the Upper and Lower Sand Stratum, respectively. Moist unit weights were determined by the applicant for select Blue Bluff Marl and Lower Sand Stratum samples from the ESP laboratory testing program, and Upper Sand Stratum, Blue Bluff Marl, and Lower Sand Stratum samples from the COL laboratory testing program. The applicant stated that the average unit weight for 15 ESP marl stratum and 3 Lower Sand Stratum samples was 1,922 and 1,970 kg/m^3 (120 and 123 pcf), respectively. During the COL laboratory testing program, the applicant measured the unit weight of 15 Upper Sand Stratum, 69 Blue Bluff Marl, and 16 Lower Sand Stratum samples, with average unit weights of 1,810, 1,842, and 1,970 kg/m^3 (113, 115, and 123 pcf). The applicant also included the in-situ moist unit weights from previous investigations for the Upper Sand Stratum (1,890 kg/m^3 (118 pcf)), the Blue Bluff Marl (1,906 kg/m^3 (119 pcf)), and the Lower Sand Stratum (1,874 kg/m^3 (117 pcf)).

The applicant compared the design SPT N-values for the ESP investigations with the range and average of the COL and Units 1 and 2 investigations. Based on the ESP results, the applicant concluded that the design SPT N-value for the Upper Sand Stratum (82 bpm (25 bpf)) was within the anticipated range and close to the average. Similarly, the applicant concluded that the design SPT N-value for the Blue Bluff Marl, taken as 328 bpm (100 bpf), also fell within the expected range and near the average N-value. However, when the design SPT N-value for the Lower Sand Stratum (203 bpm (62 bpf)) was compared to the results from the previous investigations, the applicant stated that the design value was less than the assumed range and average.

The applicant measured shear wave velocities by suspension P-S velocity tests and seismic CPTs during the ESP and COL subsurface investigations. Although suspension P-S velocity tests were performed in five ESP boreholes, the applicant acknowledged that only three of the tests extended into the Blue Bluff Marl and Lower Sand Strata, and it therefore the applicant performed tests in six additional COL boreholes. The applicant performed three seismic CPTs for the ESP investigation and eight for the COL; however, due to penetration resistance, the seismic CPTs did not extend into the Blue Bluff Marl. The applicant also determined the shear wave velocities for all strata based on all available data, including measurements from depths of

up to 88 m (290 ft) made during the previous VEGP units 1 and 2 investigations and data from seven deep borings performed at the SRS. The velocity ranges determined by the applicant were: 173 to 1,008 meters per second (m/s) (570 to 3310 feet per second (fps)) within the Upper Sand Stratum, 323 to 1298 m/s (1060 to 4260 fps) within the Blue Bluff Marl, 283 to 1423 m/s (930 to 4670 fps) within the Lower Sand Stratum, and 707 to 2849 m/s (2320 to 9350 fps) within the Dunbarton Triassic Basin. The applicant also calculated average shear wave velocities for the formations in the strata: 286 m/s (940 fps) in the Barnwell Formation and 348 m/s (1142 fps) in the Utley Limestone of the Upper Sand Stratum, 624 m/s (2050 fps) in the Blue Bluff Marl, and 533, 567, and 570 m/s (1750, 1863, and 1871 fps) in the Still Branch, Congaree, and Snapp Formations of the Lower Sand Stratum, respectively.
SSAR Table 2.5.4-6 lists the shear wave velocities for all formations. Using both suspension P-S velocities and seismic CPT results, the applicant developed a complete shear wave velocity profile from the surface to a depth of 408 m (1340 ft).

The applicant derived high strain elastic modulus values for the Upper and Lower Sands, compiled in SSAR Table 2.5.4-1, using the relationship with the SPT N-value given in Davie and Lewis (1988). The applicant derived the high strain elastic modulus for the Blue Bluff Marl stratum using the relationship with undrained shear strength given in Davie and Lewis (1988). The applicant calculated shear modulus values using the relationship between elastic modulus, shear modulus, and Poisson's ratio. The applicant derived the low strain shear modulus values for the strata using the average shear wave velocity. The elastic modulus values were obtained by the applicant from the shear modulus values using the relationship described by Bowles (1982) between elastic modulus, shear modulus, and Poisson's ratio.

3. Chemical Properties. The applicant did not include chemical tests as part of the ESP laboratory testing program, because there were no aggressive chemical subsurface conditions identified during the license renewal aging management analysis of the buried concrete at VEGP Units 1 and 2.

In support of the LWA request, the applicant submitted the following information:

Field Investigations

The applicant's field investigations included the construction of a 6 m (20 ft) thick test pad to test the proposed borrow materials, which aided in the evaluation of the compacted backfill.

Engineering Properties

The applicant also determined the engineering properties of the proposed borrow materials and derived the engineering properties of the structural backfill from the data obtained from the COL investigation and Phase 1 of the test pad program.

Chemical Properties. SSAR Subsection 2.5.4.2.5.3 describes the chemical property testing of the proposed backfill material conducted as part of the COL investigation. The applicant performed laboratory testing for pH, chloride, and sulfate on samples from the Upper Sand Stratum in the power block area, test pits excavated in the switchyard borrow area, and soil samples from Borrow Area 4. Based on the average pH test results of 6.8, 5.2, and 5.4 for samples from the Upper Sand, switchyard, and Borrow Area 4, respectively, and corresponding average chloride test results of 188, 76, and 138 parts per million (ppm), the applicant concluded the soil was mildly corrosive. Citing average sulfate test results of 21, 9.8, and 16.3 ppm, the applicant indicated that the soil/concrete interaction would provide a mild exposure for sulfate attack.

2.5.4.1.3 Exploration

SSAR Section 2.5.4.3 summarizes the results of the subsurface investigation programs conducted by the applicant at the VEGP site, including the previous VEGP Units 1 and 2 program, and the Units 3 and 4 ESP and COL subsurface investigation programs.

Previous Subsurface Investigation Program

SSAR Subsection 2.5.4.3.1 summarizes field investigations completed in the early 1970s for VEGP Units 1 and 2. The applicant stated that although borings, geophysical surveys and groundwater studies were included in these field investigations, additional investigations were needed during the excavation of the power block areas to further understand and verify the subsurface conditions. The applicant stated that of the 474 borings completed for Units 1 and 2, twenty fell within, or are in the immediate vicinity of, the proposed VEGP Units 3 and 4 power block site, and the locations of these borings were provided on SSAR Figure 2.5.4-1b. Some of the investigations the applicant considered during the review of the previous programs included: electric logging, natural gamma, density, neutron, caliper, and 3-D velocity logs (Birdwell) in selected boreholes, water pressure and Menard pressuremeter testing of the Blue Bluff Marl, and fossil, mineral or soluble carbonate testing on recovered samples. The applicant supplemented test borings with geophysical methods, completing a total of 8,650 m (28,400 ft) of shallow refraction lines, 1,525 m (5,000 ft) of deep refraction lines, and subsurface cross-hole velocities from the ground surface to a depth of 88 m (290 ft). The applicant referenced the results of these investigations to support the data obtained during the later ESP and COL subsurface investigations.

ESP Subsurface Investigation Program

SSAR Subsection 2.5.4.3.2 describes the ESP subsurface investigation program performed in late 2005 over a substantial portion of the site which would contain the VEGP Units 3 and 4 reactors, switchyard, and cooling towers. The applicant utilized exploration points, as shown on Figure 2.5.4-1 of this SER, to confirm the results of the previous investigation. In addition, the applicant stated that it developed an exploration program, in accordance with Regulatory Guide 1.132, including an audited and approved quality assurance program, and site-specific work procedures. Once the program was established, the applicant performed a variety of field investigations, including 13 exploratory borings, ten CPTs, three seismic CPTs, in-situ hydraulic conductivity tests, five geophysical down-hole suspension P-S velocity logging, a topographic survey of exploration points, and laboratory testing of borehole samples. The applicant also completed a seismic reflection and refraction survey at the VEGP site to collect additional data, which helped delineate the rock profile associated with the non-capable Pen Branch fault.

a) Borings and Samples/Cores. SSAR Subsection 2.5.4.3.2.1 describes the thirteen borings drilled for the ESP investigation with depths from 27 m (90 ft) to 93 m (304 ft). The applicant advanced the borings using mud-rotary drilling techniques, polymer and/or bentonite drilling fluids, and an SPT sampler with automatic hammers to collect samples at continuous intervals to 5 m (15 ft) and at 1.5 to 3 m (5 to 10 ft) intervals thereafter. SSAR Table 2.5.4-7 provides a summary of the ESP boring and CPT locations and depths, and identifies the geophysical testing performed in the boreholes. In addition, the applicant obtained undisturbed samples of the Blue Bluff Marl using rotary pitcher samplers. In accordance with ASTM D 2488, the applicant processed the recovered soil samples by first visually describing the samples and placing them in a labeled moisture-proof glass jar before transporting the samples, in boxes, to an onsite storage facility. Finally, the applicant provided a summary of all undisturbed samples collected from the Blue Bluff Marl during the ESP investigation and described the materials encountered during the ESP borings as similar to those found in the borings from the previous investigation at the VEGP site.

The applicant performed one continuous core boring, B-1003, that was cased through the soil column to prevent cave-ins and allowed for coring of the rock at depths below 320 m (1,049 ft). The applicant placed the recovered soil and rock core samples in wooden boxes lined with plastic sheeting, and the onsite geologist visually described the core. The applicant's geologist computed and recorded the percentage recovery (average core recovery was 77 percent) and the rock quality designation (RQD), before the filled core boxes were transported to the onsite sample storage facility where the core was photographed.

b) Cone Penetrometer Tests. SSAR Subsection 2.5.4.3.2.2 describes the CPTs conducted in accordance with ASTM D 5778 during the ESP site investigations. Using a Type 2 piezocone, the applicant advanced each CPT to refusal at depths ranging from 2 to 35 m (6 to 116 ft); offset CPTs were performed for borings with shallow refusal depths. The applicant noted that, with few exceptions, all of the CPT locations met refusal at or near the top of the Blue Bluff Marl. The applicant performed down-hole seismic testing at 1.5 m (5 ft) intervals in three CPTs to measure shear wave velocity in the Upper Sand Stratum and pore pressure dissipation tests at depths between 17 and 30 m (56 and 99 ft) in four CPTs. SSAR Appendix 2.5A contains the CPT logs, shear wave velocity results, and the pore pressure versus time plots developed from the dissipation tests.

c) In-situ Hydraulic Conductivity Testing. The applicant installed fifteen observation wells in the ESP project limits and developed each by pumping until the pH and conductivity stabilized and the pumped water was reasonably free of suspended sediment. SSAR Subsection 2.5.4.3.2.3 describes the slug tests performed in each well in accordance with ASTM D 4044. The applicant described the slug test method as the lowering of a solid cylinder into a well to increase the water level, recording the time it took the well water to return to the pre-static level, then rapidly removing the cylinder and again recording the time it took the water to recover to the pre-static level. To record the water levels and time intervals during testing, the applicant used electronic transducers and data loggers. SSAR Section 2.4.12 and Appendix 2.4A contain additional details.

d) Sample Re-evaluation. SSAR Subsection 2.5.4.3.2.4 describes the revisions the applicant made to the ESP data report based on additional laboratory data and upon re-evaluation of samples. Upon re-examination of the coarse grained fractions, previously described in the Blue Bluff Marl and Utley Limestone as gravel, the applicant found the samples consisted of angular, gravel-sized, carbonate particles that were attributed to mechanical breakage of cemented nodules, shells, cemented limestone, and fossiliferous limestone by the split barrel sampler. The applicant also redefined the top of the Utley Limestone in some of the ESP boreholes based on the identification criteria developed for the COL subsurface investigation program.

COL Subsurface Investigation Program

SSAR Subsection 2.5.4.3.3 details the COL subsurface investigation conducted over a large portion of the site, including the VEGP Units 3 and 4 power block areas, cooling towers, switchyard/borrow areas, haul road, intake structure, pump house, pipeline, and other construction-related areas, locating the exploration points in accordance with guidelines in RG 1.132. As part of its investigation, the applicant completed 174 exploratory borings across the site, 21 CPTs, eight seismic CPTs, geophysical down-hole suspension logging in six boreholes, electrical resistivity testing along ten arrays across the site, geophysical refraction microtremor (ReMi) testing across four arrays, horizontal and vertical surveys of all exploration points, and laboratory testing, including RCTS tests for selected borehole samples. The applicant stated that it performed the field investigations under an audited and approved quality assurance (QA) program using approved work procedures developed specifically for the COL site investigation. Prior to the start of the field investigations, the applicant established an onsite storage facility for soil samples which included an inventory control system. SSAR Table 2.5.4-7a provides a summary of the locations of COL borings, CPTs and test pits.

1. Borings and Samples/Cores. SSAR Subsection 2.5.4.3.3.1 describes the 174 borings drilled to depths of 6.5 to 128 m (21.5 to 420 ft). Using mud-rotary methods, polymer and/or bentonite drilling fluids, and an SPT sampler with automatic hammers, the applicant sampled the soil at 0.75 m (2.5 ft) intervals within the upper 4.5 m (15 ft) and at 1.5 to 3 m (5 or 10 ft) intervals thereafter. The applicant stated that the soils encountered in the COL borings were similar to those encountered during the ESP and Units 1 and 2 investigations at the VEGP site. The applicant used the same sample processing and storage procedures that were used for the ESP investigation. The applicant also obtained relatively undisturbed samples from the Upper Sand Stratum using the direct push method, and, due to the very hard/dense nature of the materials, used a Pitcher sampler (a double-tube core barrel sampler) for sampling the Blue Bluff Marl and Lower Sand Stratum.

2. Cone Penetrometer Tests. The applicant advanced 21 CPTs to refusal for the COL investigation. SSAR Subsection 2.5.4.3.3.2 states that refusal was generally encountered at or near the top of the Blue Bluff Marl stratum and ranged in depth from 20 to 30.5 m (65.4 to 100.4 ft). The applicant performed seismic testing in eight of the CPTs located in the power block and cooling tower areas of Units 3 and 4.

3. Test Pits. The applicant excavated eight test pits in the proposed borrow areas. SSAR Subsection 2.5.4.3.3.3 describes how a geologist visually examined the excavation walls, prepared a Geotechnical Test Pit log based on the visual examination in accordance with ASTM D 2488, and collected representative bulk samples of the material types in moisture retaining glass jars. The applicant also used a backhoe to backfill the test excavation with the excavated materials.

4. Resistivity. Using the Wenner four electrode test method, the applicant performed field resistivity testing along ten arrays in the proposed switchyard, cooling tower and circulating water line areas of the site. SSAR Figures 2.5.4-1a and -1b illustrate the locations of arrays and SSAR Subsection 2.5.4.3.3.4 states that the locations and array lengths were adjusted to accommodate obstructions. The applicant used electrode spacings from 1 to 91 m (3 to 300 ft) to determine the soil resistivity at increasing depths.

2.5.4.1.4 Geophysical Surveys

SSAR Section 2.5.4.4 includes four subsections summarizing the applicant's previous geophysical investigations for VEGP Units 1 and 2, the geophysical program used for the ESP investigation, the geophysical surveys performed as part of the COL investigation, and geophysical surveys from the Phase I test pad program conducted in support of the LWA request.

In support of the ESP application, the applicant submitted the following information:

<u>**Previous Geophysical Survey Programs**</u>

SSAR Subsection 2.5.4.4.1 describes the geophysical seismic refraction and cross-hole surveys used to evaluate the subsurface materials during the investigations for VEGP Units 1 and 2. The applicant used the seismic refraction survey to determine the depths to seismic discontinuities based on compressional wave velocity measurements, and obtained shallow and deep refraction profiles throughout the site for a combined total depth of 8,650 and 1,525 m (28,400 and 5,000 ft), respectively. The applicant conducted a cross-hole survey in the power block area to determine the in-situ velocity data for both compressional and shear waves to a depth of 88 m (290 ft), or approximately 25 m (82 ft) below sea level, in six boreholes. The applicant also determined cross-hole velocities by lowering three-component geophones into four of the boreholes to equal levels and generating energy at the same level in a fifth hole.

The applicant also examined compressional and shear wave velocity data from the previous investigations, and used the velocities to determine the Young's Modulus and Shear Modulus for the 88 m (290 ft) closest to the surface. The applicant stated that the seismic (compressional) wave velocities ranged from 426 to 2,026 m/s (1,400 to 6,650 fps) with a shear wave velocity of 182 to 502 m/s (600 to 1,650 fps) for the Upper Sand Stratum (depth from 0 to 27 m (90 ft), while the Blue Bluff Marl stratum, and the underlying Lower Sand Stratum, had a compressional wave velocity of 2,072 m/s (6,800 fps), with shear wave velocities from 487 to 548 m/s (1,600 to 1,800 fps) from 27 to 88 m (90 to 290 ft). The applicant calculated a range of Young's and Shear Moduli for the Upper Sand and the Blue Bluff Marl, including the Lower Sand Stratum.

<u>**ESP Geophysical Surveys**</u>

SSAR Subsection 2.5.4.4.2 describes the geophysical surveys performed by the applicant as part of the ESP investigations, including suspension P-S velocity tests and down-hole seismic CPTs, as well as a discussion and interpretation of results.

1. <u>Suspension P-S Velocity Tests in Boreholes</u>. The applicant conducted suspension P-S velocity tests in five ESP borings, two of which did not extend below the Upper Sand Stratum. The applicant referred to Ohya (1986) for the details of equipment used to create the seismic compressional and shear waves and to measure the seismic wave velocities. SSAR Subsection 2.5.4.4.2.1 describes the suspension P-S velocity logging system used by the applicant, which incorporated a 7 m (23 ft) probe containing a source near the bottom, and two geophone receivers spaced 1 m (3.3 ft) apart. The applicant lowered the probe into the borehole, where the source generated a pressure wave at depth that was converted to seismic waves (P-wave and S-wave) at the borehole wall. These waves were converted back to pressure waves in the fluid and received by the geophones, which sent the data to a

recorder at the surface. The applicant repeated the procedure every 0.5 to 1.0 m (1.65 to 3.3 ft) and used the results to determine the average velocity of a 1 m (3.3 ft) high column of soil around the borehole.

The applicant defined the shear wave and compressional wave velocities for each stratum to the maximum depth of 407 m (1,338 ft). The average shear wave velocities determined by the applicant were 331 m/s (1,089 fps) for the Upper Sand stratum, 717 m/s (2,354 fps) for the Blue Bluff Marl, and 695 m/s (2,282 fps) for the Lower Sand Stratum, while average compressional wave velocities were 784 m/s (2,572 fps), 2,070 m/s (6,793 fps), and 2,014 m/s (6,610 fps), respectively. The applicant also presented typical values for shear wave velocities for each geologic formation contained within the Lower Sand Stratum; 518 m/s (1,700 fps) in the Still Branch, 594 m/s (1,950 fps) in the Congaree, 624 m/s (2,050 fps) in the Snapp, 716 m/s (2,350 fps) in the Black Mingo, 807 m/s (2,650 fps) in the Steel Creek, 868 m/s (2,850 fps) in the Gaillard/Black Creek, 874 m/s (2,870 fps) in the Pio Nono, and 826 m/s (2,710 fps) in the Cape Fear. The shear wave and compressional wave velocity range was also measured for a portion of the Dunbarton Triassic Basin rock, which the applicant determined was between 707 to 2,849 m/s (2,320 to 9,350 fps) and 2,225 to 5,596 m/s (7,300 to 18,360 fps), respectively. The applicant concluded that shear wave velocities increased linearly with depth at a very high rate, a rate that lessened once shear wave velocities achieved values of about 1,615 m/s (5,300 fps). The applicant noted that sound rock with an average shear wave velocity of 2804 m/s (9,200 fps) was not encountered at the site, but was extrapolated from the measured results. The applicant used both shear and compressional wave velocities to calculate Poisson's ratios for the Upper Sand, Blue Bluff Marl, Lower Sand and Dunbarton Triassic Basin rock strata.

2. <u>Down-Hole Seismic Tests with Cone Penetrometer</u>. SSAR Subsection 2.5.4.4.2.2 describes the three CPTs performed at 1.5 m (5 ft) intervals as part of the ESP investigation. The applicant obtained measurements at depths within the Upper Sand Stratum since all CPTs reached refusal at the top of the Blue Bluff Marl. To complete this test, the applicant located a seismic source on the surface that generated shear waves, and it mounted two geophones horizontally near the bottom of the cone string to record incoming seismic data. The applicant measured shear wave velocities that were lower than those determined by the suspension P-S velocity technique: these lower velocities may reflect site variability.

3. <u>Discussion and Interpretation of Results</u>. The applicant recommended design values for each stratum based on shear and compressional wave velocity measurements. SSAR Subsection 2.5.4.4.2.3 states that seismic CPTs and suspension velocity logging were used to develop the values for the Upper Sand Stratum, but, due to the CPT refusal at the top of the Blue Bluff Marl, only suspension velocity logging results were used to determine the values for the Blue Bluff Marl and Lower Sand Stratum. The applicant did not make any shear or compressional wave velocity measurements for compacted fill during the ESP subsurface investigation, but it recommended values for the compacted fill based on data from VEGP Units 1 and 2, values which would be confirmed during the COL investigations and Phase 1 of the test pad program.

<u>COL Geophysical Surveys</u>

SSAR Subsection 2.5.4.4.3 describes the suspension P-S velocity tests, down-hole seismic CPT tests, and ReMi tests performed during the COL site investigation.

1. Suspension P-S Velocity Tests in Boreholes. The applicant conducted six suspension P-S velocity tests using the equipment described by Ohya (1986) to measure the seismic wave velocities. The method used by the applicant was the same as was used during the ESP investigations summarized in the previous section of this SER. The applicant defined the shear wave velocity to a maximum depth of 128 m (420 ft). Shear wave velocities were determined by the applicant for the Blue Bluff Marl (386 to 909 m/s (1,267 to 2,984 fps)) and the Lower Sand Stratum (227 to 781 m/s (745 to 2,563 fps). The applicant also provided the average velocities for the geologic formations contained within the Lower Sand Stratum; 494 m/s (1,621 fps) for the Still Branch, 567 m/s (1,863 fps) for the Congaree, and 570 m/s (1,871 fps) for the Snapp. As with the ESP investigation, the applicant also determined a range of Poisson's ratios and Figure 2.5.4-3 of this SER illustrates the shear wave velocity profile through borehole B-1003.

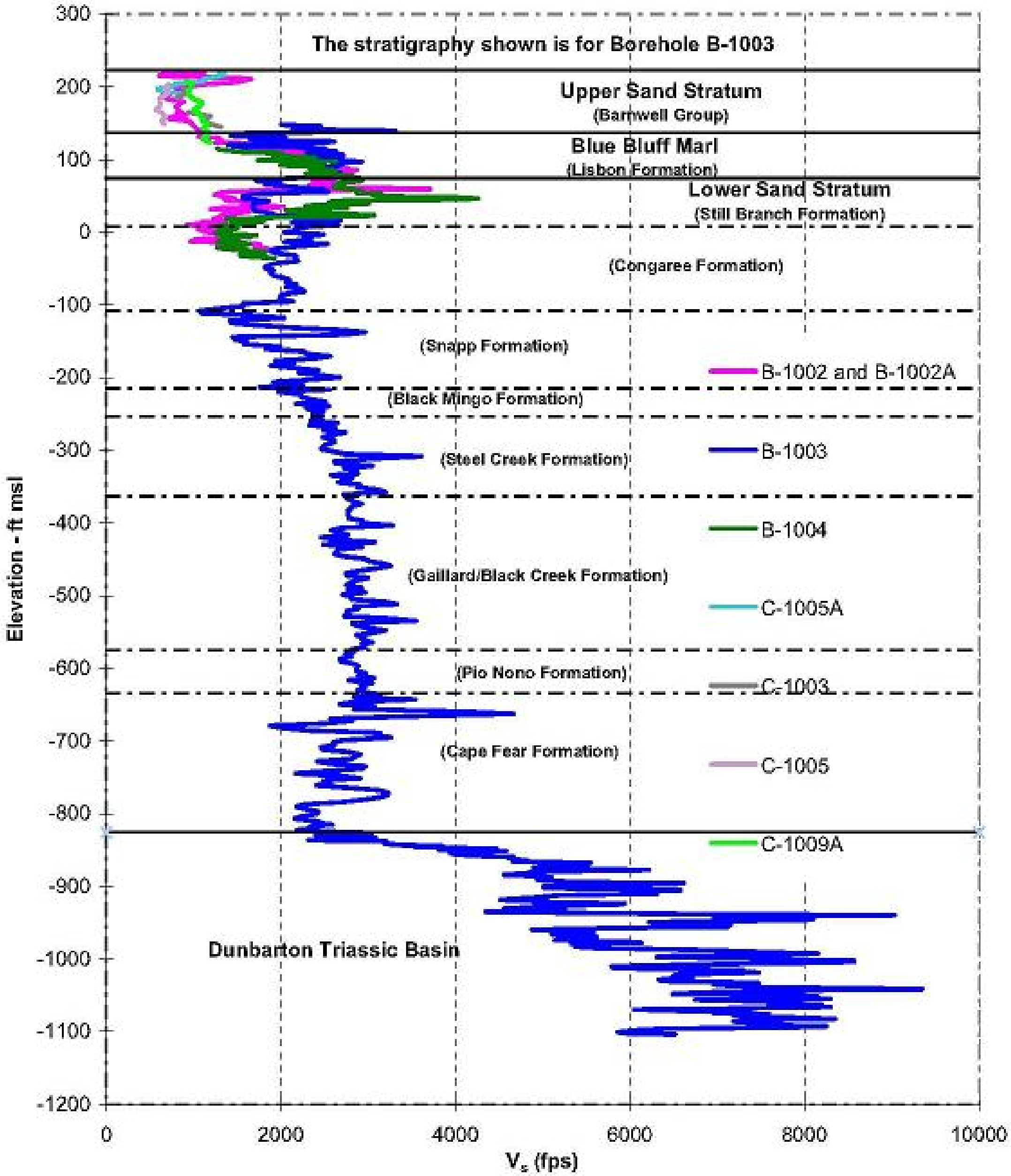


Figure 2.5.4-3 Shear Wave Velocity Measurements (SSAR Figure 2.5.4-6)

2. Down-Hole Seismic Tests with Cone Penetrometer. SSAR Subsection 2.5.4.4.3.2 describes the eight CPTs performed at 0.2 m (0.6 ft) intervals as part of the COL investigation. The method used by the applicant was the same as was used during the ESP investigations which the applicant presented in SSAR Subsection 2.5.4.4.2. Although penetrations depths ranged from 20 to 30.5 m (65.4 to 100.4 ft), CPT soundings could not penetrate the dense/hard materials encountered in the Utley Limestone and Blue Bluff Marl, and therefore the applicant was only able to obtain measurements in the Upper Sand Stratum. The applicant reported shear wave velocity measurements of 132 to 1,158 m/s (435 to 3,802 fps), and it plotted the summary of the average COL shear wave velocity profiles in the Upper Sand Stratum in SSAR Figure 2.5.4-6a.

3. Refraction Microtremor Testing. The applicant conducted ReMi testing across two arrays in the power block areas of the existing VEGP Units 1 and 2 and two arrays in the footprint of the proposed Units 3 and 4. SSAR Subsection 2.5.4.4.3.3 states that although ReMi testing was originally intended to establish the shear wave velocity characteristics of the existing backfill at Units 1 and 2, the applicant noticed frequency interference from the equipment of the operating plant on the ReMi. Although the applicant attempted to overcome the interference and consulted with Dr. K. Stokoe, the applicant concluded that the results did not truly represent the shear wave velocity profile, and therefore these results were not considered in the COL geophysical survey conclusions.

In support of the LWA request, the applicant submitted the following information:

Geophysical Surveys in Compacted Fill

The applicant conducted a test pad program that included the construction of a 6 m (20 ft) deep compacted test fill pad using the proposed backfill materials. SSAR Subsection 2.5.4.4.4 describes the geophysical surveys conducted at three different levels within the test pad to evaluate the shear wave profile in the compacted backfill. The applicant stated that it determined the shear wave velocity using the Spectral Analysis of Surface Waves (SASW) method at various stages of construction and upon completion of the test pad; the cross-hole method was used to measure shear wave velocity through the compacted test fill. Upon completion of the test pad, the applicant installed and measured compressional and shear wave velocities between three cased boreholes extending through the test pad into native materials. The applicant incorporated the results, along with RCTS test results, into the analysis to develop the shear wave profile through the entire depth (about 27 m (90 ft)) of proposed backfill.

2.5.4.1.5 Excavation and Backfill

SSAR Section 2.5.4.5 summarizes the excavation and backfill for VEGP Units 3 and 4, including the extent of safety-related excavations, fills, and slopes; excavation methods and stability; an overview of backfill design; a discussion of backfill sources; quality control and ITAAC; control of groundwater during excavation; and retaining wall construction.

In support of the LWA application, the applicant submitted the following information:

Extent of Excavations, Fills, and Slopes

SSAR Subsection 2.5.4.5.1 describes the substantial excavations necessary for construction of VEGP Units 3 and 4. The applicant presented subsurface profiles providing the grade elevation range across the site, one of which is presented as Figure 2.5.4-2 in this SER. Since the existing ground elevation was at Elevation (El.) 67 m (220 ft) above mean sea level (msl), while the base of the nuclear island foundations for the proposed new units would be at about El. 55 m (180 ft) msl, the applicant determined that the entirety of the Upper Sand Stratum would be excavated for the Units 3 and 4 power blocks. Based on the borings completed during the ESP and COL subsurface investigations, the applicant concluded that the total depth of excavation to the top of the Blue Bluff Marl will range from 24 to 27 m (80 to 90 ft) below the existing grade, with deeper localized excavations using conventional excavating equipment to remove potentially weathered zones in the upper portion of the Blue Bluff Marl.

The applicant stated that once the excavation was complete, Seismic Category 1 backfill would be placed from the top of the Blue Bluff Marl to the bottom of the nuclear island foundation. Although Seismic Category 2 backfill would be used above the nuclear island foundation level, the applicant stated that all of the backfill placed above the foundation would be engineered to the same criteria as Seismic Category 1 backfill. The applicant also described plans to construct a retaining wall along the perimeter of the nuclear island to facilitate construction and backfilling operations with Seismic Category 2 backfill behind it to final grade or foundation elevation of non-nuclear island structures. The applicant described this backfill as granular material selected from portions of the excavated Upper Sand Stratum and other acceptable onsite borrow sources.

Excavation Methods and Stability

SSAR Subsection 2.5.4.5.2 describes the applicant's plans to excavate and stabilize the large volume of Upper Sand Stratum that needs to be removed. The applicant described plans to use conventional equipment to remove any weathered material encountered at the top of the Blue Bluff Marl, and would slope any necessary excavations to facilitate placement of compacted structural fill. The applicant described the overall excavation as an open-cut excavation, with slopes no steeper than 2-horizontal to 1-vertical (2h:1v), and adhering to OSHA regulations (OSHA 2000). The applicant stated that all slopes would be sealed and protected from the highly erosive sandy soils. The applicant determined that where vertical cuts were required due to space constraints, sheet pile or soldier and lagging walls would be adequate support. The applicant determined there were no permanent slopes that need to be considered for stability in the nuclear island area. Finally, the applicant concluded that dewatering operations would be needed once the excavation progressed to depths beneath the groundwater table, approximately El. 45 to 47 m (150 to 155 ft), based on groundwater monitoring results from SSAR Section 2.4.12.

Control of Groundwater During Excavation

SSAR Subsection 2.5.4.5.6 refers to SSAR Subsection 2.5.4.6.2 for a discussion of construction dewatering. However, the applicant stated that because the Upper Sand Stratum soils were highly erosive, the tops of all excavations would be sloped back to prevent runoff, and sumps and ditches constructed for dewatering purposes would be lined, although the applicant did not describe the liner material.

Backfill Design

The applicant established the design of the Seismic Category 1 and Seismic Category 2 backfill for VEGP Units 3 and 4 through analysis and testing of the proposed borrow materials during the COL investigation, Phase I of the test pad program, and the previous site investigations for VEGP Units 1 and 2. SSAR Subsection 2.5.4.5.3 describes the selection and compaction requirements for the backfill. The applicant stated that it selected materials for Seismic Category 1 and Seismic Category 2 backfill that were sands and silty sands that met the gradation requirements specified in SSAR Table 2.5.4-14. According to the applicant, material not within the requirements was evaluated on a case-by-case basis to assess the overall impact of the material on backfill design, although the applicant considered borrow material that did not meet the limits on percentage of particle sizes smaller than the No. 200 (0.075mm) sieve to be unacceptable for use. The applicant stated that all Seismic Category 1 and 2 backfill materials would be compacted to a minimum of 95 percent of the maximum dry density as determined by the ASTM D 1557 standard test method.

The applicant utilized a two-phase test pad program to establish site-specific design properties for the structural backfill materials, verify the materials would satisfy the AP1000 standard plant design siting criteria for a shear wave velocity of at least 304.8 m/s (1,000 fps), and finalize the placement procedures and equipment. For Phase I, the applicant constructed a 6 m by 18 m by 6 m (20 ft by 60 ft by 20 ft) test pad below grade in the switchyard borrow area using methods similar to those used to construct the VEGP units 1 and 2 structural backfill. The applicant stated that it utilized field and laboratory tests, including density, SASW, SPTs, moisture density relationships, grain size distribution, percentage of fine material and plasticity, shear, and shear modulus and damping relationships, to determine the backfill properties. SER Table 2.5.4-1 presents the calculated shear wave velocity profile based on field measurements of velocity in the test pad and in laboratory samples. After interpreting this data, the applicant concluded that the siting criterion for a shear wave velocity of at least 304.8 m/s (1,000 fps) at the nuclear island foundation had been achieved using the proposed backfill materials within the thickness of the test pad.

Table 2.5.4-1 Estimated (ESP) Shear Wave Velocity and Dynamic Shear Modulus Values and Calculated (COL) Shear Wave Velocity Values for Compacted Backfill

Estimated (ESP)			Calculated (COL)	
Depth m (ft)	**Vs (fps)**	**Gmax (ksf)**	**Depth m (ft)**	**Vs (fps)**
0 to 1.8 (0 to 6)	573	1,255	0 (0)	550
1.8 to 3 (6 to 10)	732	2,049	1.5 (5)	724
3 to 4.2 (10 to 14)	811	2,510	3 (10)	832
4.2 to 5.5 (14 to 18)	871	2,898	6 (20)	975
5.5 to 7 (18 to 23)	927	3,280	9.1 (30)	1,064
7 to 8.8 (23 to 29)	983	3,694	12.2 (40)	1,130
8.8 to 11 (29 to 36)	1,040	4,130	15.2 (50)	1,183
11 to 13.1 (36 to 43)	1,092	4,553	18.2 (60)	1,228
13.1 to 15.2 (43 to 50)	1,137	4,940	21.3 (70)	1,267
15.2 to 17 (50 to 56)	1,175	5,274	24.4 (80)	1,302
17 to 19.2 (56 to 63)	1,209	5,588	25.9 (85)	1,318
19.2 to 21.6 (63 to 71)	1,232	5,796	26.3 (86.5)	1,327
21.6 to 24 (71 to 79)	1,253	6,001	26.8 (88)	1,327
24 to 26.2 (79 to 86)	1,273	6,186	-	-

The applicant stated that Phase II of the test pad program would be used to finalize the placement procedures and equipment, including the material placement procedures and equipment types, construction methods, compaction requirements and methods, and the testing protocol, that would be used during the emplacement of backfill. The applicant described plans to use onsite borrow material excavated from the switchyard and nuclear island areas and its eventual intent to incorporate the backfill placement and compaction methodologies into its earthwork specifications and implementing procedures prior to beginning approved excavation and backfill operations. The applicant completed the Phase II test pad program in July 2008 and incorporated the results into the revised SSAR. The applicant evaluated the results of the various types and combinations of equipment and methodologies used during the program and stated that it determined the optimum placement and compaction strategy for the material types proposed for structural backfill. The applicant stated that it planned to develop its soils specification and structural backfill implementing procedures prior to the start of approved construction activities. However, the applicant did provide the staff with the draft procedures used for the test pad program, which the applicant stated it would use as the basis for its actual specification and procedures. The applicant also stated that the final specifications and corresponding implementing procedures would be developed in accordance with the applicant's approved quality assurance/quality control program prior to its commencement of any actual construction activities approved under the LWA.

Backfill Sources

SSAR Subsection 2.5.4.5.4 describes the backfill material sources that the applicant identified at the Vogtle site through borings and laboratory testing programs and analyses. The applicant identified onsite borrow material sources, including the acceptable portion of Upper Sand Stratum material excavated from the power block and switchyard area north of the power block, and from an alternative location (Borrow Area 4) that was identified and investigated during construction of VEGP Units 1 and 2. The applicant stated that flowable backfill may be used in small restricted areas where adequate compaction may not be achieved; this flowable backfill would be designed to have similar strength characteristics as the proposed compacted backfill materials. The applicant stated that approximately 2,750,000 cubic meters (m^3; 3,600,000 cubic yards(yds^3)) of material were necessary to complete backfilling of the planned 3,000,000 m^3 (3,900,000 yds^3) excavation. Based on the COL investigation and laboratory testing, the applicant estimated that 30-50 percent of the material excavated from the power block area would be suitable backfill material; however, as the suitable and unsuitable materials were generally inter-layered, the applicant conservatively estimated the recovery of about 900,000-1,500,000 m^3 (1,200,000-2,000,000 yds^3) of usable material.

The applicant determined that 1,200,000 m^3 (1,600,000 yds^3) of backfill needed for the power block areas was available from an old borrow stockpile area, developed during the construction of Units 1 and 2 and located to the north of the power blocks in the area of the switchyard for Units 3 and 4. SER Figure 2.5.4-4 (SSAR Figure 2.5.4-15) show the plan and section views, respectively, of this borrow area. The applicant explored the switchyard area with fifteen SPT borings and five test pits during the COL investigation and determined that the needed volume of suitable backfill material was available at the switchyard borrow source. The applicant classified the material as silty sands and poorly graded sands, with lesser amounts of clayey sands in some samples.

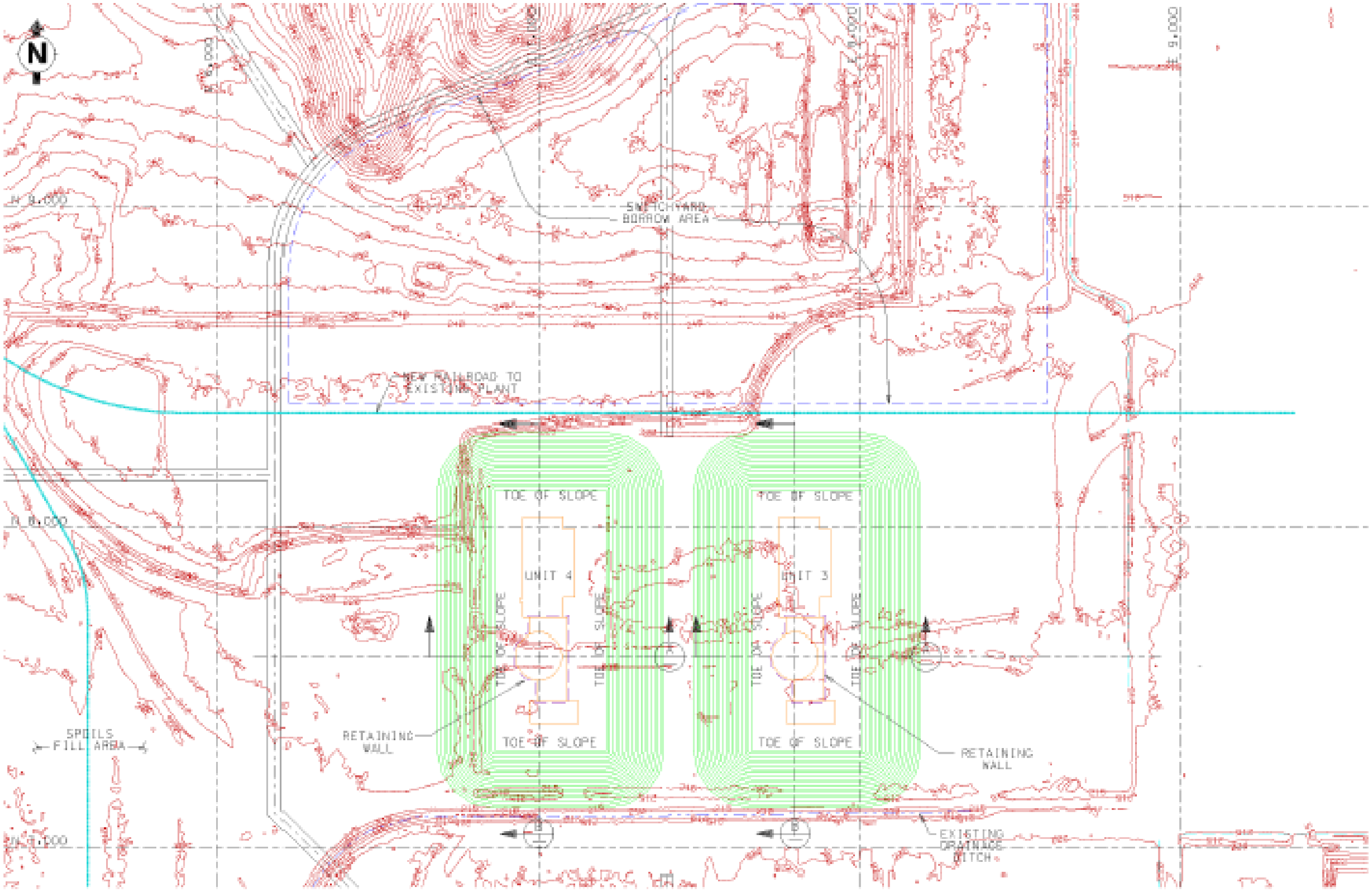


Figure 2.5.4-4 Power Block Excavation and Switchyard Borrow Areas (SSAR Figure 2.5.4-15)

In addition to the switchyard borrow source, the applicant also explored an alternative borrow source, Borrow Area 4, located about 1,220 m (4,000 ft) north of the power block area. Utilizing the results of four SPT borings and three test pits to add to the exploration data for Units 1 and 2, the applicant concluded that approximately 900,000 cubic meters (1,200,000 cubic yards) of suitable backfill material were available from the surface (approximate El. 246 ft) to a depth of 11 m (36 ft; approximate El. 210 ft) at Borrow Area 4.

Quality Control and ITAAC

SSAR Subsection 2.5.4.5.5 describes the quality control and quality assurance program that would be established by the applicant to verify that the backfill was constructed to design requirements as well as the applicable Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). The applicant detailed plans to use a soil testing contractor with an onsite laboratory and a separate earthwork contractor, each of which would be monitored independent of the other. From the soil testing contractor, the applicant expected that sufficient laboratory modified compaction and grain size distribution tests would be performed to ensure that variations of fill material were addressed.

The applicant stated that an additional quality control program would be applied to all aspects of the backfill testing program, from qualification of borrow material to confirmatory shear wave velocity testing of the as-placed backfill. Qualification of the borrow materials would include soil classification, grain size distribution, and laboratory moisture-density relationship (modified Proctor compaction) tests. These results were used by the applicant to determine the acceptability of borrow materials and the optimum moisture content for field soil compaction. The applicant stated that field density testing would be performed to verify the compaction requirements were met. For earthwork in limited areas, where fill was compacted with hand equipment, there would be one test for every 608 square meters per meter (2,000 square ft per ft) of material placed; for mass earthwork for both Seismic Category 1 and Seismic Category 2, a minimum of one test for every 382 cubic meters (500 cubic yards) of compacted fill, but no less than one test per every lift was performed, and at least two field density tests per lift were located within the footprint directly beneath the nuclear island.

The applicant also planned to review backfill test results, backfill-related non-conformance reports, and QA audits of backfill operations to determine if the as-built backfill met the requirement of 95 percent for minimum compaction for backfill under Seismic Category 1 structures. Only the field density tests performed on backfill directly beneath the nuclear island would be used in the evaluation that would be submitted by the applicant in a report to support ITAAC closure.

Shear wave velocity tests, as measured by the SASW method, would be performed by the applicant on the completed backfill to confirm that the shear wave velocity at the bottom of the nuclear island foundation was greater than or equal to 304.8 m/s (1,000 fps). The applicant also described plans to develop a report to document that the ITAAC requirement for shear wave velocity was met. Preliminary measurements of the shear wave velocity characteristics of the backfill made when placement of backfill reached the approximate elevation of the bottom of the nuclear island foundation, SASW measurements taken within the foundation footprint, representative measurements from locations outside the nuclear island footprint, and SASW measurements made at finish grade would all be used by the applicant to document that the backfill shear wave velocity profile at the elevation of the bottom of the foundation and below was greater than or equal to 304.8 m/s (1,000 fps). Finally, the applicant described plans to use a second method, such as cross-hole testing or seismic CPT, to measure shear wave velocity at one of the finish grade reference locations to validate the SASW results at the same reference. In the event that the velocity measurements do not provide adequate evidence to support closure of the ITAAC, the applicant stated that additional testing and evaluations would be completed before the final report to close the ITAAC is completed. A table of the backfill ITAAC was also provided in the SSAR (now SER Table 2.5.4-2):

Table 2.5.4-2 Backfill ITAAC

Design Requirement	Inspections and Tests	Acceptance Criteria
Backfill material under Seismic Category 1 structures is installed to meet a minimum of 95 percent modified Proctor compaction.	Required testing will be performed during placement of the backfill materials.	A report exists that documents that the backfill material under Seismic Category 1 structures meets the minimum 95 percent modified Proctor compaction.
Backfill shear wave velocity is greater than or equal to 1,000 fps at the depth of the NI foundation and below.	Field shear wave velocity measurements will be performed when backfill placement is at the elevation of the bottom of the Nuclear Island foundation and at finish grade.	A report exists and documents that the as-built backfill shear wave velocity at the NI foundation depth and below is greater than or equal to 1,000 fps.

Retaining Wall

SSAR Subsection 2.5.4.5.7 describes the applicant's plans to construct a mechanically stabilized earth (MSE) retaining wall within each power block excavation to facilitate construction of the nuclear island. The applicant stated that the MSE wall would permit backfilling of the excavations before construction of the nuclear island foundations and substructure walls as well as act as the exterior formwork for the foundation and substructure walls. The applicant also described plans to waterproof the surface of the pre-cast concrete MSE wall facing panels before placing the concrete for the nuclear island foundation and substructure walls.

2.5.4.1.6 Groundwater Conditions

SSAR Section 2.5.4.6 describes the groundwater conditions at the site, including groundwater measurements and elevations, and construction dewatering.

In support of the ESP application, the applicant submitted the following information:

Groundwater Measurements and Elevations

In SSAR Section 2.5.4.6.1, the applicant presented a summary of groundwater conditions at the site of VEGP Units 3 and 4; additional detailed discussions can be found in SSAR Section 2.4.12. The applicant stated that groundwater was present in unconfined conditions in the Upper Sand Stratum and in confined conditions in the Lower Sand Stratum at the VEGP site. The applicant concluded that the Blue Bluff Marl was an aquiclude, a unit which absorbs and holds but does not transmit water, separating the unconfined water table aquifer in the Upper Sand from the confined Tertiary aquifer in the Lower Sand, with groundwater generally occurring at depths between 19 and 21 m (65 and 70 ft) below the existing ground surface.

In mid-2005, prior to the start of the ESP subsurface investigation program, the applicant installed ten observation wells in the unconfined aquifer and five wells in the confined aquifer. The applicant also used the existing wells, thirteen in the unconfined aquifer and nine in the confined aquifer, to monitor groundwater levels at the site. The groundwater levels in the unconfined water table wells ranged from elevation (El.) 40 to 50 m (132 to 165 ft), and the levels in the confined aquifer ranged from El. 25 to 39 m (82 to 128 ft). The applicant performed hydraulic conductivity (slug) tests in the wells, using the same method that was described in SSAR 2.5.4.3.2.3. Based on the slug test results, the applicant concluded that the hydraulic conductivity (k) values for the unconfined water table aquifer in the Upper Sand Stratum ranged from 4.4×10^{-5} to 9.3×10^{-4} cm/second, while the values for the confined Tertiary aquifer in the Lower Sand Stratum ranged from 1.3×10^{-4} to 7.5×10^{-4} cm/sec.

Due to groundwater levels that would be higher than the depth of planned excavations at the site, the applicant described its plans to temporarily dewater the excavations that extended below the water table during construction of the new units, and further stated that the dewatering would be performed in a manner that minimized the effects of drawdown on the environment and the operating units. The applicant expected the drawdown effects would be limited to the VEGP site and would have only a negligible effect on the existing Units 1 and 2.

The design groundwater level for VEGP Units 3 and 4 was at El. 50 m (165 ft) msl based on the results of ten years of groundwater monitoring prior to and during the ESP subsurface investigation. The El. 50 m (165 ft) msl level also corresponded to the design groundwater level for the existing VEGP Units 1 and 2, and the applicant based the static stability of the proposed structures on this design groundwater level.

In support of the LWA request, the applicant provided the following information:

Construction Dewatering

Due to the relatively impermeable nature of the Upper Sand Stratum and underlying Blue Bluff Marl, the applicant concluded that sumps and pumps would be sufficient for construction dewatering, and dewatering would be accomplished using gravity-type systems for sump-pumping of ditches that would advance below the progressing excavation grade. SSAR Subsection 2.5.4.6.2 also describes the dewatering methods used during construction of Units 1 and 2, which included a series of ditches oriented in an east-west direction and connected by a north-south ditch that drained to a sump equipped with four high-volume pumps. The applicant stated that the dewatering plans for Units 3 and 4 would use similar methods.

2.5.4.1.7 Response of Soil and Rock to Dynamic Loading

SSAR Section 2.5.4.7 describes the applicant's estimates of the amplification and attenuation of the seismic acceleration at sound bedrock through the soil and rock column. The applicant stated that it compiled data from shear wave velocity profiles of soils and rock, variations of the shear modulus and damping values of soils with strain, and site-specific seismic acceleration-time history, all analyzed using an appropriate computer program.

In support of the ESP application, the applicant provided the following information:

Shear Wave Velocity Profile

SSAR Subsection 2.5.4.7.1 describes the shear wave velocity profiles developed for both soil and rock in the site area.

1. Soil Shear Wave Velocity Profile. During the ESP investigation, the applicant collected a variety of measurements to obtain estimates of shear wave velocity in the soil, estimates that were later confirmed during the COL investigation. The applicant used P-S velocity and CPT down-hole seismic testing to measure the shear wave velocity as part of the ESP subsurface investigations. The applicant developed the shear wave velocity profile used in the seismic amplification/attenuation analysis from the ESP investigation, shown on SSAR Figure 2.5.4-7, and the soil profile used consists of compacted backfill from 0 to 26 m (86 ft), Blue Bluff Marl from 26 to 45.5 m (86 to 149 ft), Lower Sand Stratum from 45.5 to 320 m (149 to 1,049 ft), and Dunbarton Triassic Basin and Paleozoic Crystalline Rock below 320 m (1,049 ft).

   The applicant stated that when compared, the profile of the combined data set (COL) in the middle and upper portions of the Blue Bluff Marl was in good agreement with the ESP profile, although, in the lower portions of the Blue Bluff Marl and the Lower Sand Stratum, the COL profile exhibited slightly lower shear wave velocity values than in the ESP profile. The applicant concluded that the COL shear wave velocity generally increased with depth and supported the findings of the ESP.

2. Rock Shear Wave Velocity Profile. SSAR Subsection 2.5.4.7.1.2 states that due to the thickness of sediments at the VEGP site, the applicant needs to know the shear wave velocity profile and material properties for the site down to the depth where the material shear wave velocity is approximately 2804 m/s (9,200 fps). Since the site is underlain by both the Triassic Basin and Paleozoic crystalline rocks, the applicant considered the effect of shear wave velocities and the material properties of both rocks and their geometries. The applicant concluded that shear wave velocities measured at the top of the Triassic Basin, including the weathered portion, did not reach 2,804 m/s (9,200 fps). The applicant then compared deep borehole shear wave velocity data available from the Savannah River Site (SRS) with data from borehole B-1003 to determine the character of the rock shear wave in the Triassic Basin. The applicant concluded that a weathered zone 61 m (200 ft) thick was present at the top of the Triassic Basin, characterized by the shear wave velocity rapidly increasing with depth to a point where there was a relatively high shear wave velocity, but still less than 2,804 m/s (9,200 fps). The applicant observed a gentler shear wave velocity gradient increasing with depth below the weathered zone. Finally, the applicant noted an arrangement of gentle gradients and shear wave velocities at the top of the unweathered Triassic basin that was interpreted as a continuation of the site-specific profile from borehole B-1003.

   After considering data suggesting that the non-capable Pen Branch fault separated the Triassic Basin from the Paleozoic crystalline rocks, as well as the structural geometry of the rock units and the fault, and the velocity profiles from SRS investigations, the applicant stated the shear wave velocity profile through the Triassic Basin probably would not reach 2,804 m/s (9,200 fps) before encountering the Paleozoic crystalline rock, where the shear wave velocity was interpreted as at least 2,804 m/s (9,200 fps). Accounting for the variability of the depth where the Paleozoic crystalline rock was encountered and the uncertainty of the shear wave velocity gradient, the applicant considered six rock shear wave velocity profiles to comprise the base case used in the seismic amplification and attenuation analysis. The applicant also considered the deep boring rock shear wave velocities from three SRS locations, velocities that suggested additional geometries for the shear wave velocity profiles of the Triassic Basin and the Paleozoic crystalline rock that could impact site response. A closer inspection of the shear wave velocity profile from three SRS locations suggested there was a low velocity zone at the bottom of the Triassic basin where the Pen Branch fault was encountered. The applicant determined through sensitivity analyses that the alternate shear wave velocity models suggested by these observations resulted in insignificant variations in the site response relative to the six profiles previously considered.

Variation of Shear Modulus and Damping with Shear Strain

SSAR Subsection 2.5.4.7.2 describes the variations of the shear modulus and damping with shear strain for both the ESP and COL analyses. Site-specific shear modulus and damping curves are presented as Figures 2.5.4-6 and 2.5.4-7 of this SER.

1. Shear Modulus (ESP Analysis). SSAR Subsection 2.5.4.7.2.1.1 describes the variation of shear modulus with shear strain as determined during the ESP analysis at the VEGP site. The applicant derived the shear modulus from the unit weight data and shear wave velocity of the soil, the determination of which was described in SSAR 2.5.4.7.1. Using the SHAKE2000 (Bechtel 2000) analysis, the applicant tabulated values for shear modulus, as well as the low strain values for the existing soils and rock and for compacted backfill as shown in Tables 2.5.4-1 and 2.5.4-3 of this SER, respectively. The applicant also used the EPRI curves for sands and clays (EPRI TR-102293 1993) to derive the dynamic shear modulus reduction in terms of depth for granular soils (Upper and Lower Sand Stratum) and in terms of the Plasticity Index (PI) for cohesive soils (Blue Bluff Marl) using a PI of 25 percent for the clay of the Lisbon Formation. Table 2.5.4-4 of this SER provides the results of the shear modulus reduction factors. The applicant also used the shear modulus reduction factors developed for the neighboring SRS, selected based on their stratigraphic relationship to the site of VEGP Units 3 and 4, for the ESP analysis. The applicant equally weighted the site amplification factors using the EPRI and SRS shear modulus degradation relationships as described in SSAR Subsection 2.5.2.5.1.2.1.

2. Shear Modulus (COL Analysis). SSAR Subsection 2.5.4.7.2.1.2 describes the development of site-specific dynamic shear modulus reduction curves using RCTS test results from the Blue Bluff Marl, Lower Sand Stratum, and the proposed borrow materials for the compacted backfill. The applicant tested undisturbed samples from both the Blue Bluff Marl and Lower Sand Stratum, plotted the shear modulus reduction data against shearing strain, and overlaid the data on the EPRI curves for clay or for depth for granular soils. The applicant stated that for the Blue Bluff Marl, the site-specific data followed the EPRI trend of the relationship with plasticity index, while the Lower Sand Stratum followed the EPRI trend for depth for granular soils.

3. Damping (ESP Analysis). SSAR Subsection 2.5.4.7.2.2.1 describes the derivation of the damping ratio from EPRI in terms of depth for granular soils, such as the Upper and Lower Sand Strata, and in terms of Plasticity Index for cohesive soils, such as the Blue Bluff Marl, as conducted as part of the ESP site analysis. The applicant used the EPRI curves for sands to derive the damping ratios for the granular soil strata (compacted backfill and Lower Sand Stratum), and the EPRI curves for clays to derive the damping ratios for the Lisbon Formation using a PI of 25 percent. SER Table 2.5.4-4 provides the calculated damping

ratios. The applicant also used certain damping ratio values developed for the SRS, selected based on their stratigraphic relationship to the VEGP site. The applicant stated that it weighted the mean site reduction and site amplification factors using EPRI and SRS shear modulus degradation relationships.

4. Damping (COL Analysis). SSAR Subsection 2.5.4.7.2.2.2 describes the development of the site-specific damping curves from the RCTS test results performed on samples from the Blue Bluff Marl, the Lower Sand Stratum, and the proposed borrow materials for compacted backfill. The applicant stated that it plotted the RCTS damping relationships for the Blue Bluff Marl samples, which were then overlain on the EPRI curves for clay, and it concluded that the site-specific data followed trends that were consistent with the EPRI damping relationships for PI. The applicant also derived site-specific curves for low and high PI materials based on the similarity of the EPRI PI curves. Utilizing similar plots and overlays for the Lower Sand Stratum and clayey samples, the applicant concluded that the site-specific data for both the sand and clay samples followed trends consistent with the EPRI relationships for depth for granular soils and were based on the EPRI curves for depth for granular soils.

Table 2.5.4-3 Design Dynamic Shear Modulus and Typical Shear Wave Velocity from ESP Investigations (Taken from SSAR Tables 2.5.4-2 and 2.5.4-6)

Geologic Formation	Depth m (ft)	Elevation m (ft)	Gmax (ksf)	Vs (fps)
Upper Sand Stratum (Barnwell Group)	0 to 4.8 (0 to 16)	68 to 63 (223 to 207)	7,000	1,400
	4.8 to 12.5 (16 to 41)	63 to 55.4 (207 to 182)	2,286	800
	12.5 to 17.7 (41 to 58)	55.4 to 50.2 (182 to 165)	2,580	850
	17.7 to 26.2 (58 to 86)	50.2 to 41.7 (165 to 137)	2,893	900
Blue Bluff Marl (Lisbon Formation)	26.2 to 28 (86 to 92)	41.7 to 40 (137 to 131)	6,978	1,400
	28 to 29.5 (92 to 97)	40 to 38.4 (131 to 126)	10,321	1,700
	29.5 to 31 (97 to 102)	38.4 to 36.8 (126 to 121)	15,750	2,100
	31 to 32 (102 to 105)	36.8 to 35.9 (121 to 118)	10,321	1,700
	32 to 33.8 (105 to 111)	35.9 to 34.1 (118 to 112)	17,286	2,200
	33.8 to 37.5 (111 to 123)	34.1 to 30.5 (112 to 100)	19,723	2,350
	37.5 to 45.4 (123 to 149)	30.5 to 22.5 (100 to 74)	25,080	2,650
Lower Sand Stratum	45.4 to 47.5 (149 to 156)	22.5 to 20.4 (74 to 67)	14,286	2,000
Still Branch	47.5 to 65.8 (156 to 216)	20.4 to 2.1 (67 to 7)	9,723	1,650
Congaree	65.8 to 101 (216 to 331)	2.1 to -32.9 (7 to -108)	13,580	1,950
Snapp	101 to 134 (331 to 438)	-32.9 to -65.5 (-108 to -215)	15,009	2,050
Black Mingo	134 to 145 (438 to 477)	-65.5 to -77.4 (-215 to -254)	19,723	2,350
Steel Creek	145 to 179 (477 to 587)	-77.4 to -111 (-254 to -364)	25,080	2,650
Gaillard/Black Creek	179 to 243 (587 to 798)	-111 to -175 (-364 to -575)	29,009	2,850
Pio Nino	243 to 262 (798 to 858)	-175 to -193 (-575 to -635)	29,418	2,870
Cape Fear	262 to 320 (858 to 1,049)	-193 to -251 (-635 to -826)	26,229	2,710
Dunbarton Triassic Basin	320 (1,049)	-251 (-826)		2,710
	333 (1,093)	-265 (-870)		5,300
	403 (1,323)	-335 (-1,100)		7,800

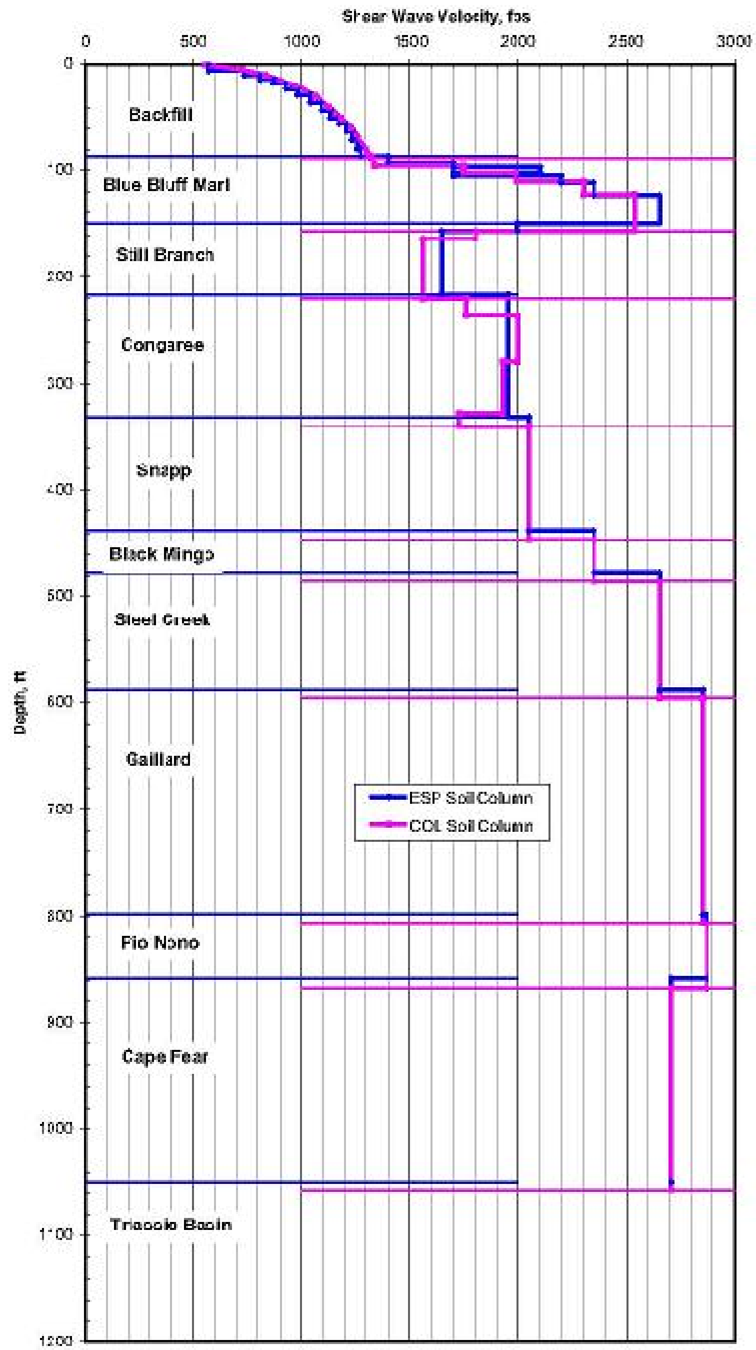


Figure 2.5.4-5 Shear Wave Velocity Profile – ESP and COL Soil Column (SSAR Figure 2.5.4-7a)

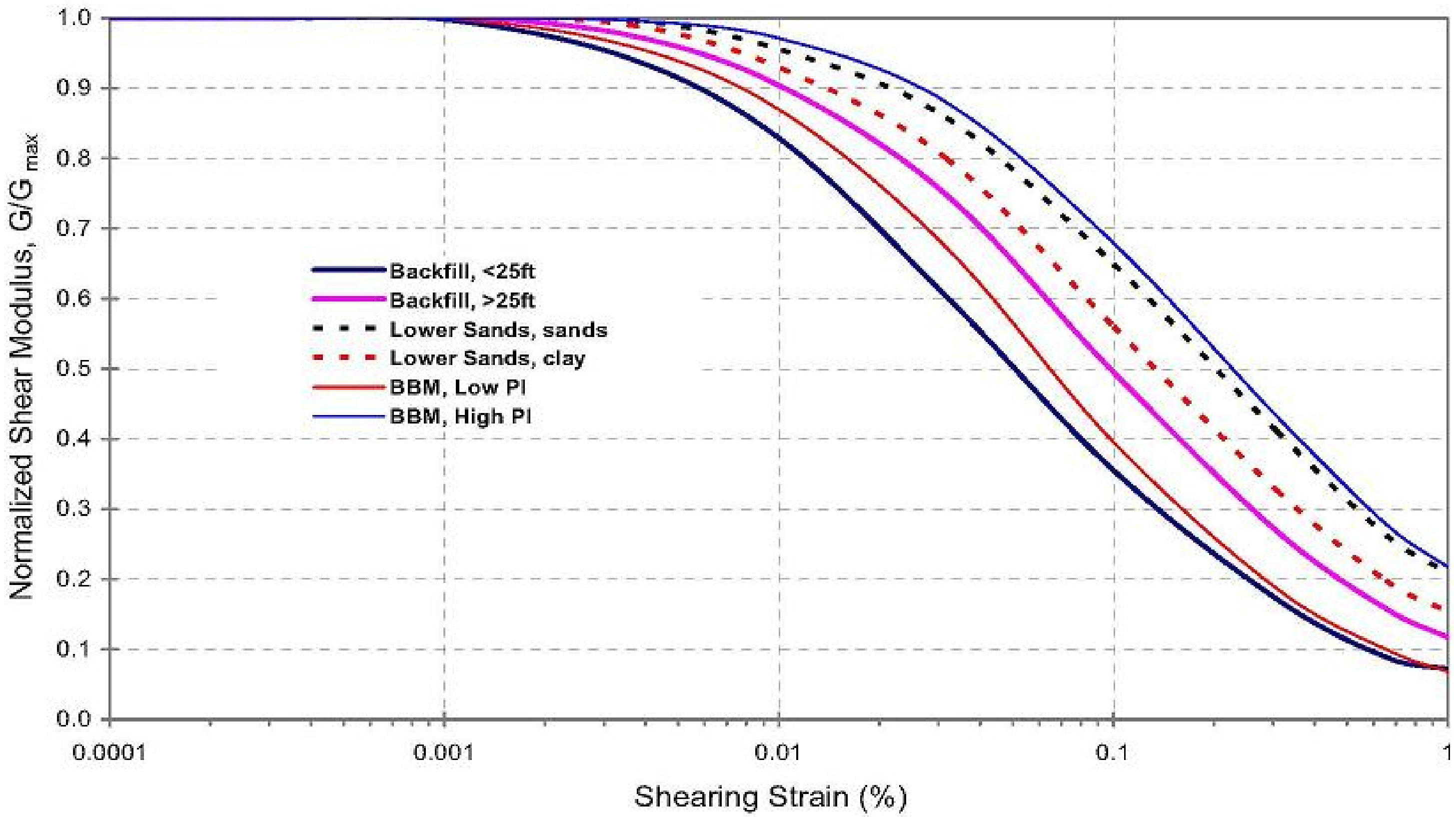


Figure 2.5.4-6 Site-Specific Shear Modulus Reduction Curves (SSAR Figure 2.5.4-9a)

Soil/Rock Amplification/Attenuation Analysis

SSAR Subsection 2.5.4.7.3 describes the use of the SHAKE2000 computer program to determine the site dynamic responses for the soil and rock profiles. The applicant stated that SHAKE2000 used an equivalent linear procedure to account for the non-linearity of the soil by employing an iterative procedure to obtain values for shear modulus and damping that were compatible with the equivalent uniform strain induced in each sublayer. At the beginning of the analysis, the applicant assigned a set of shear modulus and damping value properties to each sub-layer of the soil profile, properties which were used during the analysis to calculate the shear strain induced in each sub-layer. The applicant then modified the shear modulus and damping ratio for each sub-layer based on the shear modulus and the damping ratio versus strain relationships, repeating the analysis until strain-compatible modulus and damping values were achieved.

Comparison of ESP versus COL Soil Column

SSAR Subsection 2.5.4.7.5 compares the subsurface data collected and evaluated during two distinct phases referred to as the ESP and COL investigations, including Phase 1 of the test pad program. The applicant described the ESP investigation as limited in scope but broad in aerial coverage, whereas the COL investigation was extensive in scope but limited to the Units 3 and 4 power block areas. SER Figure 2.5.4-5 presents the stratification and shear wave velocity profiles of the ESP and COL soil columns. The applicant stated that the offset in the soil stratification between the soil columns reflected refinements due to the additional data collected during the COL investigation. The applicant concluded that a comparison of the ESP and COL shear wave velocity profiles indicated good agreement between the data sets and consistency of trends within the strata.

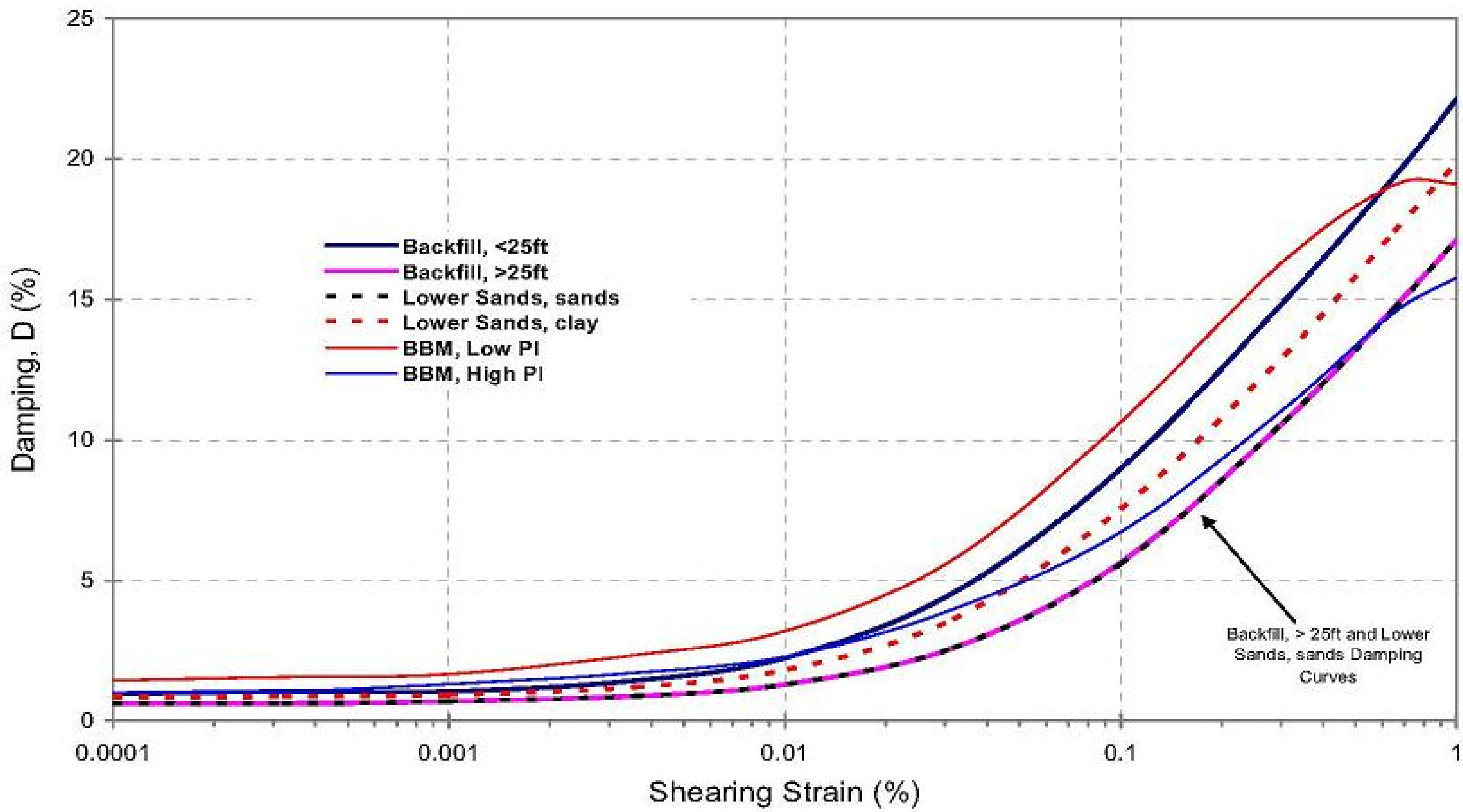


Figure 2.5.4-7 Site-Specific Damping Ratio Curves (SSAR Figure 2.5.4-11a)

In support of the LWA request, the applicant submitted the following information:

Shear Wave Velocity Profile

Soil Shear Wave Velocity. The applicant collected shear wave velocity data from the ESP and COL investigations, and it stated that the ESP data was derived from the backfill shear wave velocity data determined during the previous investigations conducted for VEGP Units 1 and 2, while the COL investigations considered the shear wave velocity data determined for the structural backfill to be used at the VEGP Units 3 and 4 site.

The applicant measured shear wave velocity in the field by the applicant during Phase 1 of the test pad program, as well as through RCTS and other methods from the COL investigations. The applicant used this data, along with laboratory test data, to evaluate the shear wave velocity of the backfill and develop the shear wave velocity profile for the backfill. During the COL investigation, the applicant calculated the shear wave velocity values from 0 to 27 m (88 ft) in the backfill, 27 to 47.5 m (88 to 156 ft) in the Blue Bluff Marl, 47.5 to 322 m (156 to 1,058 ft) in the Lower Sand Stratum, including the Still Branch, Congaree, and Snapp Formations, and in the Dunbarton Triassic Basin and Paleozoic crystalline rock below 322 m (1,058 ft). The applicant stated that it combined and averaged the data from the six COL profiles and two ESP data profiles to produce SSAR Figure 2.5.4-7a (reproduced as SER Figure 2.5.4-5), an average shear wave velocity profile for the data. The applicant stated that the figure illustrates the relationship and similarity between the ESP and COL data sets.

Table 2.5.4-4 Summary of Site-specific Modulus Reduction and Damping Ratio Values

Stratum	Backfill				Blue Bluff Marl				Lower Sands			
Sub strata	< 7.6 m (25 ft)		> 7.6 m (25 ft)		Low PI		High PI		Sands		Clay (Congaree/Snapp)	
Shear Strain (%)	G/Gmax	Damping Ratio	G/Gmax	Damping Ratio	G/Gmax	Damping Ratio	G/Gmax	Damping Ratio	G/Gmax	Damping Ratio	G/Gmax	Damping Ratio
0.00010	1	0.97	1	0.62	1	1.44	1	1	1	0.62	1	0.86
0.00032	1	1.05	1	0.62	1	1.56	1	1.05	1	0.62	1	0.87
0.00100	0.998	1.05	1	0.7	1	1.67	1	1.32	1	0.7	1	0.93
0.00359	0.942	1.44	0.975	0.89	0.96	2.34	0.9965	1.71	0.997	0.89	0.99	1.21
0.01019	0.826	2.26	0.902	1.3	0.867	3.23	0.97	2.3	0.954	1.32	0.928	1.8
0.03170	0.603	4.55	0.748	2.6	0.673	5.75	0.88	3.97	0.828	2.6	0.8	3.62
0.10000	0.355	8.97	0.495	5.64	0.395	10.63	0.679	6.715	0.649	5.59	0.56	7.54
0.30690	0.172	14.94	0.269	10.65	0.187	16.39	0.433	11.115	0.411	10.65	0.327	13
0.65313	0.089	19.38	0.158	14.73	0.1	19.08	0.2785	14.545	0.263	14.68	0.198	17.42
1.00000	0.072	22.12	0.117	17.11	0.068	19.12	0.217	15.77	0.209	17.11	0.154	19.87

Variation of Shear Modulus and Damping with Shear Strain

1. Shear Modulus (COL Analysis). In addition to the information summarized from this section in support of the ESP application, the applicant also included the following information in support of the LWA request. SSAR Subsection 2.5.4.7.2.1.2 describes the variation of shear modulus with shear strain as determined during the COL analysis at the VEGP site. The applicant developed the site-specific dynamic shear modulus reduction curves from the results of RCTS tests on Blue Bluff Marl and Lower Sand strata samples, as well as on samples from the proposed borrow materials. As part of the COL analysis, the applicant also tested five bulk soil samples from test pits in the proposed borrow sources. The tests conducted by the applicant included percent fines (8 to 25 percent), moisture-density and index testing on the samples. The applicant stated that RCTS tests were performed on the bulk samples at two different levels of compaction (at 95 percent and 97 percent, or at 95 percent and 100 percent), using confining pressures based on representative depths throughout the proposed 27 m (90 ft) backfill soil column. The applicant concluded that the results disclosed little variation based on the level of compaction. The applicant then plotted the shear modulus reduction data against shearing strain, overlaid the data on the EPRI curves for depth for granular soils, and concluded that the site-specific data followed trends consistent with the EPRI relationships for depth for granular soils.

2. Damping (COL Analysis). In addition to the information summarized from this section in support of the ESP application, the applicant also included the following information in support of the LWA request. SSAR Subsection 2.5.4.7.2.2.2 describes the development of the site-specific damping curves from the RCTS test results performed on samples from the Blue Bluff Marl, the Lower Sand Stratum, and the proposed borrow materials for compacted backfill. The applicant stated that it developed site-specific damping curves for the borrow material for samples under low confining pressure (less than 7.5 m (25 ft) deep) and for samples under higher confining pressures (more than 7.5 m (25 ft) deep) based on the similarity of the EPRI curves for depth for granular soils.

Two-Dimensional Effects Site Response Analysis (Bathtub Model)

SSAR Subsection 2.5.4.7.4 states that the model for the site dynamic response analysis, as discussed in SSAR Section 2.5.2.5, depicting the backfill above the Blue Bluff Marl as a continuum, did not account for the extent of the excavation and backfill or any impacts of the Upper Sand Stratum on site response. Therefore, the applicant stated that it evaluated these impacts by considering the site response with both the Upper Sand Stratum in place and replaced by backfill. According to the applicant, the average shear wave profile of the stratum was developed and used to characterize shear wave velocity of the Upper Sand. The applicant provided a more detailed discussion of these analyses and results in SSAR Section 2.5.2.9.2.

MSE Backfill Shear Wave Velocity Profile

SSAR Subsection 2.5.4.7.6 provides further discussion on the Mechanically Stabilized Earth (MSE) retaining wall presented in SSAR Subsection 2.5.4.5.7. The wall, as shown on SER Figure 2.5.4-17, consists of wall facing panels and tensile elements embedded in the structural backfill placed behind the wall face. Immediately behind the wall face and away from the wall face for a distance of about 5 ft, the applicant plans to place backfill in thinner lifts and utilize smaller hand-operated compaction equipment to achieve the compaction criteria of at least 95 percent of the maximum dry density as determined by the ASTM D 1557 standard test method. Beyond a distance of about 5 ft away from the wall face, the applicant's mass earthwork operations will place and compact the structural backfill in thicker lifts utilizing larger self-propelled equipment. The applicant stated that due to the likely different compaction procedures and the presence of the MSE wall face, the shear wave velocity profile of the backfill within the 5 ft wall face zone may be reduced. The applicant investigated the effect of this possibility by using a reduced velocity profile for the full height of the wall, identified as the MSE best estimate, in a soil structure interaction analysis and presented the results in SSAR Appendix 2.5.E. The applicant concluded that the results show no differences in the seismic structural responses from the potentially reduced shear wave velocity behind the MSE wall.

2.5.4.1.8 Liquefaction Potential

SSAR Section 2.5.4.8 describes soil liquefaction as the process where loose, saturated, granular deposits lose a significant portion of their shear strength due to the buildup of pore pressure as a result of cyclic loading such as that caused by an earthquake. The applicant stated that multiple factors contributed to liquefaction potential, including geologic age, state of soil saturation, density, grain size distribution, plasticity, and intensity and duration of earthquakes. The applicant stated that, in general, when the following criteria are met, liquefaction can occur: 1) the design ground acceleration is high, 2) the soil is saturated (i.e., the soil is close to or below the water table), and 3) the site soils are sands or silty sands in a loose or medium dense condition.

In support of the ESP application, the applicant submitted the following information:

At the VEGP site, the applicant identified the Upper Sand Stratum, consisting of sands of varying fines content, as meeting all three criteria. According to the applicant, liquefaction was not a concern in either the Blue Bluff Marl or the Lower Sand Stratum, although the applicant addressed the liquefaction potential of the coarse-grained materials within the Blue Bluff Marl. Due to the potential susceptibility of the Upper Sand Stratum to liquefaction, the applicant completely removed the entire potion of the Upper Sand Stratum during construction of VEGP Units 1 and 2, and replaced it with engineered backfill. The applicant stated that it planned for a similar removal and replacement procedure during construction of VEGP Units 3 and 4.

<u>Acceptable Factor of Safety Against Liquefaction</u>

The applicant used Regulatory Guide 1.198 (RG1.198) as a guide for liquefaction analysis. RG 1.198 considers factors of safety (FS) less than or equal to 1.1 against liquefaction to be low, FS between 1.1 and 1.4 to be moderate, and FS equal to or greater than 1.4 to be high.

<u>Previous Liquefaction Analyses</u>

SSAR Subsection 2.5.4.8.2 describes the applicant's evaluation of the liquefaction potential of the Upper Sand Stratum performed during the VEGP Units 1 and 2 investigations. The applicant determined that the Upper Sand Stratum below the groundwater table was susceptible to liquefaction when it was subjected to the maximum SSE acceleration of 0.2g developed for Units 1 and 2. To account for this potential, the applicant removed the Upper Sand Stratum to an approximate El. of 39.5 to 41 m (130 to 135 ft) in the Units 1 and 2 power block area and replaced it with compacted structural backfill. The applicant evaluated, using cyclic strength data from test specimens, the liquefaction potential of the compacted structural backfill in the power block area and determined an FS against liquefaction of 1.9 to 2.0. The applicant concluded that this was an adequate factor of safety against liquefaction for the compacted backfill for VEGP Units 1 and 2.

Liquefaction Analyses Performed for the ESP Application

SSAR Subsection 2.5.4.8.3 describes the liquefaction analyses performed for the strata at the VEGP site as part of the ESP application, including the Upper Sand, Blue Bluff Marl, and compacted backfill.

1. Liquefaction Analyses of the Upper Sands. Based on the previous investigations and excavations for VEGP Units 1 and 2, as well as on the proximity of proposed Units 3 and 4, the applicant stated that it did not perform a liquefaction study as part of the ESP investigation because the unit would be completely removed and replaced with select compacted non-liquefiable structural backfill up to plant grade within the footprint of the power block.

2. Liquefaction Analyses of the Blue Bluff Marl. The applicant identified the Blue Bluff Marl as a cemented, overconsolidated, calcareous, fine-grained silt and clay material that exhibited a high factor of safety against liquefaction; however, the applicant stated that since it found some lenses of silty fine sand during the COL investigation, additional analyses were performed. The applicant stated that it evaluated the data from SPT, CPT, and shear wave velocity measurements, with the SPT measurement method being the most well developed and well recognized. The applicant calculated the cyclic stress ratio (CSR), a measure of the stress imparted to the soils by the ground motion; then the cyclic resistance ratio (CRR), a measure of the resistance of soils to the ground motion; and finally used the ratio of the CRR to the CSR to determine the FS.

    a. Liquefaction Potential Based on SPT Data. The applicant presented SPT N60-values versus elevation for the 70 COL investigation borings in the VEGP Units 3 and 4 power block area and stated that the results were indicative of non-liquefiable coarse-grained soil samples. The applicant stated that of eight soil samples it analyzed, three were potentially liquefiable, with calculated FSs against liquefaction of 1.43, 1.75, and 2.19, and in all cases, greater than 1.1. Therefore, the applicant concluded the FS against liquefaction in the Blue Bluff Marl was adequate based on the SPT data.

    b. Liquefaction Potential Based on Shear Wave Velocity Data. The applicant stated that it measured shear wave velocity (Vs) data in the Blue Bluff Marl by P-S logging in six power block area borings during the COL investigation to evaluate the potential for liquefaction. Following the recommendations in Youd et al, the applicant stated that it corrected the shear wave velocity values for overburden (Vs1), and calculated Vs1 values from 253 to 508 m/s (830 to 1666 fps). Based on the relationship between Vs1, cyclic resistance ratio (CRR), and liquefaction presented by Youd et al., the applicant concluded that the Blue Bluff Marl was non-liquefiable.

Liquefaction Conclusions

Based on its analysis of the potential for liquefaction, the applicant concluded that the only potentially liquefiable soil was the portion of the Upper Sand Stratum below the groundwater table. The applicant stated that for this reason, the Upper Sand Stratum was removed and replaced with compacted structural backfill during construction of Units 1 and 2 and that the same would be done during construction of Units 3 and 4. Through various analyses, the applicant concluded that the liquefaction potential of the compacted structural backfill material, consisting of materials and using methods similar to those for VEGP Units 1 and 2, was not a concern. Finally, the applicant determined that the FS against liquefaction of the Blue Bluff Marl (greater than 1.1) was adequate.

In support of the LWA request, the applicant provided the following information:

> Liquefaction Analyses of the Compacted Backfill. In SSAR Subsection 2.5.4.8.3.3, the applicant stated that the structural backfill would be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 1557, and that the backfill materials, construction, and field compaction methods would be consistent with those used during construction of Units 1 and 2. The applicant evaluated the properties of backfill from the proposed borrow sources during Phase 1 of the test pad program through field and laboratory testing of the materials, and by consistent comparison with results from Units 1 and 2, and concluded that for the design basis earthquake, liquefaction was not a concern for the compacted backfill at Units 3 and 4.

2.5.4.1.9 Earthquake Design Basis

SSAR Sections 2.5.2.6 and 2.5.2.7 discuss in detail the Safe Shutdown Earthquake (SSE). SSAR Section 2.5.2.8 discusses the Operating Basis Earthquake (OBE).

2.5.4.1.10 Static Stability

In support of the ESP application, the applicant submitted the following information:

SSAR Section 2.5.4.10 describes the two scenarios used for the bearing capacity and settlement analyses for VEGP Units 3 and 4. The first scenario, as identified by the applicant, was the Containment and Auxiliary Building foundations, which would be constructed at about El. 55 m (180 ft) msl, a level that corresponded to a depth of 12 m (40 ft) below the final grade of El. 67 m (220 ft) msl, and 15 to 18 m (50 to 60 ft) above the top of Blue Bluff Marl bearing stratum based on the ESP subsurface investigation. The second scenario was the construction of the other foundations in the power block area, which the applicant stated would be placed at depths of about 1.2 m (4 ft) below final grade. Based on the results of the ESP and COL investigations and Phase I of the test pad program, the applicant determined that the soils supporting the nuclear island did not exhibit extreme variations in subgrade stiffness and considered the site to be uniform.

Bearing Capacity

For calculation purposes, the applicant modeled the containment building mat as a circle with a diameter of about 43 m (142 ft) placed at a depth of 12 m (39.5 ft) below finished grade, while other structures would be founded at an approximate depth of 1.2 m (4 ft) below grade. The applicant assumed that all structures in the power block area would be founded on a 27 meter (90 feet) thick layer of structural backfill compacted to a minimum of 95 percent.

Settlement Analysis

The applicant noted that, based on previous site experiences, the total settlement for large mat foundations that support major power plant structures can exceed the limit of 5.08 cm (2 inches) suggested in geotechnical literature. The applicant stated that the settlements of VEGP Units 1 and 2 foundations were from 6.8 to 8.1 cm (2.7 to 3.2 in) for containment buildings, 2.8 to 4.8 cm (1.1 to 1.9 in) for the control building, 7.4 to 8.4 cm (2.9 to 3.3 in) for the auxiliary building, and 6.35 to 9.1 cm (2.5 to 3.6 in) for the cooling towers, all of which were significantly below the maximum design values. The applicant also provided the ratio of measured to predicted settlement for these structures, which ranged from less than 0.50 to about 0.75, which indicated that the subsurface soils were stiffer than anticipated.

The applicant also acknowledged that differential settlement between buildings could affect the pipe connections between those buildings, and therefore it measured differential settlements between the basemats of Units 1 and 2 and reported that they were generally within the limit of 1.9 cm (0.75 in) suggested in geotechnical literature and smaller than the design limit. The applicant noted that the settlements were essentially elastic in that they took place during construction of the units and reflected the elastic nature of the compacted backfill, the heavily overconsolidated Blue Bluff Marl, and the underlying Lower Sand Stratum. The results of laboratory consolidation tests that the applicant conducted on relatively undisturbed samples from the Blue Bluff Marl and Lower Sand Strata confirmed that the elastic behavior and very stiff and dense nature of the strata. Furthermore, the applicant confirmed the very dense nature and the expected performance under load of compacted backfill would be similar to VEGP Units 1 and 2 based on the results from the test pad program. The applicant concluded that settlement could be limited to one inch while differential settlement between footings could be limited to 1.27 cm (½ inch) for footings supporting smaller structures. As an additional strategy, the applicant planned to install piping as late in the construction schedule as practicable and install pipe supports only when construction of the structure to which the pipe connected was near completion.

> Displacement Monitoring. The applicant described plans to develop a detailed instrumentation plan to monitor heave in subsurface soils due to excavation, changes in pore pressures due to excavation and dewatering, and settlement due to construction of the structures. This plan will also include displacement monitoring at depth in order to estimate and confirm moduli of the subsurface soils. The applicant stated that instrumentation would be regularly monitored, including conventional survey, electronic instrumentation, and remote telemetry, where practical. Finally, the applicant stated its intention to place particular emphasis on differential movement and structure tilt. The applicant will develop the plan prior to construction activities.

In support of the LWA request, the applicant provided the following information:

The applicant stated that an earthwork specification for compacted backfill would be developed after Phase 2 of the test pad program was completed. The Phase II test pad program was completed by the applicant in July 2008 and the results used by the applicant to develop draft construction specifications and structural backfill placement procedures. The applicant stated that its final soils specification and backfill implementing procedures are to be finalized in accordance with its quality program, which would be approved as part of the LWA request, prior to the start of any construction activities authorized by the LWA. The applicant also stated that a coefficient of friction of 0.45 against the concrete foundation for the proposed sand and silty sand compacted backfill materials was expected to be achieved, and a site-specific evaluation was conducted and presented by the applicant in Appendix 2.5E of the revised SSAR. The staff's evaluation of the coefficient of friction against sliding is discussed in SER Section 3.8.

Bearing Capacity

Allowable static bearing capacity values were calculated with Terzaghi's bearing capacity equations using an internal angle of friction of 36 degrees for the compacted backfill as developed by the applicant from field and laboratory testing of the borrow materials during the COL investigation and Phase 1 of the test pad program. With an FS of 3.0, the applicant determined that the site conditions provided an allowable bearing pressure of 1,627 kPa (34 ksf) under static loading conditions for the nuclear island; that capacity is greater than the AP1000 DCD requirement of 411.77 kPa (8.6 ksf). The allowable bearing capacity values for foundations placed on compacted fills at depths of about 1.2 m (4 ft) below finished grade are shown on SSAR Figure 2.5.4-13.

The applicant also evaluated the allowable bearing capacity of the structural backfill under the nuclear island for dynamic loading conditions, again using Terzaghi's bearing capacity equation for local shear and Soubra's method with seismic bearing capacity factors using Terzaghi's bearing capacity equation for general shear with an internal friction angle of 36 degrees. To simulate the potential for higher edge pressures during dynamic loading, the applicant considered 3 foundation widths, corresponding to 10, 25 and 50 percent of the width, of the nuclear island basemat. Using a width of 25 ft and a FS of 2.25, the applicant concluded that site specific conditions provided an allowable bearing pressure greater than 2,011 kPa (42 ksf) under dynamic loading conditions for the nuclear island, which was greater than the required 1676 kPa (35 ksf) for dynamic bearing as provided in the DCD as well as the Vogtle site specific maximum dynamic demand for the ESP soil profile of 862 kPa (18 ksf).

The applicant also evaluated the bearing capacity of the structural backfill in terms of the ratio of the ultimate bearing capacity against the structure demand, and this capacity over demand (C/D) ratio provided an alternative measure of the margin of safety against bearing failure. The applicant evaluated the C/D ratios for the static and dynamic demand conditions as provided in the DCD as well as the maximum dynamic demand from the Vogtle site specific seismic evaluation. The applicant stated that the C/D ratios were higher than those typically utilized for standard practice, and that while the results did not take into account settlement of the structures, the significant margin suggested that the settlements would be minimal and within the requirements of the AP1000 DCD.

Settlement Analysis

The applicant performed a detailed settlement analysis for VEGP Units 3 and 4 using elastic properties similar to those used in the analysis for VEGP Units 1 and 2. In the analysis, the applicant incorporated excavation, dewatering, and a timeline of construction to estimate basemat displacement time histories. According to the applicant, the results of the analysis indicated that for the assumed loads, the predicted total settlements ranged from about 5.08 to 7.62 cm (2 to 3 in), with a tilt of approximately 0.63 cm (¼ in) in 15 m (50 ft), a differential settlement between structures of less than 2.54 cm (1 in), and the predicted heave due to foundation excavation ranged from about 2.54 to 6.35 cm (1 to 2 ½ in). The applicant noted that the results were similar to the movements measured for Units 1 and 2.

2.5.4.1.11 Design Criteria

SSAR Section 2.5.4.11 summarizes the design criteria provided in the AP1000 DCD, Revision 15, and covered in various sections of the SSAR. The applicant summarized the geotechnical criteria, except for the criteria that pertain to structural design (e.g., wall rotation, sliding, or overturning), which is discussed in Section 3.8 of this SER. As noted by the applicant in SSAR Section 2.5.4.8, the acceptable factor of safety (FS) against liquefaction of site soils was greater than or equal to 1.1. SSAR Section 2.5.4.10 specifies bearing capacity criteria, including the minimum FS of 3 when applied to bearing capacity equations and against breakout failure due to uplift on buried piping. For soils, an FS of 2.25 can be used when dynamic or transient loading conditions apply. SSAR Section 2.5.5.2 specifies that the minimum acceptable long-term static FS against slope stability failure is 1.5. SSAR Section 2.5.5.2 states that the minimum acceptable long-term seismic FS against slope stability failure is 1.1.

2.5.4.1.12 Techniques to Improve Subsurface Conditions

SSAR Section 2.5.4.12 describes the techniques employed by the applicant to improve the subsurface conditions. For the ESP and COL investigations, the applicant did not consider any ground improvement techniques beyond the removal and replacement of the Upper Sand Stratum, while the test pad program defined the materials and methods for the backfill that would replace the Upper Sand Stratum. The applicant also described plans to improve surficial areas outside the power block excavation through densification with heavy vibratory rollers, and other ground improvement methods, such as the use of piles, as warranted.

2.5.4.2 Regulatory Basis

The applicable regulatory requirements for reviewing the applicant’s discussion of stability of subsurface materials and foundations are:

1. 10 CFR 50.55a, “Codes and Standards,” requires that structures, systems, and components be designed, fabricated, erected, constructed, tested and inspected to quality standards commensurate with the importance of the safety function to be performed.

2. 10 CFR Part 50, Appendix A, General Design Criterion 1 (GDC 1), "Quality Standards and Records," requires that structures, systems and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. It also requires that appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

3. 10 CFR Part 50, Appendix A, General Design Criterion 2 (GDC 2), "Design Bases for Protection Against Natural Phenomena,” as it relates to consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

4. 10 CFR Part 50, Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants,” establishes quality assurance requirements for the design, construction, and operation of those structures, systems, and components of nuclear power plants that

prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public.

5. 10 CFR Part 50, Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” as it applies to the design of nuclear power plant structures, systems, and components important to safety to withstand the effects of earthquakes.

6. 10 CFR Part 100, "Reactor Site Criteria," provides the criteria that guide the evaluation of the suitability of proposed sites for nuclear power and testing reactors.

7. 10 CFR 100.23, "Geologic and Seismic Criteria," provides the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants.

The related acceptance criteria are described in SRP Section 2.5.4:

1. Geologic Features: In meeting the requirements of 10 CFR Parts 50 and 100, the section defining geologic features is acceptable if the discussions, maps, and profiles of the site stratigraphy, lithology, structural geology, geologic history, and engineering geology are complete and are supported by site investigations sufficiently detailed to obtain an unambiguous representation of the geology.

2. Properties of Subsurface Materials: In meeting the requirements of 10 CFR Parts 50 and 100, the description of properties of underlying materials is considered acceptable if state-of-the-art methods are used to determine the static and dynamic engineering properties of all foundation soils and rocks in the site area.

3. Foundation Interfaces: In meeting the requirements of 10 CFR Parts 50 and 100, the discussion of the relationship of foundations and underlying materials is acceptable if it includes (1) a plot plan or plans showing the locations of all site explorations, such as borings, trenches, seismic lines, piezometers, geologic profiles, and excavations with the locations of the safety-related facilities superimposed thereon; (2) profiles illustrating the detailed relationship of the foundations of all seismic Category I and other safety-related facilities to the subsurface materials; (3) logs of core borings and test pits; and (4) logs and maps of exploratory trenches in the application for a COL.

4. Geophysical Surveys: In meeting the requirements of 10 CFR 100.23, the presentation of the dynamic characteristics of soil or rock is acceptable if geophysical investigations have been performed at the site and the results obtained wherefrom are presented in detail.

5. Excavation and Backfill: In meeting the requirements of 10 CFR Part 50, the presentation of the data concerning excavation, backfill, and earthwork analyses is acceptable if: (1) the sources and quantities of backfill and borrow are identified and are shown to have been adequately investigated by borings, pits, and laboratory property and strength testing (dynamic and static) and these data are included, interpreted, and summarized; (2) the extent (horizontally and vertically) of all Category I excavations, fills, and slopes are clearly shown on plot plans and profiles; (3) compaction specifications and embankment and foundation designs are justified by field and laboratory tests and analyses to ensure stability and reliable performance; (4) the impact of compaction methods are incorporated into the structural design of the plant facilities; (5) quality control methods are discussed and the

quality assurance program described and referenced; (6) control of groundwater during excavation to preclude degradation of foundation materials and properties is described and referenced.

6. Ground Water Conditions: In meeting the requirements of 10 CFR Parts 50 and 100, the analysis of groundwater conditions is acceptable if the following are included in this subsection or cross-referenced to the appropriate subsections in SRP Section 2.4 of the SAR: (1) discussion of critical cases of groundwater conditions relative to the foundation settlement and stability of the safety-related facilities of the nuclear power plant; (2) plans for dewatering during construction and the impact of the dewatering on temporary and permanent structures; (3) analysis and interpretation of seepage and potential piping conditions during construction; (4) records of field and laboratory permeability tests as well as dewatering induced settlements; (5) history of groundwater fluctuations as determined by periodic monitoring of 16 local wells and piezometers.

7. Response of Soil and Rock to Dynamic Loading: In meeting the requirements of 10 CFR Parts 50 and 100, descriptions of the response of soil and rock to dynamic loading are acceptable if: (1) an investigation has been conducted and discussed to determine the effects of prior earthquakes on the soils and rocks in the vicinity of the site; (2) field seismic surveys (surface refraction and reflection and in-hole and cross-hole seismic explorations) have been accomplished and the data presented and interpreted to develop bounding P and S wave velocity profiles; (3) dynamic tests have been performed in the laboratory on undisturbed samples of the foundation soil and rock sufficient to develop strain-dependent modulus reduction and hysterietic damping properties of the soils and the results included.

8. Liquefaction Potential: In meeting the requirements of 10 CFR Parts 50 and 100, if the foundation materials at the site adjacent to and under Category I structures and facilities are saturated soils and the water table is above bedrock, then an analysis of the liquefaction potential at the site is required.

10. Static Stability: In meeting the requirements of 10 CFR Parts 50 and 100, the discussions of static analyses are acceptable if the stability of all safety-related facilities has been analyzed from a static stability standpoint including bearing capacity, rebound, settlement, and differential settlements under deadloads of fills and plant facilities, and lateral loading conditions.

11. Design Criteria: In meeting the requirements of 10 CFR Part 50, the discussion of criteria and design methods is acceptable if the criteria used for the design, the design methods employed, and the factors of safety obtained in the design analyses are described and a list of references presented.

12. Techniques to Improve Subsurface Conditions: In meeting the requirements of 10 CFR Part 50, the discussion of techniques to improve subsurface conditions is acceptable if plans, summaries of specifications, and methods of quality control are described for all techniques to be used to improve foundation conditions (such as grouting, vibroflotation, dental work, rock bolting, or anchors).

In addition, the geologic characteristics should be consistent with appropriate sections from: Regulatory Guide 1.27, “Ultimate Heat Sink for Nuclear Power Plants,” Regulatory Guide 1.28, “Quality Assurance Program Requirements (Design and Construction),” Regulatory Guide 1.132, “Site Investigations for Foundations of Nuclear Power Plants,” Regulatory Guide 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants," Regulatory Guide 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites," and Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

2.5.4.3 Technical Evaluation

This section discusses the staff's evaluation of the geotechnical investigations conducted by the applicant to evaluate the stability and determine the static and dynamic engineering properties of the subsurface materials and foundations at the site of VEGP Units 3 and 4, in particular with respect to the specific LWA activities requested. The applicant presented technical information in SSAR Section 2.5.4 resulting from field and laboratory investigations, data gathered during the ESP phase site investigations, and additional field and laboratory data from a COL level investigation in support of the LWA request. The applicant used the subsurface material properties from its field and laboratory testing to evaluate the site geotechnical conditions and to derive the design values for the ESP, LWA request, and COL application. The staff also identified, summarized and considered the applicant's responses to Requests for Additional Information (RAIs) and Open Items from the SER with Open Items.

2.5.4.3.1 Description of Site Geologic Features

SSAR Section 2.5.4.1 refers to SSAR Section 2.5.1.1 for a description of the regional and site geology. Section 2.5.1.3 of this SER presents the staff's evaluation of the regional and site geology.

2.5.4.3.2 Properties of Subsurface Materials

The staff focused its review of SSAR Section 2.5.4.2 on the applicant's description of the subsurface materials, field investigations and laboratory testing, and the static and dynamic engineering properties of the subsurface materials at the VEGP site. The applicant stated that the soils encountered during the ESP investigation, and during subsequent investigations supporting the LWA request and COL application, constitute alluvial and Coastal Plain deposits and were divided into three groups for stability of subsurface materials and foundation purposes; Group 1, the Upper Sand Stratum or Barnwell Group, which would be removed and replaced with structural backfill; Group 2, the Blue Bluff Marl Bearing Stratum or Lisbon Formation, which is the load bearing layer at the site; and Group 3, the Lower Sand Stratum, consisting of several formations. The Dunbarton Triassic (206 to 24 million years ago [mya]) basin rock, and the Paleozoic (543 to 248 mya) crystalline rock underlie the soil layers at the site. The applicant determined the static and dynamic properties of the three principal soil groups and compacted structural backfill through field investigations and laboratory testing performed in accordance with RG 1.138. The applicant performed grain size distribution (gradation), Atterberg Limits, natural moisture content, unit weight, and triaxial shear laboratory tests. The applicant concluded that the engineering properties obtained from the subsurface investigations and laboratory testing program were similar to those obtained from the previous VEGP Units 1 and 2 investigations. SSAR Table 2.5.4-1 summarizes the geotechnical features of the strata and their corresponding engineering properties as determined during the aforementioned investigations.

The staff's evaluation of the information provided in support of the ESP application is as follows:

In RAI 2.5.4-1, the staff asked the applicant to clarify the discrepancy in different SSAR sections on the number of borings drilled during the ESP field investigation. The applicant explained in its response that in one section it referred to the total number of borings as 14, which included the two borings without any sampling. In other SSAR sections, the applicant did not include these 2 additional borings. With this clarification, the staff considers RAI 2.5.4-1 resolved.

Geotechnical Parameters of the Lower Sand Stratum and the Blue Bluff Marl

In RAI 2.5.4-3, the staff asked the applicant to provide justification for developing geotechnical parameters for the Blue Bluff Marl and Lower Sand Stratum (the main load-bearing layers) using only the data from four borings with no significant sampling in the Lower Sand Stratum. In its response, the applicant stated that three ESP borings completely penetrated the Blue Bluff Marl and another nine borings extended partially into the marl. Among the three, borings B-1002 and B-1004 penetrated through the marl into the Still Branch and Congaree Formations and boring B-1003 went as deep as 407.8 meters (1,338 ft) into the bedrock. The applicant obtained a total of 58 SPT N-values and corresponding samples, as well as 12 tube samples from the Blue Bluff Marl and the Lower Sand Stratum, and performed P-S velocity logging in the three borings that penetrated the marl. In addition to its ESP investigation, the applicant stated that it considered the soil engineering properties from the previous investigations of Units 1 and 2.

From its review of SSAR Section 2.5.4 and the applicant's response to this and other RAIs, the staff found in the SER with Open Items that the applicant relied more on the previous investigations for the existing Units 1 and 2 than on its ESP field investigations to obtain geotechnical parameters for the ESP site. The staff determined that, while the applicant could use data from the previous investigations as a reference to support the current site characterization, the applicant should not have relied on the previous data to demonstrate the suitability of the ESP site because those data were generated by following different regulatory requirements, regulatory guidelines, and industry standards, and by using different investigation technologies. In addition, soil property variation between the two sites made reliance on the previous data inappropriate. Therefore, the staff concluded that the applicant did not conduct sufficient field and laboratory tests to reliably determine the subsurface soil static and dynamic properties for the soils beneath the Blue Bluff Marl at the ESP site. This was identified in the SER with Open Items as Open Item 2.5-11.

In response to Open Item 2.5-11, the applicant stated that the ESP investigations were intended for limited study of the site conducted in accordance with RS-002, "Processing Applications for Early Site Permits," and following the example of other recently accepted ESP studies. However, the applicant indicated that additional investigations were ongoing at the site as part of the COL investigation, including 68 power block borings, 42 of which penetrated the Blue Bluff Marl, as well as geophysical and laboratory testing, all of which were included in later revisions of the SSAR. The staff reviewed the guidelines of RS-002, as well as the additional borings and analyses conducted as part of the COL investigation and described in Revision 4 of the SSAR. Based on the inclusion of additional borings, which followed the guidance presented in RG 1.1.32 and RG 1.138, and which penetrated the load-bearing Blue Bluff Marl, the staff concludes that the applicant conducted sufficient field and laboratory tests at the site of VEGP Units 3 and 4 to adequately determine the static and dynamic property values included in Revision 4 of the SSAR. Based on this conclusion, the staff considers Open Item 2.5-11 closed. Furthermore, the closure of Open Item 2.5-11 also resolves the portions of RAI 2.5.4-3 that relate to the properties of subsurface materials at the site of VEGP Units 3 and 4.

In RAI 2.5.4-3, the staff also asked the applicant to explain the low SPT blow count values (as low as 9 bpf) in the Lower Sand Stratum below the Blue Bluff Marl, because low SPT blow count values often indicate the presence of soft soil layers. For comparison, the average blow count for the same layer is about 60 bpf. The applicant explained that this low SPT N-value (9 bpf) in the Lower Sand Stratum could be due to the existence of disturbed materials at the bottom of the drill hole because other geophysical measurements at the same depth showed no physical or strength abnormalities. After reviewing the applicant's response, the staff agreed that the disturbed materials at the bottom of the drill hole may have caused this anomalously low SPT value in the Lower Sand Stratum. However, because the Lower Sand Stratum is one of the load-bearing layers and the applicant was also committed to performing more borings during the COL stage, the staff considered that obtaining additional data on the Blue Bluff Marl and Lower Sand Stratum during the COL stage to confirm the absence of soft materials in these load-bearing layers would be acceptable. Accordingly, in the SER with Open Items, the staff identified this as COL Action Item 2.5-1.

However, in the revised SSAR, the applicant incorporated significant information obtained during the COL site investigations. The applicant included the results of additional subsurface borings, test pits, and SPTs. The staff reviewed this information and determines that none of the additional data provided as part of the applicant's COL investigation results suggests the presence of a soft material within the load-bearing layers at the VEGP Units 3 and 4 site. The inclusion of this information in the revised SSAR addresses the needs of COL Action Item 2.5-1. Therefore, the staff concludes that COL Action Item 2.5-1 is no longer necessary.

The staff considered the existence of the very low SPT N-values measured from the ESP field tests, and in RAI 2.5.4-3(c), asked the applicant to explain whether there were any indications of soft zones in the Upper Sand Stratum, such as those encountered at the SRS. In its response to RAI 2.5.4.-3(c), the applicant stated that it encountered "soft zones" with SPT N–values of 5 bpf in the Upper Sands at ESP boreholes B-1001, B-1004, B-1005, and B-1006. The applicant also stated that if these kinds of soil are saturated with water they would liquefy during certain seismic events, which may result in surface settlement of several inches. The applicant then referred to its RAI 2.5.4-2(a) response, which provided further details about the extent of the soil replacement in the power block area that would occur during the COL stage.

After reviewing the applicant's response to RAI 2.5.4-3, the staff concluded in the SER with Open Items that, because the extent of the excavation and backfill will be limited in both the vertical and horizontal directions at the ESP site, it was not clear from the response that the purpose of the placement of backfill material is to eliminate the existence of such soft zones located outside the foundation area. Although these soft zones are outside of the immediate foundation area, these soft zones can still have potential adverse impacts on the foundation and the structures of the nuclear power plant. In its response, the applicant committed to take six more deep borings (250 ft to 400 ft deep) during the COL subsurface investigation. Although this information was not necessary at the ESP stage to determine whether 10 CFR Part 100 is satisfied, the issue of confirming the locations of the soft zones and evaluating the potential impact of the soft zones on the foundation and structures was identified as COL Action Item 2.5-2 in the SER with Open Items.

However, in the revised SSAR, the applicant included the additional boring logs and data obtained as part of its COL site investigations, which the staff reviewed. The summary of this additional information can be found in Section 2.5.4.2.2 and 2.5.4.2.3, where the applicant stated that an additional 174 borings were completed as part of the COL investigations. The applicant used these additional borings to confirm the locations of soft zones within the Upper

Sand Stratum at the Unit 3 site, to evaluate the potential impact these zones would have on the stability of the plant foundations and safety-related structures, and to verify the ESP characterization of the Upper and Lower Sands, as well as to further validate the ESP characterization of the Blue Bluff Marl. Using this information, the applicant confirmed that the Upper Sand Stratum is too variable and potentially unstable a stratum and further supported the applicant's decision to completely remove the material. Since this information further confirmed the locations of soft zones within the site area, and addressed the minimum number of borings as requested by COL Action Item 2.5-2, the staff finds that COL Action Item 2.5-2 is no longer necessary.

Effective Angle of Internal Friction

In RAI 2.5.4-9, the staff asked the applicant to clarify how the effective angle of internal friction was determined for the soils underlying the ESP site. The applicant responded that it estimated the effective angle of internal friction of 34 degrees using an empirical correlation associated with SPT N-values (Bowles 1982). From its review of the applicant's response, the staff considered that the internal friction angle calculated based on SPT N-values varies significantly, depending on the correlations used. For example, for N-values between 10 and 40, the corresponding soil internal friction angle values vary from 30 degrees to 36 degrees (Peck 1974) or from 35 degrees to 40 degrees (Bowles 1982). More importantly, the N-values measured for the ESP site are all below 20 (from 3 to 19), according to SER Table 2.5.4-3. Therefore, the use of a friction angle of 34 degrees based on an N-value of 25 for the Upper Sand Stratum appeared to be inappropriate. In the SER with Open Items, the staff concluded that the applicant did not provide reliable effective angles of internal friction for the subsurface soils because it did not have sufficient SPT N-values from the ESP investigation to support its calculation. The internal friction angle for the subsurface soils is one of the input parameters in calculating bearing capacity and determination of earth pressure coefficients. Therefore, in the SER with Open Items, the issue regarding the effective angles of internal friction for the subsurface soils was designated as Open Item 2.5-14.

The applicant responded to Open Item 2.5-14 by stating that the effective angle of internal friction of the subsurface soils was estimated based on empirical correlations associated with SPT N-values. Furthermore, the applicant summarized the measured SPT N-values, noting that a large number of values were recorded in the Upper Sand Stratum, which would be removed during construction. Some N-values measured below the Upper Sand did not achieve a full 12 inches of penetration, which the applicant attributed to either the high relative density of the material encountered or the intact nature of the in-situ material. The applicant updated the SSAR to incorporate the additional COL investigation data, such as N-values and shear strength testing, which was used to verify the effective angle of internal friction.

The staff reviewed the response to Open Item 2.5-14, focusing its review on the additional data provided in the revised SSAR. In the revised SSAR, the applicant provided the effective angle of internal friction for both the Upper and Lower Sand Strata (34 and 41 degrees, respectively). The applicant used an empirical correlation associated with the average SPT N-values (Bowles 1982) from the ESP investigation, based on N60 equals 25 bpf, which the staff agrees is an acceptable method by which to determine the effective angle of internal friction. Based on the inclusion of the effective angles of internal friction in the revised SSAR, which were determined using an acceptable method of correlation to the empirical averages of Bowles, the staff considers Open Item 2.5-14 closed. The closure of Open Item 2.5.4-14 also resolves RAI 2.5.4-9.

High Strain Elastic Modulus

In RAI 2.5.4-11, the staff asked the applicant to explain: (1) why it used the Davie and Lewis' (1988) relationship to estimate the high strain elastic modulus (E) for the Upper and Lower Sand Strata underlying the ESP site; (2) what the consensus is about using the Davie and Lewis relationship between SPT and E; and (3) the extent of the application of the Davie and Lewis relationship. In response to RAI 2.5.4-11, the applicant stated that Bechtel used the Davie and Lewis relationship extensively to estimate settlement when compared to observed settlements for a wide range of foundation sizes on granular materials from clean sands to silty sands to gravels, such as the medium-dense, silty sand of the Upper Sand Stratum and the very dense silty sand of the Lower Sand Stratum. Therefore, the applicant believed that the Davie and Lewis relationship is applicable to the Lower Sands. In addition, the applicant found that the Davie and Lewis relationship provided an E value that was closer to the median value of five different relationships for both sand strata than were the four other E and N (the SPT N-value) relationships detailed in SER Table 2.5.4-5, which is taken from the applicant's response to RAI 2.5.4-11. The applicant also implied that Davie and Lewis' relationship provided reasonable predictions of settlement when compared to measured settlements, and with a reasonable consensus.

Table 2.5.4-5 - Summary of Calculation of Elastic Modulus E

Reference	Relationship	E, ksf	
		N = 25 bpf	N = 62 bpf
Bowles (1987)	E = 10 (N + 15) ksf	400	770
D'Appolonia et al. (1970)	E = 432 + 21.2N ksf	962	1,746
Parry (1971)	E = 100N ksf	2,500	6,200
Schmertman (1970) and Schmertman et al. (1978)	E = 30N to 50N ksf	750 to 1,250	1,860 to 3,100
Yoshida and Yoshinaka (1972)	E = 42N ksf	1,050	2,604
Median		**1,006**	**2,232**
Davie and Lewis (1988)	E = 36N ksf	900	2,232
Note: The references shown above are cited in Davie and Lewis (1988) and are listed at the end of the response to this RAI.			

Based on its review of the applicant's response to RAI 2.5.4-11, the staff concurs with the applicant's conclusion about the applicability of the Davie and Lewis' relationship in estimating elastic modulus. However, the applicant needed to use appropriate SPT N-values to obtain a reasonable E value. Since the N-values obtained from the ESP investigation and the design undrained shear strength values determined by the applicant for the ESP soils are not reliable for very limited data, the staff determined in the SER with Open Items that the applicant did not have sufficient site-specific data to justify the determination of the design parameter E for the Upper and Lower Sand Strata. Therefore, in the SER with Open Items, the issue of using appropriate SPT N-values to determine a reasonable elastic modulus value for the Upper and Lower Sand Strata was designated as Open Item 2.5-16.

In response to Open Item 2.5-16, the applicant referenced the guidance of RS-002 regarding the determination of the engineering properties of the soil and rock strata underlying the site. The applicant stated that the elastic modulus was derived from representative data collected during the ESP site investigation and the measured SPT N-values from the Lower Sand Stratum. Finally, the applicant conducted additional SPTs and provided the data in the revised SSAR.

The staff focused its review of the response to Open Item 2.5-16 on the additional information provided by the applicant in both the response and the revised SSAR, and on the guidance of RS-002. The applicant provided the derived elastic modulus for each of the subsurface strata at the VEGP Units 3 and 4 site (SSAR Table 2.5.4-1). Based on the inclusion in the revised SSAR of additional SPTs, which indicated the hard to very hard and the dense to very dense natures of the Blue Bluff Marl bearing stratum and the Lower Sand Stratum, respectively, from which the elastic modulus was derived, the staff concludes that the applicant has provided sufficient information to close Open Item 2.5-16. The closure of Open Item 2.5-16 also resolves RAI 2.5.4-11.

Determination of Unit Weight Values

In RAI 2.5.4-12, the staff asked the applicant to explain how unit weight values were determined for different soils and why there was a discrepancy between the average values given in the SSAR text and those listed in SSAR Table 2.5.4-1. The applicant explained in its response that the unit weight values were determined based on the laboratory test during the ESP subsurface investigation. However, the applicant used the average values of unit weight based on VEGP Unit 1 and 2 laboratory test results because there were more test data available, despite results that differed from those obtained from ESP tests. The staff considered that the unit weight values for underlying soils are very basic soil property parameters used in many calculations/analyses. However, the applicant did not have sufficient data to calculate the unit weight values for the ESP subsurface soils and instead used the values from previous investigations. In the SER with Open Items, the staff concluded that it was not acceptable for the applicant to use these previously determined engineering parameters in this manner. Accordingly, this issue was designated as Open Item 2.5-17 in the SER with Open Items.

In response to Open Item 2.5-17, the applicant provided the tabulated unit weight for 15 samples from the Blue Bluff Marl and 3 samples from the Lower Sand Stratum. The number of measurements was limited to be consistent with the scope of the ESP site investigation program as designed by the applicant. Additional unit weight measurements were included by the applicant in the revised SSAR and are provided in Table 2.5.4-1 of this SER.

In its review of the response to Open Item 2.5-17, the staff focused on the additional unit weight measurements provided in the revised SSAR Table 2.5.4-1. The staff also considered the description of these additional unit weight measurements and concludes that a sufficient number of samples was measured and that the value ranges of the samples tested are consistent for the sand, silt, and clay materials that were tested. Therefore, the staff concludes that the information provided by the applicant in the revised SSAR with respect to the unit weight measurements for the Blue Bluff Marl and Upper and Lower Sand Strata at the site is acceptable and follows the guidelines presented in RG 1.138. Accordingly, the staff considers Open Item 2.5-17 closed. This closure also resolves RAI 2.5.4-12.

Chemical Tests

The staff noted that, in SSAR Section 2.5.4.2.5.3, the applicant stated that chemical tests were not included in the ESP laboratory testing program. The applicant also stated in the SSAR that chemical tests would be required for the backfill materials placed in proximity of planned concrete foundations and buried metal piping, and the applicant committed to conduct these chemical tests in the COL investigation phase. Accordingly, the need to provide chemical test results on the backfill was identified as COL Action Item 2.5-3 in the SER with Open Items.

However, in a later revision to the SSAR, the applicant included additional information on the excavation and backfill plans for the site of VEGP Units 3 and 4, including the chemical tests performed on the backfill materials, the results of which are included in SSAR Appendix 2.5C. These plans and tests were evaluated by the staff as part of the information provided in support of the LWA request. Because the application now contains this information in the SSAR, the staff concludes that COL Action Item 2.5-3 is no longer necessary.

Blue Bluff Marl Design Shear Strength

In RAI 2.5.4-7, the staff asked the applicant to explain why the undrained shear strength values (7.2 kPa (150 psf) to 205.9 kPa (4,300 psf)) from the UU tests performed on the Blue Bluff Marl samples were significantly lower than the SSAR specified design value, 478.9 kPa (10,000 psf), and to explain why these values differed substantially from the values (12.0 kPa (250 psf) to 23,946.4 kPa (500,000 psf)) obtained from previous investigations conducted for Units 1 and 2. The staff also asked the applicant to justify the use of a 478.9 kPa (10,000 psf) design value based on the SPT N-values measured during the ESP investigations.

In response to RAI 2.5.4-7, the applicant stated that the laboratory measurements of undrained shear strength for the Blue Bluff Marl (Lisbon Formation) yielded low values because the tests were performed using one confining pressure corresponding to the overburden pressure. The applicant also listed some qualitative factors to explain why these laboratory values were low. These factors included (1) being unable to push the CPTs below the Barnwell Group and into the Lisbon Formation (Blue Bluff Marl), (2) Shelby tubes being unable to penetrate into the Lisbon Formation without being damaged, which indicated that the soils were very hard, and (3) possible disturbance of samples obtained by pitcher barrel due to sampling, storage, and transportation processes. For these reasons, the applicant adopted an undrained shear strength design value for the Blue Bluff Marl from the FSAR for VEGP Units 1 and 2. The applicant further provided empirical correlations between the PI value, SPT N-value, shear wave velocity, and the undrained shear strength to justify the use of the SSAR design value of 478.9 kPa (10,000 psf).

From its review of the applicant's response to RAI 2.5.4-7, the staff found in the SER with Open Items that the qualitative and quantitative information provided by the applicant did not justify the use of the SSAR design strength value of 478.9 kPa (10,000 psf) for the Blue Bluff Marl, based on the following five considerations:

1. The design strength value obtained from the previous investigation for Units 1 and 2 was generated using different regulatory requirements, different industry standards, and different testing technologies. The applicant can use the data or engineering values from the previous investigation as a reference to support the current decision, but may not use the data as a direct input to calculate engineering parameters or previous engineering values directly for the ESP site.

2. As for the qualitative reasoning presented by the applicant, being unable to push the CPT and Shelby tubes through the Blue Bluff Marl does not justify the applicant's use of a design strength value much higher than the values obtained from the testing. According to Appendix 2.5 A to the SSAR, because soil samples collected from the Blue Bluff Marl contain gravels, it is possible that the CPT and Shelby tubes engaged gravels causing it to be difficult for them to push through the soil. Therefore, this factor does not support the adoption of a specific value of 478.93 kPa (10,000 psf) as the design shear strength for the Blue Bluff Marl.

3. If, as the applicant implied, the samples used in the ESP tests were disturbed because of the sampling, storage, and transportation processes, then there would be no reliable ESP laboratory test results to support the determination of the design value for the ESP site.

4. The applicant did not justify the applicability of the empirical correlations used in its response, such as the correlations between the undrained shear strength and PI, N-value, or shear wave velocity. Specifically, Mayne (2006) developed the correlation between shear wave velocity and shear strength from one group of clays, and the applicant used this correlation in its response to RAI 2.5.4-7, but this correlation may not be applicable to the Blue Bluff Marl at the ESP site. Furthermore, Mayne recently recommended another correlation developed by Laval University Group (2007) based on data from three groups of clays. This correlation resulted in a lower shear strength value than the one originally developed by Mayne (2006).

5. Even if an empirical correlation is applicable, the applicant did not use appropriate input parameters. Instead, the applicant used inappropriate input parameters, based on very limited data, and values that vary significantly. For example, the design PI value of 25 is an average value based on 18 data points ranging from 5 to 58, with 3 points above 50. The applicant obtained the N-value 80 from a total of 58 samples; among the samples there were only 23 actual measured N-values, ranging from 27 to 81. The applicant extrapolated the N-values linearly for 35 measurements in which the sampler did not penetrate 12 inches, and most of those data ended up having the cutoff value of 100. As mentioned previously, most of the 35 SPT measurements did not penetrate 12 inches because the samplers were in contact with gravels. Therefore, the average N-value does not meaningfully represent the general soil properties due to the lack of actual measurement and possible gravel engagement during the SPT tests.

Based on the above considerations, the staff concluded in the SER with Open Items that the applicant did not provide sufficient data to reliably derive the undrained shear strength value for the Blue Bluff Marl for the design. Accordingly, this was identified as Open Item 2.5-12 in the SER with Open Items.

In response to Open Item 2.5-12, the applicant stated that SPTs and split-spoon sampling were conducted in almost all the ESP borings in accordance with ASTM D 1586 to provide a measure of the relative density for cohesionless soils and consistency for cohesive soils. The applicant also described the split-spoon sampling process, in which the sampler is driven into massive in-situ materials, converting the material to coarse-grained soils through the crushing process. The applicant indicated that it is this crushing process that was responsible for the high recorded N-value of the materials sampled. Although the applicant followed the guidance of Appendix X2 of ASTM D 2488 to identify the materials sampled during the ESP investigations, it acknowledged that this method has led to some confusion regarding the presence of gravel-sized particles taken from the borings. The applicant clarified this confusion by stating that gravel-sized particles were the result of the crushing process, and were not reflective of actual gravel encountered in the subsurface. The applicant also described ongoing laboratory tests (grain size distribution, Atterberg Limits, and carbonate content) that confirmed the visual reclassifications of the samples. Finally, the applicant revised the SSAR to include additional field and laboratory test results, which were used to verify the undrained shear strength of the Blue Bluff Marl.

The staff reviewed the information provided in response to Open Item 2.5-12. In particular, the staff focused on the applicant's classification of the crushed material from the split-spoon sampler in accordance with Appendix X2 of ASTM D 2488. The staff evaluated the applicant's explanation that no gravel was encountered in the subsurface, but that gravel-sized particles were produced from the crushing of more massive materials, such as micritic limestone or fossiliferous shale beds, which would explain the isolated occurrence of shell fragments in the subsurface investigations. The staff considers this a more likely explanation for the occurrence of "gravel-sized" particles resulting from sampling of the Blue Bluff Marl as this can happen when attempting to sample very hard material. And although this sampling method can produce "gravel-sized" particles, these "fragments" are not actual gravel and should not have been identified as such by the applicant. The applicant acknowledged this error and, in subsequent review of the sample material, was able to correctly identify the materials as resulting from the crushing of very hard massive materials. The staff also considered the additional field and laboratory tests included by the applicant in the revised SSAR as summarized in this SER. Based on the application of the appropriate ASTM guidance for reclassification of the gravel-sized particles encountered at the site, and the additional field and laboratory test results provided in the revised SSAR, in particular the Atterberg Limits and carbonate content tests indicating the presence of limestones and fossiliferous shales, the staff considers Open Item 2.5-12 closed. The closure of Open Item 2.5-12 also resolves the remaining issue from RAI 2.5.4-7.

In RAI 2.5.4-8, the staff asked the applicant for the following:

1. a description of the previous laboratory testing methods and results which indicate that the Blue Bluff Marl is highly preconsolidated,

2. justification for the assumption of an undrained shear strength of 766.3 kPa (16,000 psf) while the undrained unconsolidated test results yielded values from 7.2 to 205.9 kPa (150 to 4,300 psf).

3. justification for the conclusion that "the pre-consolidation pressure of the Blue Bluff Marl was estimated to be 3,831.4 kPa (80,000 psf)," and

4. justification for the conclusion that "settlements due to loadings from new structures would be small due to this pre-consolidation pressure" for the Blue Bluff Marl.

In its response to RAI 2.5.4-8, the applicant provided the following information:

1. The original data and interpretation were based on laboratory tests performed for VEGP Units 1 and 2, which included 191 one-point UU triaxial tests and 38 consolidation tests. The applicant used vertical pressures that reached 3,065 kPa (64000 psf) to perform consolidation tests for all 38 samples. Most of the test results (void ratio versus vertical effective stress curves) showed very flat curves, which indicated that the preconsolidation pressure had not been achieved.

2. The undrained shear strength of 766 kPa (16,000 psf) was an average value based on VEGP Unit 1 and 2 test data calculated from 185 one-point UU triaxial tests that disclosed undrained shear strength values of less than 2,394.6 kPa (50,000 psf).

3. The applicant used the Skempton (1957) method to estimate the preconsolidation pressure of the Blue Bluff Marl by relating the preconsolidation pressure to the PI value

and the undrained shear strength. The applicant concluded that the Lisbon Formation was highly overconsolidated because the calculations showed that the overconsolidation ratios (OCRs) were in the range of 3.6 to 5, and most of the consolidation test results on 38 samples from the Lisbon Formation, reported in Bechtel (1974b), showed very flat curves, which indicated that the preconsolidation pressure exceeded 3,065 kPa (64,000 psf).

4. The applicant also concluded that the settlement due to loadings from new structures would be small based on observation of VEGP Units 1 and 2 and that the settlements would take place during the construction phase.

Based on its review of the applicant's response to RAI 2.5.4-8, the staff found in the SER with Open Items that it was inappropriate to use the average undrained shear strength value for VEGP Units 1 and 2 as an input value to calculate preconsolidation pressure and OCRs for the Blue Bluff Marl at the ESP site because the previous value was obtained based on different regulatory requirements, regulatory guidelines, industry standards, and testing technologies. In addition, the spatial variation of the soil properties also made reliance on the VEGP Units 1 and 2 values inappropriate. Moreover, the previous shear strength value differs significantly from the one obtained during the ESP testing. Therefore, the applicant did not have sufficient sampling and testing results to reliably derive the input undrained shear strength used in calculating the preconsolidation pressure and OCRs of the Blue Bluff Marl. Accordingly, this was designated as Open Item 2.5-13 in the SER with Open Items.

In response to Open Item 2.5-13, the applicant stated that the ESP site investigation was limited in scope due to the depth of knowledge available based on VEGP Units 1 and 2. The applicant also noted that although the ESP borings disclosed field measurement data consistent with the previous investigations, there was some confusion regarding the material descriptions as was discussed in response to Open Item 2.5-12. The applicant clarified this issue in its revision to the SSAR, which also included calculations of preconsolidation pressure and overconsolidation ratios for the Blue Bluff Marl using additional test data from the ESP investigation.

The staff focused its review of Open Item 2.5-13 on the additional information provided in the revised SSAR related to preconsolidation pressure and the OCRs for the load-bearing Blue Bluff Marl. The staff also considered the closure of Open Item 2.5-12 as referenced in the applicant's response to Open Item 2.5-13. Based on the applicant's revisions to the SSAR to include preconsolidation pressure of 3,831 kPa (80,000 psf) and an OCR of 8 for the Blue Bluff Marl based on additional site investigations that indicated that settlements due to loadings from new structures would be small due to the high preconsolidation pressure, the staff concludes that the applicant has sufficiently addressed the calculations identified in Open Item 2.5-13 and therefore the staff considers Open Item 2.5-13 closed. Furthermore, the closure of Open Item 2.5-13 resolves RAI 2.5.4-8.

In RAI 2.5.4-10, the staff asked the applicant to provide the relative density of the Blue Bluff Marl. The applicant stated in its response that the design value of the undrained shear strength for the soil was 478.9 kPa (10,000 psf) and its preconsolidation pressure could be as high as 3,831 kPa (80,000 psf); therefore, the applicant concluded that the Blue Bluff Marl was highly overconsolidated and behaved as hard clay or soft rock material, not as a granular material. The applicant further stated that relative density does not apply to the Blue Bluff Marl. From its review of the applicant's response, the staff concluded in the SER with Open Items that test data for the Blue Bluff Marl were very limited. As described in the SSAR, the limited laboratory test data showed that the percent fines content ranged from 24 to 77 percent, the moisture content ranged from 14 to 67 percent, and the PI ranged from non-plastic to 58 percent. Each of the above-mentioned parameters does not exclude the possibility of the marl being liquefied. In addition, the undrained unconsolidated tests yielded undrained shear strength values from 7.2 to 205.9 kPa (150 to 4,300 psf), which significantly differ from the design shear strength value of 478.9 kPa (10,000 psf), as indicated in the discussion of RAI 2.5.4-7. Therefore, the applicant's response did not support the conclusion that the Blue Bluff Marl would behave as a hard clay or soft rock material because the applicant did not use the ESP soil engineering values to calculate relative density for the Blue Bluff Marl. Accordingly, the need to demonstrate that the Blue Bluff Marl would behave as a hard clay or soft rock material, and thus not need to be addressed using relative density, was designated as Open Item 2.5-15 in the SER with Open Items.

The applicant's response to Open Item 2.5-15 referenced the response to Open Item 2.5-12 and the confusion in subsurface material description. The applicant also stated that while it is technically correct to identify some Blue Bluff Marl samples as sands and gravels, this description does not accurately indicate the in-situ structure of the marl. The applicant conducted laboratory testing to evaluate the carbonate content of the marl materials previously identified as sands and gravels, which the applicant concluded were indicative of a soft rock or hard clay material with lesser amounts of coarse sand and no determinable gravel present. The applicant further stated that the material that was previously identified as gravel was reclassified as limestone fragments. Again, the applicant included the results of additional data and site investigations in the revised SSAR.

The staff considered both the applicant's response to Open Item 2.5-15 as well as the closure of Open Item 2.5-12, which was referenced therein. Since additional laboratory data and site investigations were provided in the revised SSAR that clarified the composition of the Blue Bluff Marl, and the staff concluded in Open Item 2.5-12 that there was no determinable gravel in the subsurface material, the staff concludes that the applicant has provided a sufficient explanation, including supporting data and analyses, to prove that the marl will behave as a hard clay or soft rock material at the ESP site. Based on the resolution of Open Item 2.5-12 and the additional information regarding to composition of the Blue Bluff Marl in the revised SSAR, the staff considers Open Item 2.5-15 closed. Furthermore, with the closure of Open Item 2.5-15, the staff also considers RAI 2.5.4-10 resolved.

Following the submittal of the revised SSAR and the LWA request, the staff issued further requests for additional information to address the supplemental information. These supplemental RAIs are evaluated throughout the following sections and are identified with an "S."

The staff's evaluation of the information provided in support of the LWA request is as follows:

Field Investigations

Similar to its request in RAI 2.5.4-1, in RAI 2.5.4-1S the staff asked the applicant to 1) clarify how it had arrived at the number of ESP soil borings as 174 and to provide a detailed accounting of these additional borings, and 2) identify how many of the penetrations would be unusable for the site-specific analyses because they were taken through the Upper Sand Stratum material that would be excavated and replaced. In response to RAI 2.5.4-1S, the applicant provided a table that broke the number of borings down by series number, subject (i.e., location within the site or specific structure), and the exact number of borings at the subject location. The table indicates that the applicant completed 40 borings in the Unit 3 power block and cooling tower area, and 37 in the Unit 4 power block and cooling tower area. The remaining 97 borings were distributed across the rest of the site of VEGP Units 3 and 4. With this information, the staff was able to account for the number of total borings and their locations within the site, and the staff accordingly considers Item 1 of RAI 2.5.4-1S resolved. Also in this response, the applicant stated that 70 soil borings were located in the immediate vicinity of the combined power block footprint with exploration depths varying from 6.5 to 128 m (21.5 to 420 ft). The applicant further explained that with the exception of two offset borings, each of these borings was drilled through Upper Sand Stratum and advanced into the Blue Bluff Marl. The applicant further stated that 42 of these 70 borings penetrated the Blue Bluff Marl and advanced into the Lower Sand Stratum. With this information, the staff considers Item 2 of RAI 2.5.4-1S resolved because, as the applicant advanced 68 of the 70 borings through the Upper Sand Stratum and into the underlying layers, almost every boring produced usable site-specific data. However, the applicant's response that only 42 borings penetrated the Blue Bluff Marl led the staff to request additional information identified as RAI 2.5.4-20S.

In RAI 2.5.4-20S, the staff asked the applicant to provide additional information to demonstrate that the 42 borings that penetrated the Blue Bluff Marl were sufficient to satisfy the site foundation criteria contained in Regulatory Guides 1.132 and 1.138, including the boring depth acceptance criteria. The staff also asked for clarification of the statement made in response to RAI 2.5.4-2S that only six of 70 borings penetrated the Lower Sand Stratum.

The applicant responded that, in keeping with RG 1.132, the borings were located beneath and adjacent to structures to provide the maximum aerial coverage, which resulted in a boring at the center of the safety-related structures and uniformly spaced inside and relatively close to the perimeter of the other power block structures. In the response to RAI 2.5.4-20S, the applicant provided a Table 1, Summary of COL Power Block Borings, which summarized the number of borings for each structure in each unit. The guidance in RG 1.132 for the density of site borings is one boring per 929 square meters (10,000 square feet): however, the applicant determined the density of its borings to be one boring per 501 square m (5,400 square ft). Regarding the boring depth acceptance criteria in RG 1.132, Appendix D of the RG states that "dmax, may be taken as the depth at which the change in the vertical stress during or after construction for the combined foundation loading is less than 10 [percent] of the effective in-situ overburden stress." The applicant noted that the foundation that will have the largest dmax is the nuclear island base mat. Based on the AP1000 DCD Revision 15 design bearing pressure under the base mat of 412 kPa (8.6 ksf), the applicant determined that the nuclear island base mat dmax is on the order of 82 m (270 ft). The applicant noted that three borings were drilled at each unit to a depth of at least 76 m (250 ft), and one boring at Unit 3 was drilled to a depth of 128 m (420 ft) while the deepest boring at Unit 4 was to a depth of 122 m (400 ft). As for other power block structures, the applicant noted that the other structures located in the power block were founded nominally at the surface, and that the exploration depth of the borings for these structures was generally 45.7 m (150 ft).

After considering the clarifications and additional information presented by the applicant concerning the RG 1.132 guidelines for boring spacing, depth, and density, the staff has determined that the applicant's response is sufficient to address the location of borings beneath and adjacent to structures to provide the maximum aerial coverage, the density of required borings, and the minimum depth requirements for boreholes because 1) the applicant exceeded the RG 1.132 guidance for density of site borings, 2) the applicant advanced a boring within each nuclear island power block to a depth well in excess of the RG 1.132 guidance for dmax, and 3) the applicant met the intent of the RG 1.132 guidance for spacing by locating a boring at the center of the safety-related structures and by uniformly spacing other borings around the inside and relatively close to the perimeter of the other power block structures.

With respect to the guidelines of RG 1.138, the applicant explained that specific guidance about the number of tests that should be performed was not provided in RG 1.138. In response to the RAI, the applicant provided the staff with a table that summarized the COL power block borings for each structure in each unit. Regarding the applicant's response concerning the laboratory testing guidelines in RG 1.138, the staff agrees with the applicant's statement that the RG does not provide specific guidance about the numbers of laboratory tests that should be performed and that this is most likely because the numbers and types of tests depend on various site-specific factors such as the location of borings with respect to significant structures, the depth of sampling (e.g., it may be within a zone of excavation), the type of sample materials (cohesive, cohesionless, soil or rock), and the sample type (disturbed or undisturbed). The RG states that the focus of laboratory investigations should depend on the design requirements and nature of problems encountered or suspected at the site (i.e., some level of determination about the types and quantities of testing needs to be left to professional judgment by the onsite personnel). The staff determined by its review of the applicant's referenced tables, in particular SSAR Tables 2.5.4-3, 2.5.4-3a, and 2.5.4-4, "Types and Numbers of Laboratory Tests for the ESP and COL Investigations and Summary of Laboratory Tests Performed on Selected Soils Samples", that summarize the laboratory test results performed on ESP boring samples, that the applicant has conducted a laboratory testing program sufficient to adequately characterize the engineering properties of the subsurface materials. The staff reached this determination because the laboratory testing program conducted by the applicant included a variety of conventional index (tests that determine the properties of soils that indicate the type and condition of soils and provide a relationship to structural properties such as strength, compressibility, permeability, swelling potential, e.g., particle size distribution and consistency limits) and geotechnical engineering tests as well as dynamic soil test (RCTS) such that the applicant was able to sufficiently characterize the properties of the site soils for the purpose of evaluating the stability of the site for the applicant's planned construction. Finally, the applicant stated that the listed number of borings penetrating the Lower Sand Stratum was a typographical error. Therefore, based on the applicant's responses to RAIs 2.5.4-1S and 2.5.4-20S, the staff concludes that these RAIs were adequately addressed by the applicant and considers them resolved.

Shear Wave Velocity Profiles

In RAI 2.5.4-4S, the staff requested that the applicant provide an assessment of the in-situ velocity profile through the Upper Sand Stratum. The applicant described the additional laboratory strength testing and shear wave velocity measurements performed in the Upper Sand Stratum in the power block and surrounding areas as part of its COL investigations. Figure 2.5.4-3 of this SER shows the in-situ shear wave velocity profile through the Upper Sand Stratum to the Dunbarton Triassic Basin rock. The applicant provided the test results of the laboratory strength testing, which included 10 consolidated undrained triaxial shear tests from relatively undisturbed Upper Sand Stratum samples, Atterberg Limits and chemical tests, and a plot of shear wave velocity measurements in the stratum. In follow-up RAI 2.5.4-23S, the staff asked the applicant to provide justification as to why the two-dimensional (2D) wave velocity consideration was not considered in the SSI analysis.

The staff reviewed the response to RAI 2.5.4-4S as it related to geotechnical engineering, especially the additional strength and shear wave velocity measurements included in the revised SSAR, and concludes that the applicant provided sufficient information to close the geotechnical engineering aspects of RAI 2.5.4-4S because the additional laboratory test results, particularly the Atterberg Limits, confirmed the variable nature of the Upper Sand Stratum and its corresponding low shear strength. Furthermore, the applicant collected additional shear wave velocity data in the Upper Sand Stratum that displayed values over a large range but generally below the required minimum of 304.8 m/s (1,000 fps), which also confirmed the variable nature of the Upper Sand Stratum materials and further validated the applicant's decision to completely remove this stratum. Since the response to RAI 2.5.4-23S specifically addresses structural engineering aspects at the VEGP Units 3 and 4 site, the staff evaluates the response in Section 3.8 of this SER.

The site characteristic values of shear wave velocities were specified for depth intervals and are given in Appendix A to this SER and SER Tables 2.5.4-6 and 2.5.4-7. The applicant determined these characteristic values from the geophysical surveys completed at the VEGP site. Because the values were determined from the results of the applicant's geophysical surveys, which the staff reviewed and found to be acceptable in Section 2.5.4.3.4 of this SER, the staff concludes that these values are acceptable for use as the site characteristics.

Table 2.5.4-6 Shear Wave Velocity for ESP Site Amplification Analysis

Geologic Formation	Depth (feet)	V_s (fps)
Compacted Backfill	0 to 6	573
	6 to 10	732
	10 to 14	811
	14 to 18	871
	18 to 23	927
	23 to 29	983
	29 to 36	1,040
	36 to 43	1,092
	43 to 50	1,137
	50 to 56	1,175
	56 to 63	1,209
	63 to 71	1,232
	71 to 79	1,253
	79 to 86	1,273
Blue Bluff Marl (Lisbon Formation)	86 to 92	1,400
	92 to 97	1,700
	97 to 102	2,100
	102 to 105	1,700
	105 to 111	2,200
	111 to 123	2,350
	123 to 149	2,650
Lower Sand Stratum (Still Branch)	149 to 156	2,000
	156 to 216	1,650
(Congaree)	216 to 331	1,950
(Snapp)	331 to 438	2,050
(Black Mingo)	438 to 477	2,350
(Steel Creek)	477 to 587	2,650
(Gaillard/Black Creek)	587 to 798	2,850
(Pio Nono)	798 to 858	2,870
(Cape Fear)	858 to 1,049	2,710
Dunbarton Triassic Basin & Paleozoic Crystalline Rock	> 1,049	see Table 2.5.4-11, Part B

Table 2.5.4-6 Continued, Six Alternate Profiles

Part B: Rock Shear-Wave Velocities - Six Alternate Profiles

	Vs (ft/s)	
Depth (ft)	Gradient #1	Gradient #2
1,049 to 1,100	4,400	4,400
1,100 to 1,150	5,650	5,650
1,150 to 1,225	6,650	6,650
1,225 to 1,337.5	7,600	7,600
1,337.5 to 1,402.5	8,000	8,700
1,402.5 to 1,405	8,005	8,703
1,405 to 1,525	8,059	8,739
> 1,525	9,200	9,200

Rock Vs profile corresponding to the location midway between B-1002 and B-1003.

	Vs (ft/s)	
Depth (ft)	Gradient #1	Gradient #2
1,049 to 1,100	4,400	4,400
1,100 to 1,150	5,650	5,650
1,150 to 1,225	6,650	6,650
1,225 to 1,337.5	7,600	7,600
1,337.5 to 1,450	8,000	8,700
1,450 to 1,550	8,090	8,760
1,550 to 1,650	8,180	8,820
1,650 to 1,750	8,270	8,880
1,750 to 1,830	8,360	8,940
1,830 1,900	8,414	8,976
> 1,900	9,200	9,200

Rock Vs profile corresponding to the location of B-1003.

	Vs (ft/s)	
Depth (ft)	Gradient #1	Gradient #2
1,049 to 1,100	4,400	4,400
1,100 to 1,150	5,650	5,650
1,150 to 1,225	6,650	6,650
1,225 to 1,337.5	7,600	7,600
1,337.5 to 1,450	8,000	8,700
1,450 to 1,550	8,090	8,760
1,550 to 1,650	8,180	8,820
1,650 to 1,750	8,270	8,880
1,750 to 1,850	8,360	8,940
1,850 to 1,950	8,450	9,000
1,950 to 2,050	8,540	9,060
2,050 to 2,127.5	8,630	9,120
2,127.5 to 2,155	8,679.5	9,153
2,155 to 2,275	8,733.5	9,189
> 2,275	9,200	9,200

Table 2.5.4-7 Shear Wave Velocity for COL Site Amplification Analysis

Geologic Formation	Depth (feet) (ft)	V_s (fps) (fps)
Compacted Backfill	0	550
	5	724
	10	832
	20	975
	30	1064
	40	1130
	50	1183
	60	1228
	70	1267
	80	1302
	85	1318
	86.5	1327
	88	1327
Blue Bluff Marl (Lisbon Formation)	88 to 96	1,341
	96 to 102	1,747
	102 to 110	1,988
	110 to 122	2,300
	122 to 156	2,541
Lower Sand Stratum (Still Branch)	156 to 164	1,820
	164 to 220	1,560
(Congaree)	220 to 236	1,757
	236 to 280	2,000
	280 to 328	1,926
	328 to 340	1,727
(Snapp)	340 to 447	2,050
(Black Mingo)	447 to 486	2,350
(Steel Creek)	486 to 596	2,650
(Gaillard/Black Creek)	596 to 807	2,850
(Pio Nono)	807 to 867	2,870
(Cape Fear)	867 to 1,059	2,710

Geotechnical Properties of the Lower Sand Stratum

In RAI 2.5.4-5S, the staff noted that, during its review of the ESP application, some samples below the Blue Bluff Marl were identified as having extremely low blow counts, which called into question the adequacy of the soil material for settlement and bearing capacity. The staff also noted that, although the applicant indicated through informal discussions that these low blow counts were anomalies, the LWA request did not contain an adequate discussion of this anomalous conclusion. Therefore, the staff requested that the applicant provide the basis for the conclusion that the samples with low blow counts were anomalies.

In response, the applicant stated that 42 borings in the power block area penetrated the Blue Bluff Marl, 611 linear feet of drilling was conducted in the Lower Sand Stratum, and 111 SPT split barrel samples were collected from the Lower Sands. The applicant reported that the average corrected blow count reading in the Lower Sand Stratum was 250 bpm (75 bpf), indicative of a very high relative density. The applicant also stated that, with the exception of one value, all of the N60-values taken in the Lower Sand Stratum were greater than 30 bpf, again indicative of a dense to very dense material, although one N-value from a sample taken in the Still Branch Formation of the Lower Sand Stratum at an elevation of -12.6 to -13.1 m (-41.5 to -43 ft), and from which the split barrel sampler was unable to recover a sample, indicated very loose material. The applicant attempted to take an undisturbed sample (UD-11) from elevation -39.5 to -41.5, but no recovery was obtained in this sample. Since the applicant identified the material above this elevation as light gray sand (SP), the difficulty in sampling this material and the weight of hammer reading was an anomaly in sampling that was attributed to disturbed soil conditions at the bottom of the borehole. The applicant surmised that these conditions were likely the result of a hydrostatic pressure imbalance between the borehole and the in-situ hydrostatic pressure, with the resulting imbalance causing a quick condition to develop in the poorly graded sands at the attempted sampling depth. In such circumstances, the resulting disturbed poorly-graded sand will flow out of the sampler, which makes the material difficult to sample, as the applicant appears to have experienced in its lack of sample recovery at that depth. Overall, the applicant concluded that the SPT N-values behaved as expected by increasing with depth. Based on the applicant's response to RAI 2.5.4-5S and because the applicant encountered no other evidence of soft zones or loose material in the 611 linear feet of drilling conducted in the Lower Sand Stratum, the staff concurs with the applicant's explanation that it likely encountered an anomalous condition during sampling at this depth, as such a condition is not an unusual occurrence when attempting to sample very granular material. Therefore, the staff considers RAI 2.5.4-5S resolved. This explanation also addresses COL Action Item 2.5-2, concerning the location and extent of soft zones, which was resolved earlier in this section of the SER.

Geotechnical Properties of the Blue Bluff Marl

The staff identified multiple RAIs related to the properties of the Blue Bluff Marl (BBM).
In RAI 2.5.4-2S, the staff requested that the applicant provide a description of the borings that penetrated into and through the BBM, of the number and types of samples recovered, as well as of the material underlying the BBM. In response to RAI 2.5.4-2S, the applicant stated that 70 borings were taken in the power block area; 42 of these borings penetrated the BBM, accounting for 863 linear m (2,831 linear ft) of drilling in this stratum. Additionally, seven hundred and forty-two SPT split barrel samples (disturbed samples) were obtained in the BBM, for which the applicant presented figures of the SPT N60 values and shear wave velocity measurements. From these SPT data, the applicant recorded an average N-value of 233 blows

per meter (70 blows per foot) with a median value of 240 bpm (72 bpf); the average N60-value is 96. The applicant stated that nearly all of the SPT N60 values from the BBM were greater than 100 bpm (30 bpf). Additionally, the applicant stated that the number of borings penetrating the underlying Lower Sands (LS) was six of seventy, which accounted for 186 linear meters (611 linear ft) of drilling in this stratum. The number of borings that penetrated the Lower Sands was addressed in follow-up RAI 2.5.4-20S, which was previously discussed earlier in this section of the SER.

In follow-up RAI 2.5.4-21S, the staff requested that the applicant provide clarification of how the formulas provided in the response to RAI 2.5.4-2S were used to obtain corrected SPT blow counts. The applicant responded that the formula included in the response was provided as an explanation of how the measured N-values were interpreted in cases where full penetration of the 0.45 m (18-inch) sampler was not achieved due to the presence of very dense and very hard material, which occurred primarily in the BBM. The applicant clarified its conservative approach, which involved interpreting high measured N-values by recomputing the measured N-values using a simpler more intuitive approach; the applicant performed this recomputing where full penetration of the split barrel sample was not achieved due to very hard or very dense material. The applicant noted that the recomputation would not impact the majority of measured N-values where full penetration of the split barrel sampler was achieved, and where full penetration was not achieved because of the hardness or high relative density of the soil, the majority of computed N-values would be at the capped value of 333 bpm (100 bpf). The staff agrees with the applicant's recomputation of the N-values where the applicant was unable to achieve full penetration due to the very hard nature of the marl stratum, as this only affects a relatively small number of the total values measured, and the capped values are still indicative of a very dense or hard material that is the marl stratum. The recomputed and replotted data was included in the ESP Revision 4 for staff's review. Based on the review of the data presented in response to RAIs 2.5.4-2S and 2.5.4-21S, the staff found that the applicant provided sufficient data to enable the staff to determine that the applicant adequately sampled and tested the BBM Stratum and clarified the method used to correct SPT blow counts. Accordingly, the staff considers RAIs 2.5.4-2S and 2.5.4-21S resolved.

In RAI 2.5.4-3S, the staff asked the applicant to demonstrate how BBM samples were obtained and what degree of disturbance was involved. In response, the applicant stated that soil borings into the BBM were drilled using mud rotary methods and SPT tests; split barrel soil sampling was conducted in accordance with ASTM D 1586, generally at 1.5 m (5 ft) intervals. The applicant noted that many of the split barrel samples obtained from harder layers or lenses within the marl were fractured by the sampling process, and some of these samples had the appearance of angular sands or gravels. The applicant obtained relatively undisturbed (intact) soil samples using a three inch diameter thin-walled Shelby tube sampler in accordance with ASTM D 1587. The applicant stated that, in general, the samples taken in the Upper Sands were obtained through the direct push method, whereas samples taken in the BBM and Lower Sands were obtained using a Pitcher sampler, which is recommended for hard or dense soils and soft rocks, in accordance with ASTM D 6169, due to the very hard/dense nature of these materials. The applicant also stated that undisturbed samples and tubes were inspected, sealed, and transported to the climate-controlled on-site storage area following ASTM D 4220 guidelines, and samples were transported to various off-site testing laboratories according to the applicant-approved subcontractor procedures for sample transportation, including transporting RCTS samples by automobile to Houston, Texas.

In follow-up RAI 2.5.4-22S, the staff asked the applicant to provide a description of the approved transportation procedures used to move RCTS samples from the site to a test facility. In response, the applicant provided a copy of the applicant-approved subcontractor procedure (work instruction) for transporting undisturbed samples by automobile, which the staff determined provided adequate instructions for handling and securing the samples during transportation, consistent with standard industry and ASTM guidelines. Based on its review of the applicant's response, the staff finds that the applicant demonstrated its use of appropriate material sampling techniques using acceptable industry practices or standards. Therefore, the staff considers RAIs 2.5.4-3S and 2.5.4-22S resolved.

In RAI 2.5.4-6S, the staff asked the applicant to provide the basis for its determination of the design value for cohesion of the BBM of 478 kPa (10,000 psf) and to explain how this value is to be used. The staff indicated that it is important to understand the basis for this evaluation, whether any laboratory test data was available to support the proposed design value, and where in the facility evaluation the parameter would be used.

In response, the applicant reiterated that the design value of 478 kPa (10,000 psf) for cohesion of the BBM was based on evaluating empirical correlations and laboratory test data from the ESP geotechnical investigation that was previously presented in response to RAI 2.5.4-7. The applicant also stated that this design value for cohesion of the BBM was based on evaluating empirical correlations and laboratory test data from the ESP geotechnical investigation, including 15 UU tests. The applicant collected additional data during the COL investigation to verify the design value developed during the ESP investigation. The applicant conducted UU and CU triaxial tests at various confining pressures, with results suggesting that the shear strength of the BBM increased with confining pressure as expected. The applicant stated that the marl is located at an approximate depth of 27 to 50 m (90 to 165 ft) with a design ground water level at a depth of 16.7 m (55 ft), and a range of confining pressures, based on overburden conditions, of 320 to 646 kPa (6,500 and 9,700 psf). The applicant noted that within this range, UU test results yielded minimum shear strength of 81 kPa (1,700 psf) and a maximum of 560 kPa (11,700 psf) while the CU test resulted in a minimum value of 134 kPa (2,800 psf) and a maximum value of 1,541 kPa (32,200 psf) for shear strength at the range of confining pressure. The applicant also noted that previously determined confining pressures corresponded to the upper limit of 766 kPa (16,000 psf) used in conducting the UU and CU triaxial tests, and at the higher confining pressure, the average UU and CU test results are 411 and 713 kPa (8,600 and 14,900 psf), respectively. From a review of the field and laboratory test data, the applicant concluded that, regarding the design undrained strength value of 478 kPa (10,000 psf), UU and CU tests conducted at confining pressures of 766 kPa (16,000 psf), empirical correlation with N-values, and empirical correlation with shear wave velocity, all support the design value of 478 kPa (10,000 psf).

The applicant used undrained shear strength of the marl stratum to evaluate the bearing capacity of the nuclear island, incorporating the shear strength value into the calculation of allowable bearing pressure through superposition, as follows from the RAI response:

$$qo = c \cdot Nc \cdot \zeta c + q \cdot (Nq) \cdot \zeta q + 0.5 \cdot \gamma' \cdot B \cdot N\gamma \cdot \zeta\gamma \quad (1)$$

where: qo = ultimate bearing pressure (ksf)
c = soil cohesion (ksf)
q = effective overburden pressure at bottom of foundation level (ksf)
γ' = effective unit weight of soil (kcf)
B = foundation width (ft) = 101 ft
L = foundation length (ft) = 254 ft
Nc, Nq, $N\gamma$ = bearing capacity factor

$\zeta c, \zeta q, \zeta\gamma$ = foundation shape factor

In this superposition analysis, the foundation is placed on a "strong" layer (compacted structural fill) that is underlain by a "weaker" layer (BBM). The capacity of the "strong" layer is evaluated alone to obtain qo'. The capacity of the "weaker" layer is evaluated alone to obtain qo". The governing capacity, q, is determined by evaluating the effect of the "weaker" layer on the bearing capacity by the following equation:

qo = qo".exp{0.67.[1+(B/L)].(H/B)} (2)
qa = qoFS, with Factor of Safety (FS) = 3

where: qo" = ultimate bearing pressure of the foundation sitting on the surface of the Blue Bluff Marl (ksf)

H = thickness of compacted structural fill between the bottom of the foundation and the top of the BBM (ft) (H=43.5ft)

qo = ultimate bearing pressure at the foundation level

qa = allowable bearing pressure at the foundation level

For the "strong" (backfill) layer where: Φ = 34o, γ'moist = 120 pcf, γ'sat = 130 pcf

Nc = 42.16	Nq 2 9.44	Nγ = 41.06
ζc = 1.28	ζq =1.27	ζγ =0.84
q = 4.74 ksf	γ'= 0.076 kcf	

From equation (1)
qo'=0.0 x 42.16 x 1.28 + 4.74 x (29.44) x 1.27 + 0.5 x 0.076 x 101 x 41.06 x 0.84 ≈ 0 + 177.2 +132.4 = 309.6 ksf

For the "weak" (Blue Bluff Marl) layer where: c = 10 ksf

Nc= 5.14	Nq 1.0	Nγ= 0.0	ζc= 1.08
ζq = 1.0	ζy= 0.84	q = 8.49 ksf	

From equation (1)
qo" = 10 x 5.14 x 1.08 + 8.49 x (1.0) x 1 = 55.5 + 8.5 = 64 ksf.

Through superposition using equation (2), the ultimate bearing pressure at the foundation level is:
qo = 64 x exp{0.67 x [1+(101/254)] x (43.5/101)) = 95.8 ksf

Thus, with a factor of safety of 3 and the su of the BBM = 10 ksf, the allowable bearing pressure at the foundation level is:
qa = 95.8/3 or 31.9 ksf

The applicant explained that it used the same method to evaluate the allowable bearing pressure for other pressures as well. Based on the AP1000 standard design, where foundation pressure is 411 kPa (8,600 psf), the applicant provided additional consideration of contact pressure of the foundation and contact pressure projected to the top of the BBM. The applicant explained its methodology as follows:

Foundation Load = area x foundation pressure = 254ft x 101ft x 8.6ksf = 220,625 kips

Foundation pressure influence at the top of BBM =
Foundation Load / projected area, so
220,625 / (297.5ft x 144.5ft) = 5.1 ksf

Where: projected area = {(L + 2(H x s)) x (W + 2(H x s))}
H = 43.5 ft
s = slope of zone of influence (lv:2h) = 0.5

In conclusion, the influence of the foundation load decreases with depth such that at the top of the BBM, the load has diminished by 41 percent (5.1/8.6). Based on the above, using su = 10 ksf for the BBM:

- With the NI founded on the fill, the FS against bearing failure is 958/5.1 = 18.8
- With the NI founded directly on the BBM, FS = 64/8.6 = 7.4

Using su = 6.5 ksf for the BBM:

- With the NI founded on the fill, the FS = 66.8/5.1 = 13.1
- With the NI founded directly on the BBM, FS = 44.6/8.6 = 5.2

Based on the applicant's response to RAI 2.5.4-6S, including the calculations the applicant presented in its response, the staff concludes that the applicant adequately explained the basis for the determination of the 14.8 kPa (10,000 psf) design value. This conclusion is based on data and assessments provided by the applicant, as verified by the staff's confirmatory calculations and review of the laboratory triaxial test data provided in SSAR Revision 4. Furthermore, based on the applicant's response and review of the calculations presented, the staff concludes that the applicant explained how the 478 kPa (10,000 psf) design value will be used in the calculation of a factor of safety against bearing failure. However, although the staff was able to resolve most issues related to RAI 2.5.4-6S, the staff noted some areas of additional concern. The staff noted that the applicant's response to the RAI addressed only static bearing capacity evaluations for failure conditions; settlement considerations, which normally control the allowable pressures under large rigid basemats, were not included in the calculations. The staff also noted that the response did not address dynamic effects, which are the overwhelming effects on the computed toe pressures, and the staff requested the additional information. In follow-up RAI 2.5.4-24S, the staff requested that the applicant provide information addressing settlement considerations for static bearing capacity evaluations, and dynamic effects on the computed toe pressures.

In response to RAI 2.5.4-24S, the applicant stated that additional static and dynamic bearing capacity evaluations were underway, including localized punching failure of backfill materials supporting the nuclear island. The applicant conducted these assessments as part of the Phase 1 test pad program and used conventional analyses assuming safety factors of 3 and 2, for static and dynamic bearing capacity, respectively. Finally, the applicant evaluated settlement characteristics of the site and included all results in the revised SSAR.

The staff reviewed the applicant's response to RAI 2.5.4-24S, in particular the additional information and evaluations provided in the revised SSAR. The applicant stated that the soils supporting the nuclear islands did not exhibit extreme variations in subgrade stiffness and that the proposed Vogtle site could be considered uniform. The applicant presented in Section 2.5.4.2.2.2 that subsurface data has disclosed that the Blue Bluff Marl has a nearly even top over the length of the excavation footprints with relatively uniform thickness and consistent properties. Over this will be placed approximately 27.4 m (90 ft) of structural backfill that will be placed and compacted in level uniform lifts or layers. Results of the Phase 1 and 2 test pad program disclosed that the materials proposed for structural backfill have consistent engineering properties including density, shear wave velocity and N-values.

The applicant stated in SSAR Revision 4 that it based its allowable static bearing capacity values on Terzaghi's bearing capacity equations using an internal angle of friction of 36 degrees for the compacted backfill as developed from their field and laboratory testing program during the Phase 1 test pad program and COL investigation. The applicant evaluated the influence of the Blue Bluff Marl on the allowable bearing pressure using procedures outlined by Vesic, procedures which are acceptable to the staff as they are in common use. With a factor of safety of 3.0, the applicant determined that the site conditions provide an allowable bearing pressure of 1,628 kPa (34 ksf) under static loading conditions for the nuclear island. The staff concurs with this determination because the applicant used equations from Terzaghi and procedures from Vesic that are commonly used and widely accepted industry method.

The applicant also evaluated the allowable bearing capacity of the nuclear island under dynamic loading conditions, and again the methods of analysis were based on Terzaghi's bearing capacity equation for general shear using seismic bearing capacity factors from Soubra and Terzaghi's bearing capacity equation for local shear. Using a factor of safety of 2.25, the applicant determined that the site conditions provided an allowable bearing pressure of 2,011 kPa (42 ksf) under dynamic loading conditions for the nuclear island. Both the static and dynamic bearing capacity values are well below the minimums specified in Revision 15 of the AP1000 DCD. The staff concurs with the determination because again the applicant used widely accepted equations and factors for such evaluations.

Finally, the applicant conducted laboratory consolidation tests on relatively undisturbed samples of the Blue Bluff Marl and the Lower Sand Stratum, and the results confirmed the elastic behavior and very stiff and dense nature of the two strata. Also, the applicant's test pad program assessed the properties of the proposed compacted backfill and the results confirmed the very dense nature of the materials and showed that the expected performance under load will be similar to VEGP Units 1 and 2. The applicant performed a detailed settlement analysis using similar elastic properties used for the VEGP Units 1 and 2 and incorporated excavation, dewatering, and construction duration to determine basemat displacement histories. The applicant stated that the results predicted total settlement ranges of from 5.08 to 7.62 cm (2 to 3 inches), with an approximate tilt of .635 cm in 15.24 m (¼ inch in 50 ft), and a differential settlement between structures of less than 2.54 cm (1 inch). The applicant noted that these results are similar to actual movements measured for VEGP Units 1 and 2.

The staff concludes that the applicant provided sufficient information in response to RAI 2.5.4-24S to address both the static and dynamic bearing capacities for the materials supporting the nuclear island as it presented results based on site-specific test results input into equations and factors commonly in use to determine bearing capacities and settlements. Therefore, the staff considers RAI 2.5.4-24S closed. Furthermore, the closure of RAI 2.5.4-24S also resolves RAI 2.5.4-6S.

The staff finds that the applicant conducted a subsurface investigation program consistent with the guidelines presented in RG 1.132 to adequately characterize the subsurface conditions and materials, and it performed laboratory testing consistent with the guidelines presented in RG 1.138 to adequately determine the engineering properties of the subsurface materials and used the results to perform analysis to predict how the site conditions will support the AP1000 design requirements as presented in Revision 15 of the AP1000 DCD. Based on the information and findings above, including the resolution of RAIs, and the closure of Open Items, the staff concludes that the discussion of the properties of Subsurface Materials is acceptable.

The applicant determined the static and dynamic properties of the three principal soil groups and compacted structural backfill through its field investigations and through laboratory testing performed in accordance with RG 1.138. The staff concludes that the applicant complied with the relevant guidance of RG 1.138.

In Revision 4 of the VEGP SSAR, the applicant included information on the chemical tests performed on the engineered backfill for the VEGP Units 3 and 4 site. These tests are summarized in Section 2.5.4.2.2 of this SER and Subsection 2.5.4.2.5.3 of the SSAR, and included pH, chloride, and sulfate tests. The applicant stated that, due to the high concentration of sulfate in the Upper Sand Stratum, switchyard and borrow area 4, the concrete placed at the site would face mild exposure to sulfate attack. However, since the most potentially corrosive unit, the Upper Sand Stratum, would be completely removed during site excavation, the staff does not consider the exposure to sulfate attack to be a significant issue at the VEGP Units 3 and 4 site. Since the applicant included the results of chemical tests as part of the revised SSAR, the staff concludes that COL Action Item 2.5-3, as identified in the SER with Open Items, is no longer needed.

The staff concludes that the applicant's description of the subsurface materials was acceptable in that 1) the applicant, following the guidance of RG 1.132 and RG 1.138, investigated and tested the subsurface materials to determine that the soils encountered were alluvial and coastal plain sediments and characterized the soils as sands with silt and clay, the clay marl bearing layer, and underlying coarse to fine sand with interbedded thin seams; and 2) the applicant obtained sufficient undisturbed samples to allow for the adequate characterization of each of these soil groups and determine the extent, thickness, hardness and density, consistency, strength, and static design properties. The applicant also provided sufficient information in the form of plots, plans, and boring logs; and laboratory test results and summaries that enabled the staff to determine that the applicant had adequately characterized the subsurface soils and rock materials and determined their engineering and design properties. Therefore, the staff concludes that the applicant's description of the subsurface materials and their properties at the site of VEGP Units 3 and 4, per the information obtained from the ESP, COL, and LWA investigations, is acceptable. This conclusion is based on the information and findings above, including the resolution of RAIs and Open Items, and the addition of information to the revised SSAR that rendered COL Action Items unnecessary.

2.5.4.3.3 Exploration

The staff's evaluation of the information provided in support of the ESP application is as follows:

Section 2.5.4.3 of NUREG-0800 directs the staff to compare the applicant's plot plans and profiles of Seismic Category I facilities with the subsurface profile and material properties. Based on the comparison, the staff can determine whether (1) the applicant performed sufficient exploration of the subsurface materials and (2) the applicant's foundation design assumptions contain an adequate margin of safety.

In RAI 2.5.4-20, the staff asked the applicant to justify why it did not provide the relationship of foundations to the underlying materials in the form of plot plans and profiles, the foundation stability with respect to ground water conditions, and a detailed dewatering plan. In its response, the applicant stated that it would provide this information as part of a COL application once more details become available regarding the foundation and site interaction. The staff concurs with the applicant that this design-related information is not necessary to determine whether 10 CFR Part 100 is satisfied. Accordingly, in the SER with Open Items, this was identified as COL Action Item 2.5-4. However, later revisions of the SSAR by the applicant included details of the foundation and site interaction, such as plot plans and profiles showing the relationship of the foundations in relation to the underlying materials, in particular boring location plans, boring logs and subsurface profiles, site cross-sections, shear wave velocity measurements and profiles, shear modulus and damping curves, and power block excavation sections. The applicant also provided sufficiently detailed discussions of the ground water conditions, including liquefaction analyses, and provided details about its proposed dewatering system. Accordingly, the staff concludes that the inclusion of COL Action Item 2.5-4 is no longer necessary.

MACTEC Reports

In SSAR Section 2.5.4.3, the applicant heavily referenced a MACTEC report included as an appendix to the application. In RAI 2.5.4-17S, the staff asked the applicant to provide a description of the refraction microtremor (ReMi) testing method used for site geophysical testing as discussed in the MACTEC Report. The staff specifically requested information detailing the application of this method in determining S- and P-wave velocity profiles; the staff also asked the applicant to provide a justification to demonstrate the adequacy of using these data to determine site properties and the resulting impact on response analysis.

The applicant responded to RAI 2.5.4-17S by stating that ReMi testing was conducted in the power block areas for Units 1 and 2, and in the footprint area for Units 3 and 4. The applicant also stated that the original intent was to establish a shear wave velocity profile using this data; however, during collection, it became apparent that the vibration frequency of the existing plant equipment was interfering with the results. After attempts to overcome the interference were unsuccessful in the field, the applicant consulted with Dr. K.H. Stokoe to review the results, who expressed doubt that the results represented the true profile. Therefore, the applicant concluded that the ReMi testing results should not be considered in the COL geophysical survey. The staff reviewed the applicant’s explanation of the ReMi testing at the site, including the summary provided in Revision 4 of the SSAR. The staff concurs with the applicant and Dr. Stokoe’s assessment that the test results do not truly represent the shear wave velocity profile at the site. The staff concludes that the applicant has provided sufficient information to clarify RAI 2.5.4-17S, and therefore the staff considers the RAI resolved because the applicant did not use the suspect test results.

In RAI 2.5.4-18S, the staff again referred to the MACTEC report, which indicated that Dr. K.H. Stokoe would review the RCTS data generated for appropriate use in the site evaluations. The staff asked for a description of the details, depth, and completeness of Dr. Stokoe’s review. The applicant responded by clarifying that RCTS testing is performed by Fugro Consultants at their Houston, Texas facility, Dr. Stokoe was involved in the initial set-up and review of that facility. The applicant also clarified Dr. Stokoe’s review role in that Dr. Stokoe reviewed each RCTS draft report to assure quality of the results. Dr. Stokoe also reviewed the laboratory procedures and setup prior to the commencement of RCTS testing. Additionally, the applicant stated that the geotechnical engineering contractor that was used, MACTEC, independently audited the Fugro facility and conducted surveillances of RCTS testing in progress.

The staff reviewed the applicant's response to RAI 2.5.4-18S, particularly the assurances from the applicant that the review of RCTS data by Dr. Stokoe, the foremost expert on the RCTS test method, would ensure that the quality of data generated was appropriate for use in site evaluations. The staff considered Dr. Stokoe's involvement in the initial setup and review of the Fugro RCTS testing facility and concludes that, based on the experience and expertise of Dr. Stokoe, the depth and completeness of Dr. Stokoe's review should ensure that quality information has been generated because Dr. Stokoe is the foremost expert on the RCTS test method. Furthermore, the staff concludes that the independent audit by the applicant's contractor, the leading expert on the test method in question, would further ensure quality of data. Therefore, the staff concludes that sufficient information and details were provided by the applicant to close RAI 2.5.4-18S.

The staff's evaluation of information provided in support of the LWA request is as follows:

In Revision 4 of the SSAR, the applicant provided additional figures of the plot plans and subsurface material profiles. The staff reviewed these figures and determined that because the applicant conducted its program following the guidelines presented in RG 1.132, and because the foundation design assumptions contain an adequate margin of safety consistent with regulatory guidelines and accepted industry practices, such as those developed by the U.S. Army Corps of Engineers (USACE) and delineated in the USACE Manual, Engineering and Design – Slope Stability, EM 1110-2-1902, Office of the Chief of Engineers, the applicant performed sufficient exploration of the subsurface materials. This information removed the need for COL Action Item 2.5-4, which the staff previously identified in the SER with Open Items.

The staff concludes that, based on the information and findings above, including the resolution of RAIs and Open Items, and the addition of information to the revised SSAR that rendered COL Action Items unnecessary, the discussion of the exploration of the site of VEGP Units 3 and 4, including the ESP, COL, and LWA investigations, is acceptable for approval of both the ESP application and LWA request.

2.5.4.3.4 Geophysical Surveys

The staff focused its review of SSAR Section 2.5.4.3 on the adequacy of the applicant's geophysical investigations to determine the soil and rock dynamic properties. The applicant conducted three down-hole seismic CPT tests and five suspension P-S velocity tests during the ESP site investigation. The applicant compared the soil and rock dynamic properties obtained from these tests with the results from previous geophysical surveys conducted for Units 1 and 2.

In RAI 2.5.4-3, the staff asked the applicant to explain how the base case shear wave velocity profile was developed based on only 12 borings, since most of the borings did not go deeper than 91.4 meters (300 ft). The staff asked additional questions as part of RAI 2.5.4-3, which was discussed and evaluated in Section 2.5.4.3.2 of this SER. In response to RAI 2.5.4-3, the applicant stated that the base case shear wave velocity profile was developed in association with the Lisbon Formation (Blue Bluff Marl), Still Branch Formation, and the upper portion of the Congaree Formation based on the results of the three suspension P-S velocity logging tests performed at the ESP site. One of the suspension P-S velocity logging tests extended into bedrock below the Lower Sand Stratum, and the applicant used those results to derive the base case shear wave velocity profile below the top of the Congaree Formation. The applicant explained that the randomization model captures the uncertainty in the base case shear wave velocity profile for the in-situ soils. The applicant used logarithmic standard deviation of shear wave velocity as a function of depth, which was set to values obtained from soil randomization performed at SRS. After reviewing the applicant's response, however, the staff found that shear wave velocities vary significantly among the three profiles (ESP, VEGP, Units 1 and 2 and SRS), with most terminating at a depth from 85.34 to 60.96 meters (280 to 300 ft)), and lower shear wave velocities measured from down-hole seismic tests than from the suspension P-S velocity measurements. Furthermore, the shear wave velocities from previous investigations were relatively lower than those obtained from the ESP investigations. Therefore, in the SER with Open Items, the staff concluded that the applicant did not provide sufficient shear wave velocity measurements to define the site-specific shear wave velocity profile. This issue was identified in the SER with Open Items as Open Item 2.5-18.

In response to Open Item 2.5-18, the applicant stated that the shear wave velocity provided in the ESP was based on site-specific data from velocity measurements taken in the footprint of the ESP site. The applicant also described the development of the velocity profile, which used down-hole seismic CPT data and P-S velocity logging data for elevations above the BBM and P-S suspension logging measurements for elevations below and including the marl. The applicant gave consideration to profiles developed at nearby sites, such as Units 1 and 2 and SRS. However, although the profiles were consistent, they were not incorporated by the applicant into the ESP profiles. The applicant used additional data to re-evaluate the ESP profile following more detailed site investigations, and the applicant included these evaluations in the revised SSAR.

The staff focused its review on the additional information provided by the applicant in the revised SSAR, which included shear wave velocity profiles derived from the down-hole seismic CPT data, P-S velocity logging data, and P-S suspension logging measurements. The staff finds that the applicant's shear wave velocity testing through the ESP and COL subsurface investigations and during the 2 Phase test pad program demonstrated that the site and compacted structural backfill will support the DCD's required minimum shear wave velocity. Based on these revised profiles, illustrated in Figures 2.5.4-3 and 2.5.4-5 of this SER, the staff concludes that the applicant provided shear wave velocity profiles, derived from the results of ESP site investigations, that were sufficient to address the concerns of Open Item 2.5-18. Therefore, the staff considers Open Item 2.5-18 closed. Furthermore, the closure of Open Item 2.5-18 resolves the remaining portion of RAI 2.5.4-3 as it relates to geophysical investigations at the site of VEGP Units 3 and 4.

Based on the review of SSAR Section 2.5.4.4 and the applicant's response to RAI 2.5.4-3, described above, the staff concluded that although the applicant used various methods to determine compressional and shear wave velocities, including some of the latest technologies recommended in RG 1.132, the applicant did not provide sufficient shear wave velocity measurements to define the site-specific shear wave velocity profile nor to address the velocity difference from different methods. However, in Revision 4 of the SSAR, the applicant provided additional information on the shear wave velocity measurements, including the use of multiple methods such as suspension P-S velocity tests, down-hole seismic tests with cone penetrometers, and, although unsuccessful, ReMi testing. Based on the review of SSAR 2.5.4.4 and the applicant's responses to the RAIs, the staff concludes that the applicant adequately determined the dynamic properties of soil and rock through its geophysical surveys at the site of VEGP Units 3 and 4 because the applicant conducted its exploration program following the guidelines in RG 1.132, which included fieldwork and laboratory testing performed under an approved quality program in accordance with approved industry standards and practices.

The staff concludes, based on the information and findings detailed above, including the resolution of RAIs and Open Items, that the discussion of the geophysical survey at the site of VEGP Units 3 and 4, including the ESP, COL, and LWA investigations, is acceptable for approval of the ESP application and LWA request.

2.5.4.3.5 Excavation and Backfill

The staff reviewed SSAR Section 2.5.4.5, focusing on the applicant's description of anticipated foundation excavations for safety-related structures, backfills, and slopes; excavation methods and stability; backfill sources and quality control; and control of ground water during excavation. The applicant stated that the Upper Sand Stratum would be removed and replaced with Seismic Category I backfill from the top of the BBM to the bottom of the containment and auxiliary buildings at a depth of about 12.19 meters (40 ft) below the final grade. Backfilling would continue up around those structures to final grade. The excavation would be open-cut, with slopes no steeper than 2:1 (horizontal-to-vertical ratio). The applicant indicated that the guidelines used for VEGP Units 1 and 2 would be followed during the development excavation and backfill plans at the COL phase.

The staff's evaluation of the information provided in support of the ESP application is as follows:

Extent of and Plans for Excavation

Since there was no specific description of the excavation plans in the first revision of the SSAR, in RAI 2.5.4-2, the staff asked the applicant to clarify whether the excavation and backfill would only cover the footprint of the power block or would instead extend to a certain distance beyond the foundation footprint. In response to RAI 2.5.4-2, the applicant explained that safety-related footprints of the future Units 3 and 4 would have two respective backfilled excavations, and those excavations would extend beyond their respective power block footprints. The applicant established the minimum lateral extent of each excavation by determining the stress zone as defined by a 1:1 (horizontal-to-vertical) slope ratio, extending from the bottom of the turbine, containment, and auxiliary building foundations. The approximate bottom of the foundation elevations would be 65.8 meters (216 ft) above msl for the turbine building, 54.9 meters (180 ft) above msl for the containment, and 39.6 meters (130 ft) above msl to the top of the Lisbon Formation (Blue Bluff Marl) for the auxiliary buildings. The stress zone at the top of the Lisbon Formation would extend approximately 26.2 meters (86 ft) horizontally beyond the footprint of the power block structures. The applicant considered the turbine building foundation to be the governing factor of this horizontal extension (highest foundation); therefore, the 26.2-m (86-ft) extension was conservatively set for all four sides of the excavation. The applicant planned to backfill the entire excavation, including the power block footprint, stress zone, and areas beyond the stress zone, using compacted structural fill.

Due to the concern of a possible backfill impact on the seismic response evaluation of the site and structures, in RAI 2.5.4-2, the staff also asked the applicant whether it would implement the seismic hazard calculations to the free-ground surface, including the Barnwell Group in the base case site soil column, if the site excavations were not to extend significant distances to the side of the plant. In addition, the staff asked the applicant to explain the basis for its column analysis that presumed uniform backfill in all horizontal directions, while the actual excavation and backfill would extend only to the immediate vicinity of the plant. In its response, the applicant stated that the site excavations would extend to significant horizontal distances from the structures. With the base of the excavation extending approximately 26.2 meters (86 ft) outside of the building footprint, and with the excavation side slope ratio at 2:1(horizontal to vertical), the structural backfill would extend more than 54.9 meters (180 ft) beyond the containment and auxiliary buildings at their foundation level and would extend more than 76.2 meters (250 ft) beyond the edge of the turbine building at its foundation level.

Since there was no specific description regarding the backfill compaction control, in RAI 2.5.4-2, the staff also asked the applicant to explain how compaction control would be implemented if the backfill was to contain as much as 25 percent fines content. In its response, the applicant stated that sand and silty sand with no more than 25 percent fines was obtained from onsite sources for use as backfill, as structural backfill for Units 1 and 2, and that it would use the same structural backfill criterion for Units 3 and 4. The applicant would also implement compaction controls for placement of the backfill through an independent soil testing firm. This testing firm would maintain an onsite soils testing laboratory to control the quality of the backfill material and the degree of compaction, and to monitor the compaction through field density tests performed at a minimum frequency of one test per 928 square meters (10,000 square ft) per lift of placed compacted backfill. In addition, the applicant committed to develop more detailed testing compaction control criteria during the COL phase. The applicant met this commitment through the testing performed during its Phase 1 and 2 test pad backfill program. At the time the SER with Open Items was issued, no site excavation or backfill had been performed; therefore, the staff considered this design-related information immaterial to determining whether 10 CFR Part 100 is satisfied at the ESP stage. Subsequently, the applicant performed additional subsurface investigations and laboratory testing to gather additional ESP and later COL data, which the applicant used to develop the later revisions of the SSAR and also defined the LWA portion of the activities to be the removal of the Upper Sand Stratum and excavation to the top of the Blue Bluff Marl bearing layer, placement of structural backfill to the bottom of the nuclear island foundation, installation of the concrete working surface mudmat and waterproofing membrane, installation of the MSE walls and accompanying waterproofing membrane around the perimeter of the nuclear islands, and backfilling around the outside perimeter of the MSE walls up to final plant grade.

After reviewing the responses from the applicant to RAI 2.5.4-2, the staff, in the SER with Open Items, concluded that, although the applicant provided more information on the extent of excavation, backfill material, and its compaction control, the applicant needed to consider some related issues during the COL stage including: (1) the stress zone described in the applicant's response to RAI 2.5.4-2 was based on normal static stress evaluations, but the applicant needed to consider both static and dynamic load induced stresses; and (2) since the applicant indicated that excavations would extend from about 26.2 meters (86 ft) outside of the building footprint with 2:1 (horizontal-to-vertical) side slope ratios and then extend away from the power block, the applicant needed to include the backfill material placed in and around the power block structures in the structural model when evaluating SSI, as indicated in the currently revised Section 3.7 of NUREG-0800. Thus, in the SER with Open Items, the applicant's commitment to provide detailed excavation and backfill plans during the COL stage was identified as COL Action Item 2.5-5.

Revision 4 of the SSAR contains detailed information on the excavation and backfill plans for the VEGP Units 3 and 4 site. The summary of these plans can be found in Section 2.5.4.1.5 of this SER. The applicant included discussions of the extent of excavations, methods and stability of excavations, backfill design and sources, quality control and ITAAC, groundwater control, and retaining wall plans. This information specifically fulfilled the level of detail specified by COL Action Item 2.5-5. Therefore, COL Action Item 2.5-5 is no longer necessary.

Geotechnical Parameters of Backfill Materials

Because the applicant did not describe the determination of shear wave velocity for the backfill, in RAI 2.5.4-4, the staff asked the applicant to explain how it would determine shear wave velocity values at depths of 15.2 meters (50 ft) and deeper for the backfill materials and whether it considered the effects of confinement. In its response, the applicant reiterated the statement of SSAR Section 2.5.2.5.1.2.1.1:

> Shear-wave velocity was not measured for the compacted backfill during the ESP subsurface investigation (APPENDIX 2.5A). Interpolated values based on measurements made on backfill for existing Units 1 and 2 (Bechtel 1984) are used instead.

The applicant also clarified that the measurements made of backfill soil for existing Units 1 and 2 were laboratory measurements using resonant column tests. The applicant developed shear wave velocity profiles for the backfill using equations presented in the response.

After reviewing the response to RAI 2.5.4-4, the staff found in the SER with Open Items that the applicant attempted to apply the estimated shear wave velocity from the backfill for the existing units to the backfill for the ESP site. But the equation used in the estimation dated back to the 1960s and there was significant variability, or uncertainty, for the parameter K2 in the equation. The calculation also did not account for confinement effects. Since the ability to show that the backfill meets the minimum shear wave velocity requirement with minimum in-situ variability is a major concern in the COL phase, and the procedures presented in the SSAR did not provide such information, the staff determined in the SER with Open Items that additional information to address the backfill shear wave velocity should be submitted in the COL application. Accordingly, this was identified as COL Action Item 2.5-6 in the SER with Open Items.

SSAR Revision 4 includes information on the applicant's test pad program, which was used to produce the site-specific data necessary to develop a shear wave velocity profile for the engineered backfill at the site. The applicant included the results of the test pad program in the revised SSAR, and the engineering properties, including shear wave velocity are found in Table 2.5.4-1 of this SER. The staff agrees that this information specifically addresses the needs of COL Action Item 2.5-6 because the information is specifically related to the actual materials the applicant planned to use for structural backfill and the shear wave velocity profile was developed for these proposed site-specific materials.

In summary, based on a review of SSAR Section 2.5.4.5 and the applicant's responses to RAI 2.5.4-2 and RAI 2.5.4-4 described above, the staff determined that the applicant did not initially provide detailed information on excavation and backfill plans due to the limited knowledge of the exact location of reactors and fill materials. Regulatory Position C.6 of RG 1.132 recognizes that there may be limitations on the extent of geologic mapping that may be performed prior to a site being approved under the 10 CFR Part 52 licensing procedures. To address this need for construction mapping, in the SER with Open Items, the staff proposed the inclusion of a permit condition requiring that the ESP holder or an applicant referencing the ESP perform geologic mapping of future excavations for safety-related structures, evaluate any unforeseen 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. Accordingly, this was identified as Permit Condition 2. However, geologic mapping of excavations was included within the scope of the LWA request, as was the evaluation of any unforeseen geologic features that may be encountered. Since this information is included within the scope of the LWA request, the staff concludes that Permit Condition 2 is no longer necessary.

The staff's evaluation of the information provided in support of the LWA request is as follows:

Subsequent revisions to the SSAR included additional information for the staff to review regarding the excavation and backfill plans proposed in the LWA request for VEGP Units 3 and 4. During the review of the revised SSAR, the staff identified several areas requiring additional information.

Geotechnical Parameters of Backfill Materials

In RAI 2.5.4-7S, the staff requested that the applicant provide a discussion of the required shear wave velocity condition that needs to be met to ensure the backfill soil will satisfy the analysis criteria used for the SSI calculations of the AP1000 standard design. The staff asked that this discussion refer to both the minimum shear wave velocity and the acceptable variability of the measure velocity over the nuclear island footprint.

The applicant responded by stating that a description of the borrow sources could be found in its response to RAI 2.5.4-10S. The applicant also described the general backfill design program for Units 3 and 4 as being modeled after the program that was used for the existing units, and which included a limiting fines content of no more than 25 percent passing the No. 200 sieve (0.075 mm); the Proctor test was utilized as the compaction standard. Furthermore, the applicant provided a detailed description of the two-phase backfill test pad program, which was used to develop the site-specific backfill design to satisfy the standard plant design siting criteria in Revision 15 of the AP1000 DCD and to develop placement and compaction methodologies for the construction program. The applicant stated plans to use the results of these two phases to finalize the details of the backfill construction program, including material properties criteria, construction methods, compaction methods and requirements, and testing protocol, before describing the phases of the program in greater detail:

> Phase 1 will entail a test pad, constructed below grade, approximately [6 m] 20 feet thick using on site borrow from the switchyard area borrow source. The backfill will be placed in [20.32 cm] 8 inch loose lifts and compacted to 95 percent of the maximum dry density as determined by ASTM D 1557. The placement of the backfill will be comprehensively monitored and tested. During backfill placement, field testing will include compaction and shear wave velocity testing utilizing surface wave methods (SASW). Parallel testing will be performed in the laboratory for density, grain size, moisture, and plasticity. On completion of test pad construction, SPT borings will be drilled through the test pad and sampled continuously in the backfill and at [1.5 m] 5-foot intervals to a depth of [6 m] 20 feet in the in-situ soil. Shear wave velocity will be measured in the test pad using cross-hole techniques in accordance with ASTM D4428. Shear wave velocity measurements will also be taken at the finished surface of the test pad using surface wave methods. Results of the test pad field and laboratory measurements will be used to develop expected shear wave velocity characteristics of the backfill.

The applicant concluded by stating that the description of the shear wave velocity data developed during Phase 1 would be evaluated against the assumed shear wave and soil degradation characteristics of the backfill used in SSAR Revision 2, and if significant differences were found, the SSAR would be revised. The applicant noted only minor differences and revised the shear wave profiles in the SSAR accordingly. The applicant later included the RCTS test results in Revision 4 of the SSAR. Finally, the applicant stated that the results of Phase 2 of the test pad program would be used to develop procedures, in accordance with the applicant's quality control program, to ensure that the backfill was placed as specified by design requirements, to minimize variability of backfill, and to achieve acceptable results as required by the AP1000 standard plant design.

During the review of the applicant's response to RAI 2.5.4-7S, the staff considered the information provided and, in follow-up RAI 2.5.4-25S, asked the applicant to explain how the limitation of 25 percent fines was selected, how different the fines content could be to still be acceptable, and how the acceptable ranges of fines were defined for the Phase I Test Pad program and the production of backfill. RAI 2.5.4-28S, which is discussed later in this section, also relates to the two-phase test pad program for backfill. In response to RAI 2.5.4-25S, the applicant stated that, based on studies, tests and analyses of the structural backfill used for Units 1 and 2, the maximum percent fines to minimize potential settlement of the backfill was 25 percent. The applicant also developed the grain size distribution envelope that met the prescribed criteria outlined in the SSAR for the proposed materials parameters, such as percent fines, and included the results of the settlement calculations using the geotechnical properties of the backfill in Revision 4 of the SSAR.

The staff also reviewed the explanation of the percent fines for the backfill and concludes that the use of 25 percent fines will minimize settlement of the backfill at the site of VEGP Units 3 and 4, because the proposed backfill materials are very similar to those used for Units 1 and 2, in which the materials performed acceptably, and 25 percent fines is a widely-accepted industry value for sands and silty sands. Therefore, the staff considers RAI 2.5.4-25S resolved. The staff considered the detailed description provided in response to RAI 2.5.4-7S, including the details and implementation of the two-phase backfill test pad program and inclusion of the subsequent test results in Revision 4 of the SSAR. The applicant was able to demonstrate through the Phase 1 and 2 test pad programs that, by keeping the fines content to less than 25 percent, placing and compacting the proposed materials to at least 95 percent of the modified ASTM D 1557 standard, and performing laboratory testing to verify moisture content, that the grain size distribution of the sands and silty sands did not fall outside of the proposed grain size envelope; therefore, structural backfill materials would meet the requirement for minimum shear wave velocity. The applicant verified this information through in situ testing of the placed and compacted backfill materials, and shear wave velocity testing utilizing the SASW method at various times during the construction of the test pad and again upon completion of the test pad. These test results indicated that, by employing uniform and consistent soil placement and compaction methods, as demonstrated by the applicant during the Phase 2 portion of the test pad program, the final compacted materials will meet the requirement for shear wave velocity. Based on this additional information, in conjunction with the resolution of RAI 2.5.4-25S, the staff considers RAI 2.5.4-7S resolved.

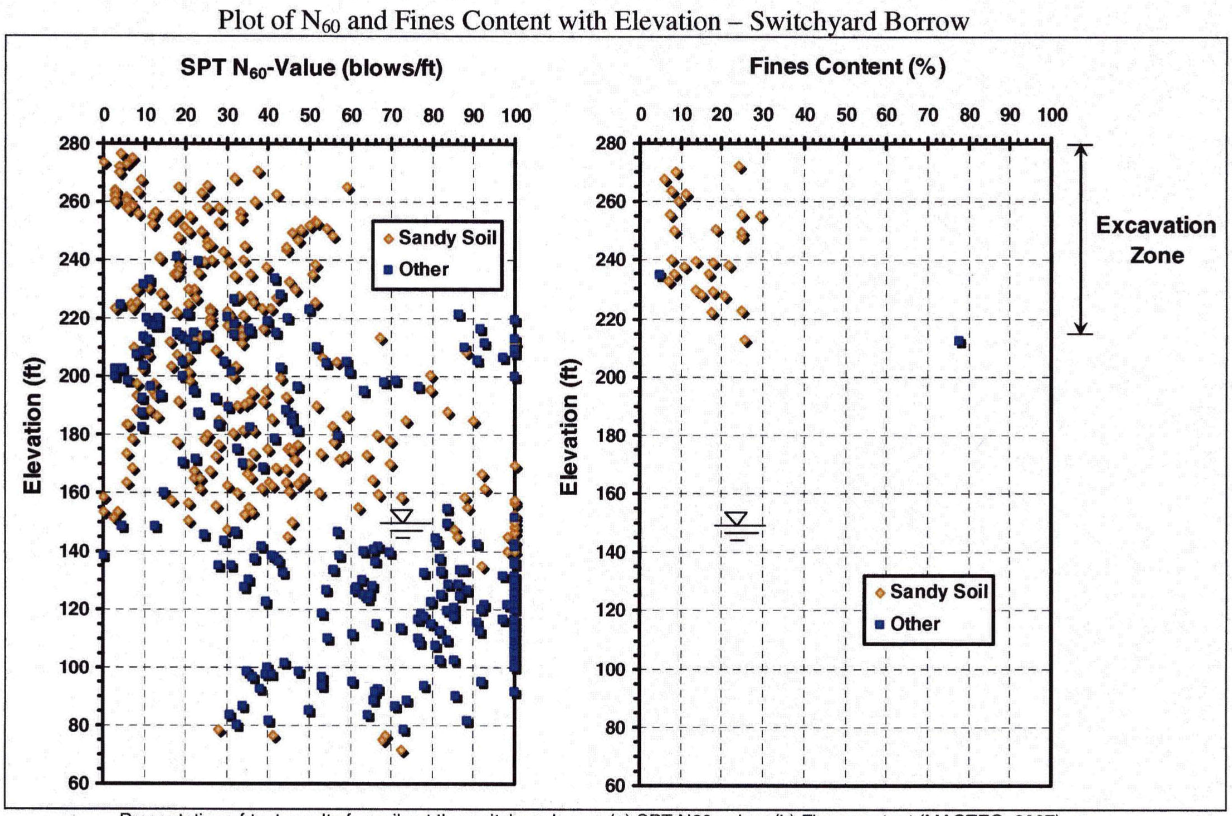
Similar to the issue the staff addressed in RAI 2.5.4-7S, in RAI 2.5.4-14S, the staff requested that the applicant provide a discussion of how velocity testing of the compacted backfill would be performed and what assurances would be provided to ensure, in the completed condition, that the resultant velocities will meet target velocity requirements. In response to this RAI, the applicant referred to the velocity testing of compacted backfill that would be performed as part of the two-phase backfill test pad program described in the response to RAI 2.5.4-7S. The applicant also stated that "assuring the in-placed backfill meets the backfill design and construction requirements will provide the assurance that the shear wave velocity profile of the in-place backfill falls within an acceptable range consistent with the appropriate requirements stated in the Westinghouse DCD and the Vogtle site-specific analyses including the development of the GMRS and FIRS and the soil-structure interaction analyses."

The staff reviewed the applicant's response and the backfill test program described in response to RAI 2.5.4-7S. The staff observed significant portions of both Phase 1 and 2 of the test pad program and actual in situ SASW shear wave velocity testing conducted on the compacted backfill and reviewed laboratory test results, as documented in the trip reports from the staff's December 2007 and July 2008 visits to the VEGP site (ML080110651 and ML082280539). Based on the staff's observation of the applicant's structural backfill placement and compaction methodologies, the applicant's SASW shear wave velocity testing and results, and the applicant's proposed soil specifications arrived at through laboratory testing, the staff concludes that the applicant has provided assurance that, during construction activities, if the applicant meets its soils specification and follows its backfill placement and compaction procedures as determined during the two-phase test pad program, the applicable soil density and shear wave velocity requirements will be met as specified in the proposed backfill ITAAC presented in SER Section 2.5.4.1.5. Based on the resolution of RAI 2.5.4-7S and the acceptable shear wave velocity results presented in the revised SSAR and reviewed by the staff, as well as the assurances that the soil density and shear wave velocity requirements will be met and confirmed through ITAAC, the staff concludes that the applicant supplied sufficient information to resolve RAI 2.5.4-14S. The staff's further evaluation of the proposed backfill ITAAC is provided below in this section of the SER.

<u>Volume and Sources of Backfill Materials</u>

In SSAR Section 2.5.4.5.3, the applicant stated that the volume of material to be excavated at the site was approximately 2.98 million (M) cubic meters (3.9M cubic yards), which will require 2.90 M cubic meters (3.8 M cubic yards) of structural backfill. The applicant further stated that only 30 percent of the excavated material will be available for reuse as structural backfill. In RAI 2.5.4-10S, the staff asked the applicant to perform additional investigations and testing at both horizontal and vertical intervals sufficient to determine the material variability of the remaining 70 percent of borrowed soil that will be used for backfill.

In response to this request, the applicant reiterated its previous conclusion that sufficient borrow material was identified at the site and that no additional investigations or testing was necessary. The applicant summarized the COL level investigation at the switchyard borrow area, including the results of 15 SPT borings that were drilled through these materials and five excavated test pits. Grain size, chemical tests, and compaction tests were part of the laboratory investigation described by the applicant for the borrow materials, an investigation which identified 1.9 million cubic meters (2.5 million cubic yards) of suitable borrow material. Again, the applicant referred to the backfill test pad program described in its response to RAI 2.5.4-7S for additional information on tests to be conducted on the borrow materials. Finally, the applicant described plans for investigations at an alternative borrow source, Borrow Area 4, which included four SPT borings and three test pits, and included preliminary comparison plats of N60 and Fines Content between the Switchyard Borrow area and Borrow Area 4 (SER Figures 2.5.4-8 and -9). However, in reviewing this response, the staff noted that survey results and/or figures were not provided to justify that sufficient material exists at the various borrow sources.

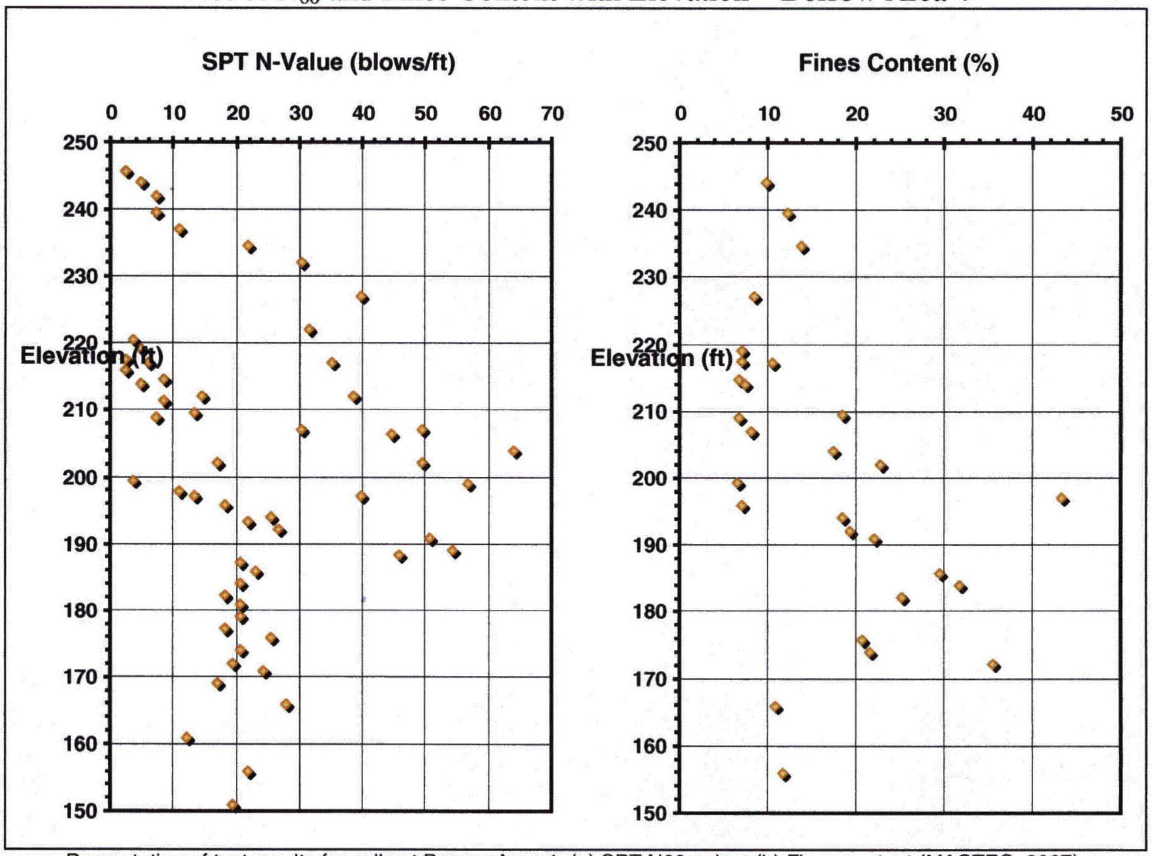


Presentation of test results for soils at the switchyard area: (a) SPT N60-value; (b) Fines content (MACTEC, 2007).

Note: It is assumed the measured SPT N = 100 blows/ft for refusal, and SPT N = 50 + 50/Δ/10 blows/ft for recorded blow counts of 50/(Δ ft). The energy-corrected SPT N_{60} does not exceed 100 blows/ft.

Figure 2.5.4-8 Plot of N_{60} and Fines Content with Elevation for Switchyard Borrow.

Plot of N_{60} and Fines Content with Elevation – Borrow Area 4



Presentation of test results for soils at Borrow Area 4: (a) SPT N60-value; (b) Fines content (MACTEC, 2007).

Note: It is assumed the measured SPT N = 100 blows/ft for refusal, and SPT N = 50 + 50/Δ/10 blows/ft for recorded blow counts of 50/(Δ ft). The energy-corrected SPT N_{60} does not exceed 100 blows/ft.

Figure 2.5.4-9 Plot of N_{60} and Fines Content with Elevation for Borrow Area 4

Accordingly, follow-up RAI 2.5.4-27S requested that the applicant provide clarification and justification of the quantity of suitable material in the switchyard area stockpiles, as well as describe how the percentage of reusable material excavated at the site was determined to be 30 percent. In response, the applicant stated that of the 2.75 million cubic meters (3.6 million cubic yards) of backfill required, two-thirds will come from the switchyard area and one-third will come from the power block excavations. The applicant also identified 1.5 million cubic meters (2.0 million cubic yards) of additional borrow material available at Borrow Area 4 and from the power block excavation. Details of the two major sources of backfill, the switchyard and power block areas, were provided by the applicant as follows:

> Switchyard Area: A detailed geotechnical investigation of the switchyard area was performed to confirm the suitability of the material in this area for use as backfill. As discussed in SSAR Section 2.5.4.5.4, the subsurface conditions in this area were explored with 15 SPT borings and five test pits during the COL investigation. Laboratory testing was conducted on representative samples to determine their engineering characteristics and to assess their suitability for use as backfill. These data, along with the backfill criteria as discussed in SSAR

Section 2.5.4.5.3, were used to estimate the horizontal and vertical extent of suitable borrow material in the switchyard area.

The field and laboratory test data from the switchyard borrow area borings were compiled onto logs of the borings. This information was used to develop subsurface profiles through the switchyard area and the volume of suitable borrow material was calculated using CADD. The surfaces of the suitable materials were projected onto a 3-D plot of the borrow area and the volume of suitable material was esstimated to be approximately 2,400,000 cubic yards. The material identified as suitable for use as backfill, identified as the Sands 1 Belt, extended down to the rough grade excavation surface.

The surfaces of the Sands 1 Belt of suitable borrow material are relatively horizontal (not undulating); therefore, segregation of the suitable material from unsuitable material is not expected to be an issue.

Power Block Area: Field and laboratory data were used to develop subsurface profiles in the power block excavation area. A total of 70 SPT borings in this area were considered, along with borings outside this footprint to add additional data and clarity to interpretation of the subsurface conditions.

Engineering judgment was used to correlate the layers of suitable borrow material identified in the borings for use in developing 3-D CADD surfaces. The materials identified by the applicant as the Sands 1, Sands 2, and Sands 3 layers constitute suitable borrow material, and the applicant calculated that the total quantity of borrow material in the excavation was approximately 2,000,000 cubic yards.

Prior to utilization of the subsurface data from the borings, approximately 30 percent of excavation materials were judged to be suitable material for backfill. However, analysis of the subsurface data indicated that over 50 percent of the material was suitable. For estimating purposes, the original conservative estimate of approximately 30 percent (1,200,000 cubic yards) has been maintained for use as backfill. The remaining 800,000 cubic yards of suitable borrow material will be segregated and stockpiled for potential future use.

The staff reviewed the information regarding the determination of borrow material availability at the VEGP site, including the site maps and figures provided to support the applicant's conclusion that sufficient borrow material exists in two areas at the site to be used as structural backfill, and the subsequent revised estimated quantities in SSAR Revision 5 that indicated that the applicant overestimated the quantity of available backfill from the borrow source located immediately north of the Units 3 and 4 power block areas. In SSAR Revision 5, the applicant indicated that rather than the original estimate of 2,400,000 cubic yards, approximately 1,600,000 cubic yards is available. However, the applicant also revised the estimated recovery of excavated material that could be designated for borrow material as an estimated 30-50 percent rather than its original conservative estimate of 30 percent of the material excavated from the power block areas as qualifying for reuse as Seismic Category I or II backfill. Based on its review, the staff concurs with the applicant that sufficient borrow material is available at the site based on the applicant's exploration through borings and laboratory testing to adequately determine the horizontal and vertical extent of acceptable materials, the applicant's use of computer-aided design and drafting (CADD) to calculate the volume of suitable materials, and the applicant's revised quantities of available borrow material which, although recalculated, indicated that sufficient quantities are still otherwise available. The estimated shortfall of 800,000 cubic yards in the switchyard area would be made up through enhanced recovery of the power block excavated materials and the materials at Borrow Area 4. As such, the staff concludes that RAI 2.5.4-27S is resolved. Given this resolution of RAI 2.5.4-27S, combined with the applicant's description of laboratory tests to determine the variability of borrow material at the site provided in response to RAI 2.5.4-10S, the staff agrees with the applicant's subsurface investigation and laboratory results and the method of calculating material quantities, and concludes that the applicant provided sufficient information to describe the variability and availability of borrow material at the site of VEGP Units 3 and 4. Therefore, the staff considers RAI 2.5.4-10S to be resolved. Additionally, the applicant provided sufficient information (as presented in SSAR Revision 5) regarding the available quantities of borrow material to demonstrate that the revised estimated quantities are equal to or greater than the estimated quantities of material required to backfill the VEGP Units 3 and 4 power block excavations.

In SSAR Subsection 2.5.4.5.3, the staff reviewed the information provided regarding the control of the uniformity of the backfill. Included in this review, the staff considered any plans regarding grain size tests, maximum dry density and optimum water content. In RAI 2.5.4-11S, the staff asked the applicant to ensure that the backfill underneath and to the sides of the nuclear island satisfies the AP1000 SSI criteria by providing a description of the program needed to assure the correlation of grain size distribution of the borrow material, and the corresponding maximum dry density and associated shear wave velocity is defined.

The applicant responded to RAI 2.5.4-11S by referring to the two-phase test pad backfill program that was described in the response to RAI 2.5.4-7S, which evaluated the range of acceptable backfill material properties at the site, including the maximum dry density and optimum water content for backfill, properties related to the grain size distribution, density, and shear wave velocity. According to the applicant, the test program would also specify the material property and field and laboratory testing criteria to ensure that the material would conform to the AP1000 standard plant criteria included in Revision 15 to the DCD.

The staff reviewed the backfill test program described in response to RAI 2.5.4-7S and referenced in response to RAI 2.5.4-11S, focusing its review on the correlation of grain size distribution, maximum dry density and shear wave velocity. The staff concluded, through review of the applicant's laboratory test results and results of the two-phased test pad program, that the applicant thoroughly characterized the material properties of the proposed structural backfill materials according to the guidance presented in RG 1.138. With the field density and shear wave velocity testing conducted during the two-phase test pad program, the applicant demonstrated that the soil placement and compaction methodology developed during the test pad program will ensure that soil specifications, resulting from its laboratory and field testing, will result in a uniformly placed and compacted backfill program that will meet the standard plant criteria in AP1000, as considered by the staff in review of the applicant's response and activities to address the RAI condition. Accordingly, the staff concludes that the applicant's plans to use the results of the test pad program to determine the final material properties and soil specifications for the compacted backfill are sufficient to ensure the appropriate correlation between material properties and soil specifications from the laboratory and field testing at the site, as well as to ensure conformance with the standard plant criteria. Therefore, the staff considers RAI 2.5.4-11S resolved.

Flowable Fill

In SSAR Subsection 2.5.4.5.3, the applicant indicated that a flowable fill would be used in place of compacted backfill to a very limited extent. In RAI 2.5.4-12S, the staff asked the applicant to specify: 1) the target properties of this material; 2) the required uniformity of the target properties; 3) the relationship of the flowable fill to the remainder of the compacted backfill; and 4) the potential extent of the material's use. The applicant provided a four-part response that addressed each portion of the RAI individually.

With respect to the target properties of the flowable fill, the applicant provided both the expected unit weight (1,922 to 2,242 kg/m^3 (120 to 140 pcf)) and the shear wave velocity, which would be determined empirically following the equation $V_s = (G_0/p)^{0.5}$ where Vs = shear wave velocity, p is soil density determined from unit weight of soil, and G_0 is shear modulus. The applicant then addressed the required uniformity of the properties, which it indicated would be adjusted to meet the strength requirements of the particular application. In an effort to maintain uniformity, the applicant described plans to produce the flowable fill in a ready-mixed concrete batch plant and transport the fill material using standard concrete mixing trucks to minimize the potential for component separation. The applicant also plans that most uses of the flowable fill at the site would be well removed from safety-related structures of the proposed units, but regardless of its eventual use, all flowable fill constituents, mix design, and placement will be controlled by widely-used industry specifications and procedures, the uses and locations of which will be documented on drawings. Regarding the relationship between flowable fill and the compacted backfill, the applicant stated that the flowable fill would have a higher load-bearing capacity, higher unconfined compressive strength, and greater bearing strength than the compacted backfill. Finally, the applicant addressed the potential extent of flowable fill at the VEGP Units 3 and 4 site, noting that flowable fill would be used where placement, compaction, and testing of compacted backfill was difficult. As was stated in response to the uniformity of the flowable fill, the applicant stated that flowable fill will be used at locations where the placement of soil backfill would be difficult or impractical to place and that those applications would be around piping, sewer and utility trenches, pipe bedding and slope stabilization well removed from the safety-related structures of the AP1000 units. Some potential locations where flowable fill may be used, as identified by the applicant, included the backfilling of sewer and utility trenches, road base, pipe bedding, and slope stabilization.

The staff considered the target properties and uniformity of the flowable fill, as well as the relationship to compacted backfill and potential extent of flowable fill at the site, provided in response to RAI 2.5.4-12S. The staff concludes that the applicant adequately addressed all aspects of the RAI by explaining the inclusion of target properties, its plans to maintain uniformity of fill, flowable fill's relationship to other backfill materials, and the extent of its usage at the site as described above; the staff therefore considers RAI 2.5.4-12S resolved, because while any use of flowable fill will be determined later, it will be controlled by specifications, procedures and drawings in accordance with the applicant's approved quality program.

Compaction of Backfill

SSAR Subsection 2.5.4.5.3 describes the classification of the backfill soils, including the percent compaction for each of the two categories. The applicant stated that the Seismic Category 1 backfill would be compacted to an average of 97 percent compaction, with no more than 10 percent of field compaction below 95 percent of the maximum dry density, while the Seismic Category 2 backfill would be compacted to an average of 93 percent, also with no more than

10 percent of field compaction below 95 percent. In RAI 2.5.4-8S, the staff asked the applicant to: a) correlate between density and velocity to ensure site characteristics and backfill requirements are met; b) justify how the 93 percent compaction minimum under Seismic Category I structures would not adversely impact soil density to the point the shear wave velocity falls below the minimum requirement; and c) justify how the average dry density of Seismic Category 2 backfill will meet the 95 percent compaction requirement that no more than 10 percent would fail below 95 percent.

The applicant provided a three-part response to RAI 2.5.4-8S, each part addressing one aspect of the RAI. First, the applicant responded to the correlation between velocity and backfill design and construction requirements. The applicant stated that this correlation was based on the two-phase backfill and test pad program described in response to RAI 2.5.4-7S. The program resulted in detailed design and construction parameters, including backfill selection criteria, placement techniques, compaction methods and requirements, and testing protocol, which the applicant then used to assure the expected shear wave velocity profile would be achieved. In response to the second part of the RAI, regarding minimum compaction requirements of the backfill, the applicant revised the backfill compaction specification to a single compaction requirement for both Seismic Category 1 and 2 backfill. The applicant stated that the criteria were revised to be 95 percent of the maximum dry density per the modified Proctor compaction standard as described and determined in accordance with ASTM standard D 1557, which should provide uniformity in placement and strength of the backfill. Finally, the applicant justified the average dry density of Seismic Category 2 backfill by stating that the same compaction requirements of Seismic Category 1 backfill would be applied to Seismic Category 2 and the 93 percent compaction requirement would be deleted; density for all backfill will be as required and verified by the backfill ITAAC presented in Section 2.5.4.1.5 of this SER and evaluated in the following section of this SER.

The staff focused its review of this additional information on the correlation of density and velocity, and the revision of the Seismic Category 2 backfill criteria to mirror that of Seismic Category 1. The staff noted that the change in the compaction and density requirements of Seismic Category 2 backfill to match the engineering criteria of Seismic Category 1 results in location being the only difference between Seismic Category 1 and 2 backfill. That is, Seismic Category 1 backfill will be beneath the Seismic Category 1 (safety-related) structures, and Seismic Category 2 backfill, although engineered to the same criteria as Seismic Category 1, will be beneath the Seismic Category 2 (non-safety-related) structures. The staff concludes that the applicant’s plan to utilize the backfill and test pad program described in response to RAI 2.5.4-7S to correlate shear wave velocity to density is an acceptable plan to address the required correlation because shear wave velocity and density are functions of each other, i.e., the denser a material is generally, the higher the shear wave velocity. Furthermore, the staff concludes that the revision of Seismic Category 2 requirements to reflect the compaction requirements of Seismic Category 1 backfill is sufficient to address the compaction concerns raised for Seismic Category 2 backfill because both materials will be placed and compacted to an industry accepted minimum density in accordance with the backfill ITAAC evaluated in the following section of this SER. Based on these conclusions, the staff considers RAI 2.5.4-8S resolved.

SSAR Subsection 2.5.4.5.3 states that the two categories of backfill will be compacted to the Proctor density requirements given based on tests performed at a density of one test per 929 square meters (10,000 square feet). In RAI 2.5.4-9S, the staff requested that the applicant provide the basis for using a testing density of one test per 929 square meters (10,000 square ft) of lift and to explain how this distribution will provide assurance of adequate uniformity of shear wave velocity as used in the SSI analyses of the AP1000 standard design. The applicant responded by describing an evaluation that, with respect to justifying the testing frequency for performing field density testing of engineered backfill, would use the recommendations of ASME NQA-1-2004. The applicant revised the ESP application to conform to the testing frequency recommended by the aforementioned ASME code. Once again, the applicant referenced the backfill testing program described in response to RAI 2.5.4-7S and stated that the use of the ASME code for quality assurance requirements would provide an acceptable and consistent industry testing frequency for the development of the final construction specifications. The staff considers the applicant's utilization of ASME NQA-1-2004 as the recommended testing frequency for mass earthwork at nuclear facilities to be a suitable testing frequency for the density tests to assure uniformity of shear wave velocity as applied to the SSI analyses of the AP1000 standard design. In follow up RAI 2.5.4-26S, the staff requested that the applicant provide further clarification of how the ASME standard referenced in the response to RAI 2.5.4-9S will be implemented, and to provide justification of the testing density and how the applicant will ensure adequate uniformity of shear wave velocity.

In response to this supplemental request, the applicant stated that both the 152 cubic meter (2000 cubic yard) criteria and lift criteria will be applied and that the backfill testing program will provide the necessary assurance that the backfill will achieve the required shear wave velocity at the nuclear island foundation. The applicant further stated that the testing density for mass earthwork was consistent with the guidance of NRC Inspection Manual, Inspection Procedure 88131, which references the test frequency (testing density) of ASME NQA-1 initially cited by the applicant. The applicant then described the testing frequency in greater detail, stating that "early during placement of the production backfill, the frequency of field density testing is expected to exceed the minimum frequency until sufficient data are developed to document that the required degree of compaction is consistently being achieved, based on field engineering judgment." The applicant also made comparisons to the frequency of testing for the MOX facility at the Savannah River Site and the National Enrichment Facility in New Mexico. The applicant concluded that a higher frequency of in-place testing was required depending on the size of the area; six nuclear tests per lift for areas between 1858 and 5574 m^2 (20,000 and 60,000 ft^2), four tests per lift for areas between 929 and 1858 m^2 (10,000 and 20,000 ft^2), and three tests per lift for smaller areas.

During the review of RAI 2.5.4-26S, the staff focused its review on the applicability of ASME NQA-1 to nuclear power plant sites. The staff agrees with the use of the criteria from the inspection manual as it specifies testing frequencies consistent with those used successfully at other nuclear facilities. Based on the applicant's reliance on the code in question in the NRC Inspection Manual, Inspection Procedure 88131, as well as the comparison to other facilities handling special nuclear material, and the applicant's proposed backfill ITAAC, evaluated in the following section of this SER, whereby it will prepare final reports documenting the minimum 95 percent compaction and shear wave velocity equal to or greater than 304.8 m/s (1,000 fps) requirements, the staff concludes that the applicant adequately justified the testing density used to resolve RAI 2.5.4-26S. With the resolution of RAI 2.5.4-26S, the staff also considers RAI 2.5.4-9S resolved.

Backfill ITAAC, Test Pad Program and MSE

While reviewing the excavation and backfill section for the VEGP Units 3 and 4 site, the staff also considered the applicant's discussions of its proposed ITAAC for backfill soil, which is provided in table 2.5.4-2 from Section 2.5.4.1.5 of this SER.

In RAI 2.5.4-15S, the staff asked the applicant to address the following four issues: 1) include the requirement of minimum shear wave velocity of 304 m/sec (1,000 ft/sec) in the Design Requirement; 2) provide a detailed description of the testing program for the placement of the backfill materials as part of the inspections and tests; 3) describe the report that is referenced in the Acceptance Criteria; and 4) include the minimum shear wave velocity of 304 m/sec (1,000 ft/sec) in the Acceptance Criteria.

In its response, the applicant addressed all four issues simultaneously by stating that SSAR Subsection 2.5.4.5.3.2 would be updated to provide additional discussion of the design of engineered backfill. In Revision 4, the applicant revised the SSAR to include a description of the test pad program and RCTS testing to provide assurances that the minimum shear wave velocity would be met. With respect to the backfill ITAAC, the application stated that the conformance to shear wave velocity would be demonstrated through the test pad program and not through the ITAAC process. In reviewing this information, the staff determined that it was not inherently clear whether the normal variability would be sufficiently evaluated without adequate shear wave velocity testing. Accordingly, in follow-up RAI 2.5.4-28S, the staff asked the applicant to justify the adequacy of the production backfill test program to estimate the average velocities of placed soils and their variability.

The applicant replied by referring the staff to the response given for RAI 2.5.4-19S and to a structural backfill evaluation report it submitted with the RAI responses. In RAI 2.5.4-19S, the staff asked the applicant to address two issues related to MSE wall backfill placement and footing construction. On the first issue, the staff asked the applicant to provide information on how the procedures modified from Phase I of the test pad program and revised compaction procedures from Phase II would be developed, to indicate whether a section of the MSE wall would be included in Phase II, and if so, to explain how compaction around the wall would be accomplished. The staff also requested confirmation from the applicant that the procedures developed at the end of Phase II would be used during the placement of production backfill. Finally, the staff asked for information on how the soil wave velocity testing would be accomplished during the placement of the production backfill in and around the final nuclear island configuration.

In response to the first issue, the applicant stated that Phase II of the test pad program would focus on the establishment of placement procedures and equipment to be combined with the Phase I results to develop backfill specifications and procedures, including frequency and type of quality control testing. Based on preliminary testing as part of Phase I of the test pad program, the applicant concluded that shear wave velocity testing during production fill placement would not be necessary since the results of the test pad program indicated that proper controls on backfill gradation and compaction would result in a homogenous fill with minimum shear wave velocity meeting the criteria of the AP1000 DCD. The staff reviewed this information, particularly the conclusion that shear wave velocity testing would not be needed during placement of fill because the applicant intends to use its specific backfill placement and compaction procedures developed during the test pad program, in conjunction with its laboratory testing program, to control the structural backfill gradation and compaction density to produce a homogeneous soil backfill foundation that will result in a minimum shear wave velocity at the foundation level of the NI that meets the AP1000 DCD criteria. Thus, because the applicant will verify and document the shear wave velocity as required by ITAAC, the staff concludes that the applicant provided sufficient information to resolve the first issue of RAI 2.5.4-19S.

On the second issue of RAI 2.5.4-19S, the staff requested that the applicant describe in detail the concrete footer that will be installed at the start of construction of the MSE wall. The staff noted that this description should include such parameters as concrete mix design, and reinforcing steel sizes so that the staff could determine the adequacy of the design. The applicant responded that the MSE wall is an internally stabilized system of panels that would act as forms for pouring the nuclear island structures. In order for the panels to be erected, the applicant explained that a thin leveling pad, or footer, is needed to provide a stable working surface from which the panels can be erected. The applicant stated the specifications of the footer, including the 28-day concrete strength, which would be 17 MPa (2,500 psi) or above, and the dead-load pressure of the wall (less than 275 kPa (40 psi)). The applicant further stated that reinforcing steel will not be needed since the pad will be confined by its neighboring elements and shrinkage will be negligible. Finally, the applicant provided the profile dimensions of the footer (15.24 cm wide by 30.48 cm deep (12 in by 6 in)), stated the length to be equal to that of the MSE wall, and specified that the concrete mix would be designed in accordance with the governing ACI code. The staff reviewed these specifications, including the use of the governing ACI code for the concrete mix and concludes that the applicant provided an acceptable level of detail for the staff to determine that the design of the MSE wall footer is adequate because 1) the purpose of the concrete footer is to provide a clean smooth working surface for construction of the MSE wall and as such has no bearing capacity requirements, 2) the applicant stated that the design of the MSE wall considers that the horizontal soil reinforcements at or most near to the wall leveling pad (footer) have full effective pullout length so that the footer takes no or insignificant tension force when lateral pressure is exerted on the MSE wall system, 3) the 28 day compressive strength for the cast in place concrete footer will be a minimum of 17 MPa (2,500 psi) or greater and the dead load pressure exerted by the wall system will be at or less than 275 kPa (40 psi), 4) and the concrete will be designed in accordance with ACI-318, which is the governing code used for all nuclear plant construction, and finally 5) the concrete footer will be allowed to cure to meet its design strength prior to the placement of MSE wall sections. Based on the above, the staff considers the second issue of RAI 2.5.4-19S to be resolved.

With the resolution of these two issues, which relate to geotechnical engineering aspects of the VEGP LWA request, the staff considers the geotechnical engineering aspects of RAI 2.5.4-19S to be resolved. Based on the resolution of these aspects of RAI 2.5.4-19S, which is referenced by RAI 2.5.4-28S, the staff also considers RAI 2.5.4-28S resolved based on the resolution of issue 1 for RAI 2.5.4-19S. Finally, since the resolution of RAI 2.5.4-15S was contingent upon the resolution of RAI 2.5.4-28S, the staff also considers RAI 2.5.4-15S to be resolved as well because the applicant included in the ITAAC for shear wave velocity all four of the items requested by the staff in RAI 2.5.4-15S.

SSAR Subsection 2.5.4.5.5 discusses the quality control program and ITAAC associated with the excavation and backfill at the VEGP Units 3 and 4 site. The applicant stated that a MSE will be used as a form against which the nuclear island structures would be poured; however, it was not obvious to the staff that the backfill immediately behind the MSE wall would be compacted to the same density criteria of the remainder of the fill. Accordingly, in RAI 2.5.4-13S, the staff asked the applicant to provide the procedures for compaction of the backfill immediately adjacent to the MSE wall.

The applicant responded to RAI 2.5.4-13S by stating that with the exception of within five feet of the panels, the backfill will be compacted using a large smooth drum vibratory roller. For the five feet immediately behind the panels of the MSE, the applicant planned to use small single or double-drum vibratory walk-behind rollers, walk behind vibratory plate compactors, and jumping jack compactors to achieve the requisite compaction. The applicant concluded that using these methods, the compacted fill would meet or exceed the established specifications. The staff reviewed this response, including the numerous tools which might be used to compact the fill adjacent to the MSE wall, and concludes that the applicant provided sufficient information in its response to resolve RAI 2.5.4-13S. The staff further based its conclusion on results from the Phase 2 of the test pad program, portions of which were observed by the staff and audited by Region II staff during the December 2007 and July 2008 visits to the VEGP site as documented in the staff-written trip reports (ML080110651 and ML082280539). During these trips, the staff observed the actual placement methodologies and subsequent field and laboratory test results for structural backfill materials placed adjacent to test portions of constructed MSE wall system. Therefore, the staff concludes that the applicant provided sufficient evidence to resolve RAI 2.5.4-13S.

The applicant described the extent of the excavations, planned backfills, and described its construction slopes, including providing adequate plans and profiles and boring logs supported by laboratory testing following the guidelines of RG 1.138. The applicant also described why and how the Upper Sand Stratum will be removed and replaced with engineered structural backfill, the specifications and locations of which the applicant adequately described in detail as discussed in this section. The applicant also established the design of its Seismic Category 1 and 2 structural backfill materials through analysis and testing, and provided sufficient test results in the form of laboratory test result summaries that adequately characterized the properties of the materials and provided sufficient information to allow the staff to determine material acceptability. The applicant conducted exploration and testing of potential borrow sources to identify backfill material sources, from which it was able to identify and verify that sufficient backfill material was available at the site. As discussed above, the applicant also proposed acceptable ITAAC for the structural backfill compaction density and shear wave velocity requirements and to provide documented evidence that testing is sufficient to verify that the AP1000 DCD requirements have been met. An associated ITAAC, concerning the applicant's approach to securing the waterproof membrane to the mudmat and placing the membrane against the vertical MSE wall, is evaluated in Section 3.8.5 of this SER. Finally, the applicant provided details for the MSE walls that will permit backfilling of the excavations up to plant grade.

Based on the information and findings above, including the resolution of RAIs and Open Items, the staff concludes that the discussion of the excavation and backfill plans at the site of VEGP Units 3 and 4, including the ESP, COL, and LWA investigations, is acceptable, and that the proposed Backfill ITAAC are appropriate. The staff concludes that the geotechnical parameters of minimum soil backfill density of 95 percent as determined by ASTM D 1557, and minimum shear wave velocity of 1000 fps at the bottom of the NI foundation are acceptable criteria because 1) a minimum compaction of 95 percent is the accepted industry standard for nuclear construction, and 2) the minimum shear wave velocity of 1000 fps is as required by the AP1000 DCD. The staff agrees with the applicant's density testing frequency because it will use the ASME NQA-1 industry standard and because the ITAAC will require the applicant's shear wave velocity testing at the bottom of the nuclear island foundation as required by the AP1000 DCD.

2.5.4.3.6 Groundwater Conditions

In SSAR Section 2.5.4.6, the applicant provided some basic groundwater conditions based on the water well observations and a summary of the dewatering plan implemented for VEGP Units 1 and 2. The staff determined that this information is necessary to understand the ground water conditions and potential dewatering plan at the ESP site.

The staff's evaluation of the information provided in support of the ESP application is as follows:

The staff reviewed the groundwater conditions described by the applicant in SSAR Section 2.5.4.6.1. The staff's evaluation of this information can be found in Section 2.4.12 of this SER.

The staff's evaluation of the information provided in support of the LWA request is as follows:

In RAI 2.5.4-6, the staff asked the applicant to explain the dewatering procedures it will use for the construction of the new units. In its response to this RAI, the applicant stated that it would implement the same dewatering program as that developed for the VEGP Units 1 and 2 but with some deviations. The applicant considered the dewatering program deployed at Units 1 and 2 to be successful, and subsurface conditions at the ESP site and at Units 1 and 2 are similar.

After reviewing the applicant's response, the staff concluded that, since the applicant had not yet determined the reactors' location within the ESP site and did not have a site-specific dewatering program, the staff could not evaluate the groundwater conditions as they affect the loading and stability of foundation materials. The staff was also unable to assess the applicant's dewatering plans during construction as well as ground water control throughout the life of the plant. Because the plant specific dewatering program could not be planned until the reactor location is decided, the staff considered that this design-related information was not necessary to determine whether 10 CFR Part 100 is satisfied. Therefore, in the SER with Open Items, the staff identified the need for the submission of groundwater condition evaluations and a detailed dewatering plan during the COL stage as COL Action Item 2.5-7.

However, in the revised SSAR, the applicant described plans for temporary dewatering of the site during the excavation and construction of VEGP Units 3 and 4. These plans are summarized in Section 2.5.4.2.6 of this SER and include the sump-pumping of ditches to remove groundwater during construction at the site. The staff reviewed this information, especially the dewatering plans and groundwater characterization through observation wells, and concludes that due to this additional information, COL Action Item 2.5-7 is no longer necessary.

The staff considered the following information acceptable to meet the criteria of RG 1.132 and 10 CFR Part 100.23: 1) as the staff discusses in SER Section 2.4.12, groundwater conditions at the site were discussed in sufficient detail in SSAR Section 2.4.12, 2) the applicant installed fifteen observation wells at the site for the ESP subsurface investigation and also used an additional 22 existing wells for the groundwater monitoring program, 3) the applicant had a representative number of wells in both the unconfined water table aquifer in the Upper Sand Stratum and in the confined Tertiary aquifer in the Lower Sand Stratum, and concluded that the Blue Bluff Marl is an aquiclude that separates the unconfined WT aquifer and the confined Tertiary aquifer, 4) the applicant was able to determine the groundwater levels in the wells and determine the hydraulic conductivity (k) values, through "slug" testing, 5) the applicant determined that some temporary dewatering of excavations will be required during construction and that, due to the low permeability of the Upper Sand Stratum and Blue Bluff Marl, sumps and pumps would be sufficient for successful construction dewatering, and 6) the applicant determined that groundwater levels for VEGP Units 3 and 4 correspond to design levels for the existing Units 1 and 2. The staff also concludes that the applicant's use of a liner in the sumps and ditches is acceptable, even though the liner material was not specified, since the type of liner material is peripheral to the adequate performance of the liner except in special applications, such as hazmat, which are not involved in the proposed construction dewatering.

The staff considered the criteria of RG 1.132 and 10 CFR Part 100.23 in its review of SSAR Section 2.5.4.6 and, for the above reasons, concludes that the applicant's assessment of groundwater conditions at the site is acceptable.

2.5.4.3.7 Response of Soil and Rock to Dynamic Loading

The staff's review of the information provided in support of the ESP application is as follows::

The staff reviewed SSAR Section 2.5.4.7, focusing on how the applicant developed the base shear wave velocity profile and modeled soil modulus reduction and damping with respect to cyclic shear strain. The applicant derived shear modulus for the soil strata from the relationship relating the unit weight to shear wave velocity, as well as the dynamic shear modulus reduction and damping ratio curves derived from EPRI (EPRI TR-102293 1993). The applicant used the SHAKE2000 (Bechtel 2000) computer program to evaluate the site dynamic responses.

The applicant derived ESP soil shear modulus degradation and damping curves from the curves developed by EPRI (1993). In RAI 2.5.4-5, the staff asked the applicant to justify its application of the EPRI curves to fine-grained soils. In response, the applicant stated that EPRI (1993) developed degradation curves for soils from gravels to high plasticity clays, and thus it was appropriate to apply the curves to fine-grained soils. EPRI (1993) presented fine-grained soils in Figures 7.A-16 (shear modulus reduction curves) and 7.A-17 (damping ratio curves) in terms of soil plasticity and required the use of the plasticity index. The applicant referred the staff to its response to RAI 2.5.4-17 for more details on how it derived the degradation curves from the EPRI (1993) curves. The applicant further indicated that the soil degradation relationships for fine-grained soil (and coarse-grained soils) used in the SSAR would be verified by laboratory testing during the COL subsurface investigation. Figures 2.5.4-6 and -7 of this SER present the site-specific shear modulus and damping ratio curves, respectively.

After reviewing the applicant's response and references, the staff determined that although Section 7A.6 of the EPRI (1993) report recommends the modulus degradation and hysteretic damping strain-dependent curves for generic CEUS sites, these curves are intended for gravelly sands to low plasticity silty or sandy clays and should not be applied to either very gravelly or very clayey deposits. The curves presented in the report for silts and clays of high plasticity are significantly different from those for sandy soils. In its response to RAI 2.5.4-10, however, the applicant indicated that the BBM "is described as hard, slightly sandy, cemented calcareous clay, and with less than 50 [percent] fine material," which was different from the type of materials for which the curves were intended. Therefore, the staff concluded that the applicant did not adequately explain why it was appropriate to apply those relationships to the silt and clay soils at the ESP site. The report further stated that, while the generic curves are appropriate for preliminary site studies, one should use site-specific data for final evaluations. In conclusion, the staff agreed with the applicant that it needed to verify the soil modulus degradation and damping curves. However, the staff concluded that this verification should not wait until the COL stage. Without site-specific soil modulus degradation and damping curves, the determination of site-specific GMRS (SSE) is inadequate. In the SER with Open Items, the need to provide site-specific soil degradation and damping ratio curves for the site-specific soil amplification calculation discussed in SER Section 2.5.2 was identified as Open Item 2.5-19.

The applicant responded to Open Item 2.5-19 by stating that site-specific soil degradation and damping ratio curves were not developed as part of the ESP investigations at the VEGP Units 3 and 4 site. The applicant also referenced its responses to RAIs 2.5.4-5 and 2.5.4-17 with respect to the applicability of the generic EPRI curves to the materials at the VEGP site, stating that in addition to the EPRI curves, soil degradation and damping ratio curves from the adjacent SRS were also included in the analysis. Finally, the applicant stated that the data determined from the EPRI and SRS curves would be confirmed after RCTS testing was completed during the COL investigation. The staff considered this justification, including with respect to the assertion that the use of both generic and adjacent curves was sufficient, as well as the applicant's plans to confirm these conclusions during the COL phase of site investigations. Because the applicant confirmed the EPRI and SRS curves through RCTS testing performed as part of the COL investigations and included that information in the revised SSAR, the staff concludes that the applicant provided sufficient information to satisfy Open Item 2.5-19. Therefore, the staff considers Open Item 2.5-19 closed, which also resolves RAI 2.5.4-17 since the response provides a suitable description of how the soil degradation and damping ratio curves were developed.

The SSAR stated that the applicant used values of shear modulus and damping ratio to extend the EPRI curves beyond the 1 to 3.3 percent strain level. In RAI 2.5.4-13, the staff asked the applicant to justify how it extended the values beyond the 1 percent strain level and to provide a complete description and supporting data. In its response, the applicant stated that, even though it extended the EPRI curves beyond the 1 percent strain level, the maximum strains calculated during the site amplification analyses remained below 1 percent. But the applicant then stated that SSAR Sections 2.5.2.5.1.5, 2.5.4.7.2.1, and 2.5.4.7.2.2 would be revised, along with associated tables and figures, to show the degradation curves only at a 1 percent or less cyclic shear strain. In light of the applicant's commitment to revise the shear modulus and damping ratio curves back to a 1 percent strain level without extrapolation, the staff concluded that this RAI could not be resolved until the revised SSAR sections were submitted for review. This was identified as Open Item 2.5-20 in the SER with Open Items.

In response to Open Item 2.5-20, the applicant updated the appropriate SSAR sections. The staff reviewed the revised figures and tables, and, based on the revisions to the SSAR and included tables and figures, which reflect the revised degradation curves at 1 percent cyclic shear strain, the staff concludes that the applicant provided sufficient data in the revised tables and figures of SSAR Sections 2.5.2.5.1.5, 2.5.4.7.2.1, and 2.5.4.7.2.2 to close Open Item 2.5-20. The closure of Open Item 2.5-20 also resolves RAI 2.5.4-13 since it provides the necessary updating of figures and tables referencing the excess percent strain that was previously modeled.

In RAI 2.5.4-17, the staff asked the applicant to provide a complete description, including sample calculations, to show how it derived the shear modulus reduction and damping curves and how it incorporated uncertainties in the site characteristics into the curves' development. The applicant explained in its response that it used the shear wave velocity to calculate the low strain dynamic shear modulus (Gmax) only. The EPRI (1993) curves simply showed the ratio G/Gmax versus cyclic shear strain, regardless of the initial value of Gmax. The shear modulus reduction and damping ratio curves for cohesionless materials were based on confining pressure at depth, or simply depth, but were based on the plasticity index for cohesive material like BBM. The applicant then described how the shear modulus reduction and damping ratio curves were derived from the EPRI (1993) curves for each layer included in the base shear wave velocity profile. The applicant also stated that, "shear modulus reduction and damping curves will be obtained using undisturbed samples collected during the COL subsurface investigation."

In addressing how uncertainties were incorporated, the applicant stated that EPRI shear modulus reduction curves were extended from the strain level of 1 percent to 3 percent and uncertainties were incorporated in the site parameters during the randomization process. SER Figures 2.5.4-6 and 2.5.4-7 show shear modulus reduction and damping ratio curves, respectively, for each layer in the profile. The applicant randomized the shear modulus reduction and damping ratios at one strain level using log-normal distributions with median values given by the corresponding base-case curves and logarithmic standard deviations taken from the statistical summaries obtained by Costantino (1997) for natural soils. For the engineered backfill, the applicant reduced these standard deviations by one-third to account for a more homogeneous soil mass. The applicant also used a hyperbolic parametric form to generate the shear modulus reduction and damping ratios at other strains from the randomized values obtained above. The applicant stated that this approach produced realistic curves with logarithmic standard deviations that approximate the Costantino (1997) values over a wide range of strains. The applicant assumed that the normal random variables associated with the log-normal shear modulus reduction and damping ratios had a correlation coefficient of -0.75.

After reviewing the responses from the applicant, the staff reached the following conclusions:

1. Although the EPRI (1993) curves were up to the 1 percent strain level, the applicant did not provide information on the strain levels associated with the 10^{-4}, 10^{-5}, and 10-6 uniform hazard response spectra (UHRS) at the bedrock in the site response analyses and did not indicate whether the laboratory data developed during the SRS testing program carried to those levels of strain.

2. The adequacy of the equivalent-linear approximations for site response deteriorates as strain levels exceed about 0.5 percent effective shear strain. The applicant did not justify the applicability of the equivalent-linear method used in the SHAKE2000 model analysis if the strain levels were to exceed 1 percent.

3. In its response to RAI 2.5.4-13, the applicant indicated that it would revise the 3.3 percent strain level extrapolation back to 1 percent for the EPRI (1993) modulus reduction and damping curves; however, its response to this RAI indicated otherwise.

4. The applicant needed to demonstrate that it can confidently obtain undisturbed samples for deeper depths (e.g., in the Blue Bluff Marl and lower sands of the Congaree and Lower Snapp formations) for use in site response and SSI studies.

5. The applicant also needed to test disturbed samples of the compacted fill material to estimate appropriate modulus reduction and damping properties for the SSI analysis.

6. Other RAI responses indicated that the applicant used both SRS and EPRI (1993) models in the site response analyses and weighted them equally. Considering that site-specific data are almost always desired over generic models, the applicant needed to evaluate the strain level difference in the surface UHRS at different exceedance levels that result from application of these different models and to justify whether the equal-weighting approach is appropriate.

Based on its review of SSAR Section 2.5.4.7, the related references, and the applicant's responses to RAIs described above, the staff concluded that the applicant did not have sufficient site-specific laboratory data to support the determination of the site response to dynamic loading. Although the applicant committed to provide the site-specific modulus reduction and damping curves during the COL stage, the staff determined that this issue, raised with a different perspective in RAI 2.5.4-13, needed to be resolved in the ESP application to provide site-specific shear modulus reduction and damping curves for the site SSE determination. Therefore, as stated earlier, resolving this issue was designated as Open Item 2.5-19 in the SER with Open Items; and the evaluation and closure of that Open Item was discussed in more detail above.

The staff's review of the information provided in support of the LWA request is as follows:

In supplemental RAI 2.5.4-16S, the staff asked the applicant to provide further discussions on the comparison of the EPRI 1993 soil degradation models to the SRS models, identify which model is more appropriate for the VEGP site, and explain how significant the models are to both site response and soil structure interaction (SSI) analyses. In its response, the applicant referenced its response to RAI 2.5.4-17 described above. The applicant also stated that both the EPRI and SRS curves were used as inputs into the SHAKE analysis at the VEGP ESP site. Also in the response, the applicant provided additional figures demonstrating the relationship between the EPRI-derived curves and those derived from the SRS data, selecting the SRS curves based on their stratigraphic relationship to the ESP site. Finally, the applicant stated the results of RCTS testing were used to develop site-specific data as well as confirm the derived curves. The staff agrees with the applicant that the SRS curves are more appropriate for the VEGP Units 3 and 4 site since the SRS curves represent a stratigraphy similar to that of the VEGP site. Based on the supplied response, especially the figures provided to compare the EPRI-derived and SRS curves and the selection of the SRS curves based on the stratigraphic correlation to the VEGP site, the staff concludes that the applicant provided the information to resolve RAI 2.5.4-16S.

In supplemental RAI 2.5E-2, the staff asked the applicant to provide a description and discussion of the effect of backfill adjacent to the MSE walls on SSI analysis results, due to the fill placement and compaction techniques within the zone immediately behind the wall. In its response, the applicant stated that to investigate the effect of differential compaction within 5 ft of the wall face zone, it used a reduced velocity profile for the full height of the wall (referred to as MSE best estimate) in a soil structure interaction analysis and stated that the results showed that there was no difference in the seismic structural responses from the potentially reduced shear wave velocity profile behind the MSE wall. The applicant performed the sensitivity analysis using two-dimensional (2D) seismic soil structure interaction SASSI models and presented the results of the sensitivity study of backfill behind the MSE wall; the applicant included the figures showing the FRS comparisons between the Vogtle 2D model with the reduced shear wave velocity directly behind the MSE wall and the Vogtle ESP best estimate (BE) 2D SASSI model at Nodes shown in SSAR Table 5.1-1. The figures also showed the AP1000 SASSI 2D SSI FRS envelope. Based on the applicant's response, the staff concludes that the applicant provided sufficient information to resolve RAI 2.5E-2 because the FRS for the model that included the lower bound (LB) backfill shear wave velocity (V_s) directly behind the MSE wall was almost identical to the FRS of the same model including no reduction in V_s directly behind the wall; therefore, the potentially reduced shear wave velocity of the backfill directly behind the MSE wall would not affect the nuclear island building responses because, as stated above, the shear wave velocities are almost identical.

Based on its review of SSAR Section 2.5.4.7 and the resolution of RAIs and closure of Open Items described above, the staff concludes that the applicant adequately determined the response of the soil and rock underlying the site of VEGP Units 3 and 4 to dynamic loading and that this determination is acceptable for both the ESP application and the LWA request.

2.5.4.3.8 Liquefaction Potential

In its review of SSAR Section 2.5.4.8, the staff evaluated the applicant's description of liquefaction potential and plans for future liquefaction studies at the ESP site. The staff's review focused on the applicant's conclusion that, based on the previous investigations and excavation completed for the VEGP Units 1 and 2, liquefaction would occur only in the Upper Sand Stratum.

The staff's evaluation of the information provided in support of the ESP application is as follows:

In RAI 2.5.4-14, the staff asked the applicant to justify why liquefaction analyses were not performed on the Blue Bluff Marl (BBM), since the unit has a relatively high variable fines content (24–77 percent) and saturation level (14–67 percent), and a potentially high ground motion level at the site. In response, the applicant first discussed the liquefaction potential for the BBM (Lisbon Formation) based on the material and age. The applicant then examined the field strength and shear wave velocity results to determine whether the marl would liquefy based on these results.

The applicant stated that, although the BBM frequently contained less than 50 percent of fine material, it had the appearance and characteristics of a calcareous claystone or siltstone and was a hard, slightly sandy, cemented calcareous clay. The design undrained shear strength of the marl was set as 478 kPa (10,000 psf) with a preconsolidation pressure as high as 3,831 kPa (80,000 psf), indicative of a highly overconsolidated material. Although the marl would be below the groundwater table, its compressed structure would prevent it from having the free water characteristic of a saturated granular material. Based on these characteristics, the applicant concluded that the BBM is not a material with liquefaction potential, regardless of the ground motion level. The applicant further indicated that liquefaction resistance would increase markedly with geologic age. Based on Youd et al. (2001), Pleistocene (1.8 mya to 10,000 year) sediments were more resistant, while pre-Pleistocene (older than 1.8 mya) sediments were generally immune to liquefaction. The BBM's age is late middle Eocene (40 to 41 million years old), much older than Pleistocene.

The applicant also stated that, based on Youd et al. (2001), there were thresholds for the N-values, tip resistance, and shear wave velocity beyond which the material was considered nonliquefiable (e.g., a sand with 35 percent or more fines or a soil with a corrected N-value over about 21 is not liquefiable). According to the applicant, of the 58 N-values measured in the marl for the ESP investigation, 5 were below 50, ranging from 27 to 46. Thus, if the marl were a potentially liquefiable material, a liquefaction analysis would be run for these five samples. An initial analysis of these five samples showed factor-of-safety values in excess of the accepted 1.35 value in all cases. All of the CPTs that penetrated into the marl had refusal at or near the top of the stratum; therefore, the applicant concluded that the measured tip resistance showed the material to be nonliquefiable. The applicant also stated that the typical shear wave velocities in the marl ranged from 426 to 807 m/s (1,400 to 2,650 ft/s) but dropped to 301 to 512 m/s (990 to 1,680 ft/s) when corrected for overburden. According to the applicant, Youd et al. (2001) indicated that, for a sand with 35 percent or more fines, soils with a corrected shear wave velocity in excess of about 190.5 m/s (625 ft/s) were nonliquefiable.

The applicant stated that, based on material and age, the BBM does not have the potential to liquefy, and that the CPTs, as well as shear wave velocities, consistently indicated the marl is nonliquefiable material. In addition, the applicant indicated that over 90 percent of the

SPT N-values indicated the marl as nonliquefiable material and the remaining N-values showed adequate factors of safety.

After review of the applicant's response, however, the staff was concerned that (1) the general observation of liquefaction occurrence with respect to age and material type did not exclude the liquefaction potential of the BBM because of the limitation of the observations, such as the possible gravel engagement during the SPT and CPT tests; and (2) limited test data, including N-values, tip resistance, and shear wave velocity, could not reliably exclude the liquefaction potential for the BBM. The staff concluded that limited data prevented the applicant from making a conclusion on the liquefaction potential for the BBM; therefore, the staff determined that the applicant did not have sufficient ESP soil property data to confirm that the BBM is not liquefiable. Accordingly, the staff in the SER with Open Items designated this issue as Open Item 2.5-21.

In response to Open Item 2.5-21, the applicant stated that additional boring logs were used to re-characterize the confusion surrounding the presence of hard layers (i.e. gravel) in the BBM that may have yielded anomalously high SPT results. The applicant provided updated boring logs, along with additional laboratory tests, which it stated showed that the BBM was a hard clay or soft rock material and therefore not prone to liquefaction. The applicant incorporated additional boring logs and field and laboratory test data into later revisions of the SSAR. The staff reviewed these additional boring logs and information and concludes that the soil property data support the applicant's conclusion that the BBM was not susceptible to liquefaction. The staff based its conclusion on the results of the liquefaction potential analyses performed for the application, including liquefaction potential based on SPT data, liquefaction potential based on shear wave velocity data, and liquefaction analyses of the compacted backfill. The applicant also determined that the Blue Bluff Marl is primarily cohesive but has some lenses of coarse grained materials, but these materials have an adequate factor of safety, greater than 1.1, against liquefaction. RG 1.198 states that factors of safety against liquefaction of 1.1 to 1.4 are considered to be moderate. Accordingly, the staff considers that the applicant has demonstrated an adequate factor of safety against liquefaction for the Blue Bluff Marl for Open Item 2.5-21 to be closed. The closure of Open Item 2.5-21 also resolves RAI 2.5.4-14, since the applicant provided the additional information required to confirm the liquefaction potential of the BBM.

The staff identified the site characteristic value for liquefaction potential and determined it should be defined as negligible. Because portions of the soil at the VEGP site are susceptible to liquefaction, the applicant stated that these soils would be either removed and replaced, or physically improved, such that the liquefaction potential is reduced to negligible and the factor of safety against liquefaction is increased to at least 1.1. The staff therefore proposes to include the following condition in any ESP that might be issued in connection with this application: The ESP holder shall either remove and replace, or shall improve, the soils directly above the Blue Bluff Marl for soil under or adjacent to Seismic Category 1 structures, to eliminate any liquefaction potential. This is **Permit Condition 1**.

The staff's evaluation of the information provided in support of the LWA request is as follows:

The staff reviewed the information provided by the applicant regarding the liquefaction potential of the backfill materials proposed for use at the site. Based on the properties of the backfill material described in SSAR Section 2.5.4.5.3, and the results of field and laboratory testing, the applicant concluded that, for the design basis earthquake, liquefaction was not a concern within the compacted backfill. Considering the dry density of 95 percent, and the relatively high blow count and shear wave velocity of the compacted backfill, the staff concurs with the applicant's conclusion that liquefaction potential of the compacted backfill was not a concern at the VEGP Units 3 and 4 site. Therefore, the staff concludes that the assessment of the liquefaction potential of the compacted backfill at the site is adequate to satisfy the criteria of 10 CFR Parts 50 and 100 with respect to the liquefaction potential of the materials underlying the Seismic Category 1 structures at the site.

Based on its review of SSAR Section 2.5.4.8 and the resolution of RAIs and closure of Open Items, the staff concludes that the applicant's assessment of the liquefaction potential of the soil and rock underlying the site of Units 3 and 4 is acceptable for both the ESP and LWA applications, subject to Permit Condition 1.

2.5.4.3.9 Earthquake Design Basis

SSAR Sections 2.5.2.6 and 2.5.2.7 present the applicant's derivation of the safe shutdown earthquake (SSE), and Section 2.5.2.8 presents the operating basis earthquake (OBE). Sections 2.5.2.3.6 and 2.5.2.3.8 of this SER provide the staff's evaluation of the applicant's determination of the SSE and OBE. Shear wave velocity profiles, soil modulus reduction, and damping curves described in Section 2.5.4 are critical inputs to the site seismic response and therefore to the SSE and OBE. However, the staff's analysis of these inputs is fully discussed in SER Section 2.5.2.

2.5.4.3.10 Static Stability

In its review of SSAR Section 2.5.4.10, the staff focused on the applicant's evaluation of bearing capacity and settlement of the bearing strata at the ESP site. The applicant used the following assumptions in calculating soil-bearing capacity and structure settlement: (1) placing all safety-related structures on the structural backfill above the Blue Bluff Marl after removal of the Upper Sand Stratum; (2) placing the base of the containment and auxiliary building foundations about 12.19 meters (40 ft) below final grade, or 15.3 to 18.3 meters (50 to 60 ft) above the top of the Blue Bluff Marl Stratum; and (3) placing other foundations in the power block area at depths of about 1.2 meters (4 ft) below final grade. The applicant modeled the containment building mat as a circle with a diameter of about 43.3 meters (142 ft) placed at a depth of 12.0 meters (39.5 ft) below finish grade in the calculations. The applicant determined that the allowable bearing pressure was 1470.3 kPa (30,700 psf) under static loading conditions and 2203 kPa (46,000 psf) under dynamic loading conditions. The settlement under an average bearing pressure of 239.5 kPa (50,000 psf) was 41 mm (1.6 in.).

In RAI 2.5.4-15, the staff asked the following of the applicant:

1. Justify the adoption of the Peck et al. (1974) settlement and differential settlement values as guidelines which suggest total settlement of no more than 50 mm (2 in.), and differential settlement of no more than 19 mm (0.75 in.). For footings that support smaller plant components, the total settlement should be no more than 25 mm (1 in.), and the differential settlement no more than 13 mm (.5 in,).

2. Explain the main causes for exceeding these settlement values at the foundation levels of Units 1 and 2 and whether it would take any measures to prevent settlements and differential settlements for the new units.

3. Justify the use of an average bearing pressure of 239.5 kPa (50000 psf) for the settlement analyses of compacted fills.

In response to this RAI, the applicant stated the following:

1. The geotechnical community has widely accepted and used the Peck et al. (1974) total settlement guidelines of 25 mm (1 in.) for column footings and 50 mm (2 in.) for mats. When limiting foundation settlements to these values, differential settlements are usually very small. The applicant further stated that, even if these settlement values were exceeded, it would not necessarily have adverse effects on structures, especially for large mat foundations which can efficiently distribute structural loads to the soil. The applicant used the VEGP Units 1 and 2 as an example where the calculated settlements of the containment buildings ranged from 102 to 109 mm (4 to 4.3 in.)

2. It (the applicant) will not use the settlement guidelines from Peck et al. (1974) for Units 3 and 4. The approach used for Units 3 and 4 consisted of estimating settlements for power block structures and using them as design values. The "VEGP Report on Settlement" prepared by Bechtel in 1986 provides comparisons of measured versus calculated settlements and concludes that the measured values did not exceed calculated or design values. The applicant would reanalyze and employ corrective measures in the event that monitored settlements exceed the design values. The applicant committed to follow the same approach for Units 3 and 4 and to revise SSAR Sections 2.5.4.10.2 and 2.5.4.11 accordingly in the next revision to the ESP application.

3. It (the applicant) used a bearing pressure value of 239.5 kPa (50,000 psf) in foundation settlement analysis for illustrative purposes because no design value was available during the ESP. The applicant will revise the calculation using design values during the COL application.

After reviewing the responses, the staff concluded the following:

1. A primary concern of potential total and differential settlements is how these settlements compare with what the design of the reactor takes into consideration. It is important to compare the estimated settlements, which are appropriate for evaluation of the acceptability of the site at the ESP stage, with those incorporated into the plant design to evaluate the degree of conservatism because there will be severe impact to the safety of the SSCs once unexpected differential settlements occur.

2. The contact pressures associated with the planned reactor model are of interest and need to be considered at the ESP stage to estimate potential settlement. Since the data for a given reactor facility are available, the applicant incorporated the data into the site evaluation. Based on the above considerations and in lieu of the fact that large settlements were observed at VEGP Units 1 and 2, the staff concludes that the applicant did not demonstrate quantitatively whether the observed large settlement that occurred at the existing VEGP units will occur at the VEGP site and have no impact on the new units. This was identified as COL Action Item 2.5-8 in the SER with Open Items.

In the revised SSAR, the applicant provided additional information on the settlement analysis for the ESP site. These analyses are summarized in Section 2.5.4.2.10 of this SER, and include details on the differential settlement and the application of the elastic properties of VEGP Units 1 and 2 to determine the settlement of Units 3 and 4. The staff reviewed the additional information supplied in Revision 4 and determines that because the applicant provided the information on settlement analysis using differential settlement and the elastic properties of the existing units, the response negates the need to include COL Action Item 2.5-8 in the final safety evaluation report.

In RAI 2.5.4-16, the staff asked the applicant to justify not analyzing the stability of all planned safety-related facilities in terms of bearing capacity, rebound, settlement, and differential settlements with the consideration of dead loads of fills and the reactor facility, as well as the lateral loadings. In its response, the applicant explained that this kind of information is not available at the ESP stage. Based on the applicant's response, the staff concluded that, since the applicant committed to provide more details regarding the bearing capacity, the staff agreed with the applicant that this information will not be available until the COL stage, and considered that this design-related information was not necessary to determine whether 10 CFR Part 100 is satisfied. Accordingly, this issue was designated as COL Action Item 2.5-9 in the SER with Open Items.

Revision 4 of the SSAR incorporates additional site investigation results from the COL stage, including bearing capacity calculations summarized in Section 2.5.4.2.10 of this SER. The staff reviewed this additional information from the COL site investigations, including the influence of the load-bearing layer (Blue Bluff Marl) on the allowable bearing pressure. The staff determined that because the applicant provided additional factors of safety and allowable bearing capacity details that the applicant determined as part of its COL investigation, the applicant provided adequate information to address concerns identified in COL Action Item 2.5-9. Therefore, the staff concludes that COL Action Item 2.5-9 does not need to be included in the FSER.

In RAI 2.5.4-18, the staff asked the applicant to provide detailed information on its determination of the allowable bearing capacity value. In its response, the applicant provided a detailed description of bearing capacity evaluations based on the Vesic (1975) formula. In addition, the applicant later clarified that the calculated value was net allowable bearing capacity, not the gross bearing capacity; therefore, the formula used in the actual calculation was slightly different from that presented in the reference. From its review of the applicant's response, the staff considered that the Vesic (1975) formula is based on primary assumptions of gross shear failure of soils under the foundation. Although this allowable bearing capacity formulation is applicable for general foundation analysis, the staff considers it inappropriate to use in nuclear power plant foundation design. The control factors of allowable contact pressure for a large and heavy structure typically are not general shear failure but are (1) settlements; (2) allowable pressures used in design of the wall/basemat intersection; and (3) toe pressures developed during potential overturning and sliding of the facility. Based on the above considerations, the staff concluded that the allowable bearing capacity value provided by the applicant is not appropriate when considering the expected governing issues controlling the site evaluation. This was identified as Open Item 2.5-22 in the SER with Open Items.

In response to Open Item 2.5-22, the applicant stated that the bearing and settlement analysis would be completed in late 2007 and would be incorporated in a later revision of the SSAR. When the applicant submitted Revision 4 of the SSAR, the staff reviewed the bearing capacity of the containment and auxiliary buildings, which the applicant stated was 2011 kPa (42 ksf) under dynamic loading conditions with a factor of safety of 2.25 and 1628 kPa (2.25 and 34 ksf) under static loading conditions with a factor of safety of 3.0. These bearing capacity values were identified by the staff as the site characteristic values. The staff also considered the settlement analysis performed by the applicant for the large mat foundations that will support the major power plant structures. The applicant concluded that the settlement at the site would be

5.08 to 7.6 cm (2 to 3 in), with a tilt of approximately 0.63 cm (¼ in) in 15 m (50 ft), a differential settlement between structures of less than 2.54 cm (1 in), and the predicted heave due to foundation excavation ranging from about 2.54 to 6.35 cm (1 to 2 ½ in).

As a result of a staff audit of seismic calculations, the applicant revised SSAR Subsection 2.5.4.10.1 for Revision 5. The applicant evaluated the allowable bearing capacity of the structural backfill under the nuclear island for dynamic loading conditions using both Terzaghi's bearing capacity equation for local shear and Soubra's method with seismic bearing capacity factors, which incorporates Terzaghi's bearing capacity equation for general shear with an internal friction angle of 36^{o} (SNC 2008d). To simulate the potential for higher edge pressures during dynamic loading, the applicant considered three foundation widths corresponding to 10, 25, and 50 percent of the width of the nuclear island basemat. The applicant stated that the results from these two methods compared well with Terzaghi's approach for local shear, providing more conservative values, and it reported the computed average ultimate capacities for the three widths as 4261, 4788, and 5698 kPa (89, 100, and 119 ksf). The applicant reported that using a width of 7.62 m (25 ft) and a factor of safety of 2.25 for site-specific conditions provided an allowable bearing pressure greater than 2011 kPa (42 ksf) under dynamic loading conditions for the nuclear island. The applicant also noted that the value was greater than the DCD requirement of 1676 kPa (35 ksf) for dynamic bearing as well as the Vogtle site-specific maximum dynamic demand of 862kPa (18 ksf) for the ESP soil profile.

The applicant also evaluated the bearing capacity of the structural backfill in terms of the ratio of the ultimate bearing capacity against structure demand, and stated that this capacity over demand (C/D) ratio provided an alternative measure of the margin of safety against bearing failure (SNC 2008d). The applicant evaluated these C/D ratios for the static and dynamic demand conditions as well as the maximum dynamic demand from the Vogtle site-specific seismic evaluation. The applicant stated that the C/D ratios, 11.9 for DCD static, 2.9 for DCD dynamic, and 5.6 for the site-specific dynamic, were higher than those typically utilized for standard practice. While the results did not account for settlement of the structures, the applicant concluded the significant margin suggested that settlements would be minimal and within the DCD requirements.

Considering: 1) the updated bearing capacities determined for both static and dynamic conditions, which incorporated capacity-over-demand ratios as an alternative measure to the factor of safety against bearing failure; 2) the settlement analysis results, which showed minimal settlement; and 3) the displacement monitoring plans for the VEGP site, the staff concludes that the information provided by the applicant in the revised SSAR addressed the concerns identified in Open Item 2.5-22 and the staff considers the Open Item closed. The closure of Open Item 2.5-22 also resolves RAIs 2.5.4-15, 2.5.4-16 and 2.5.4-18. Based on its review of SSAR Section 2.5.4.10, including Revision 5, and the applicant's responses to the RAIs, as described above, the staff further concludes that the applicant provided an adequate assessment of the static stability of the ESP site through the incorporation of data and results for both ESP and COL site investigations, including through additional calculations performed by the applicant as a result of the staff's seismic calculation audit included in Revision 5. The site characteristics approved by the staff for minimum bearing capacity (static and dynamic) are included in Appendix A. Furthermore, the staff concludes that the applicant provided sufficient information with respect to the static and dynamic stability of the site to satisfy the applicable criteria of 10 CFR Parts 50 and 100.

2.5.4.3.11 Design Criteria

In SSAR Section 2.5.4.11, the applicant provided general geotechnical criteria, such as acceptable factors of safety against liquefaction, allowable bearing capacities, acceptable total and differential settlements, and an acceptable factor of safety against slope stability failure.

The staff's evaluation of the information provided in support of the ESP application is as follows:

The staff reviewed the information provided by the applicant regarding the applicable AP1000 geotechnical design criteria to determine if the applicant conducted an exploration and testing program sufficient to determine whether the site would support the design parameters. The staff focused on 1) the applicant's efforts to determine the ability of the Blue Bluff Marl bearing layer to support the plant structures and whether the overall site geology met site parameters, 2) the applicant's studies to determine static and dynamic bearing capacity and whether the site properties and properties of the engineered backfill met or exceeded site perimeters and required factors of safety, 3) whether the applicant's studies and backfill designs supported DCD shear wave velocity minimum requirements, and 4) whether the applicant sufficiently analyzed site liquefaction potential. As discussed in the previous sections, the staff concludes that the applicant conducted an exploration and testing program consistent with the guidance presented in RG 1.132, RG 1.138, and RG 1.198 to adequately characterize the site and verify that the site would support the AP1000 design criteria discussed and applied in Section 2.5.4 of this SER.

The staff focused its review on the design criteria, including the factors of safety against specific events, such as liquefaction and loading conditions. The application did not provide structural design criteria, such as wall rotation, sliding, or overturning. The staff also considered the applicant's incorporation of standard design criteria into the most recent revision (Rev. 4) of the SSAR. Based on the applicant's inclusion of site-specific design criteria, including the factors of safety against events such as liquefaction or loading, the staff considers the applicant's design criteria used in the ESP application to be acceptable, as the applicant has met the applicable standards of 10 CFR Part 50.

The staff's evaluation of the information provided in support of the LWA request is as follows:

The staff reviewed the information provided by the applicant regarding the design criteria required to support the LWA request to excavate, prepare the site, and backfill the proposed plant site to the bottom of the foundation within the nuclear islands and up to plant grade outside the MSE walls. To meet the requirement for the LWA, the applicant needed to characterize the site down to a depth sufficient to support the AP1000 site parameters for bearing capacity, shear wave velocity and liquefaction, and it also needed to develop the site-specific criteria for engineered structural backfill, MSE retaining walls, concrete mudmats, and MSE and concrete mudmat waterproofing materials sufficient to meet the intent of the DCD design for coefficient of friction. As discussed in the preceding sections, the staff concludes that the applicant presented sufficient information for a LWA request because the staff determined that the applicant 1) adequately characterized the site following the guidelines presented in RG 1.132, 2) performed field and laboratory testing following the guidelines presented in RG 1.132 and RG 1.138 to verify that the site and engineered structural backfill support the DCD minimum required shear wave velocity, 3) presented sufficient design details for the concrete mudmat and MSE wall, including constructing a test section for staff observation, and 4) worked with the DCD design organization to determine the proper waterproofing system and minimum required coefficient of friction for the system.

In RAI 2.5.4-19, the staff asked the applicant to justify the omission of additional design criteria and factors of safety (FS). In response, the applicant revised the SSAR to reference the applicable design criteria in the AP1000 DCD, Revision 15. The applicant also stated that the FS against liquefaction should be greater than 1.1; FS of 3 should be applied to bearing capacity equations, but this FS can be reduced to 2.25 when dynamic or transient load conditions apply; and the long-term static and seismic FS against slope stability failure was 1.5 and 1.1, respectively. Because the applicant incorporated the applicable design criteria from Revision 15 of the AP1000 DCD and the revised SSAR to include relevant factors of safety, the staff considers RAI 2.5.4-19 resolved. Furthermore, based on the closure of RAI 2.5.4-19, the staff concludes that the design criteria presented for an ESP at the VEGP Units 3 and 4 site is acceptable to satisfy the requirements of 10 CFR Part 50 because the revised SSAR contained a description and safety assessment of the site and the site evaluation factors identified in Part 100, including the information relative to the materials of construction, general arrangement and approximate dimensions of the facility sufficient to provide reasonable assurance that the final design will satisfy the design bases with adequate margin of safety.

Based on the applicant's inclusion of the design-specific criteria, including the factors of safety against events such as liquefaction or loading, the staff considers the applicant's design criteria to be acceptable for the LWA request, as the applicant has met the applicable standards of 10 CFR Part 50.

2.5.4.3.12 Techniques to Improve Subsurface Conditions

SSAR Section 2.5.4.12 states that no ground improvement techniques were considered beyond the removal and replacement of the Upper Sand Stratum with engineered structural backfill; however, other ground improvement techniques will be considered as necessary. The staff therefore focused its review on the subsurface improvement plans, the most significant of which is the planned removal of the entirety of the Upper Sand Stratum. The staff reviewed the plans for removal of the Upper Sand Stratum, as described in Section 2.5.4.1.5, and for the reasons evaluated in Section 2.5.4.3.5 of this SER, as well as the applicant's consideration of other improvement techniques, as necessary, the staff concludes that the plans for subsurface improvement therefore satisfy the criteria of 10 CFR Part 100. The inclusion of the detailed plans for removal of the Upper Sand Stratum, as well as the applicant's consideration of additional ground improvement techniques make fulfills COL Action Item 2.5-11. Therefore, COL Action Item 2.5-11 is no longer necessary.

2.5.4.4 Conclusions

Based on its review of SSAR Section 2.5.4, related references, and the applicant's responses to the associated RAIs and Open Items described above, the staff concludes:

The applicant conducted a limited ESP investigation to determine the engineering properties of subsurface soils at the ESP site. The applicant supplemented the few field and laboratory tests conducted as part of the ESP investigation to determine static and dynamic and other engineering properties of the underlying soils with information from the subsequent COL investigation. The additional quantity and quality of the test results were sufficient for the applicant to reliably determine the engineering properties of the subsurface materials.

Therefore, the staff concludes that the applicant has adequately determined the engineering properties of the subsurface materials.

The applicant provided a site-specific shear wave velocity profile in a situation that assumed the shear wave velocity measured from the down-hole tests was lower than the shear wave velocity obtained from the suspension P-S velocity measurements; the shear wave velocities from previous investigations associated with VEGP Units 1 and 2 were also lower. Additionally, the applicant provided the results of soil dynamic testing on the samples from the ESP site to provide soil modulus reduction and damping curves to feed into the site response study and the site-specific shear wave velocity profile. The applicant also supplemented the SSAR with additional inputs to the development of the shear wave velocity profile and the shear modulus reduction curves. Therefore, the staff concludes that the applicant provided sufficient information to characterize the shear wave velocity profiles, and the shear modulus reduction and damping ratio curves, which are critical input to the site-specific ground motion response spectrum discussed in SER Section 2.5.2, as well as to the soil structure interactions discussed in SER Section 3.8.

The applicant provided an assessment of the liquefaction potential of the BBM, which was the load-bearing unit at the ESP site. Based on the results of extensive SPT and CPTs by the applicant, the staff concurs with the applicant that the BBM is not prone to liquefaction. The applicant also described the excavation and backfill plans, in extensive detail, to support both the ESP application and its LWA request. These plans included the use of a test pad program to better constrain the final engineering properties of the Seismic Category I backfill to be used. The staff concludes that the level of detail provided for the excavation and backfill plans, including quality control and ITAAC, is sufficient to address the requirements of 10 CFR Part 50.

The proposed Units 3 and 4 would be located above the load-bearing strata similar to that underlying the existing units, and the existing units already observed an unusually large settlement (both total and differential). The applicant provided a detailed settlement analysis to ensure that the SSCs for the AP1000 are safe. The staff finds that the applicant adequately demonstrated the stability of the subsurface materials in response to static and dynamic loading conditions at the ESP site. The applicant provided the bearing capacity for the containment and auxiliary buildings at the site, which were given as 2,010 kPa (42 ksf) under dynamic loading conditions with a factor of safety of 107 and 1,627 kPa (2.25 and 34 ksf) under static loading conditions with a factor of safety of 3.0. Based on these bearing capacities and the high factor of safety, the staff concludes that the bearing capacity of the site is acceptable to meet the requirements of 10 CFR Parts 50 and 100 with respect to the static stability of the site. The staff also reviewed the information and data from the applicant's field and laboratory investigations as well as the evaluations of the geotechnical engineering properties of the soils and rock underlying the ESP site. Additionally, the staff made several trips to the site to observe applicant activities and the geotechnical conditions of the site to determine whether the applicant followed the guidance contained in RG 1.132 and other relevant guidance in its ESP and LWA site-specific investigations.

Based on the above findings, the staff concludes that, in support of both the ESP application and LWA request, the applicant conducted sufficient site investigations and performed adequate field and laboratory tests and associated analyses, to provide sufficient information describing soil conditions underlying the ESP site, such as the possible existence of "soft zones" in the foundation-bearing layer. The applicant also demonstrated reliable engineering properties of the soils through the combination of its ESP and COL site investigations. This information was addressed and evaluated by the staff as part of its review of the LWA request. Therefore, the staff concludes that for the information required by the scope of the ESP, the applicant has provided sufficient information to characterize the subsurface materials at the ESP site of VEGP Units 3 and 4. Based on its review of the engineering properties of materials at the ESP site, the assessment of bearing capacity, liquefaction potential, and settlement, as well as the development of a shear wave velocity profile through the site, the staff finds that the applicant has met the requirements of 10 CFR 100.23 in that the applicant adequately demonstrated the overall static and dynamic stability of the site, identified the soil and rock engineering properties through field and laboratory testing, and characterized the soil subsurface profile.

In SSAR Section 2.5.4, the applicant identified the subsurface material properties as ESP site characteristic values. The first site characteristic specifies that there is no liquefaction below the Blue Bluff Marl layer (approximately 88 ft below the ground surface). The applicant demonstrated, in SSAR Section 2.5.4.8, that any liquefaction at the ESP site would be limited to the soils directly above the Blue Bluff Marl. The requirement to remove and replace or otherwise improve the liquefiable soils at the site to eliminate the liquefaction potential is Permit Condition 1. The second site characteristic value specifies a minimum bearing capacity of 1628 kPa (34 ksf) under static loading conditions and 2011 kPa (42 ksf) under dynamic loading conditions. These values are based on the VEGP site soil properties and the results of the applicant's ESP and COL investigations. Finally, the third design parameter specifies minimum S-wave velocities for the depth intervals given in SSAR Tables 2.5.4-11 and 2.5.4-11a. These S-wave velocity values are based on the applicant field geophysical surveys. The staff has reviewed the applicant's suggested site characteristics related to SSAR Section 2.5.4 for the inclusion in an ESP, should one be issued. For the reasons set forth above, the staff agrees with the applicant's proposed site characteristic and the values for those characteristics.

Based on the staff's review of the applicant's information regarding the LWA request, the staff concludes that the applicant conducted sufficient subsurface investigations and performed adequate field and laboratory testing and analyses to support that request. As discussed previously in this section of the SER, much of the information needed for the LWA request was also required for the staff's evaluation of the ESP application. The applicant had to first adequately characterize the proposed site to determine whether the site could support the applicable AP1000 design criteria for the LWA activities. As the staff has stated above, the applicant adequately characterized the site and verified that the site criteria for bearing capacity, liquefaction, and shear wave velocity could be met. The applicant also developed the criteria for the engineered structural backfill materials and verified that these criteria, in conjunction with the geologic site conditions, would further support the DCD design criteria for bearing capacity, liquefaction, and shear wave velocity. As the staff stated above, the applicant did so, following the guidance presented in the applicable Regulatory Guides.

Once the applicant determined that the site and proposed backfill materials would meet the AP1000 design criteria, the applicant determined whether sufficient material was available on-site to backfill the proposed excavation. The applicant also proposed a design for the MSE wall system. As part of the LWA request, the applicant showed the extent and depth of the excavation; disposition of the excavated materials as backfill or spoil; extent of temporary construction slopes and construction dewatering details; preparation of the marl bearing layer for placement of backfill and backfilling to the bottom of the foundation; placement of the MSE walls and nuclear island concrete mudmat working surfaces and waterproofing system; backfilling around the perimeter of the nuclear islands outside of the MSE walls to final plant grade; demonstration of mass and confined backfill placement techniques; and, finally, its demonstration of backfill density, shear wave velocity and, as evaluated in SER Section 3.8.5, waterproofing system friction coefficient, with proposed ITAAC to verify and document that the

AP1000 design criteria will be met. Therefore, for the reasons stated above, the staff concludes that the applicant has adequately demonstrated that it has met the applicable LWA requirements associated with the stability of subsurface materials and foundations for the requested LWA activities at the VEGP site.

2.5.5 Stability of Slopes

SSAR Section 2.5.5 describes the applicant's review of existing slopes at the ESP site and the applicant's plan for permanent cut and fill slopes during construction excavation. The applicant also discussed its plans for future slope stability analysis to take place during the design phase. The applicant did not perform slope stability analysis for the ESP site because there is no existing slope and the applicant cannot determine the future slope at the ESP phase.

2.5.5.1 Technical Information in the Application

The applicant stated that, since there were no existing slopes or embankments near the proposed location of VEGP Units 3 and 4, it did not perform a dynamic slope stability analysis. The applicant further stated that the site grading for construction of new units would result in nonsafety-related permanent cut and fill slopes. Permanent cut slopes would have a height of 15.2 meters (50 ft) or less and would be located several hundred meters away from planned or existing safety-related structures. Permanent fill slopes would have a height of 6.1 meters (20 ft) or less and would also be several hundred meters away from planned or existing safety-related structures. During the construction phase, the applicant will remove the soils above the Blue Bluff Marl and replace them with compacted structural fill. The applicant stated that the construction excavation cut slopes would be temporary (i.e., only during the construction period) and that they will be far away from the safety-related structures of the existing VEGP Units 1 and 2. The applicant committed to perform nonsafety-related permanent slope stability analysis for dynamic and static conditions, as well as excavation cut slope analysis for static conditions during the design stage, to ensure that these slopes will not pose a hazard to the public.

2.5.5.2 Regulatory Basis

SSAR Section 2.5.5 states that the applicant did not perform a slope stability analysis for the ESP site application. However, the applicant stated in SSAR Section 1.8 that it followed the guidance of NUREG-0800, Section 2.5.5, when it described the slope-related issues in SSAR Section 2.5.5. In its review of SSAR Section 2.5.5, the staff considered the regulatory requirements in 10 CFR 100.23(c) and 10 CFR 100.23(d). According to 10 CFR 100.23(c), applicants must investigate the engineering characteristics of a site and its environs in sufficient scope and detail to permit an adequate evaluation of the proposed site. Pursuant to 10 CFR 100.23(d)(4), applicants must evaluate siting factors such as natural and artificial slope stability.

2.5.5.3 Technical Evaluation

The staff focused its review of SSAR Section 2.5.5 on whether there are any existing or planned new slopes that would adversely affect the safety-related structures of the proposed new units due to any possible loading conditions and/or natural events. After reviewing the information provided by the applicant, the staff concludes that, because there are no existing significant slopes near the proposed ESP site, a detailed slope stability analysis is not necessary at the ESP stage. The staff considers the creation of permanent slopes during construction to be a design-related issue, which must be addressed at the COL stage. However, after reviewing the site construction plan layout and discussions with the applicant, the staff confirmed that the only permanent slopes are not safety-related. Therefore COL action item 2.5-12 is no longer needed.

2.5.5.4 Conclusions

Since there are no safety-related permanent slopes, the applicant did not perform any slope stability analysis. The excavation will create nonsafety-related permanent cut and fill slopes during the new units' construction stage, however, since these slopes are not permanent, they are not part of the staff's review.

2.5.6 Embankments and Dams

SSAR Section 2.5.6 presents a general description of existing and potential new embankments and dams at the ESP site.

2.5.6.1 Technical Information in the Application

SSAR Section 2.5.6 indicates that there is no earth, rock or earth, and rock fill embankments required for plant flood protection or for impounding the cooling water required for the operation of the plant. The applicant indicated that there are three existing nonsafety-related impoundments at the site—Mallard Pond, Debris Basin Dam 1, and Debris Basin Dam 2. The Mallard Pond is located to the north of the proposed switchyard, Debris Basin Dam 1 is located to the southeast of the proposed cooling towers, and Debris Basin Dam 2 is located to the southwest of the proposed cooling towers. The applicant stated that it would not use the impoundments for plant flood protection or for impounding cooling water for the operation of the plant. The pool level in Mallard Pond is below the elevation of 38.1 meters (125 ft) above msl. In the event of a dam breach at Mallard Pond, the water would drain to the north and away from the proposed new units. The pool levels in Debris Dams 1 and 2 are also below the elevation of 45.7 meters (150 ft) above msl, and, in the event of a dam breach, the water would drain to the south, away from the proposed new units. Therefore, the applicant concluded that there would be no need for embankments or dams for flood protection or for impounding the cooling water at the site.

2.5.6.2 Regulatory Basis

The applicant did not state which regulations SSAR Section 2.5.6 addressed; these topics are covered in NUREG 0800, Sections 2.4.4 and 2.5.5. However, in SSAR Section 1.8, Table 1-2, the applicant stated that it used RG 1.70 for guidance on format and content. 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.

2.5.6.3 Technical Evaluation

In its review of SSAR Section 2.5.6, the staff evaluated the possible impact of a breach of existing embankments and dams on the proposed new units at the ESP site and evaluated the need for construction of any embankments or dams for flood protection. Based on the information provided by the applicant, the staff notes that the proposed finished grade elevation for the new units is approximately 67 meters (220 ft) above msl, and the existing pool levels for the three impoundments are 38.1 meters (125 ft) above msl for Mallard Pond, and 45.7 meters (150 ft) above msl for both Debris Basin Dams 1 and 2. These elevations are all below the proposed finished grade elevation. In addition, as the applicant discussed in Sections 2.4.3 and 2.4.4 of the SSAR, both probable maximum flood elevation (45.8 m (150.13 ft) msl) and the dam break level (54.3 m (178.10 ft) msl) are much lower than the proposed finished grade elevation Therefore, the staff concurs with the applicant's conclusion that no embankments and dams are required.

2.5.6.4 Conclusions

The applicant provided adequate information and analysis in SSAR Section 2.5.6, with reference to Sections 2.4.3 and 2.4.4 of the SSAR, regarding the embankments and dams at the ESP site. The applicant demonstrated that no embankments or dams are needed for flood protection at the ESP site under possible flood and dam breach conditions because of the proposed finished grade elevation.

3.0 SITE SAFETY ASSESSMENT

3.5.1.6 Aircraft Hazards

3.5.1.6.1 Introduction

For its ESP application, the applicant provided information evaluating the potential hazards associated with aircraft. The NRC staff reviews these evaluations to ensure that the risks associated with potential aircraft hazards are sufficiently low.

3.5.1.6.2 Regulatory Basis

The acceptance criteria for aircraft hazards are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the site location and area description.

- 10 CFR 52.17, insofar as it requires the applicant to provide the location and description of any nearby military or transportation facilities and routes.

- 10 CFR Part 100, as it relates to the following:

- 10 CFR 100.20(b), which requires that the nature and proximity of man-related hazards (e.g., airports, transportation routes, and military facilities) must be evaluated to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.

- 10 CFR 100.21(e), which states that the potential hazards associated with nearby transportation routes, industrial, and military facilities must be evaluated and site parameters established such that potential hazards from such routes and facilities will pose no undue risk to the type of facility proposed to be located at the site.

RS-002, Section 3.5.1.6, specifies that these requirements are met if the probability of aircraft accidents having the having the potential for radiological consequences greater than the 10 CFR Part 100 exposure guidelines is less than about 10^{-7} per year. The probability is considered to be less than about 10^{-7} per year by inspection if the distance from the site meets all of the following 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 usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation, and

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, then 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

Following the procedures described in RS-002, Section 3.5.1.6, the NRC staff reviewed Section 3.5.1.6 of the SSAR included in the VEGP application. In this section, the applicant provided information that addressed and analyzed aircraft hazards. The applicant's response to the NRC staff's RAI 3.5.1.6-1 further supplements this information with regard to the calculation of effective area being used in the aircraft hazards analysis.

In Section 2.2.2.6 of the SSAR, the applicant presented information concerning the airports, airways, and military training routes in the site vicinity that need to be evaluated for potential hazards with respect to nuclear units that might be constructed on the proposed ESP site.

The applicant stated that all airports in the VEGP site vicinity are greater than 10 miles from the site. The closest and largest commercial airport is the Augusta Regional Airport at Bush Field (Bush Field), which is located about 17 miles north-northwest of the VEGP site. According to the applicant, on the basis of FAA projections up to 2025, the number of airport operations (including landings and take-offs) is estimated to be about 43,000.

The applicant stated that this total number of projected aircraft operations is substantially less than the threshold number of operations set forth in RS-002, Section 3.5.1.6., which indicates that the probability for the aircraft accident is considered acceptable if the projected annual number of operations is less than 1000 D^2, where D is the site-to-airport distance in miles. The applicant also stated that other airports in the vicinity are much smaller than Bush Field. The applicant noted that the aircraft hazard threshold for these airports is greater than the 100,000 annual number of operations because of their distance from the site. This threshold annual number of operations is significantly higher than the estimated annual operations for each of these airports. Therefore, the applicant found that the hazard probability of these airports was acceptable and did not require a detailed evaluation of the potential hazards with respect to aircraft operations at these airports.

The applicant stated that there is a small unimproved grass airstrip located immediately north of the VEGP site (north of Hancock Landing Road and west of the Savannah River). This privately owned and operated airstrip has a 1650-foot turf runway oriented 80 degrees east- 260 degrees west. The airstrip is for personal use and the associated traffic consists of small single-engine aircraft. In addition, a small helicopter landing pad is located on the VEGP site. This facility exists for corporate use and for use in case of emergency. The traffic associated with either of these facilities may be characterized as sporadic. The applicant stated that because of the small amount and the nature of the traffic, these facilities do not present a safety hazard to the VEGP site.

The applicant stated that the closest military training route is VR97-1059, the nearest edge of which is located more than 6 miles from the VEGP site. Military aircraft using route VR97-1059 come mainly from Shaw Air Force Base (about 32 miles east of Columbia, South Carolina) and McEntire Air National Guard Station (about 13 miles east-southeast of Columbia). The applicant stated that the total number of military aircraft using route VR97-1059 is approximately 833 per year. According to RS-002, the aircraft accident probability for a military training route is considered to be less than 10^{-7} per year if the distance from the site is at least 5 miles from the edge of the military training route, including low-level training routes, except for routes that have a usage greater than 1000 flights per year or where activities may create an unusual stress situation. The applicant stated that since the VEGP site is located more than 5 miles from the edge of VR97-1509, and the total military flights (833 per year) using the same route is less than 1000 per year, no aircraft accident analysis is required for flights using VR97-1509. The probability number of 10^{-7} was cited from RG 1.70, Revision 3, issued November 1978, in reference to design basis external events.

The applicant stated in Section 2.2.2.6.2 of the SSAR that the centerline of Airway V185 is approximately 1.5 miles west of the VEGP site. Additionally, Airway V417 is about 12 miles northeast of the VEGP site, and Airway V70 is approximately 20 miles south of the VEGP site. Because the VEGP site is within the 2 statute-mile limit specified in Section 3.5.1.6 of RS-002, the applicant performed a more detailed review of aircraft hazards associated with air traffic along the V185 Airway; and this analysis was presented in Section 3.5.1.6 of the SSAR. The applicant stated that the FAA does not maintain records of air traffic in Airway V185. Therefore, since the traffic data for Airway 185 is not available, the applicant calculated the maximum number of airway flights per year required to exceed the acceptance guideline crash probability of 10^{-7} per year as stated in RS-002 and NUREG-0800. The applicant estimated that the total number of flights traveling along Airway V185 would need to be greater than approximately 51,100 per year in order to exceed a crash probability of 10^{-7} per year. Since this value is higher than the projected yearly total of flights through 2025 at Bush Field, the applicant did not consider Airway V185 to pose a significant hazard to the VEGP site.

The NRC staff independently verified the applicant-identified airports. The NRC staff contacted the FAA, and obtained the Bush Field flight operations data for the 2000 through 2006. These data reveal that the average number of flight operations at Bush Field is about 42,363, which is comparable to the applicant's stated number. Therefore, the NRC staff agrees with the applicant's conclusion that all public and private airports in the vicinity of the VEGP do not have sufficient annual flight operations to warrant a detailed risk analysis for potential nuclear units at the ESP site.

The NRC staff verified the applicant's cited reference of 14 CFR Part 71, "Designation of Class A, B, C, D, and E Airspace Areas; Air Traffic Routes, and Reporting Points." The applicant used the information cited in this regulation in recommending the width of the airway as 4 nautical miles on either side of the centerline, for a total width of 8 nautical miles. The NRC staff also verified the applicant's effective area calculation based on applicant's reference of the 1996 U.S. DOE guidance. The FAA provided the NRC staff with the number of flights that traversed V185 airways (FAA, 2007). As a result of the large amount of data to be analyzed, as well as the limitations of computing time and data handling, the FAA estimated the flight count data by extracting the flight count along V185 airways for every Thursday (typically as this day of the week is observed to have large number of flights) from January 2003 through December 2006. Based on these FAA data, the NRC staff calculated the average number of flights along V185 airways to be about 3000 per year. Also based on this value and the guidance provided in RS-002, Section 3.5.1.6, the NRC staff independently estimated the annual probability of an aircraft traversing along V185, crashing into the plant to be about 6 x10-^{9}.

The NRC staff evaluated the applicant's analysis of military aircraft for route VR97-1059. Based on 3 years of military training route data for Route VR97-1059, Shaw Air Force Base determined the average number of military training flights to be 761 compared to the applicant's referenced data of 833. Because the actual flights are lower than the threshold value of 1000 flights per year, the NRC staff finds the probability to be less than 10^{-7} per year. Regarding the identification of any activities within VR97-1059 that could create an unusual stress situation, Shaw Air Force Base informed the NRC staff that practice bombings are not authorized within Route VR97-1059. However, Shaw Air Force Base indicated that military aircraft will fly to Poinsett Range, to practice bombing and strafing. Inert bombs are used at Poinsett Range, instead of live bombs. Poinsett Range is approximately 10 miles south of Shaw Air Force Base. The NRC staff calculated the distance from the VEGP site to Poinsett Range to be approximately 78 miles. The guidance contained in RG 1.70 specifies that an aircraft hazard analysis should be done for practice bombing ranges within 20 miles from the site. Because the distance from the VEGP site to Poinsett Range is greater than the 20-mile distance specified in RG 1.70, the NRC staff finds the practice bombing at Poinsett Range does not create any unusual stress situations.

The NRC staff has reviewed the applicant's assumptions and calculations and finds them to be reasonable, consistent, and acceptable. On the basis of its independent estimation of the probability of a potential aircraft crash, the NRC staff agrees with the applicant's conclusion that Airway V185 does not present a safety concern for the VEGP site.

3.5.1.6.4 Conclusions

The NRC staff has reviewed the applicant's aircraft hazard analysis using the procedures delineated in RS-002, Section 3.5.1.6. As set forth above, the NRC staff has independently verified the applicant's assessment of aircraft hazards at the site and has concluded that the estimated probability of an accident having the potential for radiological consequences in excess of the exposure criteria found in 10 CFR Part 100 is less than about 10^{-7} per year.

Based on these considerations, the NRC staff concludes that aircraft hazards do not present an undue risk to the safe operation of nuclear units at the proposed ESP site. Therefore, the NRC staff concludes that, with respect to aircraft hazards, the proposed site is acceptable for planned nuclear units, and that the site meets the relevant requirements of 10 CFR Part 52 and 10 CFR Part 100.

3.7 Seismic Design

The AP1000 seismic Category I and II structures, systems, and components (SSCs) are designed to withstand the effects of seismic loads as defined in terms of the certified seismic design response spectra (CSDRS).

Seismic Category I SSCs are designed to withstand the effects of seismic motions defined in terms of the CSDRS and to maintain their specified design functions. Seismic Category II and nonseismic structures are designed or physically arranged (or both) so that seismic motions defined in terms of the CSDRS cannot cause unacceptable structural interaction with or failure of seismic Category I SSCs.

3.7.1 Seismic Design Parameters

3.7.1.1 Introduction

In its application, SSAR Part 2, Section 3.8, the applicant submitted details for performing work within the scope of the limited work authorization (LWA) request in accordance with 10 CFR 52.17(c) and 10 CFR 50.10(d). The scope of the applicant's LWA request involves soil foundation work and the placement of a concrete mudmat, a waterproofing membrane, concrete forms, a mechanically stabilized earth (MSE) retaining wall, and drains. The applicant, in SNC letter AR-08-1337, dated September 10, 2008 (ADAMS Accession No. ML082590048), states that the scope of the LWA request excludes the placement of steel reinforcement, embedments, and concrete for the structural foundation (basemat).

The scope of the staff's review of the applicant's LWA request is limited to SRP Sections 3.7.1,"Seismic Design Parameters," 3.7.2,"Seismic System Analysis," and 3.8.5, "Foundations." These sections address the applicant's LWA request to install a mudmat with an embedded waterproofing membrane. The mudmat, as indicated in SSAR Section 3.8, is to be placed over competent soil and constructed in two halves, with a waterproofing membrane placed between the two halves.

Accordingly, the staff evaluated the applicant's (1) seismic analysis and design, including (a) the design ground motion, (b) the foundation input response spectra, and (c) the supporting media for seismic design, and (2) applicable seismic system analyses, including (a) the foundation stability of the nuclear island (NI) against sliding and overturning, (b) the maximum dynamic bearing pressures developed beneath the foundation basemat, and (c) the horizontal seismic shear stresses developed between the basemat and the top of the mudmat, between the two halves of the mudmat through the waterproofing membrane, and between the bottom of the mudmat and the foundation soils.

The staff will perform the remaining review of the applicant's seismic design (i.e., for portions outside the scope of the LWA request) during its review of the Vogtle subsequent combined operating license (SCOL) application currently on Docket 52-025 and 52-026. The staff's review of Vogtle SCOL FSAR Section 3.7 will reflect the findings of the LWA review as appropriate.

3.7.1.2 Regulatory Basis

The staff relied on the following applicable regulatory requirements in reviewing the applicant's discussion of seismic design parameters:

- 10 CFR Part 100, Subpart B, which is applicable to power reactor site applications on or after January 10, 1997, refers to 10 CFR 100.23 for seismic criteria. This section describes the criteria and nature of investigations required to obtain the geologic and seismic data necessary to determine the suitability of the proposed site and the plant design bases. In addition, 10 CFR 100.23 refers to Appendix S to 10 CFR Part 50 for the definition of the minimum SSE ground motion for use in design.

- 10 CFR Part 50, Appendix S, is applicable to applications for a design certification or combined license pursuant to 10 CFR Part 52. Appendix S requires that, for SSE ground motions, SSCs will remain functional and within applicable stress, strain, and deformation limits. The required safety functions of SSCs must be assured during and after the vibratory ground motion through design, testing, or qualification methods. The evaluation must take into account SSI effects and the expected duration of the vibratory motion. Appendix S also requires that the horizontal component of the SSE ground motion in the free field at the foundation level of the structures must be an appropriate response spectrum with a PGA of at least. 0.10g.

- 10 CFR 52.79(b) applies to a COL referencing an ESP and requires information sufficient to demonstrate that the design of the facility falls within the site characteristics and design parameters specified in the ESP.

- 10 CFR 52.79(d)(1) applies to a COL referencing a design certification and requires that COL applications include information sufficient to demonstrate that the characteristics of the site fall within the site parameters specified in the design certification.

In addition, the seismic design parameters should be consistent with appropriate sections from:

- Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Revision 1, December 1973

- Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 3, March 2007

- Regulatory Guide 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," March 2007

Section 3.7.1 of NUREG-0800 provides specific guidance concerning the evaluation of seismic design parameters.

3.7.1.3 Technical Evaluation

3.7.1.3.1 Technical Information Presented by the Applicant

To support the technical basis for the LWA, the applicant incorporated by reference (IBR) the AP1000 DCD, Revision 15, Tier 1 Section 3.3, and Tier 2 Sections 2.5.2.3, 3.7.1, 3.7.2, and 3.8.5.

In addition, the applicant performed site-specific seismic analysis and provided the results in SSAR Appendix 2.5E, "AP1000 Vogtle Site Specific Seismic Evaluation Report, Revision 3."

3.7.1.3.1.1 <u>AP1000 Standard Design</u>

AP1000 DCD, Revision 15, Tier 2, FSAR Section 3.7.1, describes the CSDRS for the AP1000 design. These response spectra, as indicated in DCD FSAR Figures 3.7.1-1 and 3.7.1-2, are based on Regulatory Guide (RG) 1.60 amplified in the high-frequency region from 9 Hz to 25 Hz. The AP1000 CSDRS have peak ground accelerations (PGAs) of 0.30g in both the vertical and horizontal directions, which are applied at the foundation level in the free field for rock sites and at the finished grade for other generic soil conditions.

3.7.1.3.1.2 <u>Vogtle Design Ground Motion Response Spectra</u>

In SSAR Section 2.5.2, the applicant described its approach for developing the GMRS using the performance-based method described in RG 1.208. The Vogtle site-specific GMRS are defined at the free ground surface in the free field, which is defined as the finished grade level (Plant elevation 220 feet).

In SSAR Appendix 2.5E, Figures 3-4 and 3-5, the applicant compared the Vogtle GMRS to the AP1000, Revision 15, CSDRS. The free-field GMRS PGAs at the finished grade level are approximately 0.26g in the horizontal direction and 0.23g in the vertical direction and are bounded by the AP1000 CSDRS free-field PGA of 0.30.

SSAR Appendix 2.5E, Figures 3-4 and 3-5, indicate that the Vogtle site-specific GMRS exceed the AP1000 CSDRS in the approximate frequency ranges of 0.4–0.7 Hz and 7–60 Hz for the horizontal direction and 0.5–0.6 Hz and 12–50 Hz for the vertical direction. As a result of these exceedances, the applicant performed a site-specific soil-structure interaction (SSI) analysis to demonstrate either the suitability of the AP1000 standard design (Revision 15) or to justify the adequacy of the mudmat, the waterproofing membrane, and the NI structure stability. The applicant described these analyses in SSAR Appendix 2.5. FSER Section 3.7.2 describes the staff's review of these SSI analyses.

In SSAR Appendix 2.5E, Section 3.0, the applicant described its approach for developing the site-specific foundation input response spectra (FIRS) for Vogtle Units 3 and 4. The Vogtle FIRS are free-field outcrop spectra (determined using the entire soil column from bedrock to the free surface) at the foundation basemat elevation (i.e., 40 feet below the finished grade level). In SSAR Appendix 2.5E, Section 3.0, the applicant defined the Vogtle FIRS at 5-percent equipment damping, which is consistent with requirements in DCD FSAR, Tier 2, Section 2.5.2.3.

For the purpose of performing site-specific SSI calculations, the applicant chose to use the 5-percent damped spectrum as input to the three deterministic SSI soil profiles determined from the site-specific probabilistic site response analysis at the median or best estimate, 14^{th} percentile or lower bound, and 84th percentile or upper bound levels. For each profile, the applicant computed the surface and corresponding in-column spectra for use in the three deterministic SSI calculations. The applicant determined the corresponding in-column spectra for each case at an elevation in the profile which is the same as the FIRS outcrop and which represents the free-field particle motions at that depth. For each of the three SSI cases, the applicant generated three enveloping time histories (two horizontal and one vertical) to envelop the in-column spectra at 40 feet below the finished grade level. The applicant then used these in-column time histories as input to the SSI cases at 40 feet below the finished grade.

3.7.1.3.1.3 Percentage of Critical Damping Values

For seismic analysis of Category I structures, the applicant used values of critical damping consistent with RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants." The applicant assumed the critical damping value for reinforced concrete to be 7 percent and the maximum critical damping value for free-field soil layers to be less than 15 percent.

3.7.1.3.1.4 Supporting Media for Seismic Category I Structures

In SSAR Appendix 2.5E, Section 2.0, the applicant described the Vogtle site characteristics. The subsurface materials for the Vogtle site consist of approximately 90 feet of loose to dense sands, 70–80 feet of very hard, slightly sandy clay (i.e., Blue Bluff Marl), 900 feet of dense sands, and Triassic sandstone at 1049 feet. The applicant will excavate the upper 90 feet of soil and replace it with approximately 50 feet of compacted granular fill materials from the top of Blue Bluff Marl to the free ground surface. The fill material will be taken from borrow materials available locally. SSAR Appendix 2.5E, Section 2.0, states that the location of the water table is expected to be at least 15 feet below the bottom of the basemat of the NI. This is consistent with the applicant's proprosed site characteristic value of 165 feet MSL for the highest ground water elevation at the site, and the proposed elevation of the bottom of the AP1000 nuclear island basemat (180 feet MSL). The SSI analysis relied on the ground water table to be 15 feet below the basemat elevation.

3.7.1.3.2 NRC Staff's Technical Evaluation

The scope of the staff's review of SSAR Appendix 2.5E is limited to those sections that support the applicant's LWA request to install a mudmat with an embedded waterproofing membrane. To this end, the staff evaluated the applicant's technical basis for developing appropriate seismic design parameters for (1) comparing with the AP1000, Revision 15, CSDRS, (2) satisfying regulatory requirements, and (3) using appropriate input motions to the site-specific SSI analyses. The staff's evaluation of the applicant's seismic design parameters was performed in accordance with SRP Section 3.7.1.

The applicant used the site-specific seismic design parameters (e.g., GMRS, FIRS, and associated randomized soil profiles) to support SSI analyses which evaluated the effects of NI dynamic response. In addition, the applicant performed SSI analyses to demonstrate that a basemat sliding coefficient of friction of 0.45 between the mudmat and the supporting soils, would prevent the NI structure from sliding against the supporting soils under the SSE seismic loads.

3.7.1.3.2.1 Design Ground Motion Response Spectra

As stated previously, SSAR Appendix 2.5E, Figures 3-4 and 3-5, indicate that the Vogtle site-specific GMRS exceed the AP1000, Revision 15, CSDRS in the approximate frequency ranges of (0.4–0.7 Hz) and (7–60 Hz) for the horizontal direction and (0.5–0.6 Hz) and (12-50 Hz) for the vertical direction. As a result of these exceedances, the applicant performed a site-specific SSI analysis either to demonstrate suitability of the AP1000, Revision 15, standard design or to justify the adequacy of the mudmat, the waterproofing membrane, and the NI structure stability. The applicant described these analyses in SSAR Appendix 2.5E, "AP1000 Vogtle Site Specific Seismic Evaluation Report, Revision 3." FSER Section 3.7.2 describes the staff's review of these SSI analyses.

The staff reviewed the applicant's method for developing the site-specific FIRS and reviewed the applicant's methods for developing spectrum compatible time histories, randomized soil profiles, artificial shear wave velocity profiles, and degradation curves for Vogtle.

The staff's review found that (1) the process used to generate randomized shear wave velocity profiles and (2) the procedures used to generate the mean uniform hazard spectra at the free-ground surface at the top of the backfill satisfied the standard guidance described in RG 1.208 and in SRP Section 3.7. However, the staff found that the procedures used to generate the corresponding "outcrop" motions at the 40-foot depth (bottom of the NI foundation) were not in accordance with SRP Section 3.7. The motions included the effects of the downcoming waves in the calculation and were inconsistent with the need to generate the outcrop motions at a free-ground surface. To address the inconsistency in generating outcrop motions, the applicant compared the surface motions used as input to the SSI calculations for the best estimate, lower bound, and upper bound site-specific profiles using the FIRS outcrop motion at the 40-foot horizon (SSAR Appendix 2.5E, Section 3.0, Figures 3-6 through 3-8). The staff reviewed these comparisons and found that the applicant's approach to generating the SSI input motions from the FIRS motion resulted in conservative horizontal and vertical motion. Therefore, in the case of Vogtle Units 3 and 4, the staff accepts the applicant's approach to generating the FIRS outcrop motion and corresponding time-histories for use in site-specific SSI analyses.

The staff reviewed the applicant's compliance with the 10 CFR Part 50, Appendix S, requirement that the horizontal component of the SSE ground motion in the free field at foundation level be an appropriate response spectrum with a PGA of at least 0.10g. SSAR Appendix 2.5E (Figures 3-4 and 3-5) demonstrates that the Vogtle FIRS PGAs at the bottom of the NI foundation are approximately 0.26g in the horizontal direction and 0.23g in the vertical direction and thus are greater than the 0.10g regulatory requirement. On the basis of this comparison, the staff finds that the applicant has satisfied the Appendix S requirement.

3.7.1.3.2.2 Percentage of Critical Damping Values

As part of the detailed review of the applicant's SSI analysis, the staff reviewed the applicant's critical damping values used in the SSI analysis of seismic Category I structures (i.e., 7 percent for reinforced concrete and less than 15 percent for soil) and found them to be consistent with RG 1.61.

3.7.1.3.2.3 Supporting Media for Seismic Category I Structures

The staff reviewed the applicant's description of supporting media for the NI, including foundation embedment depth, depth of soil over bedrock, soil layering characteristics, highest groundwater elevation, dimensions of the foundation, and soil properties in SSAR, Section 2.5.4, and Appendix 2.5E. The staff finds the 40 foot embedment and dimensions of the foundation to be consistent with the AP1000, Revision 15, NI. Additionally, the staff finds that the SSI modeling assumptions relating to depth of soil over bedrock, soil properties, soil layering characteristics and groundwater elevation are acceptable based on conformance to the criteria discussed in SRP Section 3.7.1.

The staff reviewed the ESP-calculated best-estimate soil shear wave velocity profile, described in SSAR Appendix 2.5E, Section 4.0, and found that the shear wave velocity through the backfill soil was approximately 500 fps at the ground surface, greater than 1,000 fps at the bottom of the basemat, and about 2,800 fps at approximately 700 feet below grade. The staff finds that the 1,000 fps shear wave velocity at the bottom of the basemat meets the SRP Section 3.7.1.3 criterion for minimum shear wave velocity of the supporting foundation material.

3.7.1.4 Conclusion

On the basis of its review of the applicant's submittal, the staff concludes that the applicant has adequately developed seismic design parameters (e.g., GMRS, FIRS, and associated randomized soil profiles) for use in comparing to the AP1000, Revision 15, CSDRS, satisfying regulatory requirements, and performing a site-specific two-dimensional SSI analysis to evaluate foundation stability and basemat bearing pressures.

The staff's conclusions are based on the following five findings:

(1) The free-field GMRS PGAs at the finished grade level are approximately 0.26g in the horizontal direction and 0.23g in the vertical direction and are bounded by the DCD, Revision 15, SSE free-field PGA of 0.30.

(2) Although the applicant's method for developing the FIRS (at 40 feet below grade as outcrop motion) was not consistent with SRP Section 3.7, the method resulted in conservative seismic demand.

(3) The FIRS in the free field satisfied the minimum PGA value of 0.10g and is suitably broad banded.

(4) The critical damping values used in SSI analysis were consistent withdamping values used in RG 1.61.

(5) The 1,000 fps shear wave velocity at the bottom of the basemat meets the SRP Section 3.7.1.3 criterion for minimum shear wave velocity of the supporting foundation material.

Therefore, the staff finds that with respect to the LWA request, the applicant has met the applicable requirements of 10 CFR 52.79(b), 10 CFR 52.79(d)(1), and 10 CFR Part 50, Appendix S in that the applicant adequately demonstrated (1) that the relevant portions of the design of the facility falls within the site characteristics and design parameters specified in the ESP and AP1000 certified design (Revision 15) and (2) that the horizontal component of the SSE ground motion in the free-field at the foundation elevation is an appropriate response spectrum with a PGA of at least 0.10g.

3.7.2 Seismic System Analysis

3.7.2.1 Introduction

SSAR Section 3.0, Figures 3-4 and 3-5, indicate that the Vogtle GMRS exceed the AP1000 CSDRS in the approximate frequency ranges of (0.4–0.7 Hz) and (7–60 Hz) for the horizontal direction and (0.5–0.6 Hz) and (12–50 Hz) for the vertical direction. As a result of these exceedances, the applicant performed site-specific analyses to demonstrate the suitability of the AP1000, Revision 15, certified design.

The staff reviewed the applicant's site-specific two-dimensional SSI analyses to ascertain the appropriateness of the model(s) for estimating the maximum horizontal and vertical inertial loads on the NI resulting from SSE loading. These inertial loads are used to compute factors of safety for sliding and overturning and to compute maximum foundation bearing pressures anticipated to develop from the seismic motions. The staff focused its review on computer model descriptions, analysis assumptions, shear wave velocity profiles, and sensitivity studies on backfill properties. The staff did not evaluate in-structure response of the NI because it was not needed for the LWA request.

3.7.2.2 Regulatory Basis

The staff relied on the following applicable regulatory requirements in its review of the applicant's discussion of seismic systems analysis:

- 10 CFR Part 50, General Design Criterion (GDC) 2, requires that the design basis reflect appropriate consideration of the most severe earthquakes that have been historically reported for the site and surrounding area with sufficient margin for the limited accuracy, quantity, and period of time in which historical data have been accumulated.

- 10 CFR Part 100, Subpart B of 10 CFR Part 100, which is applicable to power reactor site applications on or after January 10, 1997, refers to 10 CFR 100.23 for seismic criteria. This section describes the criteria and nature of investigations required to obtain the geologic and seismic data necessary to determine the suitability of the proposed site and the plant design bases. This section also indicates that Appendix S to 10 CFR Part 50 contains applications to engineering design.

- 10 CFR Part 50, Appendix S, is applicable to applications for a design certification or combined license pursuant to 10 CFR Part 52. Appendix S requires that, for SSE ground motions, SSCs will remain functional and within applicable stress, strain, and deformation limits. The required safety functions of SSCs must be assured during and after the vibratory ground motion through design, testing, or qualification methods. The evaluation must take into account SSI effects and the expected duration of the vibratory motion. Appendix S also requires that the horizontal component of the SSE ground motion in the free field at the foundation level of the structures must be an appropriate response spectrum with a PGA of at least 0.10g.

In addition, the seismic systems analysis should be consistent with appropriate sections from:

- Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Revision 1, December 1973

- Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Revision 2, July 2006

Section 3.7.2 of NUREG-0800 provides specific guidance concerning the evaluation of seismic analysis methods.

3.7.2.3 Technical Evaluation

3.7.2.3.1 Technical Information Provided by the Applicant

3.7.2.3.1.1 Seismic Model Description

Structural Model

SSAR Appendix 2.5E, Section 4.0, describes the applicant's seismic analysis performed using the dynamic analysis computer code, "System for Analysis of Soil-Structure Interaction" (SASSI). The NI seismic analysis models used two-dimensional SASSI stick models to represent the AP1000 auxiliary shield building (ASB), the steel containment vessel (SCV), and the containment internal structure (CIS). These models made conservative assumptions with respect to the structural configuration of the auxiliary shield building. The applicant modeled the reinforced concrete of the ASB and CIS with linear elastic constitutive models. The applicant used guidance provided in FEMA 356 to reduce the concrete modulus of elasticity by 20 percent to account for reduced stiffness under moderate seismic loading conditions.

To account for the SSI effects on the NI response, the NI SSI model includes adjacent buildings such as the annex, radwaste, and turbine buildings, which are idealized by either lumped masses (radwaste and turbine buildings) or as a two-dimensional stick model (annex building).

Soil Model

The soil adjacent to the NI foundation is modeled by 8 uniform layers, with a horizontal spacing of approximately 5 feet. Soil elements are used to connect the foundation elements to the adjacent soil layers. The soil below the NI foundation is modeled with 81 elements to a depth of 1050 feet.

Ground Motion Input

The control motion input for the SSI analyses is the FIRS outcrop motion located at the NI foundation elevation. The applicant developed the FIRS outcrop motion from the three ESP soil profiles shown in SSAR Section 4.0, Figure 4.1-2. The results of the probabilistic site response analyses define these lower bound, best-estimate, and upper bound soil profiles. The enveloping of results from the three deterministic SSI analyses is intended to account for uncertainties in soils at the site as well as variability of wave-field effects assumed for the SSI analysis.

The applicant also developed a separate FIRS outcrop motion using the three sensitivity (SEN) soil profiles shown in SSAR Section 5.0, Figure 5.0-1. The SEN soil profiles assumed a slightly greater soil shear wave velocity in the NI backfill to account for variations in backfill compaction. The applicant performed these additional two-dimensional analyses to determine sensitivity in calculated response to properties of the backfill materials.

3.7.2.3.1.2 Soil-Structure Interaction Analyses

SSAR Appendix 2.5E, Section 5.0, describes the applicant's SSI analyses. The applicant used these analyses to determine the maximum horizontal and vertical inertial loads on the NI resulting from SSE loading. The SSAR defines the SSI model which used the ESP soil profiles as the ESP model. Similarly, the SSAR defined the SSI model which used the SEN soil profiles as the SEN model.

Sensitivity Studies

The applicant performed three sensitivity studies to address uncertainties in backfill soil modeling and its effects on NI response calculations. These sensitivity studies compared the effects of (1) variable compaction of the entire backfill soil adjacent to the NI, (2) modeling simplifications for the backfill excavation geometry, and (3) variable compaction of backfill soil within a 5-foot zone adjacent to the NI while the backfill outside of this zone remain unvaried.

SSAR Appendix 2.5E, Section 5.0, describes the applicant's approach to and results from sensitivity studies on variable compaction of the backfill soil. These calculations used the SEN SSI model and assumed slightly higher shear wave velocities for the NI backfill. The applicant compared the results of the SEN and ESP SSI models at the six key locations of the NI structure, provided in SSAR Appendix 2.5E, Section 5.0, Table 5.1-1, and found that the soil backfill, with a slightly higher shear wave velocity, will not significantly affect the NI dynamic response.

SSAR Appendix 2.5E, Appendix A, describes the applicant's approach to performing sensitivity studies on backfill excavation geometry. In the ESP model, the soil adjacent to the NI is essentially modeled in one dimension (i.e., horizontal layers of infinite extent) and does not consider construction issues such as lateral extent and sloping excavation. The applicant developed two separate two-dimensional SASSI models, one with the backfill excavation explicitly modeled and one without. The applicant compared the analysis results from these models at the six critical locations of the NI structure and found that while there were minor differences at some locations, the overall effect on NI response is small.

SSAR Appendix 2.5E, Section 5.3, describes the applicant's approach to, and results from, sensitivity studies on variable compaction of backfill soil within a 5-foot zone adjacent to the NI. This study estimated the effects of potential reduced compaction immediately adjacent to the NI due to construction effects associated with the MSE wall planned for use as a temporary excavation support system. The applicant analyzed the reduced compaction by varying the soil shear wave velocity of the backfill in the 5-foot zone behind the MSE wall. The applicant compared the analysis results from these models at the six critical locations of the NI structure and found that while there were minor differences at some locations, the overall effect on the NI response is small.

3.7.2.3.2 NRC Staff's Technical Evaluation

This section of the SER provides the staff's evaluation of the seismic system analysis. The staff's review of this section is limited to the analysis required to approve the applicant's LWA request. As such, the staff reviewed the applicant's methods for performing two-dimensional SSI analysis and determining seismic forces to evaluate foundation stability and dynamic bearing pressures on soils.

3.7.2.3.2.1 Two-Dimensional Versus Three-Dimensional Seismic Analysis

SSAR Appendix 2.5E, Section 4.0 describes the applicant's approach to performing site-specific analyses. The applicant performed two-dimensional seismic analyses to evaluate seismic stability (i.e., sliding and overturning) and to compute maximum bearing pressures beneath the NI. To evaluate the sliding stability evaluation and estimate bearing pressure demand/capacity evaluations only, the staff accepted the use of these two-dimensional seismic analyses. Since applicant's NI seismic stability evaluations are considered approximate and since the calculated factors of safety from the two-dimensional analyses were found to be large for an embedded facility, the staff considered the use of the simplified two-dimensional analyses to be appropriate. The staff did not consider increased refinement in the analyses to be necessary for these calculations.

However, for development of in-structure response spectra (ISRS) and calculation of maximum seismic element force needed for structural and equipment design, the Staff considers that more refined SSI models are required. The basis for the staff's position is that the two-dimensional SSI calculations do not properly account for (1) effective radiation damping, (2) frequency-dependent impedance functions, (3) out-of-plane effects (e.g., torsion, coupled modes), or (4) vertical responses associated with irregular structural configurations. All of these can have significant impact on computed design response. It is the judgment of the staff that the two-dimensional SSI calculations may underestimate seismic demand. The staff will review in-structure response as part of the COL review of Vogtle FSAR Section 3.7.

3.7.2.3.2.2 Nuclear Island Backfill Soil Sensitivity Calculations

The staff reviewed the applicant's two-dimensional SSI model and found that the modeling approach was acceptable and performed in accordance with guidance in SRP Section 3.7.2. However, the staff found that the applicant essentially modeled the backfill soil adjacent to the NI in one dimension (i.e., infinite horizontal layers), and the model does not consider construction issues such as lateral extent and sloping excavation. To understand whether or not the lateral extent of the backfill excavation has a significant effect on SSI calculations, the staff issued RAI 2.5.2-25 requesting the applicant to compare the soil model response using both a two-dimensional SASSI and one-dimensional SHAKE, and a two-dimensional SASSI structural model response with backfill soil modeled as both infinite uniform layers and uniform layers with lateral boundaries.

In response to RAI 2.5.2-25, the applicant compared the motion response of a one-dimensional SHAKE analysis to a two-dimensional SASSI analysis. SSAR Appendix 2.5E, Figures 2.5.2-55a and 55b, show response comparisons for motions at the ground surface, at the base rock, and at the 40-foot horizon.

The staff reviewed the comparison of the one-dimensional SHAKE and two-dimensional SASSI model vibratory motion responses and found the differences between them to be small.

In response to RAI 2.5.2-25, the applicant also developed two 2-dimensional SASSI models which included the NI and adjacent buildings (SSAR Appendix 2.5E, Appendix A). The first model, "2D-AP-d5," did not account for the lateral extent of the NI. The applicant developed the second model, "Bathtub Model-d5," to represent the east-west cross-section of the Vogtle excavation (SSAR Appendix 2.5E, Figure A-1). The applicant used the same time histories for both analyses and then compared the responses at the six critical locations of the NI structure. Figures A-2 through A-13 illustrates response comparisons for several NI locations.

The staff reviewed the six key NI locations referenced in SSAR Appendix 2.5E, Section 5.0, Table 5.1-1 and agrees with the applicant that these six locations correspond to areas of the most significant safety-related equipment or locations of maximum NI displacement resulting from an SSE event. Therefore, these locations are acceptable to the staff for comparing seismic responses.

1. NI at Reactor Vessel Support Elevation
2. Auxiliary Shield Building at Control Room Floor
3. ASB Auxiliary Building Roof Area
4. ASB Shield Building Roof Area
5. Steel Containment Vessel near Polar Crane
6. Containment Internal Structure at Operating Deck

The staff reviewed the response comparisons of the two-dimensional SASSI models, 2D-AP-d5 and Bathtub Model-d5, and finds that the difference in in-structure response is relatively small. The results indicate that the influence of the backfill excavation geometry on NI dynamic response is insignificant. Therefore, the staff finds the applicant's approach acceptable.

3.7.2.3.2.3 Mechanically Stabilized Earth Backfill Soil Sensitivity

SSAR Section 2.5.4.5.7 describes the details of MSE wall design. Although most of the compaction of the backfill soil behind the MSE will be accomplished with heavy, self-propelled equipment, the applicant stated that the compaction of the zone adjacent to the wall (approximately 5 feet) will be done using smaller sized compactors with thinner lifts. Because of the potential for lower compaction in this zone, the staff was concerned that the resulting drop in shear wave velocity would affect the NI response. To clarify this issue, the staff issued RAI Appendix 2.5E-2 requesting that the applicant describe the effects of variable compactions behind the MSE wall on SSI calculations.

In response to RAI Appendix 2.5E-2, the applicant performed sensitivity studies on the effects of MSE wall backfill using two 2-dimensional SASSI models which are described in Section 5.3 of SSAR Appendix 2.5E. The first SASSI model assumed a backfill shear wave velocity of 515-909 fps with no difference in shear wave velocity in the 5-foot zone adjacent to the MSE wall. The second SSI model assumed the same backfill shear wave velocity as the first model, but the 5-foot zone had a reduced shear wave velocity of 421–755 fps. Section 5.3, Figures 5.3-1 through 5.3-19, of SSAR Appendix 2.5E show the results of these calculations. The analysis results indicate that the effect of reduced backfill compaction (resulting in lower shear wave velocities) on the seismic response at the six critical locations of the NI structure is small.

Based on a review of these results, the staff concurs with the applicant's conclusion that the potentially reduced shear wave velocity of the backfill directly behind the MSE wall does not significantly affect the NI building response for the Vogtle site. On the basis of these findings and the applicant's responses, the staff considers RAI Appendix 2.5E-2 resolved.

3.7.2.3.2.4 Soil-Structure Interaction Models

The staff reviewed the applicant's approach for developing two-dimensional models, described in SSAR Appendix 2.5E, for the purpose of site-specific SSI analysis. On the basis of its review of the backfill soil and MSE wall sensitivity calculations as discussed above, the staff finds the applicant's approach to modeling the Vogtle site soil conditions and AP1000 NI (Revision 15) acceptable for the purpose of calculating seismic demands for assessing foundation stability and dynamic bearing pressures.

The applicant provided the magnitudes of peak results of the seismic shear forces from the SSI model, which are summarized in FSER Table 3.7.2-1, in response to RAI 3.8.5-4. The applicant, in SSAR Appendix 2.5E, Section 6.1, describes the use of these values in performing stability evaluations.

The staff calculated the maximum seismic shear forces and obtained values consistent with the applicant's values in FSER Table 3.7.2-1. Therefore, the staff finds the applicant's maximum seismic shear forces to be acceptable for use in calculating foundation stability and bearing pressures.

Table 3.7.2-1 Vogtle Maximum Seismic Shear Forces

Reaction	Vogtle Lower Bound	Vogtle Best Estimate	Vogtle Upper Bound
Seismic Shear NS	78.3 E3 kips	82.5 E3 kips	89.0 E3 kips
Seismic Shear EW	88.9 E3 kips	89.8 E3 kips	95.8 E3 kips

3.7.2.4 Conclusion

On the basis of the review of the applicant’s submittal, the staff concludes that the applicant has adequately performed site-specific seismic analysis for the purpose of determining the maximum horizontal and vertical inertial loads on the NI for use in stability and bearing capacity evaluations. The calculated loads referenced above (FSER Table 3.7.2-1) are acceptable.

The staff’s above conclusions are based on the following three findings:

(1) The applicant demonstrated that the effect of excavation geometry (i.e., lateral extent of soil backfill) on the NI SSI response is minimal.

(2) The effect of higher shear wave velocity for backfill soil on the NI SSI response is minimal.

(3) The effect of reduced compaction in the 5-foot zone behind the MSE wall on the NI SSI is minimal.

The staff finds that with respect to the LWA request, the applicant has met the applicable requirements of 10 CFR Part 50, Appendix A (GDC 2), and 10 CFR Part 50, Appendix S, in that the applicant’s evaluation accounted for the SSI effects and the expected duration of the vibratory ground motion.

3.8.5 Foundations

3.8.5.1 Introduction

As part of its review of the applicant's LWA request, the staff reviewed the use of the mudmat, which is located beneath the nuclear island (NI) basemat, and the waterproofing membrane, which is located between the two halves of the mudmat. Both are within the scope of the applicant's LWA request. The staff also reviewed the sliding stability of the NI structure during the SSE to ensure that the horizontal seismic shear force can be transferred safely through the mudmat and the waterproofing membrane without sliding to the supporting soils and that the NI structure will not slide relative to its supporting soils. The staff also reviewed the overturning stability of the NI structure during the SSE event and found reasonable assurance that the NI structure will not break into the ground (the supporting soils) during the SSE event.

3.8.5.2 Regulatory Basis

The NRC staff used the following applicable regulatory requirements in its review of the applicant's discussion of foundations:

- 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 1, as they relate to safety-related structures being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed

- GDC 2, as it relates to the design of the safety-related structures that are capable of withstanding the most severe natural phenomena, such as wind, tornadoes, floods, earthquakes, and the appropriate combination of all loads, and still perform their safety functions

- Appendix B to 10 CFR Part 50, as it relates to the quality assurance criteria for nuclear power plants

- 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the COL, the provisions of the Atomic Energy Act, and NRC regulations.

Section 3.8.5 of NUREG-0800 provides specific guidance concerning the evaluation of foundation design.

3.8.5.3 Technical Evaluation

3.8.5.3.1 Technical Information Presented by the Applicant

In SSAR Section 3.8.5, the applicant described the scope of the LWA request which includes construction of MSE retaining walls, a mudmat, and the waterproofing membrane between the two halves of the mudmat.

SSAR Section 3.8.5.1 describes the process for constructing MSE retaining walls to serve as formworks for the outer walls of the NI structure. The MSE wall will be founded on a concrete strip footing that is independent of the NI structure. The wall will be approximately 40 feet high and will be backfilled with engineered fill. Because the MSE wall only serves as a formwork and is not categorized as a seismic Category I structure, it does not require a review under SRP Section 3.8. SSAR 2.5.4 provides details of the MSE wall.

SSAR Section 3.8.5 describes the installation of a concrete mudmat, which will be placed within the confines of the MSE wall. The mudmat will consist of two 6-inch layers of concrete placed on engineered fill, as described in SSAR Section 2.5.4. An elastomeric spray-on waterproofing membrane will be sandwiched between these layers to provide protection from external flooding. The waterproofing membrane will be sprayed or brushed onto the entire mudmat surface as well as the MSE wall inner face. Before the installation, the applicant will develop a qualification program to evaluate the chemical and physical properties of the waterproofing membrane material. In addition, the applicant has proposed a site-specific ITAAC, shown in Table 3.8.5-1, to confirm that the waterproofing membrane can provide a coefficient of friction of 0.7 to prevent sliding of the upper portion of the mudmat from the lower portion of the mudmat during an SSE.

Table 3.8.5-1 Waterproof Membrane Inspections, Tests, Analyses, and Acceptance Criteria (SSAR Table 3.8.5.1-1)

Waterproof Membrane Inspections, Tests, Analyses, and Acceptance Criteria		
Design Commitment	**Inspections, Tests, Analyses**	**Acceptance Criteria**
1) The friction coefficient to resist sliding is 0.7 or higher	Testing will be performed to confirm that the mudmat-waterproofing-mudmat interface beneath the Nuclear Island basemat has a minimum coefficient of friction to resist sliding of 0.7.	A report exists and documents that the as-built waterproof system (mudmat-waterproofing-mudmat interface) has a minimum coefficient of friction of 0.7 as demonstrated through material qualification testing.

3.8.5.3.2 NRC Staff's Technical Evaluation

The staff's review of this section is limited to the analysis and design required to approve the applicant's LWA request.

3.8.5.3.2.1 Waterproofing Membrane

In SSAR 3.8, the applicant proposed to use an elastomeric waterproof membrane for providing external flood protection for the NI foundation. The applicant stated that it will specify the final thickness of the membrane based on the physical properties of the selected material, but it is expected to be approximately 0.080–0.120 inches thick. SSAR Section 2.5.4.5.3 provides further details of the waterproofing membrane.

During its initial review of SSAR Section 3.8, the staff found insufficient information with respect to the waterproof membrane material. The staff issued RAI 3.8.5-3 which requested the applicant to do the following:

a) Provide chemical and structural (mechanical) properties of the waterproof membrane.

b) Describe whether the waterproof membrane has been used in structures in which a minimum 0.7 coefficient of friction between the waterproofing membrane and concrete was achieved.

c) If no data indicate that a minimum 0.7 coefficient of friction between the waterproofing membrane and concrete exists, provide the basis for the adequacy of the design assumption that the upper portion of the mudmat will not move relative to the lower portion of the mudmat during earthquakes.

d) Describe the qualification and test programs and explain how they can be used to demonstrate that the waterproofing membrane meets the waterproofing and friction requirements stated in Section 3.8.5.1.1.

In response to RAI 3.8.5-3(a), the applicant provided the intended waterproof membrane product datasheet (Sterling Lloyd, Intergitank® Structural Waterproofing Membrane). This data sheet states that the membrane material is a liquid-applied, fully reactive elastomeric membrane which cures rapidly and is available in both spray and hand grades. Typical applications include tunnels, storage tanks and silos, canals and culverts, and low-level radiation tanking.
Table 3.8.5-2 identifies several relevant properties of the membrane material.

Table 3.8.5-2 Relevant Properties of Waterproofing Membrane Material

Property	Value
Typical Tensile Strength	1711 psi (11.8 MPa)
Typical Elongation at Break	>130%
Typical Tear Strength	400 lb/in (70N/mm)
Heat Aging at 70 °C for 1 Year (equivalent to 32 years aging at 20 °C)	No significant change in tensile strength or elongation at break
Resistance to Water Pressure (19.7 ft (6m) head of water)	No leak

In response to RAI 3.8.5-3(b), the applicant provided a test report (Sterling Lloyd TR 621). This test report describes a simplified test for evaluating the coefficient of friction between the membrane material and concrete blocks of various surface textures (smooth, slightly rough). This test report also demonstrated that the static coefficient of friction ranged from 0.40 (slightly textured membrane/slightly rough concrete surface) to 0.81 (slightly textured membrane surface/smooth concrete surface).

In response to RAI 3.8.5-3(c), the applicant stated that the assumption that the upper and lower portions of the mudmat will not move relative to one another is based on the results from Sterling Lloyd TR 621, which showed that a coefficient of friction of 0.7 (or greater) is achievable.

In response to RAI 3.8.5-3(d), the applicant stated that it will conduct qualification and test programs to demonstrate that the waterproof membrane meets the waterproofing and friction requirements stated in SSAR Section 3.8.5.1.1. To this end, the applicant proposed in ESP SSAR Section 3.8.5.1, Table 3.8.5.1-1, "Waterproof Membrane Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)," to perform testing to confirm that the mudmat-waterproofing-mudmat interface has a minimum coefficient of friction of 0.7 prior to installation of the waterproof membrane.

The staff finds that the report provided by the applicant (i.e., Sterling Lloyd TR621) is based on friction testing using materials (i.e., cement block and elastomeric spray-on waterproofing) whose relevant properties are substantially similar to those proposed by the applicant for the design of the waterproof membrane described in SSAR Section 3.8.

Based on the above, the staff finds that there is sufficient technical information to conclude: (1) that the proposed waterproof membrane material can achieve a friction coefficient of 0.7; and (2) that the ITAAC to document the as-built waterproof system (mudmat-waterproofing-mudmat interface) has a minimum coefficient of friction of 0.7, as demonstrated through material qualification testing, is reasonable and verifiable.

Therefore, the staff considers RAI 3.8.5-3 resolved.

On the basis of the above discussion and the inclusion of the waterproof membrane ITAAC, the staff concludes that the applicant's proposed use of the waterproofing membrane for VEGP Units 3 and 4 is acceptable.

3.8.5.3.2.2 <u>Stability Analyses</u>

In SSAR Appendix 2.5E, Chapter 6, the applicant described the methods for evaluating the site-specific sliding stability and overturning stability of the AP1000 NI structure.

3.8.5.3.2.3 <u>Sliding Stability</u>

The applicant assumed a coefficient of friction of 0.45 between the basemat and the supporting soil. To further the staff's understanding of this assumption, the staff issued RAI 3.8.5-4 which requested that the applicant address the following:

a) For stability analysis during earthquakes, state whether the bottom of the mudmat is allowed to move relative to the supporting soils or not. If relative movement is predicted, state the maximum value of the horizontal movement during the SSE and the basis for accepting that amount of movement. If relative movement is not predicted, state the maximum magnitude of the horizontal force generated in the nuclear island structure during the SSE, and the magnitude of frictional force provided at the interface between the mudmat and the supporting soils.

b) If the magnitude of frictional force provided at the interface between the mudmat and the supporting soils is less than the maximum magnitude of the horizontal force generated in the nuclear island structure during the SSE, state the magnitude of forces due to the passive earth pressure on one side and the active earth pressure on the opposite side of the embedded nuclear island walls generated through the rotation of the nuclear island structure, and describe how these horizontal forces are in equilibrium so that the bottom of the mudmat will not move relative to its supporting soils. At that equilibrium stage, state: (1) the rotational angle of the nuclear island structure and the horizontal displacement at the top surface of the soils adjacent to the nuclear island structure during the SSE; and (2) whether or not buoyancy force due to ground water and vertical seismic forces were subtracted from the total weight of the nuclear island.

c) Describe how the shear loads (or stresses) in different regions of the upper portion of the mudmat are transferred through the waterproof membrane to the lower portion of the mudmat. State the maximum shear load (or stress) in the mudmat and the shear capacity of the waterproof membrane and the mudmat, and describe how these values were derived or obtained.

In response to RAI 3.8.5-4(a), the applicant stated that its stability analysis assumed that there is no relative movement at the bottom of the mudmat relative to the supporting soils. Furthermore, the applicant provided the maximum seismic shear force and the friction force between the mudmat and the supporting soil for the upper bound, best-estimate, and lower bound SSI cases in the north-south (NS) and east-west (EW) directions during the SSE (summarized in SER Table 3.8.5-3). Because the applicant provided the requested information, the staff considers RAI 3.8.5-4(a) resolved.

Table 3.8.5-3 Vogtle Maximum Seismic Shear and Friction Forces

Reaction	Vogtle Lower Bound	Vogtle Best Estimate	Vogtle Upper Bound
Seismic Shear NS	78.3 E3 kips	82.5 E3 kips	89.0 E3 kips
Seismic Shear EW	88.9 E3 kips	89.8 E3 kips	95.8 E3 kips
Friction Force	117.3 E3 kips	116.7 E3 kips	116.4 E3 kips

In response to RAI 3.8.5-4(b), the applicant stated that in all cases (see Table 3.8.5-3) the available friction forces exceed the maximum seismic shear forces.

The staff calculated the maximum seismic shear force and the friction force and obtained values close to the applicant's values listed in Table 3.8.5-3. Therefore, the staff considers RAI 3.8.5-4(b) resolved and agrees with the applicant's conclusion that the NI structure will not slide against its supporting soil during the SSE.

With respect to the shear strength of the mudmat, the applicant responded in RAI 3.8.5-4(c) that the shear strength of the mudmat is about 100 psi, based on American Concrete Institute (ACI) code calculations, because the minimum specified concrete compressive strength for the mudmat is 2500 psi. The staff agrees with the applicant's assessment of the shear strength for the mudmat. The applicant obtained an average shear stress of 25.1 psi by using the highest friction force of 117.3x103 kips, as listed in Table 3.8.5-3, divided by the footprint area of the NI structure as the required shear stress to be transferred through the mudmat and the waterproofing membrane. The staff considers the applicant's shear stress calculation of 25.1 psi to be conservative because it used the largest friction force of 117.3x103 kips instead of the largest seismic shear force of 95.8x103 kips. Therefore, the staff concludes that the mudmat, which possesses a shear strength of 100 psi, can safely transfer the required 25.1 psi shear stress through it.

With respect to the shear strength of the waterproofing membrane, the staff agrees with the applicant's statement that the waterproofing membrane, which possesses a tensile strength of 1700 psi, likely possesses a shear strength greater than 25.1 psi. Based on the soil conditions at the Vogtle site, the mudmat material strength, and the waterproofing membrane strength, the staff concludes that the NI structure can safely transfer horizontal seismic shear force through the mudmat and the waterproofing membrane, without sliding, to the supporting soils. Furthermore, the NI structure will not slide horizontally relative to its supporting soils during the SSE.

3.8.5.3.2.4 Overturning Stability

In SSAR Section 2.5.4.10.1, the applicant provided the site-specific dynamic bearing capacity of 42 ksf for soils at the Vogtle site. SSAR Appendix 2.5E, Chapter 7.0, summarizes the maximum dynamic bearing pressures on soils from the site-specific two-dimensional SSI analyses. The analyses results indicate that no structure will be overturned, and the maximum dynamic bearing pressures for the NI, radwaste, annex, and turbine buildings are 17.95 ksf, 1.68 ksf, 7.20 ksf, and 2.54 ksf, respectively, during the SSE. The minimum factor of safety with respect to a failure of the dynamic bearing capacity during the SSE is 2.34 (42 ksf divided by 17.95). The staff considers this minimum factor of safety to be adequate and concludes that the NI structure will not break into the ground (the supporting soils) during the SSE.

3.8.5.4 Conclusion

Based on its review of the applicant's submittal and responses to RAIs, the staff concludes that the applicant has demonstrated that the design of the MSE walls, the mudmat, and the waterproofing membrane, as stated in the LWA request, is adequate and can be constructed. The staff's conclusion is based on the following findings:

(1) The MSE walls are not seismic Category I structures, and they only serve as formworks for the outer walls of the NI foundation.

(2) Both the mudmat and the waterproofing membrane have sufficient shear strength to transfer the required shear stress, without sliding at interfaces, to the supporting soils.

(3) The waterproof membrane ITAAC is adequate for confirming that the mudmat-waterproofing-mudmat interface beneath the Nuclear Island basemat has a minimum coefficient of friction to resist sliding of 0.7.

(4) The soil condition at the Vogtle site is capable of preventing the NI structure, including the mudmat, from sliding horizontally relative to the ground (the supporting soils) and from breaking into the ground vertically during the SSE.

The staff finds that the applicant has met the applicable requirements of 10 CFR 52.80(a), 10 CFR Part 50, Appendix A (GDC 1 and 2), and 10 CFR Part 50, Appendix B in that the applicant adequately demonstrated: (1) that the COL application contains the proposed inspections, tests, and analyses that the licensee shall perform and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the COL, the provisions of the Atomic Energy Act, and NRC regulations; and (2) that the NI mudmat and waterproofing membrane are designed to resist an SSE event.

11.0 RADIOLOGICAL EFFLUENT RELEASE DOSE CONSEQUENCES FROM NORMAL OPERATIONS

11.1 Introduction

Because the original SSAR submitted by the applicant did not contain a Chapter 11 gaseous and liquid radiological dose analysis, the NRC staff evaluated Environmental Report (ER) Chapter 5, Section 5.4 of the ESP application, Revision 1. Subsequently, the NRC staff informed the applicant, in a RAI dated February 16, 2007, that the SSAR did not comply with 10 CFR 52.17(a)(1) and 10 CFR 100.21(c)(1). By letter dated May 3, 2007, the applicant provided its response to the NRC staff's RAI. The applicant submitted Revision 2 of the ESP application, including SSAR Chapter 11, "Radioactive Waste Management." Chapter 11, Sections 11.2 and 11.3, contain the analysis for the gaseous and liquid radioactive effluents.

11.2 Regulatory Evaluation

The acceptance criteria for addressing radiological doses to members of the public from radiological effluents due to postulated normal plant operations are based on meeting the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100. The NRC staff considered the following regulatory requirements in reviewing the applicant's discussion and analysis of radiological doses to members of the public from radiological effluents due to postulated normal plant operations:

- 10 CFR 52.17(a), which requires that the application contain a description of the anticipated maximum levels of radiological and thermal effluents each proposed facility will produce.

- 10 CFR 100.21(c), which requires that site atmospheric dispersion characteristics be evaluated and dispersion parameters established such that (1) radiological effluent release limits associated with normal operation from the type of facility to be located at the site can be met for any individual located offsite; (2) radiological dose consequences of postulated accidents shall meet the criteria set forth in 10 CFR 50.34(a)(1) for the type of facility proposed to be located at the site.

The information assembled in compliance with the above regulatory requirements would be necessary, at the COL or CP stage, to assess whether the proposed facility will control, monitor, and maintain radioactive gaseous and liquid effluents from the proposed facility within the regulatory limits (including the referenced dose standards in 40 CFR Part 190) specified in 10 CFR Part 20 as well as maintain radiological effluents at as low as reasonably achievable (ALARA) levels, in accordance with the dose objective of 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. Table 11.2-1 provides a quantitative summary of the above standards.

To the extent applicable under the above-cited regulatory requirements, the applicant applied the NRC-endorsed analytical methodologies and parameters found in RG 1.109, Revision 1, issued October 1977, and RG 1.111, Revision 1, issued July 1977. When independently assessing the accuracy of the information presented by the applicant in SSAR Chapter 11, the NRC staff applied the same above-cited analytical methodologies and parameters.

Table 11.2-1 - NRC Staff's Summary of 10 CFR Part 50 Appendix I Dose Objectives and 40 CFR Part 190 Environmental Dose Standards

Regulation	Type of Effluent	Pathway	Organ	Dose Limit (mrem/yr per unit)
10 CFR Part 50, Appendix I *	Liquid	all	total body	3
		all	any organ	10
	Gaseous	all	total body	5
		all	skin	15
	Radioiodines & Particulates	all	any organ	15
	Gaseous	gamma air dose	n/a	10***
		beta air dose	n/a	20***
40 CFR Part 190 **	all	all	total body	25#
	all	all	thyroid	75#
	all	all	any other organs	25#

Notes:

* 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," defines dose objectives for the maximally exposed individual (MEI).

** Dose limits are defined for any real member of the public. Under NRC requirements, this standard is implemented under 10 CFR Part 20.1301(e).

*** Air doses are expressed in mrad/year instead of mrem/year.

\# 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations." dose limits are for the entire site and apply to all operating units.

11.3 Technical Evaluation

The applicant provided estimates of radiological impacts on members of the public from gaseous and liquid effluents that would be generated as a normal byproduct of nuclear power operations. This included a description of the exposure pathways by which radiation and radioactive effluents could be transmitted to members of the public within a 50-mile (80 Km) radius from the site. The estimates of the maximum doses to the public are based on the AP1000 reactor's normal operational effluent releases, as discussed in Westinghouse Electric Company, LLC, AP1000 Design Control Document, Revision 15, November 11, 2005. The applicant evaluated the impact of these doses by comparing them to applicable regulatory limits.

The applicant also provided a list of fission and activation products that may be released in liquid and gaseous effluents from the two proposed units. The applicant evaluated the impacts from effluent releases and direct radiation by considering the probable pathways to individuals, populations, and biota near the proposed new units. The applicant also calculated the highest dose from the major exposure pathways for a given specific receptor. In addition, the applicant estimated the dose to the maximally exposed individual (MEI) from both the liquid and gaseous effluent release pathways, and calculated a collective whole body dose for the population within 50 miles (80 km) of the Vogtle site. The NRC staff's analysis of the gaseous and liquid radioactive effluents is provided in the following sections 11.3.1 and 11.3.2.

11.3.1 Gaseous Effluents

The applicant provided an analysis describing the exposure pathways by which radiation and radioactive effluents could be transmitted from the new units to individuals living near the plant, and estimated the maximum doses to the public.

The applicant calculated the total body and individual organ dose to a hypothetical maximally-exposed member of the public from gaseous effluents using radiological exposure models based on RG 1.109, the GASPAR II computer program (NUREG/CR-4653, "GASPAR II - Technical Reference and User Guide," March 1987), and RG 1.111. Section 2.3.5 of the SSAR discusses the derivation of the atmospheric dispersion parameters, and presents specific values for the dispersion and deposition parameters used in the applicant's radiological dose assessment.

The applicant calculated the gaseous pathway doses to the MEI at the nearest site boundary, residence, garden, and meat animal. The applicant did not include the milk consumption pathway for the maximally-exposed individual because the current land use census found no milk producing animals within 5 miles of the facility. The applicant did, however, include milk consumption for the population dose calculation. The applicant estimated the site boundary dose for noble gas plume immersion, ground shine from deposited radioactive iodine and particulate radionuclides, and inhalation of radio-iodine, and particulate radionuclides (including tritium and carbon-14). The applicant also estimated the dose for the current MEI receptor based on plume and ground plane exposure, inhalation, and ingestion of cow meat and garden vegetables.

In Table 11.3-3 of the SSAR, the applicant provided an estimate of the radiological releases associated with gaseous effluents that may occur during normal operation of the plant. The applicant obtained estimates of gaseous radioactive effluent releases from Table 11.3-3 of the NRC staff approved DCD for the AP1000.

These gaseous effluent releases are used to estimate doses at the site boundary and to the MEI. Tables 11.3-1, 11.3-2, and 11.3-4 of the SSAR include other calculation input data, including regional milk, meat and vegetable production rates, atmospheric dispersion and ground deposition factors, receptor locations, and the assumed consumption rates of food products by the MEI.

As shown in Tables 11.3-5 and 11.3-6 of the SSAR, the applicant calculated the gaseous pathway doses to the MEI for the site boundary, the nearest residence and garden and meat animal. The results show for the site boundary a gamma annual air dose of 0.0067 milliGray (mGy) or 0.67 millirad (mrad), a beta annual air dose of 0.028 mGy or 2.8 mrads; a total annual body dose of 0.0056 milliSieverts (mSv) or 0.56 millirem (mrem) and an annual skin dose of 0.022 mSv or 2.2 mrem. Table 11.3-6 of the SSAR also lists the maximum annual organ dose (thyroid) of 0.059 mSv or 5.9 mrem for the child.

Using the GASPAR II code and the applicant's input data, the NRC staff performed an independent evaluation of the applicant's gaseous effluent pathway doses, and the NRC staff calculations achieved results similar to that of the applicant. Therefore, the NRC staff finds that the applicant's calculated doses are correct and appropriate per the applicable dose criteria listed in SER Table 11.2-1.

The applicant also compared the MEI doses with the exposure criteria of 40 CFR Part 190, as would be required of the applicant at the COL stage, per 10 CFR 20.1301(e). The applicant's results are presented in Table 11.3-7 of the SSAR and included the sum of doses from the two proposed units and the two existing units. For the total site, the applicant's results were less than the maximum doses specified in 40 CFR Part 190.10(a) of 25 mrem/yr whole body, 75 mrem/yr thyroid, and 25 mrem/yr any other organ (Table 11.2-1):

- 2.4 mrem/yr (0.024 mSv) for the whole body,
- 12 mrem/yr (0.12 mSv) for the thyroid, and
- 8.9 mrem/yr (0.089 mSv) to bone.

As such, the NRC staff find that the applicant's results would comply with the requirements of 40 CFR Part 190 and 10 CFR Part 20.1301(e).

Based on the above, the NRC staff concludes that the applicant has provided a bounding assessment for gaseous effluents, demonstrating its capability to comply with the regulatory requirements in 10 CFR Part 20 and Appendix I to 10 CFR Part 50 given the atmospheric dispersion parameters set forth in Section 2.3.5 of the NRC staff's SER.

11.3.2 Liquid Effluents

If built, the postulated two new units at the Vogtle site would release liquid effluents into the Savannah River through a newly constructed discharge structure. The applicant calculated liquid pathway doses for several pathways, including eating fish caught in the Savannah River, drinking Savannah River water, shoreline exposure, and exposure from swimming and boating. The applicant excluded crop irrigation and livestock watering because the results of the most recent land use censuses described in the 2005 Radiological Environmental Operating Report for Vogtle Electric Generating Plant, Units 1 and 2, confirmed that the Savannah River is not used for these purposes within 100 miles downstream of the site.

In its response to the NRC staff's RAI dated May 3, 2007, the applicant provided a description of all required model assumptions and input parameters needed to run LADTAP II computer codes; justification for excluding potential exposure pathways; and its basis for using a dilution factor.

Using radiological exposure models based on RG 1.109 and the LADTAP II computer program (NUREG/CR-4013, "LADTAP II - Technical Reference and User Guide," April 1986), the applicant calculated the estimated doses to a hypothetical MEI of the public and to the population within 50 miles (80 Km) from the postulated liquid effluents discharged.

In Table 11.2-3 of the SSAR, the applicant listed the estimated radiological source terms associated with liquid effluents that may be released from normal operation of the plant. The applicant obtained these estimates of liquid radioactive effluent from the NRC staff-approved AP1000 DCD, Table 11.2-7. Tables 11.2-1 and 11.2-2 of the SSAR include other liquid pathway parameters used as input to the dose calculation, including effluent discharge flow rate, site-specific dilution factors, transit time to receptor and consumption factors rates for fish and water, and recreational usage data for the Savannah River. The analysis assumed direct releases into the Savannah River without dilution by the discharge flow of the plant. The liquid effluent release parameters shown in Tables 11.2-1, 11.2-2, and 11.2-3 were then used to calculate the annual liquid pathway doses to the MEI (SSAR Table 11.2-4). The applicant calculated a maximum annual dose to the total body of 0.00017 mSv (0.017 mrem) and a maximum annual dose to the liver of 0.00021 mSv (0.021 mrem). The applicant compared the MEI doses with the 10 CFR Part 50, Appendix I criteria in Table 11.2-5 of the SSAR. The NRC staff reviewed these calculated doses and found that the applicant's analysis would satisfy, at the COL stage, 10 CFR Part 50, Appendix I, Section II.A dose requirements for the MEI.

The applicant also analyzed whether the above-discussed data would comply with the exposure criteria of 40 CFR Part 190, as would be required to be demonstrated by the applicant at the COL stage, per 10 CFR 20.1301(e). The applicant's results are presented in SSAR Tables 11.2-6 and 11.2-7 for the MEI; the applicant's results are less than the maximum doses specified in 40 CFR Part 190.10(a) of 25 mrem/yr whole body, 75 mrem/yr thyroid, and 25 mrem/yr any other organ (Table 11.2-1). Therefore, the NRC staff determined that the applicant's analysis would meet the requirements of 40 CFR Part 190 and 10 CFR 20.1301(e).

The NRC staff performed an independent assessment and determined that the applicant's results represent conservative upper bound estimates for three reasons:

- First, the applicant assumed the drinking of Savannah River water when no such use has been shown to exist within 100 miles downstream of the site.

- Second, the applicant ignored the dilution from the plant discharge water.

- Third, the applicant used a low estimate of annual average river flow.

Table 11.3-1 below shows the comparison of important input values between the applicant's and the NRC staff's analyses. Table 11.3-2 compares the resulting dose estimates between the applicant's and the NRC staff's analyses. These tables show that the assumptions and parameters used by the applicant result in about an order of magnitude higher total body and maximum organ doses when compared to the NRC staff's independent assessment.

The NRC staff concludes that the applicant has provided a bounding assessment demonstrating its capability to comply in the future, at the COL stage, with the regulatory requirements in 10 CFR Part 20 and Appendix I, to 10 CFR Part 50.

Table 11.3-1 - Comparison of Input Parameters

Pathways and Parameters	Application	NRC Staff's Analysis
Drinking water pathway	Yes	No*
Fish ingestion pathway	Yes	Yes
Recreational use of river	Yes	Yes
Annual average river flow (ft3/sec)	9,229	10,362**
Plant discharge flow (ft3/sec)	0	10.7***

*The current land use census does not identify any withdrawal of Savannah River water for drinking or irrigation for 100 miles downstream of the site.

**Average of annual mean stream flow calculated from 50 years of data for Burtons Ferry, Environmental Report (ER) Table 2.3.1-9.

***Taken from ER Table 3.3-1 and assuming single unit discharge.

Table 11.3-2 - Comparison of Maximum Individual Doses (mrem/yr)

Organ/Body	Application	NRC Staff's Analysis
Skin	7.2 E-05	6.5 E-05
Bone	1.2 E-02	1.0 E-02
Liver	2.1 E-02	1.2 E-02
Total Body	1.7 E-02	1.0 E-03
Thyroid	1.5 E-02	1.0 E-03
Kidney	1.2 E-02	4.0 E-03
Lung	8.9 E-03	1.5 E-03
GI-Tract and Lower Large Intestine	8.6 E-03	3.9 E-04

11.4 Conclusion

As set forth above, the NRC staff has independently confirmed the adequacy of the applicant's dose consequence calculations from normal operations. The applicant provided adequate information to give reasonable assurances that it will control and maintain radioactive gaseous and liquid effluents from the proposed facility within the regulatory limits specified in 10 CFR Part 20, as well as maintain radiological effluents at ALARA levels, in accordance with Appendix I to 10 CFR Part 50. Based upon the foregoing, the NRC staff concludes that the postulated radiological doses to members of the public from radiological gaseous and liquid effluents resulting from the normal operation of one or more new nuclear power plants constructed on the proposed site would not pose an undue risk to the health and safety of the public. Therefore, the NRC staff concludes that, with respect to radiological effluent release dose consequences from normal operations, that the proposed site is acceptable for the applicant's chosen type of nuclear plant, and that the application meets the relevant requirements of 10 CFR 52.17 and 10 CFR Part 100.

13.0 CONDUCT OF OPERATIONS

13.3 Emergency Planning

The 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 ESP application, pursuant to 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 applicant may also propose major features of emergency plans, as described in Supplement 2 to NRC guidance document 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" (hereafter referred to as "Supplement 2"),[12] issued April 1996, or may propose complete and integrated emergency plans. In addition, for the major features option, the applicant must describe the contacts and arrangements it has made with Federal, State, and local government agencies with emergency planning responsibilities. For complete and integrated emergency plans, the applicant must make good faith efforts to obtain from the same government agencies various certifications, which are discussed in Section 13.3.2 of this SER.

The ESP applicant, or Southern Nuclear Operating Company (SNC), acting on behalf of itself and the owners of the VEGP site (identified in Section 1.1 of Part 1 of the SSAR, and known as co-owners), stated that it has been authorized to act as agent for the owners to apply for an ESP for the VEGP site. SNC is the licensed operator of the existing generating facilities at the VEGP site (i.e., nuclear reactor Units 1 and 2).

In Section 13.3 of Part 2, "Emergency Planning," of the SSAR, and in Part 5, "Emergency Plan" (hereafter referred to as the "ESP Plan"), the applicant has proposed a complete and integrated emergency plan pursuant to 10 CFR 52.17(b)(2)(ii). The applicant developed the ESP Plan using the current VEGP Emergency Plan (hereafter referred to as the "VEGP Plan"). Since the proposed ESP site footprint consists of a portion of the existing VEGP site and is located immediately adjacent to VEGP Units 1 and 2, little distinction exists between the VEGP site and the ESP site for purposes of emergency planning. The ESP application takes advantage of the emergency planning resources, capabilities, and organization that currently exist at the VEGP site.

As described below, the staff, in consultation with the Federal Emergency Management Agency (FEMA),[13] has reviewed the ESP application (which includes the applicant's onsite emergency plan, i.e., the ESP Plan), the radiological emergency response plans (RERPs) for the States of South Carolina and Georgia, the RERPs for the affected counties, responses to requests for additional information (RAIs), response to the preliminary Safety Evaluation Report open

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[12] NUREG-0654/FEMA-REP-1 and Supplement 2 are joint NRC and FEMA guidance documents. NUREG-0654 is the NRC document designation, and FEMA-REP-1 is the FEMA document designation.

[13] FEMA is an agency within the Department of Homeland Security (DHS).

items,[14] and generally available reference materials in accordance with NRC Review Standard (RS)-002, issued May 2004. (See also NRC Regulatory Issue Summary (RIS) 2004-07, "Release of Final Review Standard (RS)-002, 'Processing Applications for Early Site Permits.'")

FEMA has reviewed the emergency plans for the States of Georgia and South Carolina, the local government plans for Burke County in Georgia, and Aiken, Allendale, and Barnwell Counties in South Carolina, and the applicant's responses to RAIs. On March 2, 2007, and June 5, 2007, FEMA provided its findings and determinations. The staff has reviewed the FEMA reports, which are reflected below in the applicable SER sections.

The applicant has elected to present a complete and integrated emergency plan, pursuant to 10 CFR 52.17(b)(2)(ii). As stated in Section 13.3 of the ESP application, the applicant developed a set of inspections, tests, analyses, and acceptance criteria (ITAAC), and included it in the ESP Plan to address some elements of the emergency plan that have not been completed during the ESP application stage (i.e., before construction of the proposed Units 3 and 4). For a combined license (COL) application submitted pursuant to Subpart C, "Combined Licenses," of 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," 10 CFR 52.80(a) requires the inclusion of emergency planning ITAAC.[15] Section 52.17(b)(3) is the comparable requirement in Subpart A, "Early Site Permits," of 10 CFR Part 52 to include emergency planning ITAAC in an ESP application. Thus, the use of emergency planning ITAAC in the VEGP ESP application is necessary to accomplish the applicant's stated purpose. SER Sections 13.3.5 and 13.3.6 include the proposed ITAAC for VEGP Units 3 and 4, respectively, and the applicable SER sections discuss the use of the ITAAC.

The applicant seeks a finding by the NRC that there is reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency, pursuant to 10 CFR 50.47(a)(1). In the context of an ESP application submitted pursuant to 10 CFR Part 52, which includes proposed complete and integrated emergency plans, the NRC finding of reasonable assurance is a predictive conclusion that is conditioned on the ability of a subsequent COL holder – who has referenced the ESP – to adopt the ESP emergency plan and meet all of the prescribed (ESP ITAAC) acceptance criteria, as well as any other emergency planning permit conditions, consistent with the applicable regulations and COL requirements. The staff's evaluation addresses, in order, the following three basic components of such a submission (the SER section where each is discussed and the relevant regulation is also identified):

- physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans (SER Section 13.3.1, 10 CFR 52.17(b)(1))

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[14] By letter dated October 4, 2006, the applicant provided emergency planning information that supplemented its initial application, which was submitted by letter dated August 15, 2006. By letter dated March 15, 2007, the NRC requested additional information (i.e., RAI letter No. 5), and the applicant provided RAI responses by letter dated April 16, 2007. By letter dated October 15, 2007, the applicant provided its response to preliminary Safety Evaluation Report open items. The applicant provided additional information in its letters dated February 12, 2008, February 27, 2008, and March 14, 2008.

[15] The proposed complete and integrated emergency plans (with ITAAC) allowed in an ESP application by 10 CFR 52.17(b)(2)(ii) are essentially the same as those required (for the same site) in a COL application by 10 CFR 52.77, "Contents of Applications; General Information," 10 CFR 52.79, "Contents of Applications; Technical Information in Final Safety Analysis Report," and 10 CFR 52.80, "Contents of Applications; Additional Technical Information."

- contacts and arrangements with local, State, and Federal governmental agencies with emergency planning responsibilities, and good faith efforts to obtain various certifications (SER Section 13.3.2, 10 CFR 52.17(b)(4))

- proposed complete and integrated emergency plans, including necessary ITAAC (SER Section 13.3.3, 10 CFR 52.17(b)(2)(ii), (b)(3))

In SSAR Part 2, Section 13.3, “Emergency Planning,” the applicant identified 10 CFR 50.47, “Emergency Plans,” and 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 proposed emergency plans. The staff agrees that these regulations, which constitute the core regulatory basis for emergency planning and preparedness at a nuclear power plant, apply to complete and integrated emergency plans submitted in an ESP application pursuant to Subpart A of 10 CFR Part 52. The Regulatory Basis subsections of this SER identify additional regulations that may apply and are considered in the staff’s review.

The staff’s evaluation and findings, described throughout Section 13.3 of this SER, address the applicant’s proposed complete and integrated emergency plans and parallel the planning standards and evaluation criteria in NUREG-0654/FEMA-REP-1, issued November 1980, and the March 2002 addenda. The staff also reviewed the application against the generic emergency planning ITAAC provided in Table C.II.1-B1 of Regulatory Guide (RG) 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” issued June 2007, and applicable sections of Supplement 2 (pursuant to Section 13.3, “Emergency Planning”) of RS-002.

As discussed above, the proposed complete and integrated emergency plans (with ITAAC) allowed in an ESP application by 10 CFR 52.17(b)(2)(ii) are essentially the same as those required (for the same site) in a COL application by 10 CFR 52.77, 10 CFR 52.79, and 10 CFR 52.80. Thus, the generic ITAAC in Table C.II.1-B1 of RG 1.206 are applicable to both an ESP application (with complete and integrated emergency plans) and a COL application, which reflects the original intent of the staff when it created the generic ITAAC table.[16]

13.3.1 Significant Impediments to the Development of Emergency Plans

13.3.1.1 Regulatory Basis

In its review of the application, the staff considered the regulatory requirements of 10 CFR 52.17(b)(1), which mandate that the applicant for an ESP 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 also considered 10 CFR 52.18, “Standards for Review of Applications,” which requires consultation with FEMA to determine whether the information required 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 in an ESP application.

[16] The generic emergency planning ITAAC Table C.II.1-B1 in RG 1.206 appears as Table 14.3.10-1 in Section 14.3.10 of the “Standard Review Plan” (SRP) (NUREG-0800) (issued March 2007).

Supplement 2 defines a significant impediment as a physical characteristic or combination of physical characteristics that would pose major difficulties for an evacuation. Such unique physical characteristics may be identified by a preliminary analysis of the time for evacuating various sectors and distances within the 10-mile plume exposure emergency planning zone (EPZ) for transient and permanent populations. Such an analysis should note major difficulties for an evacuation (e.g., significant traffic-related delays).

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 evacuation time estimate (ETE) or other identification of physical impediments should consider the latest population census numbers and the most recent local conditions.

13.3.1.2 Technical Evaluation

In Part 2 of SSAR, Section 13.3, “Emergency Planning,” the applicant stated that it used the existing VEGP Emergency Plan (i.e., VEGP Plan) to develop the proposed emergency plan (i.e., ESP Plan). The ESP Plan contains the proposed complete and integrated VEGP Emergency Plan, submitted pursuant to 10 CFR 50.17(b)(2)(ii). In the preface to the ESP Plan, the applicant stated that the ESP Plan will apply to existing VEGP Units 1 and 2, as well as to the proposed Westinghouse AP1000 units (i.e., new VEGP Units 3 and 4), and to its environs as specified by the EPZs described in the ESP Plan. As discussed in more detail in this SER, the staff finds that the ESP application accounts for, and takes full advantage of, the current emergency planning resources, capabilities, and organization at the VEGP site.

In RAI 13.3-6, the staff asked the applicant to identify which revision of the VEGP Emergency Plan for Units 1 and 2 is relevant for purposes of the ESP Plan review, including the extent to which the review of the ESP Plan should rely on information in the existing VEGP Plan, and to clarify whether the ESP Plan is intended as a revision of the VEGP Plan. In addition, the staff asked the applicant to describe the manner in which the ESP Plan (including Table B-1, “Minimum Staffing for Power Operation,” and technical support center (TSC) location) will become effective for the VEGP site (i.e., transition plan), in regard to construction and operation of Units 3 and 4, withdrawal of the current Unit 1 and 2 plan, and coordination with offsite agencies and organizations. (RAI 13.3-6 and Table B-1 are addressed further in SER Section 13.3.3.2.2.)

In its response, the applicant stated that the proposed ESP Plan is based on Revision 43 of the VEGP Plan, except for ESP Plan Section D, “Emergency Classification System,” which is based on proposed Revision 42 of the VEGP Plan. Revision 42 incorporates the guidance contained in Nuclear Energy Institute (NEI) 99-01, “Methodology for Development of Emergency Action Levels [EALs].” (SER Sections 13.3.2.2, 13.3.3.1, and 13.3.3.2.4 discuss NEI 99-01, "Methodology for Development of Emergency Action Levels"). The ESP Plan is intended to be a revision of the existing VEGP Plan when it is implemented, and ultimately to be in effect for all four units. SNC expects to revise the existing corporate emergency implementing procedures (EIPs) and emergency operations facility (EOF) procedures to provide for an additional two units at the VEGP site. SNC will submit a revision to the latest revision of the VEGP emergency plan in accordance with the provisions of 10 CFR 50.54(q) for the VEGP Units 1 and 2. For VEGP Units 1 and 2, the use of the 10 CFR 50.54(q) process, along with the ITAAC schedule required by 10 CFR 52.99(a), will provide for the orderly development, implementation, and transition of the applicant's emergency plans.

In SSAR Section 13.3.1, the applicant concluded that there are no physical characteristics unique to the VEGP site that pose a significant impediment to the development of the proposed emergency plans for the VEGP. [**J.8, J.10.l, J.10.m].**[17] This conclusion is based on the SNC consideration of the general description of the site and the area population used in a recently developed (April 2006) ETE for the VEGP 10-mile plume exposure pathway EPZ. This April 2006 ETE is included as Enclosure 10, "Evacuation Time Estimate for the Vogtle Electric Generating Plant," of the application. ESP Plan Section J, "Protective Response," and SER Section 13.3.3.2.10 discuss the ETE in more detail.

As part of the existing VEGP Emergency Plan, Georgia Power Company (GPC) has a memorandum of agreement with the U.S. Department of Energy, Savannah River Operations Office (DOE-SR), for emergency response within the Savannah River Site (SRS), which provides that DOE-SR will be responsible for all emergency planning for the area included in the VEGP EPZ that lies within the boundaries of the SRS. This memorandum of agreement will continue in effect for the VEGP site when the additional Units 3 and 4 are built, as discussed in SER Section 13.3.2. The SRS is located adjacent to the VEGP site on the South Carolina side of the Savannah River, and the major portion of the EPZ in South Carolina is within the SRS, as described in Section 1.2, "Emergency Planning Zone," and shown in Figure 2, "VEGP EPZ Boundary and Protective Action Zones," of the April 2006 ETE. SSAR Section 2.1.3, "Population Distribution," states that the SRS will remain a Government-controlled facility in perpetuity.

SSAR Section 2.1.1, "Site Location and Description," states that the proposed Units 3 and 4 will be built on the existing 3169-acre VEGP site, and that the exclusion area boundary (EAB) will be the same as the EAB for the existing VEGP units. SSAR Section 2.2.2.1, "Industrial Facilities," states that the exclusion area for VEGP Units 1 and 2 is the same as that for the new units and has an irregular shape, which generally conforms to the site's boundary lines. ESP Plan, Figure ii, "Vogtle Electric Generating Plant Site Plan," shows the site and the locations of existing and proposed buildings on the site. The ESP site footprint consists of a portion of the VEGP site and is located near the existing VEGP Units 1 and 2. Units 3 and 4 will be located in the power block area shown in SSAR Figure 1-4, "Site Layout – New Development." Therefore, the boundary of the ESP site is entirely within the boundary of the existing VEGP site.

SSAR Section 13.3.1 also states that with the exception of the existing VEGP Units 1 and 2, and the GPC combustion turbine plant, Plant Wilson, there are no commercial, industrial, institutional, recreational, or residential structures within the proposed four-unit site area. In addition, the site is located in a sparsely populated section of eastern Georgia near the Savannah River, and the area near the site is lowlands and not used for commercial or industrial purposes, other than agriculturally or forestry related commercial enterprises. Land within approximately 10 miles of the site is primarily forested with limited agriculture and some rural housing. Several paved county roads traverse the area.

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17 The bracketed, alphanumeric designations used throughout SER Section 13.3 identify the corresponding NUREG-0654/FEMA-REP-1 evaluation criteria used by the staff to determine compliance with regulations.

ESP Plan Appendix 6, "Evacuation Time Estimates for the Vogtle Electric Generating Plant Plume Exposure Pathway Emergency Planning Zone," states that Innovative Emergency Management, Inc. (IEM) conducted the ETE analysis using 2006 population data and projected 2010 population data and that the methods used to obtain population data and to estimate the ETEs are documented in the IEM April 2006 report "Evacuation Time Estimates for the Vogtle Electric Generating Plant." IEM used PTV Vision VISUM, a computer simulation model, to perform the ETEs. The ETE report was submitted as part of the VEGP application.

SSAR Section 2.1.3 provides population projections for the area surrounding the VEGP site through 2070. For purposes of emergency planning associated with the ESP, the staff examined the population projections for the 20-year period of the ESP, focusing on the period between the years 2006 and 2030, for which the application provided population values. For the 10-mile EPZ, SSAR Section 13.3.1.2 states that the resident and transient population is 3767. A table in SSAR Section 2.1.3 indicates that the projected population for 2030 is 4406. The staff calculated that this indicates an increase of 639 over a 24-year period (i.e., 2006 to 2030), which reflects an increase of approximately 0.71 percent per year over that time period. Further, SSAR Section 2.2.2.1 states that the "Burke County Comprehensive Plan: 2010," Part 1, shows a relatively slow, stable population growth pattern for the county. The 10-mile EPZ area in Georgia is located almost entirely within Burke County. Section 1.2, "Emergency Planning Zone," states that Burke County has the largest resident population within the EPZ and that this population is small and dispersed. In addition, SSAR Section 2.2.2.1 states that currently no major increases are expected in industrial, military, or transportation facilities within a 25-mile radius of the VEGP site except for the development of the site for VEGP Units 3 and 4.

The staff has not identified any significant differences between the emergency planning elements proposed in the SSAR and the existing VEGP Emergency Plan elements relied on in the SSAR. The staff finds that, for purposes of identifying physical characteristics that could pose a significant impediment to developing emergency plans for the proposed two additional reactors at the VEGP site, there is little distinction between the existing VEGP site and the ESP site. Because the existing VEGP site includes the ESP site, the staff finds that the applicant's use of the 2006 ETE for the VEGP site in the ESP application is acceptable and appropriate.

13.3.1.3 Conclusion

As discussed above, the applicant has shown through use of the ETE that no physical characteristics unique to the proposed ESP site pose a significant impediment to the development of emergency plans. On the basis of its review, as described above, the NRC staff concludes that the information the applicant provided is consistent with the guidelines in RS-002 and Supplement 2. The staff finds that there are no physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans. Therefore, the information is acceptable and meets the relevant 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 Regulatory Basis

In SSAR Section 13.3, the applicant stated that Part 5 of the ESP application presents a proposed complete and integrated emergency plan (i.e., ESP Plan), in accordance with 10 CFR 52.17(b)(2)(ii). As stated in 10 CFR 52.17(b)(4), the requirements for obtaining governmental agency certifications apply to proposed complete and integrated emergency plans submitted under the option set forth in 10 CFR 52.17(b)(2)(ii).

In its review of the application, the staff considered the regulatory requirements in 10 CFR 52.17(b)(4), which mandate, in part, that the applicant shall make good faith efforts to obtain certifications from local, State, and Federal governmental agencies with emergency planning responsibilities that (1) the proposed emergency plans are practicable; (2) these agencies are committed to participating in any further development of the plans, including any required field demonstrations; and (3) these agencies are committed to executing their responsibilities under the plans in the event of an emergency. In addition, the application must contain any certifications that have been obtained. Supplement 2 and RS-002 provide guidance concerning the review and evaluation of the emergency planning information given in an ESP application.

13.3.2.2 Technical Evaluation

In Section 13.3 of Part 2 of the SSAR, the applicant stated that it developed the emergency plan using the VEGP Plan, Revisions 42 and 43, and the guidance contained in NUREG-0654/FEMA-REP-1, NEI 99-01, NEI 07-01 ("Methodology for Development of Emergency Action Levels – Advanced Passive Light Water Reactors," Revision 0, dated February 28, 2007), and Supplement 2 to NUREG-0654/FEMA-REP-1. SSAR Section 13.3.5, "Contacts and Arrangements," states that SNC currently maintains letters of agreement or contracts with State and local government agencies, the DOE-SR, medical support facilities, and independent industry support organizations, in support of emergency planning at the VEGP for the existing Units 1 and 2. In addition, Table 13.3-3, "Agency Agreements and Points of Contact," identifies the agencies with which SNC maintains current letters of agreement or contracts, including the point of contact for each agency, with the exception of local radio and television companies. Agreements with local radio and television companies will be transferred to the respective State and/or local emergency plans. The applicant provided the agreements in Enclosure 11, "Letters of Agreement with Local Agencies," of the application.
SSAR Section 13.3.5 states that, in support of the ESP application, SNC contacted each agency by letter (i.e., supplemental letters of agreement), notifying them of the proposed addition of two new AP1000 reactors at the VEGP site and the revised emergency plan for VEGP. In addition, SSAR Section 13.3.5 states that the executed supplemental letters of agreement requested that the agencies concur that the ESP Plan is practicable and commit to continued participation in any further development of the VEGP site emergency plan, including field demonstrations under the plan. Together, the executed supplemental letters of agreement and existing letters of agreement provide certification from the agencies that (1) the proposed ESP Plan is practicable; (2) the agencies are committed to participating in any further development of the proposed ESP Plan, including any required field demonstrations; and (3) the agencies are committed to executing their responsibilities under the ESP Plan in the event of an emergency. Enclosure 11 of the application provides copies of the existing letters of agreement

and contracts. Appendix 13.3A to SSAR Part 2 contains copies of the supplemental letters of agreement.

The supplemental letters of agreement state the applicant's intent to revise the existing VEGP Plan to include provisions for the addition of two new reactors at the VEGP site. The letters also request the agencies' concurrence that the proposed emergency plan is practicable and that they commit to participation in any further development of emergency plans, including any required field demonstrations. The supplemental letters of agreement were executed with all of the agencies between April and July 2006, by way of a signed and returned copy (duplicate original) from the identified official within each agency.

The staff reviewed the letters of agreement and contracts, as well as the supplemental letters of agreement. In addition, the staff reviewed the FEMA findings related to these letters of agreement and contracts and discusses them throughout SER Section 13.3.3, along with the staff's review of these documents.

13.3.2.3 Conclusion

As discussed above, the applicant has provided the required certifications from local, State, and Federal agencies with emergency planning responsibilities. On the basis of its review of the certifications and FEMA findings, as described above, the NRC staff concludes that the information provided is consistent with the guidelines in RS-002 and Supplement 2. The staff finds that the letters of agreement and contracts in the application adequately establish certification by governmental agencies relating to their support of the VEGP site and the proposed Units 3 and 4. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 52.17(b)(4).

13.3.3 Complete and Integrated Emergency Plans

13.3.3.1 Regulatory Basis

In SSAR Section 13.3, the applicant stated that Part 5 of the ESP application presents a proposed complete and integrated emergency plan (i.e., ESP Plan), in accordance with 10 CFR 52.17(b)(2)(ii). Further, the ESP Plan is designed to comply with 10 CFR 50.47(b) and Appendix E to 10 CFR Part 50 and was developed using the current VEGP Plan (Revisions 42 and 43) and the guidance contained in NUREG-0654/FEMA-REP-1, NEI 99-01, NEI 07-01, and Supplement 2 to NUREG-0654/FEMA-REP-1. In addition, the ESP Plan includes a set of ITAAC to address those elements of the emergency plan that cannot be completed during the ESP application phase.

The staff reviewed the proposed complete and integrated emergency plan in accordance with the applicable regulatory requirements in 10 CFR 52.17(b), 10 CFR 52.18, 10 CFR 50.47, and Appendix E to 10 CFR Part 50. Under 10 CFR 52.17(b)(2)(ii), an applicant for an ESP may propose complete and integrate emergency plans for NRC review and approval, in consultation with FEMA. In accordance with 10 CFR 52.17(b)(3), for complete and integrated emergency plans submitted pursuant to 10 CFR 52.17(b)(2)(ii), the applicant must include proposed ITAAC that the holder of a COL referencing the ESP shall perform. As required by 10 CFR 52.17(b)(4), the applicant should make good faith efforts to obtain certifications from the local, State, and Federal agencies with emergency planning responsibilities and include those certifications in the application. Under 10 CFR 52.18, after consultation with FEMA, the NRC will determine whether the proposed complete and integrated emergency plans provide reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. The planning standards and evaluation criteria for the preparation and evaluation of complete and integrated emergency plans appear in NUREG-0654/FEMA-REP-1.

13.3.3.2 Technical Evaluation

The following subsections describe the staff's technical evaluation of the information provided in the ESP application, consisting of SSAR Section 13.3 (SSAR Part 2) and the proposed ESP Plan (Part 5, "Emergency Plan"). The preface to the ESP Plan states that the VEGP Emergency Plan (i.e., ESP Plan) is designed to accommodate the unique features of the two unit designs used at the site. A common ESP Plan is supported by Annex V1, which contains the parts of the emergency plan that are unique to Units 1 and 2, and Annex V2, which contains the parts of the emergency plan that are unique to the proposed Units 3 and 4. Each segment of the emergency plan is supported by appendices that contain supporting information. SER Section 13.3.1.2 addresses the relationship between the ESP Plan and the VEGP Plan, including implementation of the ESP Plan for all four nuclear units at the VEGP site. The staff's review and findings in this SER apply only to VEGP Units 3 and 4. The changes to the emergency plan for Units 1 and 2 should be addressed in accordance with 10 CFR 50.54(q).

The section designations of the basic planning areas in both the ESP Plan and VEGP Plan generally correspond to the alphabetical planning standard designations in Section II of NUREG-0654/FEMA-REP-1 (i.e., planning standards A through P), and the alphanumerical subsection designations in the ESP Plan are consistent with those in the VEGP Plan. This portion of the safety evaluation adheres to the format of Section II of NUREG-0654/FEMA-REP-1. Each of the planning standards is listed and followed by a summary of the applicable portions of the ESP Plan related to that specific standard. The staff reviewed portions of the emergency response plans for the States of South Carolina and Georgia and the counties of Burke, Aiken, Barnwell, and Allendale, for understanding and content in relation to consistency with various sections of the ESP Plan that address offsite response. FEMA performed the offsite (i.e., State and local) reviews, pursuant to the applicable regulations, and under the June 17, 1993, "Memorandum of Understanding Between Federal Emergency Management Agency and Nuclear Regulatory Commission," which describes the respective emergency planning responsibilities of and the areas of cooperation between FEMA and the NRC. (See also Appendix A, "Memorandum of Understanding Between Federal Emergency Management Administration and Nuclear Regulatory Commission," to 44 CFR Part 353, "Fee for Services in Support, Review, and Approval of State and Local Government or Licensee Radiological Emergency Plans and Preparedness.")

SSAR Figure 13.3-2, "VEGP Site Map," shows that the ESP site footprint for the new Units 3 and 4, which includes the power block area and location of the Units 3 and 4 cooling towers, is located near the existing VEGP Units 1 and 2. The boundary of the ESP site is entirely within the existing VEGP site EAB. Thus, for the purpose of evaluating the adequacy of the ESP Plan, little distinction exists between the VEGP site and ESP site.

13.3.3.2.1 Assignment of Responsibility—Organization Control (10 CFR 50.47(b)(1); NUREG-0654/FEMA-REP-1, planning standard A)

The regulation, as reflected in the planning standard, requires that primary responsibilities for emergency response by the nuclear facility licensee and by State and local organizations within the EPZs have been assigned, the emergency responsibilities of the various supporting organizations have been specifically established, and each principal response organization has staff to respond and to augment its initial response on a continuous basis.

In ESP Plan Section A, "Assignment of Responsibility," the applicant described the responsibilities of the applicant and various local, State, and Federal agencies, as well as private sector organizations, that are part of the emergency response organization (ERO) for the VEGP site and may be needed to respond to an emergency at the VEGP site. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan compared to NUREG-0654/ FEMA-REP-1, planning standard A, "Assignment of Responsibility (Organization Control)." Planning standard A provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(1).

[A.1.a] In ESP Plan Section A, the applicant stated that the organizations intended to be part of the overall response include the applicant, the States of Georgia and South Carolina, the counties of Burke, Aiken, Barnwell, and Allendale, and DOE-SR. The Burke County EMA, Burke County Hospital in Waynesboro, Georgia (also referred to as Burke County Medical Center or Burke Medical Center), and Doctors Hospital in Augusta, Georgia, will provide medical support. Private sector organizations include Bechtel, which will provide engineering and construction services, and Westinghouse, which will provide general services related to NSSS operations. Additional assistance will be available from other electric utility companies, pursuant to various agreements.

[A.1.a, C.1.b] In ESP Plan Section A.9, "Federal Government," the applicant stated that the resources of the Federal agencies, appropriate to the emergency condition, will be made available in accordance with the National Response Plan (NRP). The agencies include the NRC, Department of Homeland Security (DHS), DOE, FEMA, Environmental Protection Agency (EPA), Department of Health and Human Services (HHS), DOT, and Department of Agriculture (USDA). **[A.1.c, A.1.d, B.6]** The interrelationships among the EROs are shown in Figure A-1, "Formal Interfaces among Emergency Response Organizations," and the specific individuals (by title) who will be in charge of emergency response are listed in Table A-1, "Responsible Individuals of Primary Response [Organizations]."

[A.1.b] ESP Plan Section A.10, "Concept of Operations," states that, consistent with the emergency classification system described in ESP Plan Section D (addressed in SER Section 13.3.3.2.4), the emergency preparedness program for the VEGP site will call for the coordinated response of several organizations. The VEGP site will be responsible for maintaining an effective emergency plan and preparedness through the maintenance of formal procedures for implementing the plan, training personnel, maintaining equipment, and maintaining a continuing relationship with various governmental agencies and private organizations. The application included Unit 3 ITAAC 9.1, which states that the licensee has submitted detailed emergency implementing procedures (EIPs) for the onsite emergency plan no less than 180 days prior to fuel load. In RAI 13.3-46.e, the staff asked the applicant to explain why there is no Unit 4 ITAAC 9.1 comparable to the **Unit 3 ITAAC 9.1**.

In its response, the applicant stated that the implementing procedures will be identical for Units 3 and 4; therefore, verification that the implementing procedures have been submitted under the Unit 3 ITAAC means that no additional ITAAC are required for Unit 4. While various aspects of detailed implementing procedures could be common to Units 3 and 4, the staff does not agree that all of the implementing procedures for Unit 3 will be identical to those for Unit 4 (e.g., unit-specific EALs or instrumentation setpoints). The applicant must either explain why Unit 3 **ITAAC 9.1** will demonstrate the sufficiency of the ITAAC in relation to Unit 4, or supplement Table V2A4-1 with comparable Unit 4 ITAAC. In the Safety Evaluation Report with open items, the staff identified the resolution of this issue as Open Item 13.3-1. SER Sections 13.3.3.2.2, 13.3.3.2.4, 13.3.3.2.8, 13.3.3.2.9, 13.3.3.2.10, and 13.3.3.2.16 discuss in detail the submission of detailed implementing procedures for VEGP. (See also SER Section 13.3.3.2.9, regarding **Unit 3 ITAAC 6.1 through 6.7**, and SER Section 13.3.3.2.14, regarding **Unit 3 ITAAC 8.1**.) The staff reviewed the applicant's response in its submittal dated October 15, 2007 – which included a revised Table V2A4-1 that added a **Unit 4 ITAAC 9.1** (identical to that for Unit 3) for the submission of detailed emergency implementing procedures that will be used for Unit 4 – and finds it acceptable. Therefore, Open Item 13.3-1 is resolved.

[A.1.d, B.4] ESP Plan Section A.10 also states that the emergency director will be the key individual in the VEGP site ERO and will have nondelegable responsibilities. One of these duties will be deciding to notify the authorities responsible for offsite emergency measures and the NRC.

[A.1.d] The staff also looked at ESP Plan Section B.2, "Emergency Response Organization," which identifies the emergency director as the specific individual who will be in charge of emergency response for the licensee. (See SER Section 13.3.3.2.2.) The emergency director has the authority, management ability, and knowledge to assume the overall responsibility for directing site staff in an emergency. Initially, the shift manager, or the shift supervisor, if the shift manager cannot be located expeditiously, will fill this position. The responsibility for emergency direction will be transferred to the nuclear plant general manager, or an alternate, after the general manager or the alternate receives an appropriate briefing and becomes familiar with the current status of events.

[A.1.b, A.4] As reflected in the list of activities in ESP Plan Section B.2, and as discussed in SER Section 13.3.3.2.2, it is the responsibility of the emergency director to provide overall management of emergency services related to the procurement of materials, equipment, and supplies; documentation; accountability; and security functions. The emergency director will oversee the activation and staffing of emergency response facilities (ERFs) for the duration of an emergency and may request additional support as necessary. (Facility activation is also addressed in ESP Plan Section H and SER Section 13.3.3.2.8.) The ESP Plan describes specific duties and responsibilities.

[A.1.b, A.4, B.6, B.7, H.2, H.4] The staff reviewed Appendix 7, "Emergency Operations Facility," to the ESP Plan. In Appendix 7, the applicant stated that the appendix provides the framework for operations of the EOF for SNC and is an integral part of the site-specific emergency plan. The appendix describes the mechanism for obtaining and providing additional emergency response support and resources to SNC sites in the event of an emergency. It specifies that offsite support personnel and equipment will be dispatched to the site operational support center (OSC) or TSC upon request from the emergency director. The corporate ERO will provide offsite emergency response support and resources on a 24-hour, 7-day-per-week basis until the emergency has been terminated. Appendix 7 is also addressed in ESP Plan Sections B, H, and O, which are discussed in SER Sections 13.3.3.2.2, 13.3.3.2.8, and 13.3.3.2.15, respectively. The discussions include additional staff evaluation of the EOF concept of operations and its relationship to the total emergency response effort.

[A.1.b] The emergency director will initiate the activation of the ERO by contacting the States of Georgia and South Carolina, the counties within the plume exposure pathway EPZ, the SRS, and the NRC. [A.1.e] These organizations can be contacted on a 24-hour, 7-day-per-week basis. The State and local agencies have continuously staffed communication links for the purpose of receiving notification of a radiological emergency, and the SRS is a continuously operating facility that can be contacted at all times. The Federal agencies can be notified by contacting the NRC on the emergency notification system (ENS) line, which is a dedicated communication link. The staff reviewed other sections of the application that deal with the availability of 24-hour emergency communications and response, and discusses those reviews in SER Sections 13.3.3.2.2, 13.3.3.2.5, 13.3.3.2.6, 13.3.3.2.8, and 13.3.3.2.12.

[A.1.b] The State of Georgia and Burke County responses follow the Georgia Radiological Emergency Plan (hereafter referred to as "GA REP")[18] and its associated Annex D, "Plant Vogtle." The State of South Carolina and county (i.e., Aiken, Barnwell, and Allendale Counties) responses are in accordance with the South Carolina Operational Radiological Emergency Response Plan (SCORERP) and the respective county emergency operations plans and its associated Annex Q2, "Fixed Nuclear Facility [i.e., Vogtle] Radiological Emergency Response Plan."

[A.1.b] In ESP Plan Section A.2, "State of Georgia," the applicant stated that the Georgia Office of Homeland Security – Georgia Emergency Management Agency (OHS-GEMA, Georgia EMA, or GEMA) is assigned responsibility for overall direction and coordination of emergency and disaster planning and operations in the State of Georgia.[19] GEMA has developed the Georgia Emergency Operations Plan (hereafter referred to as "GEOP"), which is an emergency operations plan for all natural disasters, accidents, and incidents, including radiological emergencies at fixed nuclear facilities (FNFs). Integral to the GEOP is the GA REP, which is used for planning for and responding to radiological emergencies. The GEOP and GA REP contain details concerning assignment of responsibilities.

[A.1.b, A.1.d, A.2.a] ESP Plan Section A.3, "Burke County, Georgia," states that all of the area within the VEGP plume exposure pathway EPZ in the State of Georgia falls within Burke County. The responsibility for overall radiological emergency response planning for Burke County rests with the Chairman of the Burke County Board of Commissioners. It is the Chairman's responsibility to initiate actions and provide direction and control at a level

18 The GA REP consists of two distinct planning elements. The first is the Base Plan, which contains planning information of a generic, nonspecific nature, such as legal authorities, organization, administration, and concept of operation. The second consists of Plan Annexes, which contain detailed, specific information about a particular facility or particular incident situation. GA REP–Annex D has been developed for VEGP.

19 Pursuant to the Governor's Executive Order (08.25.04.01), issued August 25, 2004, establishing the Homeland Security Central Command, the Director of Homeland Security has authority to coordinate and control the State's response to emergencies. All State boards, departments, agencies, associations, institutions, and authorities shall provide any personnel, equipment, information, or any other requested assistance (reference http://www.gov.state.ga.us/ExOrders/08_25_04_01.pdf, visited March 24, 2007).

consistent with the specific incident. Agencies within Burke County that have a primary role in radiological emergency planning and response include the EMA and the Sheriff's Department. Annex D to the GA REP contains details concerning assignment of responsibilities for the Burke County response.

[A.1.b, A.2.a] ESP Plan Section A.4, "State of South Carolina," states that the South Carolina Emergency Management Division (SCEMD) in the Office of the Adjutant General has responsibility for South Carolina's emergency preparedness, response, recovery, and mitigation activities. SCEMD has developed the South Carolina Emergency Operations Plan – Base Plan (SCEOP), which establishes the policies and procedures by which South Carolina will coordinate State and Federal response to disasters impacting South Carolina. SCEOP Attachment A, Annex 25, "Radiological Hazards," assigns responsibilities for radiological hazards in South Carolina. Integral to the SCEOP is SCORERP, which prescribes planning objectives, tasks, and responsibilities to departments and agencies of State and local governments for radiological events at nuclear facilities. **[A.1.d]** Details concerning assignment of responsibilities are contained in the SCEOP and SCORERP.

[A.1.a, A.1.b] ESP Plan Section A.5, "Aiken, Barnwell, and Allendale Counties, South Carolina," states that most of the plume exposure pathway EPZ within South Carolina falls within the site boundary of the SRS. The DOE-SR consists of lands owned or leased by the Federal Government. Thus, DOE-SR is responsible for the direction and control of all emergency response actions on the SRS. DOE-SR will provide the necessary response within the SRS reservation, in accordance with the SRS emergency plan. DOE will exercise overall responsibility, jurisdiction, and authority for conducting on-plant response operations to protect the health and safety of SRS personnel. DOE will provide for emergency notification and, as needed, evacuation, monitoring, decontamination, and immediate lifesaving medical treatment of non-SRS personnel on plant, as well as provide access control for SRS areas. DOE will provide initial radiological monitoring and assessment support to the State of South Carolina under the DOE Radiological Assistance Program (RAP). This includes projected release dispersion information and offsite radiological monitoring and assessment assistance. SRS will also coordinate public affairs activities with the State of South Carolina, SNC, and GPC.

ESP Plan Appendix 5, "Memorandum of Agreement with DOE-Savannah River," provides the agreement between DOE-SR and SNC, which states that DOE is responsible for the protection of all persons and for the direction and control of all emergency response actions on SRS for emergencies occurring at or affecting SRS, including emergencies originating at VEGP. Under this agreement, DOE-SR will promptly notify all persons on SRS within the VEGP plume exposure pathway EPZ, perform radiological monitoring at SRS as requested by SNC or the State of South Carolina, and provide monitoring results to SNC and to the States of South Carolina and Georgia. **[A.1.a]** Limited portions of Aiken, Barnwell, and Allendale Counties are outside of the SRS but within the plume exposure pathway EPZ of the VEGP site. The respective counties are responsible for planning and response within these areas.

[A.1] The staff finds that the applicant has identified the appropriate organizations (including identification by title of the specific individual in charge of emergency response) that are intended to be part of the overall response organization and has specified the concepts of operations and relationship of the organizations to the total effort. The interrelationships are illustrated in a block diagram, and each organization is capable of providing 24-hour-per-day emergency response, including 24-hour-per-day staffing of communications links for the necessary organizations. **[A.4]** In addition, the staff finds that the applicant's organization will be capable of continuous (24-hour) operations for a protracted period, and the emergency director has been identified as the individual who will be responsible for providing the necessary technical, administrative, and material support (i.e., assuring continuity of resources) for the duration of the emergency.

[A.3, B.8, B.9] ESP Plan Appendix 2, "Letters of Agreement," lists the letters of agreement with the principal offsite EROs and agencies, which are maintained on file with the VEGP site emergency preparedness coordinator (EPC). The individual letters of agreement provide the basic concept of operation for the organization/agency and supplement the response functions addressed by existing laws, regulations, or executive orders. Written agreements relating to the various concepts of operations developed between support agencies and organizations are also addressed in ESP Plan Section B, "VEGP Emergency Response Organization," and discussed in SER Section 13.3.3.2.2. **[A.3]** The staff finds that the applicant has provided adequate written agreements that refer to the concept of operations developed between Federal, State, and local agencies, and other support organizations having an emergency response role within the EPZs.

<u>State and Local Emergency Plans</u> [A.1, A.2, A.3, A.4]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard A of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard A are adequate. The following summarizes the FEMA findings for planning standard A.

a. State of Georgia

[A.1.a, A.1.b] Section I, "Base Plan" (Subsection IV, "Concept of Operations"), of the GEOP describes local, State, and Federal Government responsibilities during an emergency. GEOP Section II, "Emergency Support Functions (ESF)," consists of 15 ESF annexes, which identify the primary organization, including the supporting local, State, and Federal agencies that would respond to a radiological emergency. This section describes the expected interactions between local, State, and Federal response agencies for each ESF, as well as the roles and responsibilities of each agency. In addition, the ESF annexes describe specific actions that will be taken during the mitigation/preparedness and response/recovery phases.

GEOP Appendix D, "Summary of Agency/Organizational Emergency Responsibilities," describes ESFs and resources for 46 organizations. In addition, GEOP Appendix E, "Georgia Voluntary Organizations Active in Disaster (VOAD) – State Associations and Private Sector Support," lists 24 voluntary organizations that are active in disaster response in the State of Georgia and 8 State associations and private sector organizations.

[A.1.c] In Section VI, "Concept of Operation," of the GA REP–Base Plan, Figures 1, 2, and 3 show (in block diagrams) the organization and operational relationship of local and State government organizations. Figure 1, "State Government Operating in a Declared Radiological Emergency," includes the coordination and operational links between the Governor, State Disaster Coordinator, Department of Natural Resources (DNR) Radiation Emergency Coordinator, Environmental Protection Division (EPD), GEMA, Georgia State Patrol, Department of Motor Vehicle Safety, Georgia Technology Authority, DOT, Department of Human Resources, USDA, Department of Administrative Services, Georgia Forestry Commission, and other State agencies.

Figure 2, “Typical Organization of the Radiological Emergency Response Team,” shows the DNR Radiation Emergency Coordinator and includes personnel in the areas of environmental radiological surveillance, technical assessment and laboratory support, and health physics support. Figure 3, “Operational Relationships Among County Response Organizations,” includes the operational and coordination links between the nuclear power plant, GEMA, local elected (Burke County) officials, and county emergency management. In addition, Figure 3 shows an operational link between county emergency management and the following local agencies and organizations:

- Fire Department
- Sheriff’s Department
- Board of Education
- Department of Family and Children Services (DFCS)
- County Health Department
- Municipal Public Works
- County Public Works
- local hospital
- volunteer organizations

[A.3] GA REP–Base Plan, Appendix 2, lists “The Southern Agreement for Mutual State Radiation Assistance Activation Procedure” (SMRAP). GA REP–Annex D lists letters of agreement and memoranda of understanding with SNC, Burke County Hospital, Columbia-Augusta Medical Center, State of Georgia/State of South Carolina GEMA, SCEMD standard operating procedure (SOP) for Activation of the VEGP NOAA weather radio (i.e., NWR), and State of Georgia GEMA, and Burke County EMA SOP for Activation of the Plant Vogtle Siren System.

[A.1.b] The general concept of operation for development and implementation of the GA REP, as well as supporting site-specific annexes, is essentially the same as for any other emergency or disaster response planning conducted by the State of Georgia. While emergency operations are initiated at the local jurisdiction, GEOP Section IV states that all local and State operations will be in compliance with the NRP and the National Incident Management System legislation. For disasters resulting in a Presidential Declaration, GEMA will process requests for State assistance and request assistance from FEMA. Together, the GEOP and GA REP–Base Plan identify the operational role for each response organization and sub-organization that are intended to be part of the overall response and describe the concept of operations and its relationship to the total effort.

As the framework for operations, should an emergency or disaster strike anywhere in the State of Georgia, the GEOP provides for coordinated planning and action by all State agencies in response to peacetime emergencies. The State of Georgia Executive Order, which was signed by the Governor on February 14, 2006, and included in the GEOP, assigns primary and support responsibilities for emergency and disaster services to State agencies, based on their usual (or normal) functions and/or special capabilities. **[A.1.d, A.2.a]** The Executive Order authorizes the Director of GEMA to exercise overall direction, control, and coordination of emergency and disaster planning and operations. GEOP Section V, “Direction and Control,” describes the responsibilities of GEMA and other State agencies and organizations and states that the GEMA Director shall be responsible for the program of emergency management in the State, subject to the direction and control of the Governor. The GEMA Director will assume responsibility for direction and coordination of ESFs at the State Operations Center (SOC) in Atlanta, Georgia.

At the discretion of the GEMA Director, and in concurrence with the Governor, a designated alternate SOC may become operational. In addition, the GEMA Director shall coordinate emergency management activities of all agencies/organizations within the State and serve as a liaison with other States and the Federal Government.

[A.2.a] GEOP Section IV.C, "State Government," states that State services and resources are supplements to local governments and are identified in the ESFs. State agencies and organizations serve as primary and support agencies/organizations for functional responsibilities. GEOP Section III, Appendix C, "Chart of Primary and Support Agencies," identifies responsibilities by functional area and the State organization that will fulfill those responsibilities. Appendix D, "Summary of Agency/Organizational Emergency Responsibilities," also identifies responsibilities and assets of State and non-State organizations that can assist the 15 ESF functions during a declared emergency. In addition, GA REP–Base Plan, Section IV, "Concept of Operation," lists agencies and their responsibilities. Appendix 1 provides a concise summary table of agency responsibilities.

[A.1.d] Section II, "Authority and Legal Aspects," of the GA REP–Base Plan states that the Governor is authorized and empowered under Section 38-3-22 of the Official Code of Georgia Annotated (OCGA) to have general direction and control of GEMA, and in the event of disaster or emergency beyond local control, may assume direct operational control over all or any part of the emergency management functions within the State. **[A.1.a, A.1.b]** Section IV, "Responsibilities," of the GA REP–Base Plan describes the responsibilities for local, State, and Federal agencies, and course of action during an emergency. DNR is assigned primary responsibility for implementation and administration of the State radiological emergency response function, which includes interaction with appropriate local, State, and Federal agencies and with private organizations to direct all necessary radiation control actions.

[A.2.b] In addition to the State of Georgia Executive Order (discussed above), the legal bases for the authorities reflected in the GEOP and GA REP are provided in GEOP Appendix G, "Authorities and References," which lists 27 various references to State and Federal laws, statutes, and regulations governing emergency disaster planning and response. The Georgia State laws and acts are also summarized in Section II of the GA REP–Base Plan. They include the following:

- Georgia Radiation Control Act, OCGA Section 38-3-22
- Immunity from Liability, OCGA Section 38-3-35
- Georgia Radiation Control Act, OCGA Section 31-13-1-10
- Georgia Water Quality Control Act of 1974, OCGA Section 12-5-47
- Georgia Air Quality Control Act, OCGA Section 12-9-1
- Georgia Transportation of Hazardous Materials Act, OCGA Section 46-11-1

[A.1.e] GEOP ESF Annex 2, "Communications," states that the GEMA communications center serves as the 24-hour State warning point for receiving and disseminating alerts and warnings to other State agencies, local governments, and the public. GEMA maintains agreements and contracts to ensure equipment and system maintenance on a 24-hour-per-day basis.
GA REP–Base Plan, Section VI.C, "Notification," states that GEMA can be contacted through one of its 24-hour emergency numbers or toll-free numbers. Assistance may also be obtained through the DNR–EPD 24-hour emergency number. (The SOP, "Resource Contacts," provides site-specific telephone numbers and procedures for notifying FNFs.)

GA REP–Base Plan, Section VI.E, "Emergency Communications," states that the primary method for initial notification will be the Emergency Notification Network (ENN), telephone, or radio from the facility operator (or on-scene personnel) to the responsible local and State agencies. Systems that are currently in place include, but are not limited to, a direct telephone line between the facility operator and the GEMA communications center (both of which are staffed on a 24-hour basis) and commercial telephone service for calls from the facility operator to the DNR 24-hour number (which is staffed after working hours by persons who can contact an on-call coordinator by either telephone or pager).

GA REP–Annex D, Section A, "Notification Methods and Procedures," states that in the event of a radiological emergency at Plant Vogtle, the plant emergency director (or his designee) will notify local and State authorities utilizing the ENN,[20] in accordance with current procedures. The ENN terminal, which is located within the GEMA communications center, is staffed 24 hours a day, 7 days a week. In the event the ENN is not operational, the GEMA communications center will be notified by commercial telephone at the 24-hour-a-day number, as depicted in the GEMA REP SOP, "Resource Contacts." (SER Section 13.3.3.2.5 also discusses communication links.)

[A.4] The GEOP Section I, "Introduction," states that the GEMA Director, on behalf of the Governor, will determine the level and duration of resource commitment. The Governor will declare a State of Emergency and may request a Presidential Declaration when appropriate. GEOP Section V states that State agency heads have the responsibility to appoint a primary and alternate emergency coordinator, with the authority to commit agency personnel and resources in emergencies and disasters.

GA REP–Annex D, "Plant Vogtle," states that during a radiological emergency at an FNF, State assistance will probably be needed since local capabilities are limited. The State response element can operate on a 24-hour basis, both from the FEOC in Waynesboro, Georgia, and from the SOC in Atlanta, Georgia. This capability for around-the-clock operation is based on current staffing in principal State response agencies, using a 12-hour shift. It is anticipated that augmentation from appropriate Federal agencies would be needed to assist in radiological monitoring and assessment operations after 24 hours. Accordingly, an early State request for Federal assistance would be based on the seriousness of the situation and the estimated duration of the emergency.

b. Burke County, Georgia

[A.1.a, A.1.b] The Burke County Emergency Management Radiological Plan, Section IV, "Concept of Operations," describes the coordination among all responsible departments and agencies. In addition, Section IV describes the roles of the listed agencies and organizations and states that the Burke County EMA will maintain coordination with officials for the VEGP and representatives from all local and State departments and agencies that are involved in emergency planning and operations related to an incident at the nuclear power plant. Section V.F, "Departments/Agencies, Roles and Notification," identifies the local departments that interface with the Burke County EMA and staff the EOC during a radiological emergency.

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20 The ENN is a dedicated circuit with terminals located at the utility, the local emergency operations center (EOC), the GEMA Forward Emergency Operations Center (FEOC), and SOC – all of which are staffed on a 24-hour basis – and at the SRS and designated locations in South Carolina (see SER Section 13.3.3.2.6.d).

[A.1.c] Burke County Plan, Attachment B, "Operational Relationship among County Response Organizations," provides an organization chart, which shows the operational and coordination links between county organizations in the EOC. This chart includes the coordination and operational links between the Vogtle plant, OHS-GEMA, the county EMA, local elected officials, emergency medical services (EMS), fire departments, sheriff's department, board of education, municipal police, county coroner, DFCS, local hospital, county health department, municipal public works, county public works, and the county agent.

[A.1.d, A.2.a] Burke County Plan, Section V, "Responsibilities," states that the responsibility for overall radiological emergency response planning, training, and operations in Burke County rests with the Chairman, Burke County Board of Commissioners. This responsibility includes initiating action in the event of a nuclear incident and providing direction and control at the local level. The Burke County EMA Director will be responsible for coordinating emergency operations at the local level and keeping local government officials advised of the status of the situation. The EMA Director will coordinate emergency operations and support with GEMA and the GEMA Area 3 Field Coordinator, State support agencies, and officials from the nuclear power plant. Section V describes key agency and organization responsibilities. **[A.2.b]** The legal basis for the county's authority is listed in Section III, "Authority—Legal Basis."

[A.1.e] Burke County Plan, Attachment F, "Communications," states that 24-hour operations and communications will be provided. In addition, the Burke County EMA can be contacted 24 hours a day through regular telephone, the GEMA statewide radio network, Burke County Sheriffs Department/Intrastate Coordinating Channel (ICC) radio network, Burke County EMA radio network, State Fire Mutual Air Radio Network, State hospital emergency administrative radio (HEAR)/EMS, and ENN (by GEMA). The county EOC is co-located with the sheriffs department, which provides 24-hour communications coverage. **[A.4]** Attachment A, "Implementation," states that the EMA Director will develop and maintain a 12-hour shift roster for key staff. Department/agency personnel will be assigned to shifts and/or operate on day-to-day shift schedules.

[A.3] The Burke County EMA currently has an April 2, 2004, letter of agreement, and April 17, 2006, letter of agreement with SNC, in regard to the county's concept of operations in support of the VEGP site. (The application includes these letters, and SER Section 13.3.2 discusses them.)

c. State of South Carolina

[A.1.a, A.1.b] SCORERP Section IV, "Concept of Operations," discusses general activation steps and organizations involved in a response. Section V, "Organization and Assignment of Responsibilities," lists the various ESF groups, Federal agencies, local governments, and organizations including their responsibilities in an emergency. Annex H, "Interstate and Federal Agency Response Support," identifies documents and describes the concept of operations associated with expected interstate regional assistance and Federal agency response procedures. In addition, Annex H outlines the procedures for State/Federal interface and cooperation in the event of an incident at an FNF.

The SCORERP lists SCEMD as the lead State agency for coordinating the State's offsite response to an incident at an FNF, and designates the Department of Health and Environmental Control (DHEC) as the lead State radiation emergency response agency. In addition, it describes DHEC responsibilities and the responsibilities of other State and Federal agencies.

Appendix 2 and Annex H provide additional details regarding agency interrelations. The SCEOP also describes ESF responsibilities during an emergency.

[A.1.c] SCORERP Figure 1 provides a radiological emergency response (RER) organization chart (block diagram), which illustrates the interrelationships (i.e., direction and control, and coordination) between the Governor, State Emergency Operations Center (SEOC) and State Emergency Response Teams (SERTs), State ESF, local governments and adjacent States, the NRC and FEMA, and public information organizations.

[A.1.d] SCORERP Section IV states that under the Governor's direction, the total and combined efforts of State and local governments will be utilized to mitigate the effects of offsite radiological hazards resulting from an FNF accident. Section III.A of SCEOP Annex 25 restates this. SCEOP Section III.F and Annex 25 Section III.B designate the SCEMD director as the lead for coordinating departments, agencies, and organizations in emergency response activities involving radiological hazards.

[A.2.a] SCEOP Section IV.C.6 and Annexes 1–19 and SCORERP Section V identify the key positions and list the ESFs and responsible agencies (including their primary responsibilities). SCEOP Table 3 and SCORERP Appendix 2 detail the agencies and ESFs (in table format), including their primary and support functions. SCORERP Section V describes State agencies and their radiological emergency responsibilities. Finally, SCORERP Appendix 2 provides a table that lists the functional areas and identifies the responsible agencies. **[A.3]** Supplemental letters of agreement were provided on December 28, 2006, to the Chemical and Nuclear Preparedness and Protection Division, DHS, Atlanta Field Office, with cover letters dated April 17, 2006. These letters are not included in the State plan but are in the utility's plan.

[A.2.b] SCEOP Section IX.A lists the State laws and regulations associated with State emergency response. Section IX.B lists the Federal regulations. SCEOP Section III.F and Annex 25 (Section III.B) designate the SCEMD Director as the lead for coordinating departments, agencies, and organizations in emergency response activities involving radiological hazards.

[A.1.e] SCORERP Section IV.A states that all radiological EROs will be prepared to react on a 24-hour basis and will be capable of continuous operations for a protracted period. Annex A, "Alert and Notification Procedures," states that alert telephone numbers and designated representatives for State, Federal, and contiguous State agencies appear in the SCEMD telephone directory. SCEOP Section V.A states that the State warning point has 24-hour radio, special telephone operations, and operation of the emergency alert system (EAS). **[A.4]** In addition, SCEOP Section III.A of Annex 25 states the following:

Under the Governor's direction, the total and combined efforts of state and local governments will be utilized to mitigate the effects of off-site radiological hazards resulting from an FNF accident. All radiological EROs will be prepared to react on a 24-hour basis, and will be capable of continuous operations for a protracted period. Directors of State agencies, departments, and commissions are responsible for ensuring that their agencies' RER responsibilities are accomplished. Designated county officials are responsible for emergency response within their jurisdictions.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[A.1.a, A.1.b, A.1.c] Annex Q2 of each county plan references the SCORERP for State and Federal support and, in Section 1.F, lists various local and private organizations. Section IV.B lists county agencies and their basic responsibilities, and an annex to the county plans provides detailed actions and responsibilities for each agency. Section IV lists responsibilities during radiological incidents, and Appendix 1 (Tab A) shows primary and support responsibilities. The county plans reference the State plan in regard to the use of State and Federal resources to support the counties. **[A.1.d]** Section IV.B describes the direction and control for the counties. **[A.2.a, A.3]** Section IV.B.4 of the county plans identifies the key positions, lists support services, and refers to the appropriate plan annex for detailed responsibilities and functions. Appendix 1 (Tab A) displays the functions, agencies, and the primary and support responsibilities.

[A.1.e, A.4] Section IV.D.2 of the county plans states that, based on the emergency classification, local government and State radiological response forces will react on a continuous 24-hour basis. In addition, Section IV.C.4 states that the county warning point provides 24-hour emergency response through the 911 Communications Center. **[A.2.b]** Section I.B lists legislative acts and county ordinances, which provide the legal basis for county emergency response.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for assignment of responsibility, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard A of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(1), and Sections III and IV.A of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.2 Onsite Emergency Organizations (10 CFR 50.47(b)(2); NUREG-0654/FEMA-REP-1, planning standard B)

The regulation, as reflected in the planning standard, requires that the on-shift facility licensee responsibilities for emergency response are unambiguously defined, adequate staffing to provide initial facility accident response in key functional areas is maintained at all times, timely augmentation of response capabilities is available, and the interfaces among various onsite response activities and offsite support and response activities are specified.

In ESP Plan, Section B, “VEGP Emergency Response Organization,” the applicant described the organizational structure that would be available to respond to an emergency at the VEGP site. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff’s primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard B, “Onsite Emergency Organization.” Planning standard B provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(2).

[B.1] In ESP Plan Section B, the applicant stated that, initially, personnel normally employed at the site will staff the VEGP onsite ERO. An organizational chart for the ESP Plan is shown in Figure B-1, “Site Organization Chart.” [B.6, B.7] If necessary, this staff will be augmented substantially by the addition of SNC personnel and by personnel from other organizations. The organizational structure in ESP Plan Figure B-1 represents the pool of management personnel available onsite during normal working hours. Approximately 700 persons are stationed at Units 1 and 2 during the standard workday, and approximately 650 persons will be stationed at Units 3 and 4 during the standard workday. The normal operating crew for each unit includes a shift supervisor, licensed plant operators, and non-licensed plant operators. A shift manager is also on shift during operation, and personnel from the chemistry and health physics, maintenance, and security departments are also on site continuously.

[B.2] ESP Plan Section B states that the emergency director will be the key individual in the VEGP site ERO and has the responsibility to classify an event in accordance with the emergency classification system (discussed in SER Section 13.3.3.2.4). Classification of an event into one of the four emergency categories (i.e., notification of unusual event, alert, site area emergency, or general emergency) activates the VEGP site ERO. The emergency director will normally be located in either the TSC or control room, at his discretion, and is responsible for the management of the emergency response. The site-specific emergency plan and emergency plan implementing procedures (EPIPs) describe the specific duties and responsibilities. **[B.4]** One of the emergency director's nondelegable responsibilities is the decision to notify and recommend protective action to authorities responsible for offsite emergency measures and the NRC. ESP Plan Section B.2.1.1, "Emergency Director," lists the responsibilities that the emergency director may not delegate.

The emergency director has the authority to assume the overall responsibility for directing site staff in an emergency situation. ESP Plan Section B.2, "Emergency Response Organization," lists the activities that the emergency director will manage for the duration of the emergency. Initially, this position will be filled by the shift manager, or the shift supervisor if the shift manager cannot be located expeditiously. The responsibility for emergency direction will be transferred to the nuclear plant general manager or an alternate after the manager or alternate receives an appropriate briefing and becomes familiar with the current status of events. The emergency director may operate from the control room or TSC at his discretion. The emergency director may act as the TSC manager during the early phases of emergency response until the [EOF] is activated. SNC intends that the emergency director function will be transferred from the control room as soon as practicable. **[B.3]** Plant and corporate personnel who may be designated as emergency directors are listed in ESP Plan Table B-2, "Emergency Response Organization Assignments." Table B-2 lists the nuclear plant general manager as the primary emergency director and provides seven alternates.

[B.1, B.2, B.3, B.4] The staff finds that the applicant has adequately specified the onsite emergency organization of plant staff personnel for all shifts and its relation to the responsibilities and duties of the normal shift complement. In addition, the applicant has designated an individual as emergency coordinator (i.e., the emergency director), who is on shift at all times and has the authority and responsibility to immediately and unilaterally initiate any emergency actions, including providing protective action recommendations (PARs) to authorities responsible for implementing offsite emergency measures. The staff also finds that the application identifies an appropriate line of succession for the emergency director, including identifying the specific conditions for higher level utility officials to assume this function.

[B.5] ESP Plan Section B provides additional descriptions of the emergency duties of the normal shift complement, a discussion of the manner in which emergency assignments are to be made, a listing of additional support personnel on whom the site can rely, and a description of the relationships between onsite and offsite response activities. The extent to which the ERO is activated depends on the severity of the situation. In ESP Plan Section B.2, the applicant stated that a security-related emergency may delay the ordering of facility activation, in order to protect plant personnel from the security threat. The emergency director will make the decision to delay activation of the facilities. ESP Plan Section H, "Emergency Facilities and Equipment," and SER Section 13.3.3.2.8 also address facility activation.

In ESP Plan Table B-1, "Minimum Staffing for Power Operation," the applicant summarizes the personnel available on shift and lists the specific positions or titles and major tasks to be performed by the persons to be assigned to the functional areas of emergency activity. Table B-1 also provides a summary of personnel available on shift and those who would be available for staff augmentation within 75 minutes of ERO notification. In RAIs 13.3-8.a and 13.3-8.b, the staff asked the applicant to explain differences between ESP Plan Table B-1 and Table B-1 of NUREG-0654/FEMA-REP-1, as they relate to the staff augmentation time, and address various other details associated with Table B-1. The staff also asked the applicant to explain whether the application is requesting approval to change the augmentation times for Units 1 and 2, and how this change would relate to a decrease in effectiveness (pursuant to 10 CFR 50.54(q)) for the existing Unit 1 and 2 emergency plan.

In its response, the applicant stated that SNC intends to augment its emergency response staff within 75 minutes of the determination of a need to augment the staff, and that the 75 minutes is a combination of the allowable 15 minutes for notification and allowable 60 minutes for the emergency response staff to respond and activate the associated emergency response centers; and thus, 75 minutes is consistent with the wording in (ESP Plan) Section H.3 and Section I.5.[21] SNC intends that the proposed emergency plan will be in effect for Units 1 and 2 when it is put into effect, and indicates that it will submit a licensing action concerning the emergency plan for Units 1 and 2 approximately 1 year before the scheduled full participation exercise associated with Unit 3. The applicant also referenced RAI 13.3-6 (discussed in SER Section 13.3.1.2), which indicates that the "licensing action" for Units 1 and 2 is intended to be the submission of a revision to the VEGP Plan, pursuant to the provisions of 10 CFR 50.54(q). In RAI 13.3-8.b, concerning the applicant's requested extension of the current Unit 1 and 2 staff augmentation time from 60 to 75 minutes in ESP Plan Table B-1, the staff stated the following in footnote 2:

Any proposed changes related to VEGP Units 1 and 2 should be in accordance with 10 CFR 50.54(q) and submitted in accordance with applicable processes, as a licensing action associated with those units, including appropriate justification, as specified in the "Smart Application Template for Requesting Emergency Plan Changes Related to On-shift Staffing Levels and Augmentation Times," ADAMS Accession No. ML042530011 ["Smart Application"]. Additional guidance can be found in RIS 2005-002, "Clarifying the Process for Making Emergency Plan Changes," ADAMS Accession No. ML042580404.

As discussed above, in response to RAI 13.3-6 and RAI 13.3-8.b, the applicant stated that revisions to the VEGP Plan will be in accordance with 10 CFR 50.54(q) and submitted as a licensing action – the timing of which is related to the scheduled full participation exercise and fuel load for Unit 3 – and that it will implement the ESP Plan in accordance with NEI 06-01.

21 ESP Plan Section H.3, "Activation and Staffing of Emergency Facilities," states that the TSC will be activated and operational within about an hour of the initial notification, and the OSC will be operational within about an hour of initial notification. Section I.5, "Field Monitoring," states that it is estimated that teams will be in the field and performing monitoring tasks within about one hour of the determination of the need for field monitoring.

(SER Section 13.3.1.2 discusses NEI 06-01.) Therefore, this SER does not include an evaluation of shift augmentation times for VEGP Units 1 and 2, which will be evaluated separately when the licensee submits an appropriate licensing action request.

In regard to the staff augmentation time difference between ESP Plan Table B-1 (75 minutes) and Table B-1 of NUREG-0654/FEMA-REP-1 (60 minutes), the applicant did not adequately explain – in its response to the RAIs – the basis for the 15 minute difference. The applicant addressed separately the applicability of the proposed increased augmentation time for Units 1 and 2, stating that SNC will submit a future licensing action for these units approximately one year prior to the Unit 3 exercise. The applicant did not submit a revised ESP Plan Table B-1 reflecting this distinction, in that Table B-1 still included all four reactor units. As described below, and in the Safety Evaluation Report with open items, the staff identified the submission of an adequate basis for the 75-minute augmentation time in ESP Plan Table B-1, for Units 3 and 4, as Open Item 13.3-2.

The staff reviewed the applicant's response in its submittal dated October 15, 2007 (provided below), which supplemented its April 16, 2007, response to RAI 13.3-8.a and RAI 13.3-8.b.

The 75 minutes referenced in the ESP Plan Table B-1 is intended to clarify the current commitment in the existing emergency plan for VEGP Units 1 and 2 which states "60 minutes from notification". Notification timeframes are not expected to exceed 15 minutes from declaration of the emergency. Therefore, physical response times in the existing and proposed plans are consistent. The inclusion of the timeframe associated with notification into the physical response time serves to clarify the commitment to staff facilities within the specified timeframe. This approach is consistent with available guidance for activation of emergency response facilities within "about an hour." The augmentation process remains capable of ensuring augmentation of the initial response staff in accordance with existing activation requirements. The augmentation of the on-shift staff during an actual emergency remains sufficient to ensure that the planning standard will be met.

Simply stated, the applicant's responses define the total allowable time to augment staff as a 15-minute notification time, plus a 60-minute physical response time beyond the initiation of notification of the ERO. The applicant states that this approach is allowable, consistent with available guidance and in accordance with existing activation requirements, yet does not identify any specific regulation or guidance supporting this approach. Further, the proposed 75-minute augmentation time in ESP Plan Table B-1 does not adequately provide a justification for an alternative approach to regulatory guidance through reference to the existing emergency plan for VEGP Units 1 and 2.

The existing emergency plan for VEGP Units 1 and 2 (Revision 43) does state in Section B.2, "Emergency Organization," that "Table B-1 provides a summary of personnel available on shift and those who would be available within 60 min of notification." The applicant thus interprets "within 60 min of notification" as allowing 15 minutes (for notification) in addition to the 60 minutes (for physical response). Further, the comparable Section B.2, "Emergency Response Organization," in the application states that "Table B-1 provides a summary of personnel available on shift and those who would be available within 75 minutes of ERO notification" – apparently intended to reflect the clarifying interpretation of the Units 1 and 2 statement of "within 60 min of notification."

The staff does not agree with the applicant's position relating to the availability of 60 minutes for staff augmentation following the initial notification of the ERO, as this would constitute an unacceptable alternative approach for guidance relating to augmentation times for the minimum on-shift staffing levels in Table B-1 of NUREG-0654/FEMA-REP-1. Such a change would have to be addressed as described above, relating to the 10 CFR 50.54(q) process and the Smart Application.

The staff considered the adequacy of the shift staffing numbers in the proposed ESP Plan Table B-1 for Units 3 and 4, in relation to the intended purpose of the applicable requirement in 10 CFR 50.47(b)(2), which requires (in part) the availability of timely augmentation of response capabilities. Related guidance includes evaluation criterion B.5 of NUREG-0654/FEMA-REP-1, which states that the licensee must be able to augment the minimum on-shift staffing capabilities within a short period after declaration of an emergency, as indicated in Table B-1. The 60-minute augmentation time would begin at the declaration of the emergency, and not after a 15-minute notification timeframe, as proposed by the applicant. In addition, NUREG-0696, "Functional Criteria for Emergency Response Facilities," issued February 1981, provides additional guidance for emergency response facility activation (e.g., the TSC should achieve full functional operation within 30 minutes), yet does not specify a time frame for staff augmentation. Finally, Supplement 1 to NUREG-0737, "Clarification of TMI Action Plan Requirements," issued January 1983, states that the staffing levels in table 2 (which is identical to Table B-1 of NUREG-0654/FEMA-REP-1) are only goals, and are not strict requirements.

The staff also considered the proposed addition of new on-shift personnel associated with the addition of Units 3 and 4, in relation to the purpose of the requirement to have the availability of timely augmentation of response capabilities. The goal is to satisfy the number of staff that would be available on-site for each of the major functional areas; consistent with Table B-1 of NUREG-0654/FEMA-REP-1 (the minimum staffing requirements in Table B-1 are per site, not per reactor). The staff compared Table B-1 of NUREG-0654/FEMA-REP-1 (for each position, major functional area, and total number) against ESP Plan Table B-1, and found that the proposed staff numbers for some of the major functional areas in ESP Plan Table B-1 did not meet the minimum staffing specified in Table B-1 of NUREG-0654/FEMA-REP-1. In addition, as discussed above, the 75-minute staff augmentation time in ESP Plan Table B-1 is inconsistent with Table B-1 of NUREG-0654/FEMA-REP-1.

In a letter dated February 12, 2008, the applicant revised its response for Open Item 13.3-2 by providing a revised ESP Plan Table B-1, which replaced the 75-minute staff augmentation time with 60 minutes. In addition, the applicant revised the proposed staff numbers for some of the major functional areas in ESP Plan Table B-1, to be consistent with Table B-1 of NUREG-0654/FEMA-REP-1. The staff reviewed the applicant's revised ESP Plan Table B-1, and finds that it meets the minimum staffing (including staff augmentation time) provisions in Table B-1 of NUREG-0654/ FEMA-REP-1 for Units 3 and 4. Therefore, Open Item 13.3-2 is resolved.

[A.1.b, A.1.e, A.4, B.5, B.6, B.7, H.2, H.4] In ESP Plan Section B.2, "Emergency Response Organization," the applicant stated that Appendix 7 describes the corporate resources and operation. In addition, Figure B-2, "Response Organization for Alert," and Figure B-3, "Site Area or General Emergency ERO," identify Appendix 7 in relation to EOF staff and management. Appendix 7, which outlines the function of the EOF, is an integral part of the SNC site-specific emergency plans. As such, it delineates the actions to be taken by SNC corporate staff in the event of an emergency at any SNC site, including the VEGP site, and states that the corporate emergency organization will provide offsite emergency response support and resources to SNC sites 24 hours per day until the emergency has been terminated.

[B.5, B.6, B.7, H.2, H.4] ESP Plan Appendix 7, Section A7B, "EOF Organization," also states that in order to augment (provide) additional staff that may be needed in the unlikely event of a multisite accident, SNC will reactivate its ERO notification system. When the EOF is activated, all EOF staff pagers are activated, and all EOF personnel are expected to report to the EOF. Personnel who are not needed to augment positions are briefed and dismissed with a standby status. Table A7-1, "Corporate Emergency Response Organization Assignments," lists the numerous emergency positions and indicates that their respective corporate staff assignments are designated in procedure NMP-EP-001. (The submission of detailed emergency implementing procedures for VEGP Units 3 and 4 is addressed in Units 3 and 4 ITAAC 9.1, and is discussed further in SER Sections 13.3.3.2.1, 13.3.3.2.4, 13.3.3.2.8, 13.3.3.2.9, 13.3.3.2.10, and 13.3.3.2.16.) **[A.1.c, B.6]** In Figure A7-1, "EOF Organization," the applicant provided a block diagram of the corporate (EOF) positions that are used to meet augmentation requirements for EOF direction and notification/communication under the control of the EOF manager. Finally, Section A7F, "Offsite Support," identifies additional offsite resources that may be available to support an emergency response effort at the VEGP site. Appendix 7 is also addressed in ESP Plan Sections A, H, and O, which are discussed in SER Sections 13.3.3.2.1, 13.3.3.2.8, and 13.3.3.2.15, respectively.

[B.1, B.5, B.7] The staff finds that this information adequately describes the onsite emergency organization and its relation to the responsibilities and duties of the normal staff complement and specifies the positions or titles and major tasks, including corporate augmentation, to be performed by the persons to be assigned to the functional areas of emergency activity (see ESP Plan Table B-1). **[B.2]** The staff finds that the applicant has adequately designated the emergency director as the emergency coordinator who has the authority and responsibility to initiate emergency actions, including recommending protective action to authorities responsible for implementing offsite emergency measures. **[B.3, B.4]** The staff also finds that the organizational structure reflected in Table B-2 provides an adequate line of succession for the emergency director position, and VEGP Plan Section B.2.1.1 clearly specifies the emergency director's responsibilities, which may not be delegated.

[A.1.c, B.6] Figure A-1, "Formal Interfaces among Emergency Response Organizations," illustrates (in a block diagram) the various interfaces between and among the onsite functional areas of emergency activities, local services support, and State and local government response organizations. Figure B-1, "Site Organization Chart," Figure B-2, "Response Organization for Alert," and Figure B-3, "Site Area or General Emergency ERO," show additional onsite interfaces. The staff finds that this information adequately specifies the interfaces between and among the onsite functional areas of emergency activity, licensee headquarters support, local services support, and State and local government response organizations. In addition, it includes the interfaces with the TSC, OSC, and EOF.

[B.7.d, G.1-G.5, H.2] In ESP Plan Appendix 8, "Vogtle Electric Generating Plant Emergency Communications Plan," also known as the Vogtle Emergency Communications Plan, the applicant describes the public education and information organization and program for the periodic dissemination of emergency planning instructional materials to residents and transients in the plume exposure pathway EPZ. Appendix 8 also describes information flow to the public during an emergency at VEGP. Upon activation, the emergency news center (ENC) – also referred to as the joint media center, joint public information center, or joint information center (JIC) by offsite agency emergency plans – will become the primary source of utility emergency communications response. (Facility activation is addressed in ESP Plan Section H and discussed in SER Section 13.3.3.2.8. The ENC is also addressed in ESP Plan Sections G and H, which are discussed in SER Sections 13.3.3.2.7 and 13.3.3.2.8, respectively.)

The ENC will be operated as a joint information center where the utility, the States, SRS, the Federal agencies, and counties will coordinate information, issue news releases, make announcements, and participate jointly in news briefings. GPC Corporate Communication/SNC Corporate Communication (the utility) is responsible for coordinating and issuing all news announcements related to plant emergency conditions at VEGP. State and county emergency management agencies and DOE-SR are responsible for issuing public announcements related to offsite conditions, including recommended protective actions.

[G.4.c] Rumor control will be coordinated from the ENC. The SNC news writer, along with a technical assistant, will collect and assemble plant information and communicate this information to the public information director and the company spokesperson. Until the ENC has been activated, the emergency response center in Atlanta, Georgia, is the official company location for the coordination and issuance of news announcements and responses to news media inquiries.

[B.8] ESP Plan Section A.8, “Private Sector Organizations,” states that GPC/SNC has established an agreement with Bechtel to obtain engineering and construction services that may be needed following an accident. The plan also states that Bechtel’s assistance will not be needed during the early stages of the emergency response but is more likely to be requested during recovery activities. SNC has also established an agreement with Westinghouse to obtain general services related to NSSS operations during and following an accident. Westinghouse will provide a capability to respond on a 24-hour, 7-day-per-week basis. In addition, SNC is a signatory to two comprehensive agreements among electric utility companies, the Nuclear Power Plant Emergency Response Voluntary Assistance Agreement, and the Voluntary Assistance Agreement by and among Electric Utilities Involved in Transportation of Nuclear Materials. The staff reviewed other application sections that deal with the availability of 24-hour emergency communications and response, and discusses those reviews in SER Sections 13.3.3.2.1, 13.3.3.2.5, 13.3.3.2.6, 13.3.3.2.8, and 13.3.3.2.12.

[A.3, B.8, B.9] The services to be provided by local agencies for handling emergencies are addressed in ESP Plan Section A.7, “Medical Support,” and ESP Plan Section B.2.3.2, “Medical Assistance.” The VEGP site has established agreements with the Burke County EMA to provide ambulance service for the transportation of injured personnel, including people who may be radioactively contaminated, to hospital facilities for treatment. The staff reviewed the April 2, 2004, letter of agreement with the Burke County EMA, in which the county agency confirmed its responsibility to respond to all calls involving fire, rescue, sickness or injury, including casualties arising from radiation accidents at VEGP. The staff also reviewed the April 17, 2006, supplemental letter of agreement with the Burke County EMA, in which the agency further committed to continued participation in any future development of the VEGP Plan in support of Units 3 and 4.

[A.3, B.8, B.9] The applicant further states in ESP Plan Section A.7 that agreements with Radiation Management Consultants (RMC), Burke County Hospital in Waynesboro, Georgia, and Doctors Hospital in Augusta, Georgia, have been established for treatment of injured and contaminated individuals. This assistance will be requested whenever necessary, in accordance with plant procedures. Enclosure 11 of the application includes copies of these agreements, and ESP Plan Appendix 2 lists the letters of agreements. In RAI 13.3-1, the staff asked the applicant to provide a letter of agreement for RMC that was current at the time of the application, and has not expired. In its response to RAI 13.3-1, the applicant did not provide the requested letter for RMC. In the Safety Evaluation Report with open items, the staff identified the receipt of this letter as Open Item 13.3-3. The staff reviewed the applicant's response in its submittal dated October 15, 2007, which included a current, unexpired letter of agreement for RMC, and finds it acceptable. Therefore, Open Item 13.3-3 is resolved.

The staff reviewed the existing letters of agreements and the supplemental letters of agreement contained in Appendix 13.3A of Section 13.3 of the ESP application. Collectively, these agreements identify the local agency services, including support from police, ambulance, medical, hospital, and firefighting organizations, and delineate the respective authorities and responsibilities. Accordingly, the staff finds that the information given in SSAR Section 13.3 and the existing and supplemental letters of agreement adequately identify the services to be provided by local agencies for handling emergencies, and include copies of the arrangements and agreements reached with contractor, private, and local support agencies.

Conclusion

On the basis of its review of the onsite emergency plans, as described above for onsite emergency organization, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard B of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(2), and Sections III, IV.A, and IV.C of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.3 Emergency Response Support and Resources (10 CFR 50.47(b)(3); NUREG-0654/FEMA-REP-1, planning standard C)

The regulation, as reflected in the planning standard, requires that arrangements for requesting and effectively using assistance resources have been made, arrangements to accommodate State and local staff at the licensee's near-site EOF have been made, and other organizations capable of augmenting the planned response have been identified.

In ESP Plan, Section C, "Emergency Response Support and [Resources]," the applicant addressed the responsibilities and concept of operations for the various organizations that would support the VEGP site, including Units 3 and 4, in an emergency. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard C, "Emergency Response Support and Resources." Planning standard C provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(3).

[C.1.a] In ESP Plan Section C.2, "Federal Government Support," the applicant stated that the emergency director will manage requests for Federal assistance, as needed, and that these requests will usually be channeled through the GEMA. In addition, ESP Plan Section B.2, "Emergency Response Organization," which lists the basic activities that the emergency director will manage, states that the emergency director's nondelegable responsibilities include requesting Federal assistance.

[C.1.b] In the event of an incident in which Federal assistance is needed to supplement county and State emergency response capabilities, the principal points of contact for State government are FEMA, DOE, and EPA. The Federal Government's role consists of providing technical and/or logistical resource support at the request of State emergency management. Federal emergency response consists of technical and nontechnical components. The NRC and FEMA jointly coordinate Federal emergency response actions, with the NRC coordinating technical aspects and FEMA coordinating nontechnical aspects of Federal response.

[C.1.a, A.1.d] ESP Plan Section A.10, "Concept of Operation," states that the emergency director will be the key individual in the VEGP site ERO and that he will initiate the activation of the ERO by contacting the States of Georgia and South Carolina, the counties within the plume exposure pathway EPZ, SRS, and the NRC. SRS operates continuously and can be contacted at all times. The emergency director can request assistance from Federal agencies by contacting the NRC on a dedicated communication link (i.e., the ENS). ESP Plan, Section B.2.1.1, "Emergency Director," lists activities that the emergency director is authorized to manage for the duration of the emergency. These include requesting Federal assistance, which is one of the responsibilities that may not be delegated.

[C.1.b] ESP Plan Section C.2 states that, within several hours of notification, Federal response personnel will begin arriving at, or near, the VEGP site. The NRC and FEMA are expected to have representatives at the VEGP site within about 3 hours after receiving notification, and DOE can provide assistance within about 2 hours.

[A.1.a, C.1.b] ESP Plan Section A.9 states that the resources of the Federal agencies appropriate to the emergency condition will be made available in accordance with the NRP. **[C.1.a]** The NRP specifically authorizes the emergency director to request Federal assistance on behalf of the VEGP site. In addition to the NRC, other Federal agencies that may provide assistance include DHS, DOE, FEMA, EPA, HHS, DOT, and USDA.

[A.1.a, C.1.b] In ESP Plan Section C.2, the applicant describes the Federal response resources that may be employed during an emergency at VEGP. The Federal Response Center (FRC) will coordinate and exchange information among various Federal agencies during an emergency at the site. The Federal Radiological Monitoring and Assessment Center (FRMAC) will coordinate Federal monitoring and assessment assistance with State and local governments. Upon activation of the Federal Radiological Emergency Response Plan (FRERP), DOE will provide telecommunications support to those Federal agencies assisting in offsite radiological monitoring. **[C.1.c, C.4]** DOE has written agreements with all telephone companies to provide additional telephone communications, including satellite capability, within 24 to 48 hours. This capability will supplement communications among the FRC, FRMAC, EOF, and the Georgia and South Carolina EOCs.

[C.1.c] ESP Plan Section C.2 states that airfields in the plant vicinity that may be used to support the Federal response, as well as that of other response groups, include a commercial airport with scheduled service and nearby municipal airports that can accommodate small aircraft. Bush Field (Augusta, Georgia) is the closest major airport able to provide services for large aircraft. The field is a scheduled commercial air carrier facility capable of handling large multiengine jet aircraft. It is also a military air headquarters for the U.S. Army, operating out of Fort Gordon, Georgia. Daniel Field (Augusta, Georgia) and Aiken Municipal (Aiken, South Carolina) are capable of servicing and maintaining medium-size jet and propeller aircraft. The Burke County Airport (Waynesboro, Georgia), the nearest airport to the site, is used only by small general aviation aircraft.

[C.1.c] ESP Plan Section C.3, “VEGP Site Support,” states that the VEGP site will provide space, telephone communications, and administrative services for NRC and FEMA personnel at the TSC and EOF. The TSC can accommodate five NRC representatives, and the EOF can accommodate nine representatives from the NRC and one from FEMA. NRC representatives may also be present in the control room. ENS telephones and commercial telephones will be available in the control room, TSC, and EOF. Health Physics Network (HPN) telephones will be available in the TSC and the EOF. ESP Plan Section F, “Emergency Communications,” which is discussed in SER Section 13.3.3.2.6, provides additional information regarding available communication capabilities.

[C.2.a] ESP Plan Section C.1, “State and Local Government Support,” states that representatives from the States of Georgia and South Carolina will be dispatched to the EOF and the ENC. **[C.2.b]** If requested, the VEGP site will send representatives to the offsite Government centers listed in Table C-1, “State and County Emergency Operation Centers (EOCs).”

[C.3] ESP Plan, Section C.4, “Other Support,” states that the VEGP onsite laboratory will be equipped to analyze all normal in-plant samples. The equipment will include an ion chromatograph, gamma spectrometer, and other analytical support equipment. Field samples will be scanned with field instrumentation and will then be taken to the site for laboratory analyses. If necessary, samples will be transported to the GPC environmental laboratory in Smyrna, Georgia, or to Plant Hatch for analyses. GPC corporate personnel will collect environmental samples and send them to Plant Hatch or the GPC environmental laboratory. In-plant samples, such as effluent and air samples, will be analyzed using a gamma spectrometer located in the counting room. **[C.4]** Additional assistance, consisting of engineering, health physics, and general support, will be available from the following four private organizations:

- SNC, Birmingham, Alabama
- Southern Company Services, Inc. (SCS), Birmingham, Alabama
- Westinghouse Electric Company, LLC (WEC), Pittsburgh, Pennsylvania
- Institute of Nuclear Power Operations (INPO), Atlanta, Georgia

[C.4] As a member of the Institute of Nuclear Power Operators (INPO), SNC receives the INPO emergency response manual. This manual identifies the number of personnel that various organizations (utilities, service companies, and reactor vendors) could reasonably be expected to make available in response to a request for emergency support. In addition, several offsite GPC and SNC departments may be involved in the emergency response effort. These departments will, as appropriate, develop separate nuclear emergency response plans and procedures governing their emergency functions. Coordination of these plans to ensure a consistent, integrated response is the responsibility of the corporate emergency planning section. These specific plans will include the following:

- Corporate Emergency Plan, controlled by the SNC Emergency Planning Section
- Emergency Communication Plan, controlled by SNC Public Affairs
- VEGP Security Plan, controlled by the Manager, Nuclear Security
- VEGP Fire Protection Plan, controlled by engineering support

[C.4] SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.12, and 13.3.3.2.16 provide additional information pertaining to letters of agreement with nuclear and other facilities, organizations, and individuals that can be relied on to assist in an emergency.

State and Local Emergency Plans [C.1.a, C.1.b, C.1.c, C.2.a, C.3, C.4]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard C of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard C are adequate. The following summarizes the FEMA findings for planning standard C.

a. State of Georgia

[C.1.a] Section IV.C.2 of the GEOP states that the Governor may declare a State of Emergency to activate necessary State resources and may request a Presidential Declaration. If the emergency or disaster exceeds the State's capacity, the Governor may request assistance through the Emergency Management Assistance Compact. Upon a Presidential Declaration, State-requested assistance will be provided through Federal ESFs. **[C.1.b, C.1.c]** In addition, Section IV.D.1 of the GEOP states that Federal assistance will supplement State and local efforts. Federal assistance made available to relieve the effects of an emergency or disaster will be channeled through and coordinated by the Governor (or the Governor's designated authorized representative).

[C.2.a] GA REP–Base Plan, Section VI.D, "Evaluation and Response," states that upon notification of a general emergency, site area emergency, or an alert classification at a nuclear facility, a primary response team will be dispatched to an FEOC near the site. The FEOC is located in the Burke County EOC. This action will place field monitoring teams close to the plant and within radio contact with the FEOC. While the GA REP does not state that a representative will be sent to the EOF (located in Birmingham, Alabama), the current practice is that both GEMA and DNR will have representatives at the EOF.

[C.3] GA REP–Base Plan, Section VI.D.5, states that DNR has a contract with the Georgia Institute of Technology (Georgia Tech), which operates a fully equipped fixed radiochemistry laboratory. During an emergency, the DNR mobile radiation laboratory can respond within 4 hours, and the primary response team can respond to the site by air within 2 hours. Environmental samples can be sent by air to either the State's mobile radiation laboratory or Georgia Tech's laboratory in Atlanta. Ambient radiation monitoring and air sampling stations are also located near the site.

[C.3] Section D.6, "Radiological Laboratories," of the GA REP–Annex D, states that the DNR-EPD environmental radiation program laboratory will be the primary laboratory for analysis of radioactivity in the environment. This laboratory is equipped with Ge(Li) and NaI detectors, automatic and manual alpha/beta analyzers, a liquid scintillation system, an alpha spectrometer, and environmental thermoluminescent dosimeter (TLD) readers/annealer. In addition, a mobile radiation laboratory is available, which has a multichannel analyzer (with intrinsic germanium detector), alpha/beta analyzer, and liquid scintillation counter. Other laboratories with similar capabilities include the Georgia Tech Environmental Resource Center – Georgia Institute Center, DOE, and EPA. Both the mobile radiation laboratory and the DNR-EPD environmental radiation program laboratory are Georgia State assets and are available 24 hours a day.

[C.4] GA REP–Base Plan, Appendix 2, SMRAP, describes how participating States (including Georgia)[22] handle requests for assistance. GA REP–Base Plan Annex D includes letters of agreement for medical and radiation protection support with Burke County Hospital, Columbia-Augusta Medical Center, and SNC. The Oak Ridge Hospital of the Methodist Church (ORHMC) in Oak Ridge, Tennessee, is also available. The Burke County Ambulance Service has agreed to transport accident victims to the medical facilities, and the University Ambulance Service in Augusta may be called if additional ambulances are needed. In addition, if an accident requires the immediate transport of a victim for a considerable distance, the State will request assistance from the Military Assistance to Safety and Traffic (MAST), located at Fort Stewart near Savannah, Georgia.

b. Burke County, Georgia

[C.2.a] GA REP–Burke County Plan, Attachment A, "Implementation," states that, when necessary, the EMA Director will dispatch a representative to the VEGP EOF to coordinate initial offsite response activities and serve in a liaison capacity. [C.4] Attachment A also identifies the Burke County Hospital in Waynesboro and Doctor's Hospital in Augusta as medical facilities that can care for offsite victims of an incident at VEGP. GA REP–Annex D, Section F, "Medical/ Public Health Support," discusses these facilities further.

c. State of South Carolina

[C.1.a] SCEOP Section III states that if it becomes necessary to request outside assistance, the request will be coordinated through the SCEMD Director and the Governor. SCORERP Annex H, Section III.C.4, states that the Governor, acting directly or through a designee, is specifically authorized to request Federal assistance in the event of an incident at an FNF. **[C.1.b]** SCORERP Annex H (Appendix 1, Section II) describes the Federal resources that the State should expect, as part of the FRERP.[23] In addition, South Carolina Technical Radiological Emergency Response Plan (SCTRERP) Section C, Table 1, "SRS Travel Times," states that for FNFs in South Carolina, the FRERP designates SRS as the primary responder. In addition, approximate travel times are shown, with VEGP located within the SRS 1-hour response time radius.

[C.1.c] SCTRERP Sections B.IV and B.XII state that DHEC (located in Columbia, South Carolina) has limited resources to support other emergency personnel or members of the public. These resources include various supplies and equipment, including three sets of maps that show the environs of each FNF in the State. The maps show the location of the facility, evacuation routes, relocation and personnel assembly areas, and monitoring and sampling locations. In addition, the maps show features such as dairy farms, water treatment plants, airports and airstrips, hospitals, schools, and industrial plants.

[C.2.a] SCORERP–Part 5, Sections IV.B.2.B and IV.B.2.C, state that a technical representative from DHEC will be dispatched to the EOF and that a representative from SCEMD will be sent to the EOF. In addition, if the decision is made to activate the FEOC, the State will dispatch emergency response team personnel to establish the FEOC.

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22 South Carolina Technical Radiological Emergency Response Plan (SCTRERP), Section B.IV.A, identifies Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia as signatories to SMRAP.

23 The Nuclear Radiological Annex of the NRP supersedes the FRERP

[C.3] SCTRERP Section B.IV.D states that DHEC maintains a mobile radiological laboratory, equipped with radio communications on the statewide DHEC network, and has emergency response supplies and instrumentation. The mobile lab can be dispatched to an accident site to perform radiological monitoring and field sample analyses, and has the capability to detect and measure radioiodine concentrations and other radionuclides in the environment, as described in SCTRERP Appendix II, "Environmental Monitoring, Sampling, and Laboratory Analysis Capability." Appendix II, Section III.C, states that environmental samples will be transported to the radiological laboratory in Columbia or to the mobile lab deployed in the field at the discretion of the Nuclear Response and Emergency Environmental Surveillance Section (NREES) field director or the environmental surveillance coordinator. (See also SER Section 13.3.3.2.8.c.)

[C.4] SCORERP Section V discusses various local, State, Federal, and support agencies and companies that can be relied on for assistance in an emergency. Letters of agreement with the State of South Carolina are provided in Appendices 6 through 12 and include the following entities:

- State of North Carolina
- State of Georgia
- Progress Energy Carolinas, Inc.
- South Carolina Electric & Gas Company
- Duke Energy Corporation
- GPC
- DOE-SR

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[C.1.c] Section VI.B of the county plans includes specific information regarding communication systems and frequencies; Sections VI.A and VI.B list additional special resources available to support Federal response. **[C.2.a]** Section II.G.2 of the county plans states that VEGP and DHEC (Bureau of Radiological Health (BRH or DHEC/BRH)) will furnish technological RER support. **[C.4]** Section I.F of the county plans lists the principal organizations that are part of the overall response organization for EPZs; these include Federal, State, county, and private sector agencies and organizations.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for emergency response support and resources, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard C of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(3) 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.4 Emergency Classification System (10 CFR 50.47(b)(4); NUREG-0654/FEMA-REP-1, planning standard D)

The regulation, as reflected in the planning standard, requires that a standard emergency classification and action level scheme, the bases of which include facility system and effluent parameters, is in use by the nuclear facility licensee, and that State and local response plans call for reliance on information provided by facility licensees for determinations of minimum initial offsite response measures.

In ESP Plan Section D, "Emergency Classification System," the applicant addressed the emergency classification and action level scheme that will apply to VEGP Units 3 and 4. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan against NUREG-0654/ FEMA-REP-1, planning standard D, "Emergency Classification System." Planning standard D provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(4).

The staff also considered the requirements in Sections IV.B and IV.C of Appendix E to 10 CFR Part 50, which require four emergency classes, consisting of notification of unusual events, alert, site area emergency, and general emergency. In addition, the applicant must describe emergency action levels (EALs) that are based on in-plant conditions and instrumentation in addition to onsite and offsite monitoring. The initial EALs must be discussed and agreed on by the applicant or licensee and State and local governmental authorities, and approved by the NRC.

The staff examined the structure of the applicant's proposed emergency classification and action level scheme, the bases for the various emergency declarations, and the extent to which this scheme reflects the AP1000 advanced LWR technology. From the applicant's description, the staff was able to summarize the emergency classification process in the following five general steps:

1. *Initiating Condition* – The emergency classification process begins when an initiating condition (IC) is observed. An IC is a predetermined subset of plant conditions, grouped into six recognition categories (identified below), which indicates either that the potential exists for a radiological emergency or that such an emergency has occurred. The ICs lead to a classification implementing procedure.

2. *Implementing Procedure* – The classification implementing procedure contains the associated threshold values (TVs) for each IC.

3. *Threshold Value* – When a TV is met, an EAL is met.

4. *Emergency Action Level* – When an EAL is met, the event is classified and declared at the appropriate level (i.e., one of the four emergency classification levels (ECLs)).

5. *Emergency Classification Level* – When an event is classified (and an ECL is declared), the seriousness of the event has been determined, and preplanned actions can be taken by onsite and corporate emergency response personnel and by offsite authorities and organizations. (SER Sections 13.3.3.2.9 and 13.3.3.2.10 discuss onsite and offsite actions in more detail.)

In 10 CFR Part 50, Appendix E, Section IV.C, the Commission specifies the following:

> Emergency action levels (based not only on onsite and offsite radiation monitoring information but also on readings from a number of sensors that indicate a potential emergency, such as the pressure in containment and the response of the Emergency Core Cooling System) for notification of offsite agencies shall be described…. The emergency classes defined shall include: (1) notification of unusual events, (2) alert, (3) site area emergency, and (4) general emergency. These classes are further discussed in NUREG-0654; FEMA-REP-1.

[D.1] In ESP Plan Section D, the applicant stated that its emergency plan contains an emergency classification system based on four emergency classes – notification of unusual event, alert, site area emergency, and general emergency. [D.3, D.4] The described emergency classes and the EALs that determine them are agreed on by SNC, the State, and local authorities; officials from these organizations will review the classes annually. The staff finds that these classes are consistent with those in Appendix E to 10 CFR Part 50 and the four classes of EALs in Appendix 1, "Emergency Action Level Guidelines for Nuclear Power Plants," to NUREG-0654/FEMA-REP-1.

[D.1, D.2] In ESP Plan Section D.1, "Classification of Emergencies," the applicant stated that the SNC classification scheme is based on NEI 99-01. In NRC RG 1.101, Revision 4, "Emergency Planning and Preparedness for Nuclear Power Reactors," issued July 2003, the staff endorsed the guidance contained in NEI 99-01 and Revision 2 of NUMARC/NESP-007, "Methodology for Development of Emergency Action Levels," as providing acceptable alternatives to the methods described in Appendix 1 to NUREG-0654/FEMA-REP-1, for developing EALs required by 10 CFR 50.47(b)(4) and Sections IV.B and IV.C of Appendix E to 10 CFR Part 50.[24]

[D.2] In ESP Plan Section D.1, the applicant stated that the ICs lead each plant to a classification implementing procedure, which contains the TVs for each IC. Each IC has specific conditions associated with it that are termed TVs. When an IC is observed and the criteria of its associated TVs are met, an EAL is met, and the event is then classified and declared at the appropriate level. The SNC classification procedures are written to classify events based on meeting the IC and a TV for an EAL. The procedures consider each VEGP unit independently. The staff's summary of the emergency classification process appears above. (The submission of detailed emergency implementing procedures for VEGP Units 3 and 4 is addressed in **Units 3 and 4 ITAAC 9.1**, and further discussed in SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.8, 13.3.3.2.9, 13.3.3.2.10, and 13.3.3.2.16.)

During events, the IC and a TV are monitored, and if conditions meet another higher EAL, that higher emergency classification is declared and appropriate notifications made. **[J.10.c]** Notifications are made on a site-by-site basis. If two or more units are in concurrent classifications, the highest classification would be used for the notification, and the other unit classifications noted on the notification form. (Public notifications are also addressed in ESP

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24 RG 1.101 provides guidance to licensees and applicants on methods acceptable to the NRC staff for complying with the NRC's regulations for emergency response plans and preparedness at nuclear power reactors. RGs are not substitutes for regulations, and compliance with them is not required. Licensees and applicants may propose means other than those specified by RG 1.101 for meeting applicable regulations, including the development of EALs.

Plan Section E, “Notification Methods and Procedures,” and Section J, “Protective Response,” and discussed in SER Sections 13.3.3.2.5 and 13.3.3.2.10, respectively.) **[D.2]** To facilitate the expeditious classification of emergencies, the applicant grouped the ICs that may result in an emergency classification into the following six recognition categories:

- radiological (hot and cold)
- fission product barriers (hot)
- system malfunctions (hot)
- system malfunctions (cold)
- independent spent fuel storage installation (hot and cold)
- hazards (hot and cold)

The hot and cold designations reflect operational modes 1 through 6, defined in the technical specifications, and defueled status. Within each category, subcategories and specific ICs are identified. The detailed IC matrices are shown in the tables in Annex V1, Section D.2, “Classification Process,” for Units 1 and 2, and in Annex V2, Section D.2, “Emergency Class Description and Resources,” for Units 3 and 4. **[D.2]** In addition, Table V2A2-1, “VEGP Units 3 and 4 SSAR Transient Table,” provides FSAR postulated transients (accidents) for various systems and identifies the corresponding emergency levels. **[D.2]** ESP Plan Section D.2, “Classification Process,” identifies the “Classification Emergency Plan Implementing Procedure” as that which will be used to classify the emergency condition upon recognition of an off-normal condition relative to an IC.

[D.1] Unit 3 ITAAC 1.1.1 states that the parameters specified in Table Annex V2 H-1, Post Accident Monitoring Variables, are retrievable in the control room, TSC and EOF, and the ranges of values of these parameters that can be displayed encompass the values specified in the emergency classification and EAL scheme. **Unit 4 ITAAC 1.1.1** limits the ability to retrieve the parameters specified in Table Annex V2 H-1 to the control room. In Section V2H.4.3, “Process Monitoring,” the applicant stated that process variables will be monitored through the qualified data processing system, which is a subsystem of the protection and monitoring system, and will provide safety-related display of selected parameters in the control room.

[A.1.b, B.2] At all times, when conditions arise that are not explicitly included in the EAL scheme, the emergency director has discretion to declare an event based on his knowledge of the emergency classes and judgment of the situation or condition. Once an emergency classification is made, it cannot be downgraded to a lower classification. All the actions associated with the emergency classification level must be completed, and then the event can be terminated. At termination, on an event-specific basis, the site can either enter normal operating conditions or enter a recovery condition with a recovery organization established for turnover from the ERO.

The proposed reactor technology for VEGP Units 3 and 4 is the Westinghouse AP1000 design (see SER Section 13.3.1.2). The design certification for the AP1000 is provided in Appendix D, “Design Certification Rule for the AP1000 Design,” to 10 CFR Part 52. The VEGP application is a first-of-a-kind use of the AP1000 design in an ESP and presents an EAL scheme for an advanced passive LWR that has not previously been submitted to the NRC for evaluation, either for endorsement in a regulatory guide or as part of a license application.

The applicant submitted the VEGP application to the NRC on August 15, 2006. On September 19, 2006, the NRC notified SNC that while the application was acceptable for docketing, it did not contain all of the information necessary for approval of complete and integrated emergency plans. Specifically, the application lacked the identification of, and basis for, EALs. On March 1, 2007, the applicant submitted supplemental EAL information, which consisted of a proposed set of EALs and their associated bases for VEGP Units 3 and 4. The applicant stated that these EALs are based on NEI 07-01. The applicant explained that the VEGP Unit 3 and 4 EALs were the same as those in the NEI 07-01 guidelines (with various exceptions) and that NEI submitted NEI 07-01 to the NRC (for endorsement by RG 1.101) on March 1, 2007. [25]

As discussed above, the applicant stated in ESP Plan Section D.1 that the SNC classification scheme is based on NEI 99-01. In RAI 13.3-3.a (see RAI letter No. 5, dated March 15, 2007), the staff asked the applicant to explain why NEI 99-01 may be used as the basis for the AP1000 EALs – given that NEI 99-01 states in its Executive Summary that the document's generic guidance is not considered to be applicable to advanced LWR designs, and that the AP1000 is an advanced LWR design. In its April 16, 2007, response, the applicant stated that subsequent to the ESP application submittal, the industry developed a set of draft EALs for advanced passive LWRs and that these EALs had been submitted (on March 1, 2007) by NEI to the NRC for endorsement as NEI 07-01. In addition, on March 1, 2007, SNC submitted a set of EALs specific to Units 3 and 4 and based on NEI 07-01,[26] and revised the ESP application to clarify the distinction of the appropriate guidance document for Units 1 and 2 versus Units 3 and 4. Finally, the applicant submitted a revised ESP emergency plan with Revision 2 of the ESP application on May 8, 2007.

In RAI 13.3-3.b, the staff asked the applicant to explain how NEI 07-01 applies to the VEGP application and how it is used in relation to NEI 99-01. The applicant responded that the proposed VEGP Unit 3 and 4 EALs are identical to those in NEI 07-01, Revision 0, with the exception of the elimination of information pertaining to the ESBWR design[27] and the inclusion of appropriate site-specific information. NEI 07-01 will relate to Units 3 and 4, and NEI 99-01 will relate to Units 1 and 2.[28]

As discussed above, NEI submitted NEI 07-01 for NRC endorsement on March 1, 2007. On the same day, the applicant supplemented the ESP application with its separate submission of Units 3 and 4 EALs, based on the guidelines in NEI 07-01. For the VEGP application, the proposed Units 3 and 4 EALs were submitted approximately 6½ months after the initial application. By then, the staff was well into its technical review, which was consistent with the established application review schedule. Separately, the NRC began its formal endorsement

[25] NEI 07-01, which was subsequently revised by NEI and submitted to NRC on September 21, 2007, is currently under review. NEI may change the document's *NEI 07-01* designation, as a result of future revisions during the NRC's concurrence review process.

[26] SNC Letter AR-07-0404, "Vogtle Early Site Permit Application, Supplemental Information Concerning Emergency Action Levels and Generic Communications," March 1, 2007.

[27] *ESBWR* is the General Electric Co. Economic Simplified Boiling Water Reactor, which is an advanced LWR design currently under design certification review by the NRC.

[28] On December 30, 2005, SNC requested prior NRC approval for VEGP Units 1 and 2 EAL changes, in support of a conversion from its current EAL scheme to one based on NEI 99-01 (see NRC safety evaluation report, ADAMS Accession ML071070319).

review of NEI 07-01. Given the applicant's late submission of the proposed EALs, the staff's review of the Units 3 and 4 EALs for compliance with the applicable guidance and requirements was delayed. In the Safety Evaluation Report with open items, the staff identified the review and acceptance of the application's EALs for Units 3 and 4 as Open Item 13.3-4**.**

The staff reviewed the applicant's response to Open Item 13.3-4 in its submittal dated October 15, 2007, which added **Unit 3 ITAAC 1.1.2** and stated that a revised set of EALs for Units 3 and 4 will be provided with Revision 3 of the ESP Application. In its letter dated February 12, 2008, SNC made various revisions to the Units 3 and 4 ITAAC tables, including revising **Unit 3 ITAAC 1.1.2** and added **Unit 4 ITACC 1.1.2**, which both state that an analysis of the EAL technical bases will be performed to verify as-built, site-specific implementation of the EAL scheme, and that the EAL scheme is consistent with Regulatory Guide 1.101 (see SER Sections 13.3.5 and 13.3.6, respectively).

In RAI 13.3-3.b, the staff also asked the applicant how it would incorporate significant changes to NEI 07-01 that may result from the NRC's endorsement review into the EALs for Units 3 and 4. The applicant responded that SNC intends to revise the VEGP Unit 3 and 4 EALs as NEI 07-01 is revised. The applicant would then submit revisions to the ESP Plan or EAL submittal package following NRC endorsement of an approved change to NEI 07-01. Following the issuance of the ESP, SNC would change the ESP Plan in accordance with 10 CFR 50.54(q). Consistent with the applicant's stated intention, the staff has identified as **Permit Conditions 2 and 3** (listed below), the revision of the VEGP EALs for Units 3 and 4, respectively, to reflect the final revision of NEI 07-01. **Permit Conditions 2 and 3** address the extent to which the EALs would reflect the current NEI 07-01 revision at the time the COL application is submitted by an applicant for a COL referencing this ESP.

In RAI 13.3-3.d, the staff asked the applicant to identify specific areas for which EALs cannot be fully developed and submitted before construction of the plant, and therefore must be addressed as ITAAC. In its response, the applicant stated that it identified the areas for which the EALs cannot be fully developed in the March 1, 2007, EAL submittal (i.e., SNC Letter AR-07-0404) and that it expects all areas that are not yet fully developed to be developed before a COL is issued. Thus, no ITAAC are required, and SNC will submit revisions to the EAL scheme as the design details are completed. Consistent with the applicant's stated intention, the staff has identified as **Permit Conditions 4 and 5** (listed below), the submission – by an applicant for a COL referencing this ESP – of a fully developed EAL scheme for Units 3 and 4, respectively, that reflect the completed AP1000 design details, subject to allowable ITAAC.

The staff does not agree with the statements that all (EAL) areas that are not yet fully developed will be developed before a COL is issued, and that no (EAL) ITAAC are required. Numerous EALs require site-specific setpoints, instrument readings, and various thresholds that are dependent upon the as-built reactor. As such, the staff expects that EAL-related ITAAC (in some form) would carry forward from the ESP into the COL, and would be resolved (i.e., the acceptance criteria met) as the reactors are constructed – and prior to fuel load. Thus, all EAL areas would not be fully developed before a COL is issued. Irrespective of this, the addition of **Units 3 and 4 ITAAC 1.1.2** (discussed above) would encompass all as-built, site-specific EAL-related features that are not yet resolved when a COL application (referencing this ESP) is tendered.

The development of a complete EAL scheme is an essential element of review, in relation to the staff's finding of reasonable assurance pursuant to 10 CFR 50.47(a). As such, the staff has identified as **Permit Conditions 6 and 7** (listed below), the completion – by an applicant for a

COL referencing this ESP – of a fully developed set of EALs for Units 3 and 4, respectively, which are based on in-plant conditions and instrumentation in addition to onsite and offsite monitoring, and which have been discussed and agreed on by the applicant or licensee and State and local governmental authorities, and approved by the NRC (see Section IV.B of Appendix E to 10 CFR Part 50). The COL applicant shall include the full set of EALs in the COL application. **Permit Conditions 6 and 7** are subject to the respective **Units 3 and 4 ITAAC 1.1.2**, which permits a limited set of as-built, site-specific EALs to be addressed by and carried forward in the COL as ITAAC. Subject to **Permit Conditions 2 through 7**, the staff finds that SNC's response to Open Item 13.3-4 and subsequent ITAAC revisions are acceptable; and therefore, Open Item 13.3-4 is resolved. (See also SER Section 13.3.4, "Conclusion.")

Permit Conditions

2. An applicant for a combined license (COL) referencing this early site permit shall revise the EALs for Unit 3 to reflect the final revision of NEI 07-01.

3. An applicant for a combined license (COL) referencing this early site permit shall revise the EALs for Unit 4 to reflect the final revision of NEI 07-01.

4. An applicant for a combined license (COL) referencing this early site permit shall submit a fully developed EAL scheme for Unit 3 that reflects the completed AP1000 design details, subject to allowable ITAAC.

5. An applicant for a combined license (COL) referencing this early site permit shall submit a fully developed EAL scheme for Unit 4 that reflects the completed AP1000 design details, subject to allowable ITAAC.

6. An applicant for a combined license (COL) referencing this early site permit shall complete a fully developed set of EALs for Unit 3, which are based on in-plant conditions and instrumentation in addition to onsite and offsite monitoring, and which have been discussed and agreed on by the applicant or licensee and State and local governmental authorities, and approved by the NRC, and shall include the full set of EALs in the COL application. If the EALs are not fully developed, the COL application shall contain appropriate ITAAC for the fully developed set of EALs for Unit 3.

7. An applicant for a combined license (COL) referencing this early site permit shall complete a fully developed set of EALs for Unit 4, which are based on in-plant conditions and instrumentation in addition to onsite and offsite monitoring, and which have been discussed and agreed on by the applicant or licensee and State and local governmental authorities, and approved by the NRC, and shall include the full set of EALs in the COL application. If the EALs are not fully developed, the COL application shall contain appropriate ITAAC for the fully developed set of EALs for Unit 4.

State and Local Emergency Plans [D.3, D.4]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard D of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard D are adequate. The following summarizes the FEMA findings for planning standard D.

a. State of Georgia

[D.3] GA REP–Base Plan, Section VI.G.2, "Incident Assessment," states that it is the policy of the State of Georgia to make precautionary protective action decisions based on in-plant data provided by the facility operator whenever possible. In addition, GA REP–Base Plan, Section VI.G.1, "Emergency Classification and PAGs," states that incidents at fixed nuclear power facilities are classified as one of four separate emergency classifications (i.e., notification of unusual event, alert, site area emergency, and general emergency). **[D.4]** The tables included in Section VI.G.1 outline the conditions under which the facility operator may declare each of the four emergency classes and the resulting offsite response actions to be performed by State and/or local agencies. This emergency classification and action level scheme is consistent with that established by the applicant.

b. Burke County, Georgia

[D.3] GA REP–Burke County Plan, Section IV.4, states that incidents will be reported by class, as defined in NUREG-0654/FEMA-REP-1, Revision 1, and includes a general description of the four emergency classes, which are consistent with those established by the applicant. In addition, Attachment A states that the Burke County EMA Director will initiate emergency operations, including activation of the EAS, consistent with the accident/incident classification. **[D.4]** Consistent with the four classifications, Section IV.A.4 provides a general description of response actions for local responders, and Section IV.B.5 describes detailed response activities.

c. State of South Carolina

[D.3] SCORERP Section IV.A.2 states that, in conformance with NUREG-0654, radiological accidents can be categorized into one of the four ECLs, which are consistent with those of the applicant. **[D.4]** SCTRERP Section B.III, "Emergency Plan Mobilization," and Appendix I, "Protective Action Guides," further discuss ECLs and response actions. Section IV.A.3 states that the ECL determines the degree of licensee, local, and State response, as outlined in Appendix 3, "Emergency Classification Levels." In addition, offsite response will be initiated by State and local forces, as recommended by DHEC and/or the FNF.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[D.3] The county plans state that VEGP has the responsibility for classifying the emergency, in accordance with NUREG-0654, and that State and local emergency management officials will review and certify their agreement with the VEGP EALs annually. Each plan also lists the State and county EALs, which are in agreement with the applicant's EALs. **[D.4]** Section IV.D of the county plans provides detailed State and local emergency actions to be taken, corresponding to the applicant's four emergency classes.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for the emergency classification system, and subject to **Permit Conditions 2 through 7**, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard D of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(4), and Sections III, IV.B, and IV.C of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.5 Notification Methods and Procedures (10 CFR 50.47(b)(5); NUREG-0654/FEMA-REP-1, planning standard E)

The regulation, as reflected in the planning standard, requires that procedures have been established for notification, by the licensee, of State and local response organizations and for notification of emergency personnel by all organizations, the content of initial and follow-up messages to response organizations and the public has been established, and the means to provide early notification and clear instruction to the populace within the plume exposure pathway EPZ have been established.

In ESP Plan Section E, “Notification Methods and Procedures,” the applicant addressed the specific methods and sequencing of notifications that will be covered in the appropriate implementing procedures for VEGP Units 3 and 4 in an emergency. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff’s primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard E, “Notification Methods and Procedures.” Planning standard E provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(5).

[E.1, E.2, J.1, J.2, J.4, J.5] In ESP Plan Section E.1, “Notification of VEGP Personnel,” the applicant stated that the emergency director is responsible for assigning an event to the appropriate emergency class and then notifying onsite and offsite personnel. The primary means for notification of personnel within the protected area is the public address system. Upon declaration of an emergency, the emergency director will order an announcement of the emergency to site personnel. The supervisor of nuclear security will be responsible for notifying the unaffected site units, Plant Wilson, the training center, the visitor’s center, and recreation park staff. All visitors at the visitor’s center will leave the site if directed by the emergency director or if a site area emergency or general emergency is declared. Security will activate the site siren to notify personnel on site, who are outside the protected area, of an evacuation order.

The security department will also be responsible for evacuating all visitors and nonessential personnel from the Plant Vogtle Recreational Park[29] and for verifying the evacuation of all

[29] The Plant Vogtle Recreational Park property, which is owned by Georgia Power Company and located approximately 1 mile southwest of the Vogtle site, is addressed in the Vogtle emergency plan. For purposes of evacuation, persons in the park are considered part of the Vogtle site population.

nonessential personnel from the unaffected site units, Plant Vogtle, Plant Wilson, the training center, and the remaining areas inside the owner-controlled area (OCA). Visitors within the protected area are escorted by a permanently badged individual. This individual is responsible for informing visitors of emergencies and for taking action to evacuate visitors from the site, as necessary.

Before they receive a work assignment, plant and contractor personnel will be trained in actions to be taken in an emergency. The training will include instructions on the methods of personnel notification and the required personnel actions in an emergency. The corporate staff is notified in accordance with EIPs. The corporate duty manager is notified by the Vogtle duty manager, who receives notification from the emergency director. The notification procedure includes notification of offsite ERO personnel. ERO members will be notified by means of an auto-dialer system that is activated by onshift personnel. In addition to those personnel recalled, operations, maintenance, and security personnel required to report will be contacted by onshift personnel from their own respective departments. Warning and evacuating onsite personnel is also addressed in ESP Plan Section J and in SER Section 13.3.3.2.10.

[E.3, E.4, E.7, J.10.c] In ESP Plan Section E.2, "Notification of State and Local Response Personnel," the applicant stated that the emergency director is responsible for the completion of the initial message form (shown in Figure E-1, "Example of initial emergency message for State and local response agencies") and for the notification of the offsite State and county agencies within 15 minutes of the declaration of an emergency. The agencies will be responsible for notifying appropriate response personnel in accordance with their emergency plans and procedures. The ENN, a dedicated telephone system, will normally be used for these notifications. ESP Plan Section F, "Emergency Communications," describes the ENN and backup means of communication (see SER Section 13.3.3.2.6). Figure E-1 presents the sample initial message form for notifying these response centers. This form has been developed in conjunction with appropriate offsite agencies. The initial notification concept is presented in Table E-1, "Initial Notification System—Normal Working Hours," Table E-2, "Initial Notification System—Backshift Hours," and Figure E-1.

[E.1] All notification messages must be verified. When the ENN is used, verification is accomplished by roll call. This is a suitable mechanism, since the ENN is a multiparty, dedicated telephone line. When commercial telephone or radio is used for notification, the called party will contact the site to verify the validity of the message or use the authentication system provided by the SCEMD.

The staff further examined the ability of the applicant to contact the State and local organizations on a 24-hour, 7-day-per-week basis and discusses this in SER Sections 13.3.3.2.1 and 13.3.3.2.6. Public notifications are also addressed in ESP Plan Section J and SER Section 13.3.3.2.10. The staff reviewed other application sections that deal with the availability of 24-hour emergency communications and response, and discusses those reviews in SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.6, 13.3.3.2.8, and 13.3.3.2.12.

[E.1] The staff finds that the applicant has established procedures that describe mutually agreeable bases for notification of response organizations and that those procedures are consistent with the emergency classification and action level scheme in Appendix 1 to NUREG-0654/FEMA-REP-1. These procedures are further described in SER Section 13.3.3.2.4 and are reflected in Figures E-1 and E-2, "Example of NRC Event Notification Worksheet," which would be modified to add the Unit 3 and 4 designations. **[E.3]** In addition, the staff finds that the contents of the initial emergency messages to be sent from the plant contain information about the class of the emergency, whether a release is taking place, the potentially affected population and areas, and whether protective measures may be necessary.

The emergency director is responsible for ordering notification calls to the DOE-SR operations center by the ENN and to the NRC operations center by the ENS, or commercial telephone as backup, within a prescribed time following the declaration of an emergency. Examples of the type of initial emergency message form used to provide the initial notification to the DOE-SR operations center and the NRC operations center event notification form used for NRC notification are shown in Figures E-1 and E-2, respectively. **[E.2]** The establishment of adequate procedures for alerting, notifying, and mobilizing emergency response personnel will be determined upon receipt of those procedures, pursuant to **Units 3 and 4 ITAAC 9.1**, and through review of their use during an exercise, pursuant to **Units 3 and 4 ITAAC 8.1**.

[E.4, E.6] In ESP Plan Section E.4, "Notification of the Public," the applicant stated that it is the responsibility of SNC to provide adequate means for notifying the public or to be assured that such means are provided. In an emergency, State and local agencies are responsible for activating the alert notification system. Administrative and physical means have been established for providing early initial warning and subsequent clear instructions to the populace within the plume exposure pathway EPZ. The alert notification system, except for SRS, is described in Appendix 3, "Means for Providing Prompt Alerting and Notification of the Public," to the ESP Plan. **[E.5]** This system has the capability to complete the initial alert notification of residents within the plume exposure pathway EPZ in about 15 minutes. **[E.4]** Follow-up messages can be delivered to the public by commercial broadcast. If an emergency is declared at the site, DOE-SR has agreed to provide for the prompt notification of all persons at SRS within the VEGP plume exposure pathway EPZ. The staff reviewed Appendix 5, "Memorandum of Agreement with DOE – Savannah River," to the application and discusses the notification methods and procedures associated with DOE-SR in more detail in SER Sections 13.3.3.2.1 and 13.3.3.2.6. **[E.6]** The staff finds that the applicant has established administrative and physical means for notifying and providing prompt instructions to the public within the 10-mile plume exposure pathway EPZ.

[E.1, E.3] The site will provide offsite authorities with supporting information for their messages to the public. Such messages, consistent with the emergency classification scheme, will instruct the public in regard to specific protective actions to be taken by occupants of affected areas. **[E.4, E.7]** The emergency director is responsible for the completion of a follow-up emergency message (see also Figure E-1). The appropriate support coordinator will ensure that the emergency communicator(s) periodically provide follow-up messages to the appropriate offsite Federal, State, and local authorities. **[E.4]** As reflected in Figure E-1, the staff finds that the applicant has made provisions for follow-up messages from the facility to offsite authorities, which contain the appropriate information to support the timely and necessary offsite response. **[E.7]** In addition, as reflected in Figures E-1 and E-2, the staff finds that the applicant has provided adequate supporting information for the written messages intended for the public.

<u>State and Local Emergency Plans</u> [E.1, E.2, E.5, E.6, E.7]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard E of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard E are adequate. The following summarizes the FEMA findings for planning standard E.

a. State of Georgia

[E.1, E.2] GEOP ESF Annex 2 describes emergency telecommunications systems and support and the receipt and dissemination of emergency notifications associated with any large-scale emergency in the State. Section D of GA REP–Annex D lists key local, State, and Federal agency organizations (including telephone numbers); secondary radio systems will be used if the telephone system is unavailable. Section A of Annex D describes the process for notifying various State agencies and activation of the State EOC. Section A.7 states that State radiological program directors in adjacent States will be notified by the most expeditious means possible as soon as practical following a radiological emergency. Information reported (i.e., notification) will be in accordance with the emergency notification form format adopted by the States of Georgia, North Carolina, and South Carolina, and GPC, Duke Power Company, Carolina Power and Light Company, South Carolina Electric and Gas Company, and SRS Operations. The authenticity of messages will be verified using the ENN (in accordance with published procedure) and commercial telephone callback. (Notification and communication links are also addressed in GA REP–Base Plan Section VI.E and SER Section 13.3.3.2.1.)

GA REP–Base Plan, Section VI.G.3.b, “Public Notification,” states that the methods for informing the public in affected area(s) surrounding nuclear facilities are described in the site-specific annexes to the Base Plan. These methods include but are not limited to activation of the prompt notification system (PNS), a system of tone alert radios within the 10-mile EPZ, activation of sirens (Vogtle only), broadcast of emergency information by local electronic media, and door-to-door backup notification by law enforcement personnel. The site-specific annexes also address methods for notifying transient populations.

[E.5, E.6] GEOP ESF Annex 2 describes the warning strategy for notification from the GEMA communications center to the general public about emergency conditions. GEMA will serve as the 24-hour State warning point for receiving and disseminating alerts and warnings to other State agencies, local governments, and the public. **[E.7]** GEMA will disseminate understandable warning messages, which include actions that should be taken. Subsequent advisories will be sent through local and State communication networks to alert local governments and county warning points to changing conditions. GEMA SOP 3-5, “Activation of the Vogtle Electric Generating Plant Prompt Notification System,” lists EAS messages and public information. GEMA staff will request that one of the pre-scripted messages, which will specify the desired message by color code and script name, be broadcast on the NWR. The color codes correspond to messages that include instructions to stand by, shelter, or evacuate, as well as an all-clear and test message.

[E.5, E.6] Section A of GEOP ESF–Annex D states that the general populace will be notified by local and State government of an incident or emergency situation (in accordance with the requirements of NUREG-0654/FEMA-REP-1) and that the affected population within the 10-mile EPZ will be notified promptly in accordance with GEMA SOP 3-5, which describes the notification system and lists messages and public information. The VEGP public notification system is a composite system, consisting of the NWR and VEGP siren system. The NWR is capable of providing an alerting signal and an instructional message; responsibilities and procedures for activating the NWR are addressed in the “Agreement for Operation of a NOAA Weather Radio Transmitter by a Cooperator.” The VEGP siren system complements the public notification system with 47 rotating electronic sirens that are strategically located throughout the 10-mile EPZ. The VEGP siren system may be activated by either the State of Georgia or Burke County and would usually be activated following a request from the State, in conjunction with activation of the NWR.

b. Burke County, Georgia

[E.1] Burke County Plan Attachment G, "Notification and Warning," states in Section D that the VEGP emergency director will notify State and local authorities through the ENN. If the ENN is inoperable, the Burke County EOC will be notified through its 24-hour telephone number. The Burke County EMA radio network will serve as a backup channel between the VEGP EOF and the Burke County EOC. **[E.2]** Attachment A, "Implementation," states that the EMA director will initiate emergency operations in accordance with the incident classification and, if appropriate, activate the EOC and notify emergency response personnel by telephone, radio, pagers, and/or personal contact. The staff will report to the EOC and initiate emergency response activities, consistent with the incident classification. These activities may include recommending protective measures for the health and safety of the affected population. (See also Attachments C and F and Plan Section V.F.) (The county EOC is further discussed in SER Section 13.3.3.2.8.b.)

[E.5] Burke County Plan Section IV.B states that if protective actions are required or the situation warrants, GEMA will activate the PNS, in accordance with GEMA SOP 3-5, and advise the population of actions required. After the PNS has been activated, the EAS (local radio station) will be activated and will provide the public with periodic updates on the emergency status. **[E.7]** Attachment J, "Emergency Information," describes the specific information that will be provided to the public (including transients), which includes alert warnings, emergency information, and specific instructions. The VEGP emergency public brochure will also be made available. (County responsibilities for coordinating emergency operations are discussed in SER Section 13.3.3.2.1.b.)

[E.6] Attachment G states that there is an ENS in the 10-mile EPZ, consisting of tone-alert radio receivers in households and businesses and outdoor sirens. The system will be used to alert the population of a problem at VEGP and to instruct it to turn on radios or televisions for emergency information and instructions. The PNS will provide both an alert signal and an informational (or instructional) message to those within the 10-mile EPZ, within 15 minutes from when GEMA (or Burke County EMA) decides an incident at VEGP warrants activation of the system. Attachment G also addresses notification and evacuation of hunters, fishermen, other sportsmen, and handicapped persons within the 10-mile EPZ.

c. State of South Carolina

[E.1, E.2] SCORERP Section IV.3 states that the ECL determines the degree of licensee, State, and local response, as outlined in Appendix 3, "Emergency Classification Levels." Appendix 3 describes licensee, State, and local actions based on the four ECLs (notification of unusual event, alert, site area emergency, and general emergency). Appendix 1, "FNF Notification Checklist," to Annex A describes the notification and verification process and includes Figure 1, "Emergency Notification Form: Nuclear Facility to State/Local Government," and Figure 2, "Warning Message: SCEMD to State Government." In addition, SCORERP Annex A states that nuclear power plant licensees, in conjunction with State and local emergency management organizations, have established mutually agreeable measures for prompt notification of emergencies, consistent with the ECL scheme discussed in SCORERP Section IV.B.1 and Appendix 3. These measures are designed to provide offsite decision-makers with information on the class of emergency, whether a release is taking place, the potentially affected population and areas, and whether protective actions may be necessary.

[E.5] SCORERP Section IV.B states that to ensure public understanding of emergency protective action instructions, the SCEMD public information officer (PIO) will publish and transmit, immediately upon completion of an EAS message broadcast, a follow-on emergency news release to participating media stations and the South Carolina educational television network (SCETV), which will contain familiar landmark descriptions of all zones where protective actions are required. SCORERP Annex C, "Emergency Public Information Procedures," describes the need to provide direction and control in the dissemination of official statements, information (news releases), and EAS messages by the State during an FNF incident.

[E.6] SCORERP–Part 5 Section IV.B states that alert and notification procedures are designed to inform and instruct the populace in the EPZs and to notify Federal, State, and local RER forces. In the event of an incident at VEGP, the primary means for notifying offsite response forces is the ENN, which is a dedicated ring-down telephone system. Commercial telephone lines and the local government radio (LGR) provide a backup to the ENN. A fixed siren system, NWR, tone-alert radios, and drive-through route alerting are used to alert the public within the 10-mile EPZ. Emergency protective action instructions for the public will be broadcast over the EAS. SCORERP–Part 5, Annex A, "Alert and Notification," describes the siren system and other aspects of alert and notification of the public.

[E.7] SCORERP Section IV.B states that, once the decision is made to activate the siren system and EAS, the State will coordinate siren sounding and EAS activation with participating radio stations (see SCORERP, site-specific section Part 5, "Vogtle Electric Generating Plant"). To ensure public understanding of emergency PARs, the SCEMD PIO will publish and transmit, immediately upon completion of an EAS message broadcast, a follow-on emergency news release to participating media stations and SCETV, which will contain familiar landmark descriptions of all zones where protective actions are required. Descriptions of such landmarks in the VEGP 10-mile EPZ are contained in SCORERP–Part 5, and sample EAS messages are in SCORERP Annex C, Appendix 2. Annex C also describes briefings and frequency, message content, and rumor control.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[E.1] VEGP will provide initial warnings and ECL changes to the county warning point, using the ENN (with commercial telephone as a backup). The State and county warning points, which are staffed on a 24-hour basis, will receive these messages simultaneously. **[E.2]** Each county has procedures in place, which use the county warning points as the initial point of contact. The warning points have procedures that describe verification of incoming messages and identify which personnel and agencies should be contacted.

[E.5] Emergency public information will be issued by the South Carolina spokesperson from the ENC in Waynesboro, Georgia, in coordination with the State, SRS, risk counties, and the licensee. **[E.6, E.7]** Section IV.B of the county plans states that the design objective for warning the population will be to (1) provide both an alert signal to the population throughout sector G-10 (with an informational or instructional message) within 15 minutes after the decision to activate the PNS, and (2) ensure 100-percent coverage of the population within the entire 10-mile EPZ. A special follow-up notification will be made within 45 minutes of the initial notification.

Appendix 2, "Procedures for Alerting and Notifying Residents and Warning Teams of the 10-Mile EPZ," of the counties' plans describes procedures, organizations, and facilities used to alert and notify the populace in the 10-mile EPZ of an emergency at VEGP. In addition, it describes the organizations and personnel involved, including the equipment and backup means for alerting the general population and any transients. Follow-up emergency action messages will be formulated and coordinated by the respective State EOCs and relayed by the State PIO organization at the ENC.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for notification methods and procedures, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard E of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(5) and Sections III and IV.D of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.6 Emergency Communications (10 CFR 50.47(b)(6); NUREG-0654/FEMA-REP-1, planning standard F)

The regulation, as reflected in the planning standard, requires that provisions exist for prompt communications among principal response organizations to emergency personnel and to the public.

In ESP Plan Section F, "Emergency Communications," the applicant described the communication capabilities between the VEGP site and the States of Georgia and South Carolina and affected counties. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard F, "Emergency Communications." Planning standard F provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(6).

In ESP Plan Section F, the applicant stated that the primary means of communication between the site and the States of Georgia and South Carolina, the affected counties, and the SRS is the ENN, which is a dedicated telephone system that is available on a 24-hour, 7-day-per-week basis. The ENN has multiple drops in the EOC for both States, which are staffed on a 24-hour basis. ENN extensions are in the control room, TSC, and EOF, and commercial telephones provide backup communications capabilities. There is also an administrative decision line (ADL) that connects the EOF, SRS operations center, both State EOCs, and the three South Carolina counties. This line is used primarily for decisions on protective actions. In addition, telephone links and alternates exist, including 24-hour-per-day staffing of communications links that initiate emergency response actions.

The communication links are shown in ESP Plan Table F-1, "Emergency Response Communications Summary." The staff reviewed other application sections that deal with the availability of 24-hour emergency communications and response, and discusses those reviews in SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.5, 13.3.3.2.8, and 13.3.3.2.12. **[F.1.a]** The staff finds that provisions exist for 24-hour-per-day notification and activation of the State and local emergency response network.

[F.1] At the ESP site, the emergency director will be in charge of communications with the States, counties, and the SRS. ESP plan Section B.2.1.1, "Emergency Director," states that one of the activities that the emergency director will manage for the duration of the emergency is directing the notification of the site, SNC and GPC personnel and notifying and maintaining open communications with offsite authorities regarding all aspects of emergency response. The State of South Carolina emergency preparedness director will be responsible for communication at the State EOC with the site, the SRS, and contiguous State and local governments. ESP Plan Table A-1, "Responsible Individuals of Primary Response," lists the individuals in charge of emergency response, which include the State Disaster Coordinator for Georgia; the chairman for the Burke County Board of Commissioners; the chairman of the county council for the three South Carolina counties; and the Manager, DOE-SR, for the SRS, located at the SRS operations center. **[F.1.b]** The staff finds that adequate provisions exist for communications with contiguous State and local governments within the EPZs.

[F.1.f] The application included **Unit 3 and 4 ITAAC 3.2**, which state that communications are established from the control room, TSC, and EOF to the NRC headquarters and regional office EOCs, and an access port for ERDS is provided. The primary means of communications between the ESP site and the NRC is the ENS, which is located in the control room, TSC, and EOF. The NRC Region II office in Atlanta, Georgia, may also be connected on the ENS through the NRC in Rockville, Maryland. In addition, the HPN telephone will be available in the TSC and EOF, and the emergency response data system (ERDS), will allow for transmission of plant parameter information to the NRC. The ERDS provides for the automated transmission of a limited data set of selected critical plant parameters. Commercial telephone lines and SNC communications serve as backup to the ENS and HPN. Communications with other Federal EROs will be by telephone. The staff is aware that the notification and communications capability of the NRC Region II office in Atlanta, Georgia, and NRC Headquarters incident response center in Rockville, Maryland, are available on a 24-hour, 7-day-per-week basis and can support the VEGP site. SER Section 13.3.3.2.3 discusses the assistance available from Federal agencies, including coordination and communications among those agencies and with the State and local agencies and VEGP site. **[F.1.c, F.1.f]** Thus, the staff finds that adequate provisions exist for communications with Federal EROs and between the VEGP site and the NRC.

[F.1.a-e] In ESP Plan Section F.5, "Communications among VEGP Emergency Response Facilities," the applicant stated that communications among the control room, TSC, OSC, and EOF will entail the use of dedicated telephone circuits, normal plant telephones, and radio over the plant network. The radio system will also be used for communications with the radiological monitoring teams. In addition, ESP Plan Section F.5 lists the specific communications available at each of the applicant's facilities. **Unit 3 ITAAC 3.1** states that communications are established between the control room, OSC, TSC, and EOF; between the control room, TSC, and [listed offsite agencies]; and between the [proposed common] TSC and radiological monitoring teams. **Unit 4 ITAAC 3.1** is the same, except for communications between the TSC and offsite agencies, which has already been established by **Unit 3 ITAAC 3.1**.

[F.1.d, F.1.f] In ESP Plan Section F.9, "VEGP Radiological Monitoring Teams," the applicant stated that in-plant monitoring teams will communicate with the health physics (HP) or OSC communicator at least every half hour and that field monitoring teams will communicate with the EOF or TSC communicator. Multiple radio frequencies will be used for communications with monitoring teams. Transmitters and antennas are located throughout the OCA for field monitoring teams and the in-plant monitoring teams. The field monitoring team radio covers the entire plume exposure pathway EPZ. Remote stations for communicating with the field monitoring teams are located in the TSC and EOF.

[F.1.e] As described in ESP Plan Section E and discussed in SER Section 13.3.3.2.5, onsite personnel at the ESP site will be notified through a combination of public address system announcements, tone signals, and proceduralized telephone calls. After normal working hours, site personnel not on site at the time of the emergency will be notified by beeper (for plant management) or by telephone call using an auto-dialer system.

[F.2] In ESP Plan Section F.6, "Medical Support Facility Communications," the applicant stated that communications with Columbia Doctors Hospital and the Burke County Hospital are by commercial telephone. Radio contact through the Burke County EOC serves as a backup. The Burke County ambulance service is equipped with a radio for communications with the hospitals. The ambulance service and hospitals within the State are interconnected in a statewide hospital radio network. The site is able to communicate with the ambulances by contacting the hospitals, which have radio communications with the ambulances. The staff finds that a coordinated communication link exists for fixed and mobile medical support facilities.

[F.3, H.10, N.2.a] In ESP Plan Section F.8, "Communications Systems Tests," the applicant stated that communication channels with the State, counties, SRS, and the NRC are tested monthly from the control room, TSC, and EOF. Communications systems that link the control room, TSC, EOF, State EOCs and GEMA FEOC, county EOCs, and SRS EOC are tested quarterly. The system for communicating between the TSC, EOF, and the site field monitoring teams is tested quarterly.

Communications procedures and systems are tested biennially during a communications drill. This drill is normally conducted during the biennial exercise. The ERDS computers are tested quarterly. **[H.10, N.2.a]** In ESP Plan Sections H and N (discussed in SER Sections 13.3.3.2.8 and 13.3.3.2.14, respectively), the applicant further addressed the operational checks and testing of emergency equipment and instruments, which include emergency communications systems. The staff finds that the applicant has adequately provided for periodic testing of the entire emergency communications system.

<u>State and Local Emergency Plans</u> [F.1.a-e, F.2, F.3]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard F of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard F are adequate. The following summarizes the FEMA findings for planning standard F.

a. State of Georgia

[F.1.a, F.1.b] GEOP ESF Annex 2 states that the GEMA communications center serves as the 24-hour State warning point for receiving and disseminating alerts and warnings to other State agencies, local governments, and the public. GEMA coordinates with appropriate agencies and organizations to ensure operational readiness before, during, and after an emergency or disaster. This preparation includes maintaining agreements and contracts to ensure equipment and system maintenance on a 24-hour basis. [**F.3]** Alternate communication systems are maintained and tested weekly or monthly. **[F.1.c]** During an incident, GEMA will maintain channels of communication with local and Federal governments to ensure optimal information flow.

[F.1.c] GEOP ESF Annex 2, Section II.B, “Federal Response,” states that when required, the Federal Government will implement the NRP to provide communications support to State and/or local jurisdictions. FEMA operates the Federal National Alert Radio System (FNARS) and has portable radios and a mobile emergency response system that can augment State communication resources. During or in anticipation of an emergency, FEMA is authorized to establish temporary communications and can make these resources available to local and State personnel or other appropriate persons.

[F.1.a, F.1.b] GA REP–Base Plan, Section VI.E, states that when the DNR-EPD radiation emergency coordinator receives a notification call, the coordinator will immediately contact the appropriate radiological response team member by telephone, pager, or Southern LINC radio. (The Southern LINC is a radio/telephone system on the VEGP network.) The private telephone numbers of team members are available to the 24-hour dispatcher for use in notifications. The telephone numbers will be updated quarterly, and all other telephone numbers will be verified during the annual emergency plan review. After alerting and dispatching the response team, the radiation emergency coordinator will notify the appropriate State and Federal agencies by telephone. [**F.1.b, F.1.d]** State DNR field units will be able to communicate with the VEGP EOF on Southern LINC radio or cellular telephone. DNR-EPD personnel will be able to communicate with the FEOC, Burke County EOC, and other State agency units by radio on the ICC and DNR statewide repeater system. The Southern LINC portable radio system may be used for communications between GEMA, DNR-EPD, and Burke County EMA.

[F.1.d, F.1.e] GA REP–Annex D, Sections A and B, state that communications between VEGP and the SOC will be by ENN and/or telephone. In an emergency at VEGP, the plant’s emergency director (or designee) will notify local and State authorities using the ENN, which is located within the GEMA communications center and is staffed 24 hours a day, 7 days a week. The ENN is a dedicated circuit with terminals located at the utility, at the local EOC, GEMA SOC, and FEOC (all are staffed 24 hours), and at the SRS and designated locations in South Carolina (see SER Section 13.3.3.2.6.d). GEMA will notify DNR-EPD and other State agencies. State radiological program directors in adjacent States will be notified as soon as practical following a radiological emergency, and this notification will serve to request necessary assistance through the SMRAP agreement. If a State response element is dispatched to the FEOC, that element will establish communications with the plant and the SOC by ENN or telephone.

[F.2] GA REP–Annex D, Section F, “Medical/Public Health Support,” states that all ambulance services and hospitals within the State are interconnected in a statewide hospital communications network, which also provides communications between hospitals and with local sheriff’s departments. Cellular telephones are identified as backup communications. In addition, local EOCs are able to communicate with medical support providers and local hospitals to coordinate assistance for treatment and radiological monitoring through land-based telephones, radio systems, and the local cellular system.

[F.3] GA REP–Base Plan, Section VII.A.2, “Fixed Nuclear Facility Exercises/Drills,” states that ongoing program activities involving radiological surveillance and emergency preparedness functions carried out by State agencies test and utilize communications equipment on a continuing basis and that drills involving communications and notification are always incorporated as an element of the annual exercise at the FNF. GA REP–Annex D, Section B, also states that, with few exceptions, communications equipment is used daily by the agencies that would be involved in emergency activities. For example, commercial telephones and law enforcement and fire response radio nets are not covered by the periodic testing scheme because of their daily use. The ENN is tested monthly under the licensee's communication testing procedures, and the test results are reported to the NRC.

b. Burke County, Georgia

[F.1.a, F.1.b, F.1.d] Burke County Plan Attachment F states that the primary means of communication among local governments and their department/agency personnel within the 10-mile EPZ are telephone and the radio network link that each department/agency has with the EMA EOC. **[F.2]** Attachment E, "EOC, Emergency Equipment and Service Support," states that common communications for statewide hospital/medical services are also available. If the primary communication links are unavailable, the GEMA statewide radio network and/or sheriff's ICC radio network are available. **[F.1.c]** In accordance with the GEOP, GEMA will assume operational control and will coordinate the response activities of all State and Federal agencies, thus eliminating any requirement for direct contact between Burke County EMA and Federal response agencies. **[F.1.e]** In addition, Attachment A describes how the EMA director will notify personnel of an emergency condition if the Burke County EOC is activated. Attachment C contains private telephone numbers, including pagers and radio channels, and is available to the dispatchers in support of notifications. (The Burke County communication capabilities, including responsibilities and methods of activation of emergency personnel, are also discussed in SER Sections 13.3.3.2.1.b and 13.3.3.2.5.b.)

[F.3] Attachment F also states that the requirements for testing of the EMA and sheriff's/ICC radio networks are minimal because the systems are in daily use, which results in immediate detection of malfunctions and subsequent repair. This also applies to all other Burke County EMA radio networks, which include municipal police, fire departments, hospital/emergency medical service, and city/county public works departments. Attachment K, "Training and Exercises," states that communication drills between Burke County EMA and GEMA will be conducted monthly and that drills between the Burke County EMA and VEGP will be held at least annually.

c. State of South Carolina

[F.1.a, F.1.b, F.1.c] SCORERP Section V.A.4 states that State agencies will provide for a 24-hour notification system with the licensee, the SERT, and the affected counties. In addition, the State will maintain communication with FEMA Region IV and with contiguous States. **[F.1.b, F.2]** SCORERP Section IV.B.10, "Communications," lists the following State radio network communication systems that are available at the SEOC and support communications between primary RER agencies:

- SCEMD lowband very high frequency (VHF) LGR
- South Carolina Department of Public Services/Highway Patrol radio
- Civil Air Patrol highband VHF
- South Carolina DNR highband VHF
- Civil Air Patrol high frequency
- Forestry highband VHF
- Radio Amateur Civil Emergency Services
- SC Law Enforcement Division (SLED) regional and highband VHF
- Palmetto trunk radio

[F.1.b] Communications with the State of Georgia are possible through the following means:

- FNARS
- National Warning System (NAWAS)
- Catawba nuclear station ADL
- Vogtle/SRS ENN
- commercial, satellite, and cellular telephones

[F.1.c] During an FNF incident, communications with Federal response organizations will be conducted using commercial telephones, the FNARS, NAWAS, and SCEMD LGR network. An SCEMD vehicle, equipped with mobile radios and a satellite radiotelephone, will deploy to the JIC as soon as the SEOC is established and will provide backup communication with the SEOC/JIC. **[F.1.d]** Once the VEGP EOF is established, communications will be maintained with the SEOC through the ENN, commercial telephones, SCEMD LGR, and Southern LINC.

[F.1.e] Immediately upon notification of an ECL, the state warning point will relay that notification to the DHEC duty officer, who will verify the ECL and any PARs by callback to the FNF. Subsequent to DHEC contact with the FNF, ECL confirmation will be provided to the SCEMD duty officer (after hours), chief of response and operations, and the SCEMD director. The SCEMD director will determine the requirements for further State and local government response. Organizations to be notified by the state warning point for each ECL are listed in SCORERP Appendix 1, "Supporting Plans and Responsible Organizations." **[F.1.b]** Alert telephone numbers and designated representatives for South Carolina and contiguous State and Federal agencies appear in the SCEMD telephone directory.

[F.3] SCORERP–Part 5, Section IV.B.10.c, states that communications with local governments in the 10-mile EPZ will be tested monthly and with Federal EROs quarterly. Communications between the VEGP site, the State and local EOCs, and field assessment teams will be tested annually.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[F.1.a, F.1.e] Section IV.C of the county plans states that upon declaration of an emergency at VEGP, initial warning and any changes in emergency classifications will be provided to the county warning point by VEGP directly using the ENN, with commercial telephone as a backup. **[F.1.d]** The ENN is a dedicated telephone system connecting the VEGP with the State warning point, SCEMD (SEOC), State of Georgia, SRS, and county EOCs. The ENN is also used for protective action decision-making and to discuss activation of the NWR/EAS public notification system. The State and county warning points are staffed on a 24-hour basis. The primary county communications capabilities include the sheriff's office and department of public safety radio frequencies.

[F.1.b] The communications officer for the county is responsible for coordinating communication activities during a disaster and establishing and maintaining the county emergency radio networks to include communications with municipalities and adjacent counties. The primary and backup systems are VHF, ultra high frequency, and LGR (with telephone device for the deaf), Internet routing information system, mobile communication center, commercial telephone, and Southern LINC. In addition, there is a radio system located in the county EOC that can be used to communicate with other county EOCs or with the State EOC. **[F.2]** Section VI.B of the county plans states that the hospital and EMS can communicate with all other emergency response agencies using radios.

[F.1.e] The county warning point dispatcher will notify the emergency management director, who will then notify key EOC staff and either place them on standby or mobilize them to activate the ERO. Annex B of the county base plans states that when alerted by appropriate authority, the communications officer will notify the emergency communications staff and assist the warning officer in alerting other necessary emergency staff. Appendix 2 to the county plans contains a list of key personnel to be contacted.

[F.1.c] The State of South Carolina secures Federal assistance and support through FEMA and through letters of agreement with other State and Federal agencies. Offsite Federal support will be requested only by the State, and Federal agency communications will be coordinated through the State. **[F.3]** Communications between VEGP, the counties, and SCEMD will be tested monthly, and the drills will include the transmission and understanding of emergency messages.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for emergency communications, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard F of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(6) 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.7 Public Education and Information (10 CFR 50.47(b)(7); NUREG-0654/FEMA-REP-1, planning standard G)

The regulation, as reflected in the planning standard, requires that information be made available periodically to the public concerning notification methods and initial actions it should take in an emergency (e.g., listening to a local broadcast station and remaining indoors), that the principal points of contact with the news media for dissemination of information during an emergency (including the physical location or locations) be established in advance, and that procedures for coordinating dissemination of information to the public be established.

In ESP Plan Section G, “Public Information and Education,” the applicant provided a general description of the public education and information program for the VEGP site. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff’s primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard G, “Public Education and Information.” Planning standard G provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(7).

[G.1-G.5, G.4.c, J.10.c] In ESP Plan Section G, the applicant stated that the detailed planning for public information actions during an emergency, including rumor control, is contained in ESP Plan Appendix 8. (Public alerting and notification during an emergency are addressed in ESP Plan Section J and discussed in SER Section 13.3.3.2.10.) **[G.1, B.7.d]** In addition, GPC and SNC, in coordination with State and local officials, will provide information to the public at least annually regarding how it will be notified and what actions it should take in an emergency. All materials used to provide emergency planning information to the public (information brochures, advertisements, signs and notices, etc.) will be reviewed annually by GPC and SNC. **[G.2]** All materials will be updated, as necessary, and printed material distributed annually.

[G.1, G.2] The means for disseminating this information include information on siren poles, signs, notices in public areas, and publications distributed at least annually. Information is distributed annually to residents in the plume exposure pathway EPZ through the use of emergency information communication publications. In addition, ESP Plan Section G lists numerous subjects that are addressed in the various publications, including but not limited to the following:

- educational information on radiation
- contact for additional information
- protective measures
- special needs of the handicapped

[G.2] SNC operates a visitor's center on site, which is staffed with public information personnel who provide education programs to the community and any other visitors. These programs typically focus on plant operational concepts, plant safety considerations, and radiation. In ESP Plan Section G.1, "Information for Transients," the applicant stated that signs and notices providing information to transients are placed in public recreation areas, as well as other public places in the plume EPZ, such as siren poles, the VEGP visitor's center, and commercial establishments (e.g., motels, restaurants, and gas stations). This material will include the following information:

- how people will be warned of an emergency
- what to do if warned of an emergency
- a list of radio and television stations that will provide more information

[G.2] Finally, a Vogtle emergency information brochure will be made available within the EPZ to transients at commercial establishments, churches, motels, hunting clubs, the Creek and Cawden Plantations, the VEGP visitor's center, and through residents whose land is used by nonresidents (e.g., the occasional nonresident hunter). Outside the EPZ, the brochure will be made available to timber company offices for distribution to their employees who enter the EPZ on company business and to the Waynesboro office of the Agricultural Stabilization and Conservation Service for distribution to farmers who farm, but do not reside, in the EPZ.

The staff reviewed the various emergency information communication publications, including the 2006 Plant Vogtle Emergency Information Calendar. The staff finds that the applicant has adequately provided for the dissemination of information to the public regarding how it will be notified and what its actions should be in an emergency, including the establishment of a public information program that provides the permanent and transient adult population within the 10-mile plume exposure EPZ with an adequate opportunity to become aware of the information annually.

[G.3.a, B.7.d, H.2] In ESP Plan Section G.2, "Emergency News Center Operations," the applicant stated that the ENC will be the principal point of contact with the news media during an emergency. **[G.3.b]** The ENC will accommodate public information representatives from SNC and GPC and local, State, and Federal response agencies. News releases and media briefings will be coordinated to the maximum extent possible. GPC will utilize the corporate headquarters building in Atlanta, Georgia, to serve as a temporary information center until the ENC in Waynesboro (Burke County Office Park) is activated. Once activated, the ENC becomes the principal location for dissemination of information about the emergency. The facility, located approximately 15 miles from the plant, can accommodate a large number of reporters. While the ENC is referred to as the joint media center in offsite agency emergency plans, both titles refer to the same facility.

The staff finds the location of the ENC acceptable because it is near the VEGP site and outside of the 10-mile plume exposure pathway EPZ. In general, a licensee has the option but is not required to establish the EOF as its location for dissemination of information to the public during an emergency. As the applicant stated in ESP Plan Annex 7, Section A7D, “Emergency Facilities and Equipment,” SNC maintains a common EOF in Birmingham, Alabama, that serves as the EOF for all SNC sites, including the VEGP site. The staff finds that the VEGP ENC location is appropriate. The ENC is also addressed in ESP Plan Sections B and H, which are discussed in SER Sections 13.3.3.2.2 and 13.3.3.2.8, respectively.

[G.4.a, B.7.d] Principal GPC and SNC contacts for the media will be the public information director and the designated company spokesperson. The company spokesperson position is filled by individuals who, under normal operations, hold supervisory positions on the SNC corporate or plant staff and are technically and professionally qualified to perform this function. The company spokesperson has access to all information and telephone contact with the emergency director. He briefs the media on plant status and company emergency activities, and technical briefers are available to provide general and background information to reporters at the ENC. In addition, press kits are available at the ENC and corporate headquarters in Atlanta, Georgia, and an emergency Web page has been developed on the GPC Internet site, which will be activated in the event of an emergency. The Web page includes plant schematics, background information, and directions to the ENC. News releases about the event would also be available there.

[G.4.b, B.7.d] GPC and SNC will provide timely and accurate information to local, State, and Federal agencies and will seek reciprocal information from these agencies. Efforts will be made to coordinate periodic press briefings and to issue public statements in conjunction with these government agencies. A joint public information center operation at the ENC will provide ample opportunity for all parties represented to review all information before its public release.

[G.4.c] Rumors will be controlled by providing timely, accurate, and consistent information to the public and by having a single source of information. To dispel rumors in an emergency, a rumor control network will be activated. News media will be monitored to detect and respond to misinformation. The public will be instructed to listen to radio or TV. Offsite information is the responsibility of offsite agencies; however, rumor control will be coordinated between the States, SNC, and GPC. The States, SNC, and GPC provide information jointly to the rumor control desk at the ENC. Specific policies and practices for addressing rumors are presented in ESP Plan Appendix 8. The staff finds that the applicant has established coordinated arrangements, which are adequate for dealing with rumors.

[G.5] In ESP Plan Section G.5, “Media Education,” the applicant stated that GPC will offer an annual program to acquaint the news media with the method for obtaining information about overall emergency preparedness at VEGP. Training will include information about the plant, radiation, and the role of the ENC. This program was also described in ESP Plan Appendix 8, Section P.2, “News Media Training.” The staff reviewed ESP Plan Appendix 8 and finds that it is consistent with the applicant’s descriptions in ESP Plan Section G. The ENC and Appendix 8 are also addressed in ESP Plan Sections B and H, which are discussed in SER Sections 13.3.3.2.2 and 13.3.3.2.8, respectively.

<u>State and Local Emergency Plans</u> [G.1, G.2, G.3.a, G.4, G.5]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard G of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard G are adequate. The following summarizes the FEMA findings for planning standard G.

a. State of Georgia

[G.3.a, G.4.b] GA REP–Annex D, Section C, "Public Affairs," states that when the SOC in Atlanta has been activated, only the public affairs director (or designee) will be authorized to issue news releases. Before its release, all information will be coordinated to the fullest extent practicable with the utility (i.e., SNC) and State of South Carolina. If subsequent activation of the State FEOC should be required, that facility will assume the primary command and control role for the State, including all public affairs activities. If a joint media center is established among the States of Georgia and South Carolina, Burke County EMA, and the utility, all public affairs activities will be coordinated there by the designated GEMA public affairs director. The near-site joint media center will be in the Burke County Office Park in Waynesboro, Georgia. In the event that the SOC or FEOC is not activated (e.g., for a minor incident), news releases may be handled by either the DNR-EPD radiation emergency coordinator or DNR PIO, in conjunction with the public affairs office.

[G.4.a, G.4.b] GA REP–Base Plan, Section VI.I, "Public Affairs," states that the GEMA director is the sole releasing authority for news releases and other information to the news media and public after the Governor has declared a state of emergency. All news releases (or other information) must be coordinated with all appropriate agencies. The State must coordinate with the utility. Each public affairs officer must restrict his releases to information concerning his jurisdiction, and a county public affairs officer must restrict his information to that concerning his county. GA REP–Annex D, Section C.1, "Control Over News Releases," states that when the SOC has been activated, only the public affairs director (or designee) will be authorized to issue news releases. Before its release, all information will be coordinated with the utility and the State of South Carolina. If subsequent activation of the State FEOC is required, that facility will assume the primary command and control role for the State, including all public affairs activities.

[G.4.c] GEOP ESF Annex 15, "External Affairs," states that the function includes a provision for ensuring that information on actions to be taken by local and State governments and the public is clear, concise, and accurate. Every effort shall be made to prevent and counter rumors and inaccurate information. The appropriate local, State, and congressional officials will be notified of the status of response and recovery activities and will be assisted with constituent inquiries. **[G.1, G.2, G.4.c, G.5]** News media training, and the dissemination of emergency information to the public, including rumor control, are addressed in Attachment J, "Emergency Information," of the Burke County Plan (discussed below).

b. Burke County, Georgia

[G.1] Burke County Plan Attachment J states that emergency information is classified into two broad categories. The first is pre-emergency information used to educate the citizens about

Plant Vogtle and, in general, the protective actions to take if there is an accident at the plant. The second is actual emergency information issued in response to a confirmed incident, which provides the public with specific information regarding necessary protective actions. **[G.2]** Working jointly, the utility PIOs and GEMA and Burke County EMA public affairs officers will coordinate the preparation of emergency information material to be distributed (at least annually) to residents in the 10-mile EPZ. The information will address topics such as the nature of radiation, where to obtain more detailed information, notification procedures, protective actions, identification of evacuation zones and routes, and location of reception and care centers. The material will be mailed and/or delivered by SNC personnel to each household, including to handicapped persons who have been issued tone-activated radios.

[G.2] Transients in the Burke County portion of the EPZ will be informed through the use of posted signs at strategic locations within the EPZ, such as commercial establishments, gas stations, churches, public recreation areas, the VEGP visitor's center, and the Augusta office of the Agricultural Stabilization and Conservation Service. The Vogtle emergency public brochure will also be available within the EPZ to transients at commercial establishments, churches, motels, hunting clubs, the VEGP visitor's center, and through residents whose land is used by nonresidents (e.g., the occasional hunter). The brochure will also be provided to timber company offices outside the 10-mile EPZ, for distribution to employees who enter the EPZ, and to the Agricultural Stabilization and Conservation Service for distribution to farmers who farm, but do not reside, in the EPZ.

[G.3.a, G.4.a, G.4.b] Attachment J further states that in the event of an incident at the plant that threatens the offsite population, the designated point of contact for the news media is the Joint Media Center, located at Burke County Office Park in Waynesboro, Georgia. From this location, the public affairs and PIOs from State, local EMA, and the utility will carefully coordinate, approve, and disseminate information regarding the incident through regularly scheduled press conference releases. These news releases will be generated by a PIO located in the FEOC. Technical content and emergency instructions from local and State input will be approved for release by signature from the FEOC chief and the radiation emergency coordinator. Coordination with the County PIO representative and/or EMA director and the utility will also occur before the information is released. Should the incident occur before ENC activation, this sequence of events will transpire at the SOC in Atlanta, Georgia. To facilitate dissemination of accurate information to the public, written messages keyed to specific types of incidents will be prepared in advance of an actual emergency. These pre-scripted messages will include instructions regarding sheltering, evacuation, and other protective actions. Copies of the messages will be included in a package for the EMA director and PIOs and will be disseminated to the public through EAS (local radio station) broadcast, when appropriate. All EAS messages will be coordinated with the State and utility before their release.

[G.4.c] Rumor control measures will be initiated through a coordinated effort by officials from the State, local EMA, and the utility at the joint media center. A telephone number provided for public use will enable concerned citizens to receive accurate and reliable information. Coordination will be maintained with the broadcast media to keep the public advised of the emergency situation. **[G.5]** Attachment J to Section D states that the news media will be invited to participate in the VEGP emergency exercises to acquaint the media with emergency planning, organization, and execution of emergency response operations. A training and orientation program will be conducted annually to keep media personnel informed of their roles during an actual emergency. (SER Section 13.3.3.2.15 discusses this training in more detail.)

c. State of South Carolina

[G.1] SCORERP Annex C, “Emergency Public Information Procedures” (Appendix 1), states that DHS and FNF public information organizations will provide the following staff, information, and materials in support of program activities:

- identification of possible types of incidents
- means of public alert and notification
- actions for self-protection
- sources of additional information
- information relating to local, State, and FNF response plans
- information relating to special population segments
- annual media workshops [G.5]
- State-prepared and other publications

[G.2] Section IV.G of Appendix 1 states that information will be disseminated to the transient population by providing educational materials at appropriate locations, including facility visitors centers, motel/hotel lobbies, train stations, parks, campgrounds, and recreation and other public areas. The responsibility for reviewing, auditing, and information content is delegated to the licensee.

[G.4.a] SCORERP Annex C states that if the SEOC is activated as a result of an FNF incident, the Governor’s press secretary (or designee) will address issues regarding public safety and State response. Unless announced otherwise, the press secretary will assume responsibility for coordination of State emergency public information. Only the press secretary or public information director will be authorized to issue news releases on behalf of the State. The State public information coordinator will coordinate public information and EAS activities at the SEOC and will communicate/coordinate with the public information director at the JIC. (Annex C, Section V.D.5, lists the JIC location as the Burke County Office Park in Waynesboro, Georgia.) Public information releases originating from the SEOC will be coordinated with, and approved by, the Governor’s press secretary (or designated representative).

[G.3.a, G.4.b] SCORERP Annex C, Section III.B, “Coordination,” states that designated spokespersons of Federal, State, and local governments and the affected facility will coordinate JIC policy, scheduling of formal media briefings, and the preparation of joint news releases. Statements of releases will be coordinated with the designated spokespersons of other principal organizations. Formally scheduled briefings will provide the media with periodic updates. Additional information will be released as it becomes available or as needed to clarify misinformation and rumors. Annex C, Section IV.A.1, states that the SCEMD public information director will be the designated representative.

[G.4.c] SCORERP Annex C, Section III.C, “Rumor Control,” states that rumor control helps ensure that misinformation is corrected and that a line of direct communication is established with the public. Detection of rumors (or inaccurate/incomplete information) may occur through interactions with utility and/or State rumor-gathering activities, State and local agencies and their EOCs, JIC operations, reception/shelter facilities, media, or Internet, or directly with the public. The State responds to rumors by gathering accurate and timely information, by coordinating it with all responding sources, and by using media and person-to-person communication to disseminate accurate and timely information.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[G.1, G.2] Section IV.E, "Public Information," of the county plans references the SCORERP (discussed above) for the dissemination of information to the public during an emergency at VEGP. The counties will provide for the preparation and prompt dissemination of official information, instructions, and directions to the public before, during, and after disasters. **[G.3.a]** Appendix 2.II.D, "Public Information," of the Aiken and Barnwell County Plans states that emergency public information will be issued by the South Carolina spokesperson from the ENC in Waynesboro, Georgia, and will be in coordination with the State of South Carolina, SRS, risk counties, and GPC.

[G.4.a, G.4.b, G.4.c] The counties rely on the State and its resources for all public information. Section IV.E of the county plans instructs the county PIO to issue press releases and conduct timely news conferences. If a JIC is needed, the counties will coordinate with other public information agencies/representatives to ensure information consistency. The PIO is responsible for monitoring the accuracy of media reports (e.g., relating to rumor control) and will support the efforts to collect, process, report, and communicate essential information. [G.5] Annual workshops for the news media will be conducted by the State and the FNF.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for public education and information, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard G of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(7), 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.8 Emergency Facilities and Equipment (10 CFR 50.47(b)(8); NUREG-0654/FEMA-REP-1, planning standard H)

The regulation, as reflected in the planning standard, requires that adequate emergency facilities and equipment to support the emergency response be provided and maintained.

In ESP Plan Section H, "Emergency Facilities and Equipment," the applicant described the ERFs and the equipment that will be used for accident assessment and monitoring functions following the declaration of an emergency. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard H, "Emergency Facilities and Equipment." Planning standard H provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(8).

[H.1] In Section H, the applicant stated that following the declaration of an emergency, response activity will be coordinated at a number of ERFs, which include the TSC, OSC, EOF, and ENC. In ESP Plan Section H.1.1, "Technical Support Center (TSC)," the applicant stated that the TSC will be established consistent with NUREG-0696, and as described in Section H.1, "Emergency

Facilities." The TSC will be located in the lower level of an administration building sited between the Unit 2 and 3 power blocks within the VEGP site protected area, as shown in Figure ii, "Vogtle Electric Generating Plant Site Plan." **Unit 3 ITAAC 5.1.1** states that the TSC has at least 2175 square feet of floor space. The TSC will be designed to withstand plant design-basis earthquakes and high winds. The layout of the proposed TSC is shown in Figure H-1, "VEGP TSC Layout." The TSC manager will direct operations at this facility.

The TSC will be common to all four VEGP units and will accommodate the required personnel to support an event at any (or all) of the four VEGP units. In addition, **Unit 3 ITAAC 5.1.4** states that the TSC is located within the [VEGP] protected area, and no major security barriers exist between the TSC and the control room. **Unit 3 ITAAC 5.1.5** states that the OSC is located adjacent to the passage from the annex building to the control room. Support facilities will be located within the TSC to support long-term operation of the TSC. Technical and operational data and information will be available for all units within the TSC. ESP Plan Section H lists the various documents and records that will be maintained in the TSC and will be needed to respond to an emergency.

The applicant has proposed a common TSC for Units 1 through 4. The common TSC will be located in the lower level of an administration building, sited between the Unit 2 and 3 power blocks within the VEGP site protected area. In contrast, the AP1000 certified design (see Appendix D to 10 CFR Part 52) provides that each reactor (i.e., Units 3 and 4) will have a separate TSC in the annex building. The staff did not address the difference in the TSC location between the proposed common TSC and the certified design. Therefore, a COL applicant that references both the AP1000 certified design and the Vogtle Units 3 and 4 ESP, must resolve the difference in TSC location. The staff has identified as **Permit Condition 8** (listed below), the resolution of the difference between the Vogtle Units 3 and 4 common TSC, and the TSC location specified in the AP1000 certified design.

<u>Permit Condition</u>

8. An applicant for a combined license (COL) referencing this early site permit shall resolve the difference between the VEGP Units 3 and 4 common Technical Support Center (TSC), and the TSC location specified in the AP1000 certified design.

In regard to the applicant's proposed common TSC location, the staff considered the applicable guidance in NUREG-0696, which states the following in Section 2.2, "Location":

> The onsite TSC is to provide facilities near the control room for detailed analyses of plant conditions during abnormal conditions or emergencies by trained and competent technical staff. During recent events at nuclear power plants, telephone communications between the facilities were ineffective in providing all of the necessary management interaction and technical information exchange. This demonstrates the need for face-to-face communications between TSC and control room personnel. To accomplish this, the TSC shall be as close as possible to the control room, preferably located within the same building. The walking time from the TSC to the control room shall not exceed 2 minutes. This close location will facilitate face-to-face interaction between control room personnel and the senior plant manager working in the TSC. This proximity also will provide access to information in the control room that is not available in the TSC data system.

Provisions shall be made for the safe and timely movement of personnel between the TSC and the control room under emergency conditions. These provisions shall include consideration of the effects of direct radiation and airborne radioactivity from in-plant sources on personnel traveling between the two facilities. Anti-contamination clothing, respiratory protection, and other protective gear may be used to help protect personnel in transit. The 2-minute travel time between the TSC and the control room does not include time required to put on any necessary radiological protective gear, but it does include the time required to clear any security checkpoints. There should be no major security barriers between these two facilities other than access control stations for the TSC and control room.

The staff had previously considered the "2 minute walking time" criterion associated with the TSC location as part of the development of the emergency planning ITAAC addressed in SECY-05-0197.[30] In relation to the TSC location, ITAAC acceptance criterion 5.1.2 of SECY-05-0197 includes the statement that "[t]he COL applicant will adopt design certification criteria, if applicable, or otherwise specify TSC location." The equivalent ITAAC acceptance criterion 8.1.2 of the SRP (Table 14.3.10-1) and RG 1.206 (Table C.II.1-B1) added a statement that "[a]dvanced communication capabilities may be used to satisfy the two minute travel time."

The staff evaluated various factors in determining the appropriateness and acceptability of providing flexibility relating to the 2-minute walking time between the TSC and control room in the guidance document, including the advances in communication technologies since NUREG-0696 was published in 1981. In addition, having a common TSC that supports multiple reactor units and is located a moderate distance (i.e., more than 2 minutes) from the control rooms presents distinct advantages. These advantages include the increased efficiency of a centralized point of support for the entire site, the elimination of confusion regarding which TSC on a multiple-unit site would be staffed during an emergency, not having to staff multiple TSCs if an incident involved more than one unit, and consideration of security-related events. From a support and functional standpoint, the staff finds that the applicant's proposed TSC location is acceptable, subject to a demonstration of adequacy during the full participation exercise (addressed in **Unit 3 ITAAC 8.1**).

ESP Plan Section H.1.1 also states that the TSC will provide plant management and technical support personnel (including five NRC personnel) with a facility from which they can assist plant operating personnel located in the control rooms during an emergency. The emergency director and NRC director will be located next to each other to ensure proper communications. Unit 3 **ITAAC 5.1.2** states that communication equipment is installed in the TSC and OSC, and voice transmission and reception are accomplished. **[I.5]** The TSC will be equipped with a computer system, which provides source term and meteorological data and technical data displays to allow TSC personnel to perform detailed analysis and diagnosis of abnormal plant conditions, including assessment of any significant release of radioactivity to the environment. **Unit 3 ITAAC 5.1.3** states that the plant parameters listed in Table Annex V2H-1, Post Accident Monitoring Values, can be retrieved and displayed in the TSC. In addition, the TSC will have ready access to plant records. The TSC structure and ventilation system will be designed to ensure that TSC personnel are protected from radiological hazards.

30 SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria," October 28, 2005. (See also the associated February 22, 2006, Staff Requirements Memorandum.)

Unit 3 ITAAC 5.1.6 states that the TSC ventilation system includes a high-efficient particulate air (HEPA) and charcoal filter, and radiation monitors are installed. The ventilation system will be designed to maintain exposures to occupants at or below 5 rem whole body, 30 rem to the thyroid, and 75 rem skin dose for 30-day occupancy. The TSC ventilation system will be operated in accordance with EIPs and will be manually controlled from the TSC. (The submission of detailed emergency implementing procedures for VEGP Units 3 and 4 is addressed in **Units 3 and 4 ITAAC 9.1**, and in SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.4, 13.3.3.2.9, 13.3.3.2.10, and 13.3.3.2.16.) Portable radiation monitors will be available for personnel in transit from the TSC to other areas, and portable air breathing apparatus and anticontamination clothing will also be provided in the TSC.

In addition, **Unit 3 ITAAC 5.1.7** states that a reliable and backup electrical power supply is available for the TSC. Lighting will be powered by the normal and redundant electrical supply system. An emergency battery-operated lighting system will be installed. Power for vital information systems will be provided by redundant power supplies including a battery-backed uninterruptible power supply system.

[H.4] In ESP Plan Section H.3, "Activation and Staffing of Emergency Facilities," the applicant stated that during the initial stages of an emergency, activities at VEGP are directed from the applicable control room. For a notification of unusual event, no other facilities need be activated. For security-related events, the activation of emergency facilities may be delayed, as described in ESP Plan Section B, which is discussed in SER Section 13.3.3.2.2. (Facility activation is also addressed in ESP Plan Section A and in SER Section 13.3.3.2.1.) Upon declaration of an alert or higher level classification, the TSC will be activated and will be operational within about an hour of the initial notification. (The staffing of the TSC, in regard to onshift staff augmentation time, is discussed in SER Section 13.3.3.2.2.)

Activation of the appropriate OSC will be initiated at an alert or higher level classification, and the OSC will be operational within about an hour of initial notification. **Unit 3 ITAAC 5.1.5** states that the OSC is located adjacent to the passage from the annex building to the control room. The description of the OSC for existing Units 1 and 2 appears in Section V1H.1.2, "Operations Support Center (OSC)," of Annex V1, and the description of the OSCs for proposed Units 3 and 4 appears in Section V2H.1, "Emergency Facilities," of Annex V2. **[H.2, H.9, H.11]** In Table A4-4, "OSC Emergency Equipment (Typical)," the applicant listed the available supplies in the OSC.

[A.1.b, A.4, B.6, B.7, F.1.a, H.2, H.4] In ESP Plan Section H.1.3, "Emergency Operations Facility," the applicant stated that the EOF is described in Appendix 7. Figure A7-2, "EOF Layout," shows that the EOF consists of several rooms and identifies the location of various emergency response functional areas. The staff reviewed Appendix 7 and finds that it describes the applicant's existing EOF, including the facility's ability to support an emergency associated with VEGP Units 3 and 4. In addition, the staff verified that Appendix 7, supplemented by the various descriptions of the EOF in the VEGP Plan, describes the EOF emergency preparedness and response activities, consistent with NUREG-0696. Specifically, the staff finds that the applicant adequately addressed the following EOF requirements:

- function
- location, structure, and habitability
- staffing and training
- size

- radiological monitoring
- communications
- instrumentation, data system equipment, and power supplies
- technical data and data system
- records availability and management

The EOF and Appendix 7 are also addressed in ESP Plan Sections A, B, and O, which are discussed in SER Sections 13.3.3.2.1, 13.3.3.2.2, and 13.3.3.2.15, respectively.

[H.2] Evaluation and coordination of licensee activities, including how the licensee will provide information to Federal, State, and local authorities, is further addressed in ESP Plan Sections C, F, and G, which are discussed in SER Sections 13.3.3.2.3, 13.3.3.2.6, and 13.3.3.2.7, respectively. **[H.4]** Provisions for the timely activation and staffing of all facilities is discussed in ESP Plan Sections A, B, and I, which are discussed in SER Sections 13.3.3.2.1, 13.3.3.2.2, and 13.3.3.2.9, respectively.

[A.1.b, A.4, B.6, B.7.d, G.1-G.5, H.2, H.4] In ESP Plan Section H.2, "News Center Facilities," the applicant stated that Appendix 8 describes the ENC. In Section A8G.2, "Alert," of Appendix 8, the applicant stated that at the alert level, initial notification will take place, and the public information director will formally activate the emergency communications plan. In addition, the director will activate the ENC and dispatch staff accordingly. VEGP is designed to provide for 24-hour-per-day emergency communications staff coverage in the event of an emergency at the site. The ENC is also addressed in ESP Plan Sections B and G, which are discussed in SER Sections 13.3.3.2.2 and 13.3.3.2.7, respectively.

[H.5, H.6] In ESP Plan Section H.4, "Plant Monitoring and Data Handling Systems," the applicant stated that a description of plant monitoring and data handling systems for existing Units 1 and 2 appears in Annex V1 and a description of plant monitoring and data handling systems for proposed Units 3 and 4 appears in Annex V2. [H.5.a, H.8] In Annex V1, Section V1H.4.1.1, "Meteorological (Applicable for all four VEGP units)," and Annex V2, Section V2H.4.1.1, "Meteorological (Applies to all four units)," the applicant provided information about the meteorological monitoring program in place at the VEGP site, and stated that the methodology to calculate offsite radiological consequences of accidental releases of airborne radioactivity is described in ESP Plan Section I, "Accident Assessment," which is discussed in SER Section 13.3.3.2.9. **[H.6.a]** In ESP Plan Section H.5, "Out-of-Plant Monitoring," the applicant identified Bush Field in Augusta, Georgia, as an additional source of offsite meteorological data. The NWS maintains an automated observation station at the airport which can provide data on windspeed, wind direction, cloud cover, and ceiling height. Information from this automated observation station, as well as forecast information, can be obtained from the NWS in Columbia, South Carolina. The staff finds that the applicant has adequately identified onsite monitoring systems that will be used to initiate emergency measures and the provisions to acquire data from, or to gain emergency access to, offsite monitoring and analysis equipment.

[H.7, H.10] In ESP Plan Section H.5.2, "Radiological Monitoring," the applicant stated that VEGP will have sufficient portable equipment and trained personnel to field three field monitoring teams. Each team will include two people who will obtain an emergency monitoring kit. The kits will include dosimeters, a two-way radio, meters for measuring gamma and beta/gamma dose rates, and air samplers for collecting particulates and iodines. The particulate filter is used in the field primarily to clean the sample so that any activity on the cartridge (silver zeolite or the equivalent) will be iodine. The cartridge is then counted in the field to provide an estimate of airborne iodine concentration. VEGP monitoring teams will remain on the Georgia side of the Savannah River. Radiological monitoring on the South Carolina side of the Savannah River will be conducted by personnel from SRS or the State of South Carolina. These field monitoring teams will be equipped with equipment similar to that used by the VEGP teams. **[H.12]** Results of the offsite monitoring activities will be provided to the TSC until the dose assessment activities are transferred from the TSC to the EOF.

[H.7, H.10] ESP Plan Section H.6, "Emergency Kits," states that emergency kits are located in the TSC, the OSCs, the health physics control points, the EOF, and other plant locations. An ambulance kit will be carried by the VEGP health physics technician who accompanies the ambulance. Procedures require an inspection and operational check of equipment in these kits on a quarterly basis and after each use. Equipment in these kits is calibrated in accordance with the suppliers' recommendations. A set of spares of certain equipment is also maintained to replace inoperative or out-of-calibration equipment. In Annex V1 (Section V1H.1.2) and Annex V2 (Section V2H.1), the applicant stated that emergency kits containing radiation monitoring equipment, first aid and decontamination supplies, breathing apparatus, portable lighting, and hand-held radios are stored in the OSC. **[H.11, F.1.f]** A listing of the typical contents of each kit and the spares is included in Appendix 4. In ESP Plan Sections F and N (discussed in SER Sections 13.3.3.2.6 and 13.3.3.2.14, respectively), the applicant addressed the method for operational checks and tests of emergency equipment and instruments, which include emergency communications systems.

[H.7, H.10] The staff finds that the applicant has provided for adequate offsite radiological monitoring equipment in the vicinity of the nuclear facility, including sufficient reserves of instruments and equipment to replace those that are removed for calibration or repair. In addition, the applicant has identified emergency kits by general category (e.g., protective equipment, communications equipment, radiological monitoring equipment, and emergency supplies) in Table A4-3, "Emergency Field Monitoring Kits (3) (Typical)," of Appendix 4.

[H.6.c, H.12] In ESP Plan Section H.5.3, "Laboratory Facility," the applicant stated that VEGP has laboratory facilities for analysis of radioactive samples. The major pieces of equipment include a solid-state gamma spectrometer and a beta/gamma gas proportional counter. The GPC environmental laboratory located in Smyrna, Georgia, has the capability to perform isotopic analyses of drinking water, river water, milk, vegetation, sediment, and biological samples, as well as tritium and gross-beta analysis. In addition, this laboratory will handle the processing of environmental TLDs. Backup laboratory facilities are available at Plant Hatch. This backup capability could be used if facilities in VEGP are unavailable. **[H.12]** The staff finds that the applicant has established a central point for the receipt and analysis of all field monitoring data and coordination of sample media.

<u>State and Local Emergency Plans</u> [H.3, H.4, H.7, H.10, H.11, H.12]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard H of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard H are adequate. The following summarizes the FEMA findings for planning standard H.

a. State of Georgia

[H.3] GEOP Section V.A states that the GEMA director assumes responsibility for direction and coordination of ESFs at the SOC in Atlanta, Georgia. In addition, the State may establish an FEOC, mobile communications vehicle, and/or a mobile command post at or near an emergency or disaster site. If a local jurisdiction is unable to perform its responsibilities, the GEMA director may provide assistance. **[H.4]** GEOP Section V.A.7 states that upon escalation of an emergency or disaster, the GEMA director may require partial or full activation of the SOC, with representation of primary and/or support agencies and organizations. The SOC is the primary coordination point for State response. GA REP-Annex D, Section D.2, states that the SOC will be activated in accordance with procedures contained in the GEOP and GA REP–Base Plan, Section VI. (The SOC and FEOC are discussed further in SER Section 13.3.3.2.1.a, and activation and staffing of the SOC in SER Section 13.3.3.2.6.a.)

[H.7] GA REP–Annex D, Section D.4, "Inventories of Radiological Instruments," states that primary sources of radiological equipment in State government are the DNR-EPD environmental radiation program and radioactive materials program and GEMA. Portable instrument resources are also available from the Georgia Tech Nuclear Research Center. The DNR-EPD radiation program has access to portable hand-held beta-gamma type detectors, low-volume air samplers, pocket dosimeters, and portable alpha detection devices. The DNR-EPD radioactive materials program has access to beta-gamma detecting devices. GEMA maintains 13 field-monitoring kits, 8 of which are maintained in the six risk counties. Five of the kits are maintained in a calibrated status on ready reserve at GEMA headquarters. The Georgia Tech Nuclear Research Center and the Office of Radiological Safety have portable radiological detection equipment, including numerous hand-held survey meters and air samplers, that could be used in an emergency.

GA REP–Base Plan, Section VI.D.5, states that for FNFs for which plans have been developed, ambient radiation monitoring stations are currently in place, and some air sampling stations are situated nearby. In the event of a release of radioactive material from any of the facilities, information concerning radiological conditions could be obtained from these stations. Air samples could be changed by local emergency response personnel before the arrival of the State's primary response team. (See also SER Section 13.3.3.2.3.a.)

[H.10] GA REP-Annex D, Section D.7, states that most equipment and supplies to be used during a radiological emergency are also used routinely in support of radiological environmental surveillance activities, radioactive material inspections, and non-radiological emergency response planning. As such, the operation and performance of equipment and supplies are checked frequently. All DNR-EPD portable radiological instruments are calibrated at least annually and after each repair, and operational checks are performed daily when equipment is in use. Radiological laboratory instruments and other equipment are calibrated at a frequency recommended by the supplier. **[H.11]** Appendix A of DNR-EPD emergency response procedure 1.0, "Off-Site Field Monitoring Operations," provides an inventory of emergency kits.

[H.12] GA REP–Base Plan, Section VI.G.2.b, "Field Monitoring," states that offsite radiological field monitoring activities are conducted by the DNR RER team, in close cooperation with local agencies and the facility operator, to refine offsite dose projections and to provide a means of assessing the adequacy of protective measures. A field team coordinator, who will normally be located in the FEOC, directs the field monitoring activities. The field team coordinator will coordinate field monitoring activities with facility personnel to avoid unnecessary duplication of efforts and to ensure the maximum utilization of available personnel and equipment. In addition, Section VI.G.2.c, "Laboratory Radiological Analysis," states that the laboratory analysis during the plume passage phase will determine the amount and isotopic composition in air samples collected by field monitoring teams. These analyses will be performed by environmental radiation laboratory staff, operating in the DNR-EPD mobile radiation laboratory, which will normally be located adjacent to the FEOC.

GA REP–Annex D, Section E.1.d, "Radiological Assessment," states that the control of field monitoring activities, including dispatch of field teams, receipt of field monitoring data, receipt of laboratory data, and analysis of field monitoring data, will be coordinated at the FEOC. The 10-mile and 50-mile EPZ maps will be used at the FEOC to record field monitoring data, in addition to data recording forms. The 10- and 50-mile EPZ maps and Georgia DOT maps will be used to dispatch and control field teams and will be available to the field teams.

b. Burke County, Georgia

[H.3] Burke County Plan Attachment E, "EOC, Emergency Equipment and Service Support," states that the Burke County EOC is located in Waynesboro, Georgia, and that it provides adequate space and communications and supporting equipment to allow local governments and the GEMA FEOC (co-located with the EOC) to conduct sustained operations during an emergency. **[H.4**] EOC activation and staffing is addressed in Burke County Plan Attachment A and in SER Section 13.3.3.2.5.b.

[H.7, H.10, H.11, H.12] Attachment E states that additional radiological monitoring and protective equipment for support is available from various State agencies and that locally held radiological monitoring equipment is exchanged for refurbishment annually. An inventory of equipment, vehicles, and communication support systems housed in or located at the EOC is maintained by the Burke County EMA. In addition, all government and volunteer agencies maintain an inventory list of equipment and supplies necessary for day-to-day activities and sustained emergency operations.

c. State of South Carolina

[H.3, H.4] SCORERP–Part 5, Section IV.B, states that direction and control of emergency response forces will emanate from the SEOC, which is located in West Columbia, South Carolina, and will be activated when the State is notified of an "alert" ECL. An alternate State EOC is located in the State Department of Public Safety headquarters in Blythewood, South Carolina. Activation and staffing of the SEOC are described in SCEOP Section IV.G.5, which states that the SEOC will be activated and staffed in accordance with the SEOC SOP. Upon notification that the SEOC is being activated, members of the SERT will report to the SEOC. The primary agency designated for a particular ESF is responsible for ensuring that support agencies are informed and that their actions are coordinated. (SEOC activation and staffing are further discussed in SER Sections 13.3.3.2.1.c and 13.3.3.2.5.c.)

[H.7] SCTRERP Appendix IV, "Emergency Equipment and Supplies," states that the Bureau of Land and Waste Management (BLWM) maintains appropriate levels of portable radiation monitoring instruments, laboratory counting instruments, field sampling equipment, and supplies to conduct the operations of its normal radiological health activities. In addition, SCEMD has pre-positioned survey meters, portal monitors, and personal dosimetry in the FNF risk and host counties throughout the State. In the event of an incident at an FNF, the State will activate its dosimetry redistribution plan to support the threatened area. If needed to monitor a large number of evacuees, all portal monitors can be rapidly transported to any county. Monitoring/ decontamination teams will check members of the general public and emergency workers for radioactive contamination. SCORERP Appendix 4, “Radiological Emergency Response Equipment,” lists the available equipment and location. (Radiological monitoring and dosimetry use is further discussed in SER Section 13.3.3.2.11.c. The availability and use of potassium iodide (KI) is discussed in SER Section 13.3.3.2.10.c.)

[H.10, H.11] South Carolina calibrates its equipment in accordance with manufacturers' recommendations and requires that personnel check instrument operation before use. The State dosimetry and instrument redistribution plan provides for sufficient instruments for response. SCTRERP Appendix IV lists DHEC emergency kit equipment, which includes survey instruments, dosimeters, and communications equipment, and describes quarterly inspections and inventory, monthly (or after each use) operational checks, and annual calibration.

[H.12] SCTRERP Appendix II states that BLWM, in coordination with the Division of Radiological Environmental Monitoring, will establish a central point during emergency operations for the receipt and analysis of field monitoring data and for coordination of environmental biological sample collection. When the FEOC is operational, all field monitoring data will be transmitted to the BLWM representative at the FEOC. When the FEOC has not been activated, but the mobile radiological laboratory has been deployed to the incident, all field monitoring data will be transmitted to the mobile lab. (The handling of environmental sample media is further discussed in SER Section 13.3.3.2.3.c.)

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[H.3, H.4] Section VI.A.1 of the county plans describes the county EOC location, which will provide space and communications capabilities for State and Federal liaison personnel. The county base plans also describe the EOC, including activation levels, personnel response, and chain of command. The county EMA director may order a partial or full EOC activation, depending on the emergency. The county warning point dispatcher will follow procedure and notify the oncall emergency services/emergency management staff. The county base plans detail the ESFs that should be present, which will depend on the activation level. Listings of positions, agencies, and support organizations including telephone numbers are contained in the county base plan appendices.

[H.7] Section IV.Q, “Equipment,” of Annex Q2 of the county plans states that radiation detection equipment, assigned to the county monitoring station in SCORERP Appendix 4, may be used for monitoring purposes, under the guidelines of DHEC/BRH. The counties do not have any offsite radiological monitoring equipment to set up near the nuclear facility. In-place monitoring and sampling stations have been established by DHEC/BRH, as outlined in the SCTRERP. In addition, DHEC/BRH provides monitoring service and has the following supplies available at the DHEC central office:

- radiation monitoring equipment (e.g., dosimetry, survey meters, and air samplers)
- protective clothing
- sampling equipment for water, air, milk, vegetation, soil, etc.
- decontamination supplies and equipment
- up-to-date maps showing monitoring/sampling locations, hospitals, etc.

[H.10] Each county emergency service is responsible for operationally checking its equipment quarterly and after each use. Calibration of the equipment will be at intervals recommended by the SCEMD. **[H.11]** Annex Q2, Section IV.Q.7, of the county plans identifies the available emergency kits, and references the SCTRERP. **[H.12]** Section IV.M, "Radiological Monitoring and Decontamination," of Annex Q2 of the county plans states that DHEC will handle the receipt and analysis of all field monitoring data and the coordination of sample media, as outlined in the SCTRERP. (See also SER Section 13.3.3.2.8.c.)

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for emergency facilities and equipment, and subject to Permit Condition 8, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard H of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(8) and Sections III, IV.E, and VI of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.9 Accident Assessment (10 CFR 50.47(b)(9); NUREG-0654/FEMA-REP-1, planning standard I)

The regulation, as reflected in the planning standard, requires the use of adequate methods, systems, and equipment for assessing and monitoring the actual or potential offsite consequences of a radiological emergency condition.

In ESP Plan Section I, "Accident Assessment," the applicant described the methods, systems, and equipment available for assessing and monitoring actual or potential consequences of a radiological emergency. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard I, "Accident Assessment." Planning standard I provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(9).

[I.1] In ESP Plan Section I.1, "Plant Parameters," the applicant stated that ESP Plan Section D presents plant system and effluent parameter values characteristic of the spectrum of off-normal conditions and accidents and the manner in which these values are used to classify an emergency. (See SER Section 13.3.3.2.4 for a discussion of the emergency classification and action level scheme.) Emergency response procedures and EIPs include methods for quickly assessing plant system and effluent parameter values and classifying the emergency condition. (The submission of detailed emergency implementing procedures is addressed in **Units 3 and 4 ITAAC 9.1**, and in SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.4, 13.3.3.2.8, 13.3.3.2.10, and 13.3.3.2.16.) Additional information on plant instrumentation is provided in Section H.4, "Plant Monitoring and Data Handling Systems," of Annex V1 for Units 1 and 2 and Annex V2 for Units 3 and 4**.** **[I.2]** Initial assessment actions are the responsibility of the shift manager and/or the shift supervisor, using available shift personnel. Subsequent assessment actions are managed by the emergency director with assistance from the control room, TSC, EOF, and emergency teams, as necessary.

[I.1] In ESP Plan Section I.2, "Radiological Monitors," the applicant stated that in-plant radiological measurements provide information to help assess emergency conditions. The containment high-range radiation monitor and containment hydrogen monitor are used to provide an early indication of the quantity of radioactivity available for release from the containment. Emergency procedures include a correlation between the monitor reading and the extent of core damage. Data required to evaluate core conditions and coolant chemistry conditions will be obtained through chemistry procedures. Samples can be obtained from the reactor coolant system, the containment sump, and the containment atmosphere and are used for all radiochemical analyses.

In addition to the onsite capabilities for radiological assessment, AREVA ANP has agreed to provide backup analysis of samples with a high radioactivity level. Chemistry personnel will collect the sample in the sampling cask and transport it to the loading area. Documentation will be completed and the transport cask shipped to AREVA ANP. **[I.2] Unit 3 ITAAC 6.1** states that a test of the emergency plan will be conducted by performing a drill to verity the capability to perform accident assessment. Table V2A3-1 provides the specific acceptance criteria, which use the selected monitoring parameters listed in Table Annex V2H-1.

[I.1, I.2] The staff finds that the applicant has adequately identified plant system and effluent parameter values characteristic of a spectrum of off-normal conditions and accidents, and has the onsite capability and resources to provide initial values and continuing assessment throughout the course of an accident.

[I.3, I.6] In ESP Plan Section I.3, "Determination of Release Rate," the applicant stated that the source term or release rate is determined using the process and effluent radiation monitoring systems and measured or estimated flow rates for releases via monitored effluent release paths. **Unit 3 ITAAC 6.2** states that the emergency implementing procedures and ODCM correctly calculate source terms and magnitudes of postulated releases. **[I.6]** If instrumentation is off scale or inoperable, direct measurements with portable survey instruments will be used for determination and verified by field monitoring team samples.

[I.6, I.8] Unit 3 ITAAC 6.5 stated that the EIP and ODCM estimate release rates and doses when monitors are offscale or inoperable. In RAI 13.3-9, the staff asked the applicant to explain why **Unit 3 ITAAC 6.5** combines two generic ITAAC from Table C.II.2-B1 of NRC Draft Regulatory Guide DG-1145, "Combined License Applications for Nuclear Power Plant (LWR Edition)," September 2006 (subsequently changed to Table C.II.1-B1 of RG 1.206, Revision 0). The applicant responded that the numbering scheme and content of Table V2A3-1, "Unit 3 Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)," are consistent with those of Table 13.3-1, "Emergency Planning – Inspections, Tests, Analyses & Acceptance Criteria (EP ITAAC) – Combined License (COL) Applications – Subpart C to 10 CFR Part 52," of SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria."

[I.6, I.8] This response is incorrect, in that the numbering scheme and content of Table V2A3-1 are not consistent with those of Table 13.3-1. While EP ITAAC "Program Element" 6.5 in Table V2A3-1 is consistent with SECY-05-0197 (reflecting evaluation criterion I.8 of NUREG-0654/ FEMA-REP-1 and "EP Program Element" 8.7 of DG-1145), the corresponding Table V2A3-1 entries for the two columns entitled (1) Inspections, Tests, Analyses, and (2) Acceptance Criteria are not consistent. Instead, these two columns reflect acceptance criterion 8.5 of the ITAAC table in DG-1145. (DG-1145 supplemented the table in SECY-05-0197 with additional, allowable generic ITAAC. The original, smaller set of generic ITAAC from SECY-05-0197 is identified in DG-1145 with asterisks and bold text.) Generic ITAAC 8.5 was added in DG-1145 to reflect evaluation criterion I.6 of NUREG-0654/FEMAREP-1. (The applicant addressed I.6 in ESP Plan Section I.3, which is discussed above.) In the Safety Evaluation Report with open items, the staff identified as Open Item 13.3-5, the revision of **Unit 3 ITAAC 6.5** to accurately reflect the corresponding allowable generic ITAAC (consistent with Table C.II.1-B1 of RG 1.206). The staff reviewed the applicant's response in its submittal dated October 15, 2007 – which revised **Units 3 and 4 ITAAC 6.5** to reflect the corresponding ITAAC in RG 1.206 – and finds it acceptable. Therefore, Open Item 13.3-5 is resolved.

[I.4, I.10] In ESP Plan Section 1.4, "Dose Assessment System," the applicant stated that computer dose calculation systems will be located in both the TSC and EOF for offsite dose assessment purposes. These systems will support the Meteorological Information and Dose Assessment (MIDAS) code, a VEGP-specific version of a dose assessment computer code, which calculates the dispersion of the released material as it travels downwind and then estimates the resulting concentrations of this material. In RAI 13.3-47.b, the staff asked the applicant if these system capabilities will also be available in the control room(s) for use by onshift personnel. The applicant responded that MIDAS resides on a computer platform and is included in the VEGP information network. The ability to use the MIDAS software will be maintained in the control room. As shown in Table B-1 (see SER Section 13.3.3.2.2), the responsibility for performing offsite dose assessment will be assigned to the onshift HP/Chemistry Shared Foreman. While this function is intended to be performed in the TSC, it may be performed in the control room.

Initial dose projections can be made within 15 minutes of a radiological release and subsequent dose projections approximately every 15-30 minutes, depending on the variability of meteorological conditions and/or radioactive releases. MIDAS is a personal computer based program for rapidly assessing the radiological impact of accidents at nuclear power plants. It calculates total effective dose equivalent (TEDE), thyroid doses, and skin doses at various fixed downwind distances. Source term information is derived from plant effluent monitors, reactor coolant system or containment samples, field monitoring teams, or default accident scenario.

Unit 3 ITAAC 6.3 states that the emergency implementing procedures and ODCM calculate the relationship between effluent monitor readings, and onsite and offsite exposures and contamination. **[I.4, I.10]** The staff finds that the applicant has adequately established the relationship between effluent monitor readings and onsite and offsite exposures and contamination for various meteorological conditions, which includes relating the various measured parameters to dose rates for key isotopes and gross radioactivity measurements.

[I.5] Actual meteorological data and release rate data are obtained from the plant computer and information systems and entered into the dose projection computer. Minimum meteorological data to be obtained include wind speed, wind direction, and a stability indicator (either vertical temperature difference or standard deviation of the horizontal wind direction). Plant-specific default values are part of the program for use when meteorological or release rate data are not available. The computer will calculate dispersion, dose, and plume arrival times. Dose calculations are based on dose conversion factors from EPA 400-R-92-001.[31] Default release

[31] EPA 400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," May 1992.

rates are available for possible accidents if measured source term data are not available or if bounding calculations are desired.

[I.5] Meteorological data, which are obtained and used as input to the dose model, are further described in ESP Plan Section H and discussed in SER Section 13.3.3.2.8. Data from the primary meteorological monitoring system can be accessed directly from the control room, TSC, and EOF and are also available to NRC personnel and State representatives at the VEGP site. Data are also available to NRC personnel via ERDS. Meteorological data are delivered to the State via the notification form. If the primary instruments are unavailable, the backup meteorological tower is equipped with instruments at the 10-meter level to provide parameters relevant to atmospheric dispersion calculations. If both the primary and backup meteorological systems are unavailable, meteorological data will be obtained by commercial telephone directly from the NWS in Columbia, South Carolina. NWS Columbia has access to information from the automated weather station at Bush Field in Augusta, Georgia. These data will be available to NRC and State personnel via the notification form. Forecast changes in wind direction will be used in determining expected changes in plume trajectory. These forecast changes in plume trajectory may be used to expand the areas for which protective actions are recommended. [J.7] ESP Plan Section J, "Protective Response," addresses PARs to State and local officials and is discussed in SER Section 13.3.3.2.10.

Unit 3 ITAAC 6.4 and Unit 4 ITAAC 6.4 state that a test will be performed to verify the ability to access meteorological information in the TSC and control room, and list various parameters that will be displayed. (The specific acceptance criteria for Units 3 and 4 are provided in Table V2A3-1 and Table V2A4-1, respectively.) **[I.5]** The staff finds that the applicant has sufficient capability of acquiring and evaluating the necessary meteorological information, and has made adequate provisions for access to this information by the EOF, TSC, control room, the NRC, and the State(s).

[I.8] If significant windspeed or stability class changes are expected, the effect of the expected changes on dose projections will be analyzed utilizing the dose assessment model. In cases where weather forecasts predict precipitation, this information will be used in reference to adverse weather ETEs, as appropriate. When precipitation is predicted or occurring in the area of the plume, the potential for significantly increased rates of radioactivity deposition will be considered by increasing the scope of environmental sampling, as required to quantify the effects of this potentially increased deposition.

[I.10] The VEGP staff will calculate the 50-mile ingestion pathway doses from the deposition of specific radionuclides. The VEGP field monitoring team will collect sufficient environmental data to characterize the initial deposition of activity, the peak activity in pasture grass and milk, and total intake of I-131, Cs-137, Sr-90, and Sr-89. The samples will be analyzed at the VEGP site and the environmental laboratory in Smyrna, Georgia, or at the Plant Hatch laboratory. The analysis results will be compared with the preventive and emergency protective action guidelines (PAGs), and the associated doses will be determined.

[I.10] The dose assessment computer program will be used to calculate the projected deposition of radionuclides and associated doses in the ingestion pathway based on release data and meteorological conditions. These estimates will be compared to the preventive and emergency PAGs. The results of all analyses will be provided to the States of Georgia and South Carolina by the dose assessment manager. Each State is responsible for implementing protective measures based on PAGs and other criteria, consistent with U.S. Food and Drug

Administration (FDA) recommendations regarding contamination of human food and animal feed.[32] Unit 3 ITAAC 6.6 states that the EIPs and the ODCM estimate an integrated dose.

[I.7, I.8, I.9] In ESP Plan Section I.5, "Field Monitoring," the applicant stated that the emergency director or a designee can deploy up to three teams for field monitoring. These teams, which are available for field monitoring within the plume exposure pathway EPZ, are described in ESP Plan Section H and discussed in SER Section 13.3.3.2.8. Initially, the emergency director can activate at least one team from onshift personnel. Once the emergency facilities are activated, the emergency director can request additional monitoring teams from support personnel located at the OSC. Field monitoring teams will be dispatched from the EOF, TSC, or OSC, as appropriate. Before the teams leave for the field, the dose assessment manager, or designee, will direct and brief them on the initial survey and sample locations, suggested travel routes, meteorological conditions, and team identification name or number for communication purposes. It is estimated that teams will be in the field and performing monitoring tasks within about 1 hour of the determination of the need for field monitoring. The implementing procedures contain additional field monitoring team formation and dispatch details.

Pre-selected radiological sampling and monitoring locations, designated in implementing procedures, are shown in Figure iii, "VEGP 10-Mile EPZ." Field monitoring teams may be directed to perform sampling at these and other locations by the dose assessment staff at the EOF. In-transit dose rate measurements will be made. The teams may take airborne and dose rate measurements near the expected plume centerline. If the dose rate exceeds 100 mrem/h, off-centerline measurements will be made. On the basis of dose rates, the teams will be directed to sweep the plume to identify the centerline or maximum dose rate.

[I.9] The emergency monitoring kits contain a portable air sampler, silver zeolite cartridges, and counters to provide the capability to detect and measure radioiodine concentrations in the air as low as $10^{-7} \mu$Ci/cc. The list of equipment carried by the field teams is described in Table A4-3, "Emergency Field Monitoring Kits (3) (Typical)," of ESP Plan Appendix 4. Implementing procedures will describe the sampling and measuring techniques for air samples. The total sample volume and the limiting background count rate allow for a lowest limit of detection of at least $10^{-7} \mu$Ci/cc. The cartridges can be counted in the field without interference from noble gas (background count rate below 300 counts per minute (cpm) on an HP-210 probe or equivalent). The cartridge and air particulate filter will be returned to the laboratory at the plant for isotopic analysis if the field analysis reading is 100 cpm above background on an HP-210 probe or equivalent.

[I.11] Depending on wind direction and/or the severity of the incident, additional field monitoring teams may be provided by DNR, South Carolina DHEC, DOE-SR, or other divisions of DOE. These teams and data transfer will be coordinated using existing communication links. (The details are provided in ESP Plan Section F and discussed further in SER Section 13.3.3.2.6.) The State and VEGP field monitoring teams will be coordinated from the EOF by the dose assessment manager to assure a fully coordinated effort. DOE-SR will direct the field monitoring teams of SRS, depending on the wind direction, and will make their monitoring data available to VEGP and State and local representatives at the EOF. The dose assessment team at the EOF will collate field monitoring data for VEGP dose projection purposes. This information will be available to the State and local representatives at the EOF and to DOE-SR.

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32 See EPA 400-R-92-001, Chapter 3, "Protective Action Guides for the Intermediate Phase (Food and Water)," which provides FDA recommendations.

The staff finds that the applicant has made adequate arrangements to locate and track the airborne radioactive plume, using facility, Federal, and State resources.

[I.7] In ESP Plan Section I.6, “Environmental Samples,” the applicant stated that in addition to direct monitoring and air sampling, the assessment program includes an emergency environmental sampling program, in which routine types of environmental samples (water, air, soil, and vegetation) are collected and analyzed in the laboratory for detailed radionuclide data. The GPC environmental laboratory, located in Smyrna, Georgia, has the capability to perform isotopic analyses of drinking water, river water, milk, vegetation, sediment, and biological samples, as well as tritium and gross beta analysis. Fixed environmental sampling and monitoring locations are described in implementing procedures and are shown in Figure iii.

[I.8] The normal environmental sample analysis is performed at the GPC environmental laboratory in Smyrna, Georgia. During and/or subsequent to emergency conditions, the routine environmental monitoring program will be modified to collect and analyze additional samples from existing stations. The dose assessment manager will coordinate sampling and analysis activities for those areas that may have been affected by a release from the plant. Sample results will be transmitted back to the dose assessment manager by the analyzing organization. **[I.10]** Data from fixed monitoring stations (TLDs and air samplers) will be used to estimate population dose. The samples from fixed monitoring stations will be collected after termination of a radioactive release and analyzed. The results will then be reduced in a manner that will assist in defining the trajectory, radioactivity, and impact of the released plume.

[I.7] The staff finds that the applicant has adequately described the capability and resources for field monitoring within the 10-mile plume exposure EPZ. **[I.8, I.9]** In addition, the applicant has the methods, equipment, and expertise to make rapid assessments of actual or potential radiological hazards, including the capability to detect and measure radioiodine concentrations in air in the 10-mile plume exposure EPZ as low as $10^{-7} \mu$Ci/cc under field conditions.

In RAI 13.3-46.e, the staff asked the applicant to explain why there were no **Unit 4 ITAAC 6.1 through 6.7** comparable to **Unit 3 ITAAC 6.1 through 6.7**. In its response, the applicant provided comparable criteria for **Unit 4 ITAAC 6.4**, which includes the display of meteorological parameters in the separate control rooms for Units 3 and 4. However, the applicant stated that criteria 6.1-6.3 and 6.5-6.7 were verified through the Unit 3 ITAAC and are not required to be repeated for Unit 4. The staff agrees that common equipment and capabilities can be adequately demonstrated through the Unit 3 ITAAC; however, equipment and capabilities that are specific to the unit require unit-specific ITAAC. **Unit 3 ITAAC 6.1–6.3 and 6.5–6.7** include what appear to be unit-specific characteristics, such as EALs (6.1, A.1), source terms (6.2), effluent monitor readings (6.3), monitors (6.5), and EIPs (6.7).

The applicant must either explain why these **Unit 3 ITAAC criteria 6.1-6.3 and 6.5-6.7** will demonstrate the sufficiency of the ITAAC in relation to Unit 4 (i.e., describe why these are site-specific and reflect both Unit 3 and Unit 4), or supplement Table V2A4-1 with comparable Unit 4 ITAAC; as done for ITAAC 6.4. (The completion of the Unit 3 ITAAC, which demonstrates that the acceptance criteria have been met – to the extent that they apply to equipment and systems common to Unit 4 – would not have to be repeated as part of the Unit 4 ITAAC; only those capabilities specific to Unit 4.) In the Safety Evaluation Report with open items, the staff identified the resolution of this issue as Open Item 13.3-6. (See also SER Sections 13.3.3.2.1 and 13.3.3.2.14, regarding **Unit 3 ITAAC 9.1** and **Unit 3 ITAAC 8.1**, respectively.) The staff reviewed the applicant’s response in its submittal dated October 15, 2007 – which supplements Table V2A4-1 with comparable **Unit 4 ITAAC** – and finds it acceptable. Therefore, Open item 13.3-6 is resolved.

State and Local Emergency Plans [I.7, I.8, I.9, I.10, I.11]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard I of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard I are adequate. The following summarizes the FEMA findings for planning standard I.

a. State of Georgia

[I.7, I.8] GA REP–Annex D, Section E.1, "Accident Response and Assessment," states that because the capability of local personnel for initial assessment and monitoring is limited, a State response element may be dispatched by aircraft directly to the FEOC. This response element will arrive on site within flight time plus approximately 30 minutes for initial mobilization. The GEMA mobile communications vehicle and mobile laboratory will arrive within driving time plus 30 minutes for initial mobilization. In the event of an incident that does not require rapid assessment capability, the State response element will normally be deployed by surface transportation. Radiological assessment operations will be the responsibility of a primary team consisting of technically qualified personnel from DNR-EPD.

[I.7, I.8, I.9, I.10] GA REP–Annex D, Sections E.1.h through E.1.j and E.2, describe the capabilities and resources for field monitoring in relation to TLD stations, air sampling capabilities, and the sampling and interdiction of milk and other food products. Additional capabilities and resources for field monitoring, including methods, equipment and expertise, are described in SER Section 13.3.3.2.8.a.

[I.11] GA REP–Base Plan, Section VI.G.2.a, "Dose Projections," states that DNR currently has two dose projection models available for use – MIDAS and the Radiological Assessment System for Consequence Analysis (RASCAL). Both models will calculate the TEDE, committed effective dose equivalent, and committed dose equivalent (CDE) for a variety of (radioactivity) release scenarios. Based on assessments performed by the DNR RER team, the State radiation emergency coordinator will recommend the appropriate protective measures to the State disaster coordinator and local officials.

b. Burke County, Georgia

[I.7, I.8] Field monitoring capability and resources for the assessment of actual or potential radiological releases are the responsibility of the State.

c. State of South Carolina

[I.7, I.11] SCORERP Section IV.B.7, "Radiological Monitoring/Exposure Control," states that DHEC will coordinate radiological monitoring operations under the auspices of ESF 10, "Hazardous Materials," as delineated in SCEOP Annex 10. DHEC will deploy radiological monitoring field teams with equipment and the expertise necessary to detect and measure airborne radiation and radioactive particulate deposition on the ground. Field data gathered will be compared with information and recommendations from the FNF to locate the radioactive plume and project or determine potential dose to the general public and emergency workers.

Support from SRS, which has been designated as the primary responder under FRERP, is discussed further in SER Section 13.3.3.2.3.c.

[I.8] SCTRERP Section A.1 states that NREES (located within DHEC) is charged with the responsibility to develop, maintain, and coordinate the SCTRERP in support of the SCORERP objectives and concepts (Organizational Chart A-4). SCTRERP Section B describes the general notification processes, and Section C.VI describes the notification methods. Section B.I states that the primary responsibilities of NREES are to provide technical assistance in evaluating the actual and potential consequence of an incident and to provide PARs. To carry out these major responsibilities, NREES will employ field monitoring teams, environmental sampling teams, mobile and fixed laboratory facilities, health physicists, advisors, and emergency coordinators.

SCTRERP Appendix III, Sections II and III, specify the actions that the BLWM will take to assess the impact of an actual (radiological) release. By measuring contamination levels or concentrations of radioisotopes in air and water, doses can be calculated for comparison with PAGs. SCTRERP Appendix II, Section III, describes the receipt and analysis of field monitoring data. The BLWM, in coordination with the Division of Radiological Environmental Monitoring, will establish a central point during emergency operations for the receipt and analysis of field monitoring data and the coordination of collected environmental biological samples. Appendix IV lists the monitoring and communication equipment and supplies that are available for field teams and laboratories.

[I.9, I.10] The means for relating the various measured parameters to dose rates for key isotopes and gross radioactivity measurements are described in SCTRERP Appendix I, "Protective Action Guides"; Appendix II, "Environmental Monitoring, Sampling, and Laboratory Analysis Capability"; and Appendix III, "Environmental and Health Effects Assessment Plan." In addition, SCORERP Annex F, "Radiological Exposure Control," and Annex G, "Ingestion Pathway Emergency Planning Zone (IPZ)," discuss PAGs and the State's response (see also SER Section 13.3.3.2.10.c), and SCTRERP Section B.XII, "Maps," states that DHEC has maps showing the environs of each FNF in the State. (These maps are also discussed in SER Sections 13.3.3.2.3.c, 13.3.3.2.9.d, and 13.3.3.2.10.c.)

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[I.7, I.8] DHEC will handle the receipt and analysis of all field monitoring data and the coordination of sample media, as outlined in the STRERP. Annex Q2, Section IV.M.2, of the county plans states that DHEC will coordinate the monitoring and technical assessment of the 50-mile EPZ. In addition, Section IV.Q states that DHEC provides monitoring service and has various equipment available at the DHEC central office. This equipment consists of radiation sampling and monitoring equipment, protective clothing and dosimetry, decontamination supplies and equipment, and up-to-date maps showing the environs of each nuclear facility. These maps, which are also available in the mobile lab, show locations for monitoring and sampling, hospitals, landing strips, etc. (The mobile radiological laboratory's capabilities and resources are further described in SER Sections 13.3.3.2.3.c, 13.3.3.2.6.c, and 13.3.3.2.8.c.)

<u>Conclusion</u>

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for accident assessment, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard I of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(9), 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.10 Protective Response (10 CFR 50.47(b)(10); NUREG-0654/FEMA-REP-1, planning standard J)

The regulation, as reflected in the planning standard, requires that a range of protective actions have been developed for the plume exposure pathway EPZ for emergency workers and the public. In developing this range of actions, consideration has been given to evacuation, sheltering, and, as a supplement to these, the prophylactic use of KI, as appropriate. Guidelines for the choice of protective actions during an emergency, consistent with Federal guidance, are developed and in place, and protective actions for the ingestion exposure pathway EPZ appropriate to the locale have been developed.

In ESP Plan Section J, "Protective Response," the applicant described the protective actions that have been developed to limit radiation exposure of plant personnel and the public following an accident at the VEGP site. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard J, "Protective Response." Planning standard J provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(10).

[J.1, J.3, J.4] In ESP Plan Section J.1, "Protective Response for Onsite Personnel," the applicant stated that protective response for onsite personnel (including visitors and contractor personnel) depends on alerting, assembly and accountability, site dismissal, monitoring, and decontamination. In addition, ESP Plan Section E describes the methods to be used to alert onsite personnel of emergency conditions; these are discussed in SER Section 13.3.3.2.5. A security-related emergency may preclude the ordering of assembly and accountability in order to protect plant personnel from the security threat. The decision not to order assembly and accountability will be made by the emergency director. **Units 3 and 4 ITAAC 7.1** state that a test of the onsite warning and communication capability EIPs, including PAGs, assembly and accountability, and site dismissal will be performed during a drill. Various objectives are also provided as specific acceptance criteria. (The specific acceptance criteria for Units 3 and 4 are provided in Table V2A3-1 and Table V2A4-1, respectively.)

[J.5] Upon activation of the plant emergency alarm, plant personnel assigned specific emergency responsibilities proceed to their designated emergency response location. Emergency response personnel in the protected area enter their ERF (TSC, OSC, or control room) using electronic badge identification to record the entry. The security computer system performs an initial accountability of all persons in the protected area. Thereafter, the ERF managers of the control room, TSC, and OSC are responsible for periodically assuring that accountabilities in their facilities are being maintained. Assignment logs and required periodic communications between emergency response teams maintain accountability.

[J.1, J.2] Noninvolved plant personnel, visitors, and contractors located within the protected area leave the protected area upon hearing the emergency alarm and report to their designated assembly areas. As these individuals exit the protected area, they record their exit using electronic badge identification. The security department accounts for each person inside the protected area at the start of an emergency by using the security computer system. **[J.5]** This method accounts for all individuals inside the protected area within about 30 minutes of the emergency declaration page announcement. Accountability reports are made periodically to the emergency director by the security department. If protected area accountability reveals a missing person, the emergency director assembles a search and rescue team per emergency response procedures. (The submission of detailed implementing procedures is addressed in **Units 3 and 4 ITAAC 9.1**, and further discussed in SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.4, 13.3.3.2.8, 13.3.3.2.9, and 13.3.3.2.16.) Likely areas are searched until the missing individual is located.

[J.2] Site dismissal, with or without monitoring, of noninvolved personnel on site (if feasible) is ordered by the emergency director whenever a site area or general emergency is declared. If there has been no radioactive release and a release is not projected, the emergency director may elect to order a "site dismissal with no monitoring" rather than with monitoring. For a site dismissal with no monitoring, noninvolved personnel are sent home instead of to reception centers.

[J.2] If site dismissal with monitoring is necessary, the emergency director will notify the Burke County EMA and request setup of a reception center to receive VEGP noninvolved personnel. The route selected to the reception center is based on meteorological and/or radiological conditions. The location of the reception center is shown in (Preface) Figure iv, "VEGP and Savannah River Site 50-Mile Ingestion Pathway EPZ." **[J.1]** Personnel on site will be notified by public address, site siren, or other communication of the dismissal of noninvolved personnel to the applicable reception center and of the specified route. Security will dispatch officers to search areas outside the protected area to ensure that all noninvolved personnel have left the OCA.

[J.3] Upon site dismissal to a reception center, noninvolved personnel will be monitored for contamination to determine gross contamination in accordance with the Burke County emergency operations plan. **[J.4]** Contaminated personnel will undergo a decontamination process in accordance with standard health physics procedures. Those personnel who are not contaminated will be released upon clearance of their vehicles. Vehicles will be monitored for contamination in the designated parking areas. Contaminated vehicles will be decontaminated in accordance with the Burke County emergency operations plan. Contaminated articles and clothing and waste material will be collected and placed in containers or bags for disposal and/or processing at the site. **[J.6.a, J.6.b]** The staff reviewed ESP Plan Table J-1, "Use of Equipment and Supplies," and finds that it adequately identifies various and sufficient respiratory and protective clothing available for individuals remaining or arriving on site during the emergency and also identifies the onsite locations and describes the criteria for issuance and means of distribution.

[J.3, J.4] When an alert is declared and site dismissal with no monitoring is anticipated, personnel who have left the protected area are monitored by portal monitors. If necessary, decontamination is completed using the plant decontamination facilities located in the control building or other appropriate location. When site dismissal with monitoring is expected and release of radioactivity has occurred, monitoring is performed by Burke County emergency workers at an established reception center. Should decontamination be necessary, the reception center establishes a field decontamination area, using materials from emergency kits located in the vicinity of the reception center. Decontamination and waste disposal are completed in accordance with the Burke County emergency operations plan.

[J.6.c] A supply of KI is stored in the TSC (for TSC and control room use), OSC, main control point, or health physics room. The health physics supervisor will direct the issuance of KI when the projected thyroid exposure is greater than 25 rem. The health physics supervisor will direct radiological survey personnel to distribute KI and record the name and social security number of those individuals who are issued KI. The KI will be issued in 130-mg doses daily for at least 3 days but not more than 10 days. It will be issued immediately before exposure or not longer than 4 hours after exposure. At the time KI is distributed, an iodine sensitivity check will be made by querying each individual concerning known reactions to iodine. Individuals who have experienced reactions to iodine will be excused from duties requiring issuance of KI.

[J.1, J.2, J.3, J.4, J.5, J.6] The staff finds that the applicant has adequately provided for the protection of onsite individuals. This includes the description of the means and time required to warn, advise, and account for onsite individuals; provisions for evacuation routes and transportation for onsite individuals to suitable offsite locations, including radiological monitoring and decontamination of people evacuated from the site; and provisions for individuals remaining (or arriving) on site during the emergency, which include respiratory protection, protective clothing, and thyroid protection in the form of KI.

[J.7] VEGP is responsible for ensuring that timely recommendations for protective actions reach appropriate State and local officials. These officials, who are then responsible for alerting the public and ordering shelter and/or evacuation, if necessary, are described in ESP Plan Section A, "Assignment of Responsibility," and discussed in SER Section 13.3.3.2.1. **[J.10.c]** The means used by VEGP to alert local and State agencies and the means used by local and State agencies to alert the public are described in ESP Plan Section E and Appendix 3. The staff reviewed Appendix 3 and finds that it contains a detailed and comprehensive overview of the means for prompt alerting and notification of the public within the 10-mile plume exposure pathway EPZ. Additional information on the means for notifying all segments of the transient and resident population is provided in ESP Plan Sections D, E, and G. These sections are discussed in SER Sections 13.3.3.2.4, 13.3.3.2.5, and 13.3.3.2.7, respectively. In Appendix 3, the applicant also provided the locations and design coverage contours of the 47 rotating electronic sirens in Figure A3-1, "60 and 50 dBC Design Coverage Contours."

[J.7, J.10.m] In ESP Plan Section J.2, "Protective Response for the Public," the applicant stated that the emergency director is responsible for providing PARs to State and local officials as part of initial notifications and follow-up communications. These recommendations are based on assessment actions, which are described in ESP Plan Section I and discussed in SER Section 13.3.3.2.9. Using available information on plant conditions, projected dose estimates, and any available monitoring data, the emergency director recommends whether the public should be advised to seek shelter or evacuate. State and local officials will evaluate other factors that influence protective actions. The mechanism for communicating these recommendations is described in ESP Plan Section E and discussed in SER Section 13.3.3.2.5. These recommendations are based on the EPA PAGs, as shown in Table J-2, "Protective Action Recommendations." Table J-3, "Sheltering Guidance," provides information to the emergency director on the expected protection afforded by residential units.

In addition, implementing procedures provide guidance on PARs in the absence of any release of radioactivity. **[J.4]** Site dismissal of noninvolved station personnel and evacuation and/or sheltering of the general public is recommended for a general emergency even though there has not been a release of radioactivity from the plant. **[J.7]** The staff finds that the applicant has established an adequate mechanism for recommending protective actions to the appropriate State and local authorities, which include EALs corresponding to projected dose to the population at risk. (EALs are addressed in ESP Plan Section D and in SER Section 13.3.3.2.4.)

[J.9] The GEMA (in coordination with the Georgia DNR) and SCEMD (in coordination with the South Carolina DHEC) are responsible for deciding protective measures for affected offsite areas within their jurisdictions. State officials will consider the potential risks of implementing protective actions against the reduction of radiological risk achieved by the protective action.

[J.8, J.10.l, J.10.m] Determination of the benefit of evacuation must take into account the time needed to complete the evacuation. Table J-4, "Evacuation Time Estimates," summarizes the total evacuation times for various areas, zones, and weather conditions. ESP Plan Appendix 6 includes more detail on how these estimates were developed and presents information on evacuation routes, evacuation areas, relocation centers, shelter areas, and the population distribution by evacuation areas and sectors. **[J.10.b]** Maps showing the population distribution around VEGP, including evacuation areas and sector format, are provided in ESP Plan Figure v, "2006 Permanent Population within the VEGP Plume EPZ," and Figure vi, "Transient and Special Facility Population within the VEGP Plume EPZ." The ETE is discussed in SER Section 13.3.1.

In RAI 13.3-38, the staff asked the applicant to explain and resolve apparent discrepancies between the ETE and Burke County plan regarding the location of the Lord's House of Praise Christian School (a "special facility"), in relation to the VEGP 10-mile plume exposure pathway EPZ. In addition, the staff asked the applicant to address the need for changes/corrections to the existing State and county emergency plans, as well as the school's emergency evacuation plan, to address whether the students would be evacuated by county buses or by the school's own transportation resources.

The applicant responded that the school does have independent general emergency plans, as a requirement for licensing as a certified school. After notification of a radiological emergency requiring evacuation of the zone where the school is located, if the school is unable to evacuate with its private transportation vehicles, the Burke County EMA will request the Burke County Board of Education to dispatch sufficient buses to the school to transport the occupants to the designated local reception center. In addition, the applicant stated that GEMA is updating the Burke County Emergency Plan in response to a request from the Burke County EMA, to include the Lord's House of Praise Christian School as a legitimate school just inside the 10-mile EPZ boundary. The update and changes will go through review and approval by the Burke County EMA Director. In the Safety Evaluation Report with open items, the staff identified the updating of the Burke County Emergency Plan, and its review and approval by the Burke County EMA Director, as Open Item 13.3-7. The staff reviewed the applicant's response in its submittal dated October 15, 2007, which provided the updated and approved Burke County Emergency Plan (Plant Vogtle Annex D, April 2007), which includes the Lord's House of Praise Christian School, and finds it acceptable. Therefore, Open Item 13.3-7 is resolved.

[J.8, J.10.l, J.10.m] In RAI 13.3-21, the staff asked the applicant to provide information regarding the State and local resources that will be used to evacuate residents who do not own autos and specify the time required to mobilize these resources. The applicant responded that this population group would use privately owned vehicles of friends or relatives to evacuate. This response is inconsistent with the Burke County Emergency Management Radiological Plan, which states in paragraph D of Attachment H, "Evacuation and Sheltering," that privately owned vehicles will be the primary mode of transportation if evacuation is directed, and that county school buses, traveling their regular routes, will transport those individuals lacking personal transportation. In the Safety Evaluation Report with open items, the staff identified the apparent inconsistency of the use of buses to evacuate non-auto-owning residents as Open Item 13.3-8. The staff reviewed the applicant's response in its submittal dated October 15, 2007 – which described how this population (20 individuals) is considered in the ETE, and the vehicles available from the Burke County Transit Authority (8 vans, 12 ambulances, and 100 school buses) for their evacuation – and finds it acceptable. Therefore, Open Item 13.3-8 is resolved.

In RAI 13.3-22, the staff asked the applicant to address sportsmen population numbers and to explain why the ETE did not mention the Yuchi Wildlife Management Area (WMA). In its response, the applicant did not explain how it derived the sportsmen population numbers for zones G-10 and H-10 (200 each), other than that those were the numbers used in the emergency plan appendices (stated in the applicant's response to RAI 13.3-16.e). In addition, the applicant did not address sportsmen associated with the Yuchi WMA. In the Safety Evaluation Report with open items, the staff identified the clarification of the sportsmen population numbers and Yuchi WMA, as it relates to the ETE, as Open Item 13.3-9.

The staff reviewed the applicant's response in its submittal dated October 15, 2007, which stated that hunters are included in the values for transient population. The values for transient population within the South Carolina portions of the VEGP EPZ (protective action zones G-10 and H-10) include hunters visiting the Cowden Plantation in Aiken County, boaters using Gray's Landing and the Barnwell Boat Landing, visitors to the St. Mary's Baptist Church, and visitors to the Creek Plantation area for horse auctions or shows. Peak population estimates for each of these areas were based on studies performed in support of the ETE update performed in 1985, which specifically addressed these areas. Assumptions utilized in the updated [April 2006 ETE] study are consistent with current usage of these areas. In regard to the ETE, the applicant stated that the maximum WMA usage for various hunting seasons was utilized in the development of the updated ETE. In addition, the applicant states that data obtained from the Georgia DNR shows that the 8-year average for the period 2000-2007 is 190 hunters – which represents the total number of hunters for the designated seasons. The staff finds this information acceptable, and Open Item 13.3-9 is resolved.

In RAI 13.3-30.b, the staff asked the applicant to discuss whether State and local agencies have reviewed and commented on the draft ETE. The applicant responded that a copy of the ETE has been provided to State and local agencies for their review. The staff compared ETE Table 11, "ETEs in Minutes," with the comparable Table J-4, "Evacuation Time Estimate Summary," of Revision 43 of the VEGP Plan and finds that the evacuation times for the various evacuation areas are inconsistent. As discussed below, portions of the VEGP Plan ETE are included in the county emergency operating procedures (EOPs), and site-specific annexes (e.g., Burke County Plan Attachment H, "Evacuation and Sheltering," regarding vehicle capacities on principal evacuation routes, and Table H-3, "EPZ Vehicle Totals"). While the specific evacuation times appear to have changed (been updated), as reflected in the April 2006 ETE, the extent to which these changes have been, or need to be, reflected in the State and county plans was unclear. In the Safety Evaluation Report with open items, the staff identified as Open Item 13.3-10, the need for the applicant to discuss State and local agencies' review and comment on the ETE, and the resolution of those comments. The staff reviewed the applicant's response in its submittal dated October 15, 2007 – which stated that State and local agencies have reviewed the updated ETE and did not find any significant impact to their current plans or procedures – and finds it acceptable. Therefore, Open Item 13.3-10 is resolved.

[J.10.a] If a decision is made to evacuate any part (or all) of the plume exposure pathway EPZ, the evacuation will be carried out in accordance with the emergency response plan of each affected county. The populace will be instructed to proceed by the appropriate evacuation route to predesignated reception centers/shelters. Reception centers/shelters for Georgia and South Carolina counties within the plume exposure pathway EPZ are listed in Table J-5, "Reception Centers/Shelters." The reception centers are also shown in ETE Figure 14, "VEGP EPZ Boundary, Evacuation Zones, and Reception Centers." The services to be provided in the reception centers include:

- registration
- screening for contamination
- decontamination, as needed
- information and assistance for family unification
- food and lodging
- first aid

Privately owned vehicles will be the primary mode of transportation if evacuation is directed. Individuals who do not have their own means of transportation have been advised to arrange their own transportation if possible. If this is not possible, individuals are instructed to stay tuned to the radio or television and listen for the phone number to call for transportation.

[J.10.d] Specially equipped vehicles will be dispatched directly to the homes of handicapped and/or nonambulatory individuals requiring special transportation. **[J.10.m]** Under certain conditions, sheltering inside the home may be the preferred recommended action. Area radio and television stations or tone alert radios will advise the public on taking this action, will provide instructions to the public, and will give the "all clear signal" when appropriate. The staff finds that the applicant has provided adequate plans to implement protective measures for the 10-mile plume exposure pathway EPZ. This includes maps showing evacuation routes and areas, preselected radiological sampling and monitoring points, and relocation/shelter centers. In addition, the applicant has established the necessary means for notifying all segments of the transient and resident population, including the bases for the choice of recommended protective actions from the 10-mile plume exposure pathway EPZ during emergency conditions.

<u>State and Local Emergency Plans</u> [J.2, J.9, J.10, J.11, J.12]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard J of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard J are adequate. The following summarizes the FEMA findings for planning standard J.

a. State of Georgia

[J.2, J.10.a, J.10.g, J.10.j] GEOP ESF-5, "Emergency Management," states that GEMA will monitor conditions that have the potential to require evacuation within the State and will assist with coordination of evacuation, routing to shelters, personnel, transportation, and public information to deal effectively with the situation. GA REP–Base Plan, Section IV.G.3.c, states that to aid in the evacuation of the general public from the affected areas, predesignated evacuation routes have been established. Along these routes, traffic control points have been established to maintain traffic flow. Evacuation routes and traffic control points are presented in the site-specific annex to the GA REP–Base Plan (i.e., GA REP–Annex D for Plant Vogtle).

GA REP-Annex D, Section E.2.d, states that areas affected by a radiological release will be evacuated by the most expedient methods available. Evacuation routes will normally be the major thoroughfares close to VEGP. Resources available to assist in the evacuation include local emergency management and law enforcement personnel and Georgia Departments of Safety and Transportation personnel. **[J.10.h]** The Burke County High School reception center/shelter (i.e., host area relocation center) is discussed in SER Section 13.3.3.2.10.b.

Annex D shows the major road networks around the facility, which are expected to be the principal evacuation routes, and Section I, "Local Plans," describes the evacuation plans and includes relevant maps. **[J.10.k, J.10.l]** Should an evacuation route be impeded, the State emergency coordinator will designate alternate routes after consultation with local officials, State DOT officials, and representatives of the Department of Public Safety. GA REP–Base Plan, Section IV.B.5, states that the DOT will provide required heavy equipment and personnel.

[J.10.I, J.10.j] GA REP–Annex D, Section E.2.g, states that if an evacuation is necessary, the boundaries of the evacuated area will be controlled to prevent unauthorized access, primarily by the use of roadblocks on major thoroughfares. Personnel from local emergency management, law enforcement, and the State Department of Public Safety will establish these roadblocks. If required, radiological survey teams will be assigned to the roadblocks and will conduct necessary surveys of personnel and equipment leaving the controlled area. The survey team lead will be authorized to release (or retain) personnel and equipment based on survey results. (Projected traffic capacities of evacuation routes and control of access to evacuated areas are discussed in SER Section 13.3.3.2.10.b.)

[J.9] GA REP–Base Plan, Section VI.G, "Incident Assessment and Protective Response," establishes the guidelines for protective action measures and states that PAGs for the early phase of an incident are values of projected doses for both whole body and thyroid exposure. Section VI.G includes tables for the early and intermediate phases of an incident, including PAGs (that are consistent with those of the EPA) and the corresponding protective action (i.e., shelter, evacuate, administer KI). The PAGs are presented as ranges to permit flexibility in protective action decision-making to deal with situations such as institutionalized populations, adverse weather conditions, or other local constraints on the implementation of protective measures. **[J.11]** In addition, ingestion pathway PAGs are provided, which are consistent with FDA guidance. Section IV.B.2.h states that the Georgia State Patrol will assist in required public warnings or evacuation, including available ground and airborne means.

[J.10.b] GA REP–Base Plan, Section VI.G.3.a, "Protective Action Zones," states that the plume exposure EPZ is subdivided into protective zones (commonly referred to as "evacuation zones"). The zone descriptions for VEGP are found in the site-specific Annex D. GA REP–Annex D, Table E-1, lists each county in the 50-mile ingestion exposure EPZ (IPZ) for VEGP and includes the population distribution. **[J.10.c]** (The means for notifying all segments of the transient and resident population are addressed in SER Section 13.3.3.2.5.a.)

[J.10.e, J.10.f] GA REP–Base Plan, Section VI.G.1, states that a protective action for emergency workers includes the administration of stable iodine (i.e., KI) for a PAG projected thyroid dose of 25 rem or more. GA REP-Annex D, Section F.5, states that in the event of an accident that warrants offsite monitoring or other emergency duties, all State and local emergency workers, before entering the area of possible exposure, will report to the (Burke

County) FEOC for receipt of KI. The procedure for distribution of KI to emergency workers is outlined in a memorandum of understanding (MOU) between DNR-EPD and the DNR Division of Public Health. Since the State considers evacuation or sheltering to be a more effective measure for the general public, no dependence has been placed on the distribution of KI to the general public.

[J.10.m] GA REP–Base Plan, Section VI.G, states that incident assessment during the emergency or plume passage (early) phase of a radiological incident involves four separate but interrelated activities – offsite dose projection, radiological field monitoring, limited laboratory radiological analysis, and health physics/contamination control. Based on assessments performed by the RER team, the radiation emergency coordinator will recommend the appropriate protective measure to the State disaster coordinator and local officials. GA REP–Base Plan, Section VI.G.3, “Protective Actions,” states that the primary offsite protective actions for the general public fall into two broad categories, evacuation and in-place sheltering. In-place sheltering will be considered only if anticipated radiation doses are well below PAG values (discussed above for the early phase of an emergency), or if evacuation would subject members of the public to larger radiation doses than if they were sheltered in place. Such a situation could occur if radioactive material released from the plant had already arrived, or if unusual environmental or safety conditions existed (e.g., severe weather or the case of institutionalized individuals). In addition, GA REP–Annex D, Section E.2.e (1), describes various passive and active measures that may be taken to minimize exposure while sheltered in place.

[J.10.d] GEOP ESF-8, “Public Health and Medical Services,” Section III.B.2.b.v, states that the hospitals and long-term health care facilities (including nursing homes and assisted living centers) will receive assistance with patient evacuation and relocation. GA REP–Base Plan, Section VI.G.3.e, also states that local plans include the notification and, if necessary, evacuation of handicapped and/or mobility-impaired persons within the 10-mile EPZ.

[J.11] GEOP Appendix A, Section II.C, “Radiological Incidents/Nuclear Power Plant Accident,” states that the ingestion exposure pathway is within a 50-mile IPZ of the nuclear power plant. The IPZ defines the area for which emergency plans are specifically needed to outline and describe actions necessary to protect the health and safety of the population in case of a facility accident. To mitigate or eliminate the effects of such an accident, protective measures are necessary. Response within the IPZ may include monitoring for contaminated water, food, and livestock, as well as environmental monitoring and (if needed) decontamination of people in the area. The duration of activities within the IPZ, referred to as the recovery phase, may range from hours to months to ensure that the environment and community are safe for the resumption of normal activities.

GA REP-Annex D, Section E.1.g (3), identifies the counties within the VEGP IPZ as Bulloch, Burke, Candler, Chatham, Columbia, Effingham, Emanuel, Glascock, Jefferson, Jenkins, McDuffie, Richmond, Screven, and Warren. (See also Figure E-1.) A description of generic (IPZ) operations is contained in GA REP–Annex F. Activities associated with the evaluation and (if necessary) interdiction of milk and food are described in GA REP–Annex D, Sections E.1.i and E.1.j, respectively. The evaluation of potentially affected land and water is addressed in Section E.2.f. (Sampling and interdiction of food products are also discussed in SER Section 13.3.3.2.9.a.)

[J.12] GEOP ESF-6, “Mass Care, Housing, and Human Services,” states that the Georgia Department of Human Resources and the American Red Cross (ARC) will coordinate with appropriate agencies and organizations to ensure operational readiness to provide mass care to disaster victims, including management of congregate shelters for the general population and bulk distribution of supplies. In addition, the Department of Human Resources and ARC will provide necessary emergency first aid services to supplement emergency health and medical services established by the county to meet victims' needs.

b. Burke County, Georgia

[J.9] Burke County Plan Attachment A, Section E, "Protective Actions," states that the decision to shelter or evacuate the population from an area affected by an incident at VEGP will be based on recommendations from a VEGP official and the judgment of county officials as to whether the situation poses an immediate threat to the citizens of Burke County. The decision may also be based on advice and guidance from GEMA and the Georgia DNR. **[J.10.e, J.10.f]** If the (radioactivity) release data from the facility indicates the potential for hazardous exposure to the thyroid, DNR may recommend that emergency workers entering the affected area take KI. The use of KI is also addressed in Burke County Plan Section V.E. (County authorities are discussed in SER Section 13.3.3.2.1.b.)

[J.10.a, J.10.b] Attachment D, "Affected Area," includes a VEGP 10-mile EPZ map (i.e., Map 1), which shows the Burke County evacuation zones, and Table D-2 shows the population distribution within each zone. (The geographical boundaries of the zones are provided in Table D-1.) **[J.10.h]** In addition, Attachment H includes Map 2, which shows the locations of the EOC/FEOC, boat landings, evacuation routes, traffic control points, hospital, news center, and reception center/shelter (i.e., Burke County High School, which is approximately 15 miles from the VEGP). Attachment I, "Reception and Care," describes the reception center/shelter features and functions. The specific locations, including global positioning system coordinates, are listed in Table H-1.

[J.10.c] Burke County Plan Section IV.B.5.d(2) states that GEMA will activate the PNS in accordance with SOP 3-5 and inform the public of the emergency status and recommend protective actions. Specific actions are described in Attachment A, "Implementation." Augmenting the PNS, and as necessary, public notification will be accomplished using vehicles equipped with sirens and/or public address systems, personnel making door-to-door contact, and boats traveling the affected waterways to warn sportsmen. Notifications are further discussed in SER Section 13.3.3.2.5.b. The county EMA director will coordinate impending activation with GEMA, either at the FEOC or at GEMA headquarters in Atlanta, Georgia. Coordination with NWR activation is discussed in SER Sections 13.3.3.2.1.a and 13.3.3.2.5.a.

[J.10.g] Attachment H, Section D, states that privately owned vehicles will be the primary mode of evacuation. County school buses and specially equipped vehicles will also be available. **[J.10.d]** Section D also addresses the evacuation of the handicapped. Attachment G states that notification and evacuation of handicapped persons living in the 10-mile EPZ are addressed in Burke County SOPs, which are maintained by the EMA Health Department and DFCS. Section E states that an evacuation confirmation process will determine that the entire population has left the affected area and will also assist those who are having difficulty evacuating. Section E describes the agencies involved in the confirmation, as well as the general process.

[J.2, J.10.l] Burke County Plan Attachment H, "Evacuation and Sheltering," states that the selected evacuation routes are adequate to move the population from any part of (or the entire) plume exposure pathway EPZ and channel the evacuees to the reception center and that there are no physical barriers to the movement of evacuation traffic within the 10-mile EPZ. The principal routes have the capacity to carry approximately 550 vehicles per lane per hour in one direction at a safe, constant flow when weather and darkness are not factors. Nighttime and poor weather conditions could reduce this rate of traffic flow up to 30 percent. These numbers are based on a study of the road system designated for evacuation routes. (See Section E of Annex D.)

[J.10.I, J.10.j] Plan Section V.F.2 states that the Burke County Sheriff's Department will provide traffic control, including control of ingress and egress within the affected area and along evacuation routes. Table H2 in Attachment H lists the evacuation routes and traffic control points. Each traffic control point will be manned and/or roadblocks will be employed to channel evacuees out of the affected area and to deny access into the area. Route markers will be placed along the evacuation routes at critical intersections and at roadblock locations to assist traffic flow and increase movement time. [J.10.k] Attachment E, Section H, states that 24-hour wrecker service is available from the private sector (listings are maintained in the county EOC), the county public works department will provide equipment to maintain roadway clearance, and additional assistance can be requested from the Georgia DOT. **[J.10.l]** Attachment H, Table H-3, "EPZ Vehicle Totals," addresses the estimated vehicles within the 10-mile EPZ and provides the ETEs for the residential and transient population and VEGP workforce for various times of the week, and for fair and adverse weather conditions. ETEs for the 10-mile EPZ are also discussed in SER Section 13.3.1.

[J.12] Section V.F.5 describes the means for activation of the high school as a reception center, including providing space, security, facilities, buses for transportation, and manpower for shelter management. Section IV.B.5.d(12) states that reception and care service activities consistent with the Burke County EOP would include monitoring for contamination and decontamination of evacuees and vehicles if a release occurs. Evacuees would be registered and assigned to a shelter area. The reception center would also provide necessary health and other social services to the evacuees. Attachment I presents the details of registering and monitoring evacuees. The Burke County High School would provide adequate space and accommodations to process (e.g., monitor all potentially contaminated residents and transients within 10 to 12 hours after their arrival) and care for the entire 10-mile EPZ population, if necessary. Trained shelter managers and staff will be assigned to the reception center and shelter area to conduct operations necessary to receive, process, shelter, and care for evacuees.

c. State of South Carolina

[J.2] The coordination of evacuation with the South Carolina Highway Patrol is discussed in SER Section 13.3.3.2.10.d. The State of South Carolina is not responsible for evacuation routes and transportation for onsite individuals, as VEGP is located across the Savannah River from South Carolina, and there are no evacuation routes for onsite personnel within the State's boundaries.

[J.9] SCORERP Section IV.B.f states that as warranted by the ECL, DHEC will continuously assess the gravity of the situation by evaluation of the reported radiological release data from the impacted FNF, analysis of field environmental sampling data, and consultation with the NRC. Based on dose assessment data and/or the potential for plant conditions to deteriorate, DHEC will provide protective action recommendation (PARs) to the Governor (or SCEMD director). PARs will, in turn, be coordinated with each impacted county to obtain consensus. Once all with authority to make decisions agree, protective actions will be established by SCEMD and executed in accordance with procedures contained in FNF site-specific plans.

Based on comparisons of projected or actual dose measured and EPA PAGs, DHEC will promptly recommend to SCEMD and State government decisionmakers protective actions to shelter or evacuate the population. **[J.10.d, J.10.e, J.10.f]** If appropriate, the DHEC PARs will also include a recommendation to issue KI to emergency workers and mobility-impaired individuals and to commence monitoring and decontamination activities for evacuees. KI will be issued only if ordered by the DHEC Commissioner (or designee).

[J.10.e, J.10.f] SCORERP Annex F describes the DHEC responsibilities for the distribution of KI to the county health departments for pre-event distribution to the general public who reside within the 10-mile EPZ (including persons who are unable to readily evacuate a particular zone; see SCTRERP Section B.V.B). DHEC also maintains adequate quantities of KI for emergency issue to institutionalized individuals and to State and local government emergency workers. Annex F also describes the county EMA responsibilities relating to KI. (See SER Section 13.3.3.10.d.) KI tablets have been predistributed to the general population who reside in the VEGP 10-mile EPZ, and additional quantities of KI, stockpiled at DHEC and county public health departments, will be transported (on order) to school pickup points, reception centers, and shelters for emergency distribution. Information on the availability of KI and locations where it can be obtained is published annually in the VEGP emergency information brochure and calendar (see SER Section 13.3.3.2.7), which are distributed to all residents within the 10mile EPZ. SCORERP Appendix 2 provides general guidelines and information concerning KI use, and SCTRERP Section B.V.B describes the KI use policy. SCTRERP Appendixes I and IV describe KI distribution, storage, and dosage. SER Section 13.3.3.2.10.a also discusses KI.

[J.10.a] SCORERP–Part 5, Section IV.B, describes evacuation zones, landmarks, and boundaries. In addition, the table to Figure 1 describes the main evacuation routes for Aiken and Barnwell Counties (there are no persons within the Allendale County portion of the 10-mile EPZ). Maps showing evacuation routes, relocation and personnel assembly areas, and sampling and survey locations for the VEGP environs are discussed in SER Sections 13.3.3.2.3.c, 13.3.3.2.9.c and 13.3.3.2.9.d. **[J.10.b]** Figure 3 shows the population distribution, which totals approximately 54 persons.

[J.10.c] SCORERP–Part 5, Annex A, “Alert and Notification,” establishes procedures for the prompt notification of the public within the VEGP 10-mile EPZ. The process consists of State and local coordination of fixed siren activation and EAS broadcast messages which contain protective action instructions based on decisions by government officials. The notification of the transient and resident population is discussed further in SER Sections 13.3.3.2.5.c and 13.3.3.2.7.c.

[J.10.d] Emergency transportation services are the primary responsibility of the affected county. Counties and municipal governments have plans for acquiring emergency transportation in the event of a radiological incident. The means for evacuating schools, jails, hospitals, nursing homes, the homebound, and those without private transportation are identified in the county plans. The affected counties will provide transportation to those evacuees who do not have transportation and confined persons who require special transportation. The counties may request additional assistance from the State. Special transportation needs are addressed in the county EOPs. (See also SER Section 13.3.3.2.10.d.)

[J.10.g, J.10.k] At a site area emergency ECL or as directed by the SEOC chief of operations, in coordination with local law enforcement agencies, the South Carolina Highway Patrol will occupy the traffic control points designated in the VEGP plan. In cooperation with the DNR, all lakes and waterways within the 10-mile EPZ will be cleared, and 2-mile road blocks from the

FNF will be established to restrict access to the facility (by road or water). SCORERP Section IV.B.4, “Evacuation,” states that the South Carolina Department of Public Safety will coordinate evacuation operations under ESF 16, “Emergency Traffic Management,” as described in SCEOP Annex 16.

ESF 16 will coordinate requests from local authorities when reinforcements are needed. The South Carolina DOT will coordinate transportation support operations under ESF 1, “Transportation,” as described in SCEOP Annex 1. If county emergency transportation resources are insufficient to complete a required evacuation or provide other essential services during a radiological emergency, the county may request backup transportation support from the State. SCORERP Section IV.B.6, “Law Enforcement,” states that during an FNF emergency, SLED will coordinate general law enforcement activities, including providing security for all evacuated areas, shelters, and reception centers. (See also SCEOP Annex 13, ESF 13.)

[J.10.l, J.10.j, J.10.k, J.10.l] Portions of the evacuation time study (i.e., ETE) for the VEGP 10-mile EPZ have been excerpted from the VEGP emergency evacuation plan and are included in the county EOPs and site-specific annexes. SCORERP–Part 5, Section IV.B.6, lists population densities and evacuation times. SCORERP Section IV.B.4 states that evacuation time studies for the 10-mile EPZ have been prepared by the utility for the FNF emergency plan. Portions of the study have been included in the county EOPs and site-specific annex to the State plan.

[J.10.m] SCORERP Annex F, Section V, “Radiological Exposure Control for the General Public,” describes the reasoning behind protective action decisions and the overall mission. Rapid action will be needed to protect members of the general public during an incident involving a large release, or having the potential for a large release, of radioactive materials to the atmosphere. Consideration of all risks is important in determining the appropriate response recommendations, and some judgment will be necessary when considering the types of protective actions to be implemented and at what (projected radiation dose) level in an emergency situation. Protective actions should not expose individuals to greater risks than the risk avoided.

[J.10.h] SCORERP–Part 5, Section IV.B.6.i, states that all evacuees will be processed through the shelters or reception centers as outlined in Annex B and that temporary housing should be located at least 5 miles from the 10-mile EPZ outer boundary (i.e., 15 miles from the nuclear facility site). SCORERP Annex B, Section B (Appendix 1), lists the locations of reception centers and shelters in Aiken and Allendale Counties; Barnwell County has none. If a shelter is full, evacuees will be assigned to additional predesignated shelters. ESF 6 and the role of supporting organizations, such as the ARC, are discussed in SER Sections 13.3.3.2.10.a and 13.3.3.2.15.c.

[J.11] SCORERP Annex G describes ingestion pathway activities and states that following a radiological release, the impact on the IPZ will not be known until sample collection and analysis are completed. Once the samples have been analyzed, final protective measures will be determined and implemented. Preventive protective actions are taken to either avoid or reduce the contamination of food, milk, or water and to isolate food to prevent its introduction into commerce. All human consumption foodstuffs in the IPZ will be sampled for radioactive contamination. Additional information on sampling and priorities is available in SCTRERP Appendices I and II, DHEC SOPs.

The SCORERP, SCEOP, and SCTRERP outline responsibilities for protecting the public from ingesting contaminated food and water. Many State agencies share these responsibilities. DHEC takes the lead, and SCEMD is responsible for overall State coordination of nontechnical radiological resources. DHEC determines IPZ-related PARs and presents them to the Governor for approval and implementation. DHEC maintains annually updated records that include the locations of major food producers, processors, distributors, dairies, and surface water systems within the State's IPZ. In coordination with other State agencies, DHEC will develop procedures for utilizing this information to keep affected food producers, processors, and distributors informed about PARs and required post-incident response actions. (See also SER Section 3.3.3.2.9.c.)

[J.12] SCORERP–Part 5, Annex B, "Reception Centers and Shelters," outlines the procedures for the operation of reception centers and/or shelters in the event of an incident at VEGP, which requires evacuation of personnel from the 10-mile EPZ. The facilities will be staffed by ARC, county Department of Social Services, medical, DHEC, and radiological monitoring personnel to provide various services, including registration and lodging assignment, first aid and basic personal needs, and radiological monitoring/decontamination. SCORERP Annex F, Section VII, "Radiological Monitoring/Decontamination," states that reception centers for evacuees will serve as points where radiological contamination monitoring and decontamination will be conducted when ordered. Trained monitoring teams, under the supervision of the county radiological officer, will conduct the monitoring and decontamination (if necessary) and complete the associated records. DHEC will provide technical guidance and advice. Annex F contains monitoring and decontamination procedures and associated documentation forms.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[J.2] In regard to evacuation routes, the county sheriff will, in coordination with the South Carolina Highway Patrol and other law enforcement agencies, coordinate activities in accordance with the affected county EOP. **[J.10.c]** The means for notifying all segments of the transient and resident populations are discussed in SER Sections 13.3.3.2.5.c and 13.3.3.2.5.d. Alert and notification of the public, in support of implementing protective measures, are discussed in SER Sections 13.3.3.2.5.c and 13.3.3.2.5.d. **[J.10.d]** Appendix 4 or 5 of Annex Q2 to the Aiken, Barnwell, and Allendale County Plans states that there are no schools, hospitals, nursing homes, or industries located within the county's respective portion of the VEGP 10-mile EPZ.

[J.9] Section IV.L, "Protective Response," of the county plans states that the SCTRERP provides protective action guides and other criteria consistent with existing EPA guides. The counties provide the mechanism for implementing protective actions, such as sheltering and/or evacuation, for the county population in (and from) sectors recommended by DHEC/SCEMD and ordered by the Governor. Annex F, Section 3.A, states that in the event of a release (or threat of release) of radionuclides from an FNF, DHEC will assess the need for the initiation of radiological exposure control activities specified in Annex F and recommend them to SCEMD. SCEMD will instruct State departments and agencies, including county EMAs, to commence radiological exposure control operations (e.g., monitoring, decontamination, recording) and take protective action measures when advised. The ECLs that would initiate the implementation of protective measures are discussed in SER Sections 13.3.3.2.4.c and 13.3.3.2.4.d.
[J.10.e, J.10.f] The decisions and methods for issuance of KI are discussed in SER Section 13.3.3.2.10.c.

[J.10.a, J.10.b, J.10.I, J.10.j, J.10.I, J.10.m] Section IV.L discusses evacuation and lists the sectors, population, and estimated evacuation times. Attachments 1 and 3 provide maps that show features such as population distributions, evacuation routes, traffic/access control points (and procedures), traffic capacities, and road conditions. **[J.10.k]** Appendix 3 of the county plans states that the responsibility for traffic control during an evacuation of the South Carolina portion of the VEGP 10-mile EPZ is the responsibility of the South Carolina Department of Public Safety, Highway Patrol. The Aiken County Sheriff's Office will staff traffic and access control points. Each traffic management location will be staffed and/or use roadblocks to direct evacuees out of the EPZ and to restrict unauthorized access into the affected area. Route markers will be placed along the evacuation route at critical locations to promote efficient traffic flow.

[J.10.g, J.10.j] Sections IV.J and IV.K of the county plans state that the South Carolina Highway Patrol will operate State traffic control points on roads leading into the EPZ from the county. Staffing of predetermined traffic control points will be assigned to county law enforcement. In the event of an evacuation, the limited populace within the 10-mile EPZ is expected to evacuate using available personal vehicles. If required for special cases, county resources will be made available. **[J.10.l]** Evacuation estimates have been computed to give local officials time data when evacuation decisions become necessary. Attachment 3, Tab A, to Annex Q2, "Traffic Capacities for Evacuation Routes," lists the ETEs for the routes.

[J.10.h] Aiken County will evacuate to South Aiken High School (primary) and/or Kennedy Middle School (backup), and Barnwell County will evacuate to Allendale–Fairfax High School (primary) and/or Allendale Elementary School (backup) in Allendale County. Both facilities are more than 15 miles from VEGP. [J.12] Annex Q2, Section G, of the county plans states that the county Department of Social Services will provide emergency workers to assist the ARC at the predesignated shelters. Evacuees will be directed through these shelters to be monitored and registered, and the counties will maintain monitoring records for evacuees and their vehicles. Monitors at the shelters will complete the dosimetry tracking form and forward the information to the radiological officer on a regular basis.

<u>Conclusion</u>

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for protective response, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard J of NUREG-0654/ FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(10), 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.11 Radiological Exposure Control (10 CFR 50.47(b)(11); NUREG-0654/FEMA-REP-1, planning standard K)

The regulation, as reflected in the planning standard, requires that means for controlling radiological exposures in an emergency be established for emergency workers. The means for controlling radiological exposures shall include exposure guidelines consistent with EPA Emergency Worker and Lifesaving Activity PAGs.

In ESP Plan Section K, “Radiological Exposure Control,” the applicant described the emergency exposure limits for emergency workers, including decisions and efforts made to minimize exposures. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff’s primary focus was the evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard K, “Radiological Exposure Control.” Planning standard K provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(11).

[K.1, K.2] In ESP Plan Section K.1, “Emergency Exposure Guidelines,” the applicant stated that equipment and facilities have been designed to assure adequate safety under normal and postulated accident conditions. Plant design has undergone an extensive as low as reasonably achievable (ALARA) review. Design features are considered for potential exposure, and changes are recommended to reduce potentially high doses. The post-accident sampling procedures have been, or will be, designed to provide adequate protection to personnel during the collection of grab samples. The effluent sampling procedures have been, or will be, written to ensure that no individual receives a dose in excess of regulatory criteria (i.e., 5 rem whole body, 25 rem thyroid, and 75 rem extremities). Plant procedures will specify designated sample points.

During an emergency, it may be necessary to authorize radiation exposures above the limits specified in 10 CFR Part 20, “Standards for Protection against Radiation.” **[K.2]** The emergency director can authorize emergency exposures in excess of these limits but within the limits in Table K-1, “Emergency Worker Limits for Workers Performing Emergency Services.” These higher exposures may be necessary to complete protective, corrective, or lifesaving actions. In all such situations, every reasonable effort will be made to minimize exposures. The emergency director, in consultation with health physics personnel, will make decisions as to appropriate exposures, considering the action required and relative risks. The staff reviewed ESP Plan Table K-1 and found that the guidelines for dose limits, activities, and conditions are consistent with those in Table 2-2, “Guidance on Dose Limits for Workers Performing Emergency Services,” in EPA 400-R-92-001. The staff finds that the applicant has established onsite exposure guidelines that are consistent with the EPA emergency worker and lifesaving activity PAGs.

In ESP Plan Section K.2, “Onsite Radiation Protection Program,” the applicant further stated that where possible, the normal radiation work permit (RWP) procedure will be used to control exposures. This procedure requires signature approval, prior knowledge of worker past exposures, and guidance on protective actions to be used in the course of the emergency work. If time and urgency do not allow this procedure to be followed, the health physics supervisor may approve emergency RWP controls. In all cases, the health physics staff briefs the emergency team on the hazards involved in the planned actions and protective actions to be taken, and a qualified health physics technician accompanies each team.

The dosimetry team will maintain a record of individual and collective exposure received during the emergency. After each entry into a radiologically controlled area, the dosimetry team will update exposure records at the control point or the OSC either through the dosimetry records computer system or manually. An individual’s dose margin will be assessed by determining the difference between the updated exposure and current administrative limit; these margins are used to determine emergency assignments. The implementing procedures describe the operation of the manual system and activation of the dosimetry team.

The health physics supervisor will normally control the radiation dose within the limits authorized by routine station health physics procedures, and personnel radiation exposure records will include all emergency exposures. **[K.2]** The 10 CFR Part 20 limits will not be exceeded without the prior approval of the emergency director. **[K.3.a]** Emergency dosimetry will be available to each member of the ERO for both onsite and offsite organizations as required by the radiological conditions at the time. VEGP Plan, Appendix 4, "Emergency Equipment Lists," presents information on the types of dosimetry available in each emergency response facility and other locations, as well as other equipment (such as protective clothing, respirators, and KI) in support of radiological exposure control.

[K.3.b] Emergency response personnel will be made aware that self-reading dosimeters should be checked every 15 to 30 minutes during the emergency. There is the capability to read TLDs within 24 hours. They will also be read if the individual has received greater than a previously established value as determined by health physics procedures on the individual's direct reading dosimeter. In situations where exposures in excess of 10 CFR Part 20 limits are authorized, emergency team selection will be limited to volunteers who are fully aware of the risks involved for doses greater than 25 rem, and declared pregnant female employees will not be allowed to participate.

[K.6] Personnel exiting the radiation-controlled area will be monitored for contamination by stand-up monitoring booths or by a whole-body scan with a hand-held probe. The standard health physics contamination limits will be used for release of personnel. Plant areas that require access to facilitate recovery operations will be surveyed with portable instruments equipped with beta/gamma detectors. Personnel will wear appropriate protective clothing, as determined by this survey, to perform activities in these areas. **[K.6.c]** Recovery operations will necessitate more detailed surveys on an as-needed basis. The emergency health physics supervisor is responsible for permitting the return of onsite areas and equipment to normal use once monitoring and decontamination are completed.

In ESP Plan Section K.4, "Onsite Radiological Contamination Control," the applicant stated that the security department controls access during emergency conditions. Only authorized emergency response personnel are allowed to enter the protected area. Access to in-plant areas that are contaminated is controlled by barriers, signs, locked doors, or personnel stationed for that purpose. Emergency monitoring teams are responsible for determining the need for onsite access control and establishing the proper method through discussions with TSC personnel. Plant procedures used for determining contaminated areas will be used for determining the need for access control. Any food, tobacco, or potable liquids that are inside a radiation or contamination controlled area, regardless of the packaging, will be considered to be contaminated until surveyed or otherwise determined to be free of contamination. The plant health physics procedures will control these areas, and no eating, smoking, or drinking will be allowed. The emergency director or designee will arrange for supplies to be delivered.

[K.5, L.1] Standard health physics practices will govern the decontamination of personnel. The TSC manager, maintenance supervisor, operations supervisor, or health physics supervisor will determine how to conduct equipment and area decontamination. In ESP Plan, Section K.3, "Decontamination," the applicant stated that the plant administrative and health physics procedures delineate the action levels for determining the need for decontamination of personnel, equipment, and areas. Decontamination facilities are located adjacent to the health physics stations. Instrumentation to survey personnel during and after decontamination is located at the health physics station. The facility has vertical showering and normal wash sinks.

If decontamination activities are required, a controlled access area will be established by roping off the area. Supplies of clean clothing will be available. Personnel will be decontaminated through the use of water washes or other methods for extreme cases as described in plant health physics procedures. These procedures will apply to removal of radioisotopes from the skin. **[K.1, L.2, L.4, O.4.f & .h]** Medical personnel at Doctors Hospital or the Burke Medical Center, as described in Section L of the ESP Plan and discussed in SER Section 13.3.3.2.12, will handle decontamination of serious wounds.

Decontamination equipment for personnel is similar to that available in the decontamination emergency equipment kit (see VEGP ESP Plan, Appendix 4, "Emergency Equipment Lists"), except that the supply is greater and stronger cleaning solutions are available. The plant liquid radwaste system collects and processes waste generated through the use of the decontamination facilities. **[K.7]** ESP Plan Section L.3, "Offsite Support Services," and SER Section 13.3.3.2.12 address the capability for decontaminating relocated onsite personnel.

The staff finds that the applicant has provided an adequate onsite radiation protection program to be implemented during emergencies, which includes provisions for the use of dosimetry and establishment of the means for contamination control and for decontamination of both onsite and relocated onsite personnel.

<u>State and Local Emergency Plans</u> [K.3, K.4, K.5]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard K of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard K are adequate. The following summarizes the FEMA findings for planning standard K.

a.	State of Georgia

[K.3.a, K.3.b] GA REP–Base Plan, Section VI.G.2.d, "Health Physics/Contamination Control," states that during response to a radiological incident, State and local officials will implement health physics and contamination control procedures to limit radiation exposures to the general public and emergency response personnel. Appendix 5, "List of Radiological Emergency Operations Procedures," to this plan lists the procedures, which cover exposure limits for emergency workers and distribution and administration of KI to emergency workers. **[K.5.a]** Depending on the isotopic composition of any released material and the overall severity of an incident, the radiation emergency coordinator may elect to use the guidance found in Tables 1 through 3 of Section VI.G.2 for exposure limits for emergency personnel and for contamination control. **[K.4]** While the radiation exposure limits in the procedures in Appendix 5 are administrative limits and may be exceeded for lifesaving purposes, or with written approval from the radiation emergency coordinator, exposures in excess of the limits in Table 1 will not be authorized.

GA REP–Annex D, Section E.3.b, "Dosimetry Evaluations," states that personnel engaged in emergency response activities that may lead to radiation exposures will be provided dosimetry. Survey meters and limiting area stay times are other methods that may be used to control exposure. If necessary, the evaluation of internal exposures will use bioassay techniques, which will be supported by other agencies and commercial labs. GA REP–Annex D, Section D, “Manpower, Equipment and Instrument Resources,” addresses available radiological equipment.

[K.5.a, K.5.b] GA REP–Annex D, Section E.3.d, “Personnel Contamination Control/ Decontamination,” states that in situations where evacuees become contaminated, radiological survey and decontamination parties will be organized and dispatched to the location of the contaminated personnel and will accomplish the necessary decontamination. Members of the general public will be decontaminated to background (radiation) levels, if possible, and emergency response personnel to the levels in GA REP–Base Plan, Section VI.G, “Incident Assessment and Protective Response.” Tables 2 and 3 in Section VI.G.2.d of the plan specify contamination limits for persons, animals, and surfaces. Trained State and local radiation monitors posted at appropriate locations will check for contamination of personnel who have been in the affected areas.

b. Burke County, Georgia

[K.3.a, K.3.b] Burke County Plan, Attachment A, Section E.4, “Radiological Exposure Control,” states that personnel engaged in emergency response activities that may lead to radiation exposures will receive pocket dosimeters and TLDs. Those engaged in monitoring operations will use equipment to take direct radiation readings, as well as soil, vegetation, and air samples. All persons entering the affected areas will record exposures on exposure control forms and return them to the Burke County EMA radiation officer. A continuous 24-hour-per-day capability will be maintained to determine doses to emergency response personnel, including volunteers. **[K.5.a]** Exposure control and contamination guidelines will be in accordance with emergency response personnel PAGs. **[K.4]** Only the GEMA, upon recommendation from the DNR-EPD radiation emergency coordinator, can authorize exposures up to the PAG limits. Personnel dosimetry kits will contain criteria/instructions for decontamination procedures, including identification of the location for decontamination of personnel, equipment, and vehicles.

[K.5.a, K.5.b] Burke County Plan Section IV.B.5(12) states that if a release has occurred, evacuees will be monitored upon their arrival at the reception and care center. Equipment and trained personnel from local and State agencies will be assigned to the reception center to monitor evacuees. All potentially contaminated residents and transients from the EPZ will be monitored within 10 to 12 hours after their arrival. Contaminated evacuees will be processed through a decontamination area located in the gymnasium (shower area) of the Burke County High School. Vehicles will be surveyed for contamination and decontaminated at a designated site, if required. All local and State emergency workers returning from the affected area will report to the vehicle decontamination point.

Section V.F, “Departments/Agencies, Roles and Notification,” states that the Burke County fire department will provide decontamination service in the affected areas and at a vehicle decontamination point near the reception center. The Burke County health department will perform radiation surveys of evacuees, decontaminate personnel, and identify health hazards in coordination with DNR-EPD and the Georgia Department of Agriculture and DNR. The Burke County Hospital is the primary facility for treating offsite victims of a radiological accident, including contaminated injuries. If a radiation accident victim requires more definitive care than that available at the primary or secondary medical facilities, the victim may be transported to ORHMC in Oak Ridge, Tennessee.

c. State of South Carolina

[K.3.a, K.3.b] The SEOC will provide incident assessment and dose projection information to affected counties and State RER agencies. County emergency management directors and State agency chiefs are responsible for monitoring the exposures received by their respective emergency workers and for ensuring that exposures do not exceed dose limits in SCORERP Annex F, Table B, "Guidance on Dose Limits for Workers Performing Emergency Services." All 10-mile EPZ emergency workers will receive personal dosimetry and KI, and they will periodically read and maintain a record of individual exposures. Throughout the incident, DHEC will monitor State and local emergency workers' exposure rates and accumulated doses, in order to provide timely protective action guidance.

In Section IV.A of SCORERP Annex F, the SCEMD is responsible for distribution of dosimetry, in coordination with risk and host county EMAs, as well as collecting dosimetry and records after an incident. Section III.D states that local governments will distribute dosimetry that has been pre-positioned by the State and that the county radiological officer will maintain permanent records of exposures and submit them daily to DHEC at the SEOC. SCORERP Section IV.D, "Dosimetry," states that before dispatch, all emergency workers with assignments inside the 10-mile EPZ will receive dosimetry and a 10-day supply of KI. Annex F to Section VII.B states that each risk county EMA will provide monitoring stations for emergency workers and that, following a mission, emergency workers must report to a monitoring station (or reception center monitoring point) to be monitored for contamination and, if necessary, be decontaminated. Each emergency worker will maintain individual exposure records, in accordance with Appendix 3 of Annex F, which provides instructions relating to dosimeter use, including reading the dosimeter every 15-30 minutes. DHEC is responsible for maintaining emergency worker and general public radiation exposure records.

[K.4] SCORERP Annex F, Section III, states that DHEC may authorize emergency workers to exceed PAG exposure levels. All others, including county and municipal employees serving as radiological emergency workers, will be authorized to exceed PAG levels in the following manner:

- The DHEC RER coordinator recommends exposure level limitations to the SCEMD director.
- The SCEMD director passes the recommendation to the county EMA director, who makes a recommendation to the chairman, county council/administrator/supervisor.
- The county authority, with DHEC consent, authorizes an emergency worker to exceed the general public PAG radiation limits.

[K.5.a, K.5.b] SCORERP Annex F, Section VII, "Radiological Monitoring/Decontamination," addresses action levels for determining the need for decontamination, including the means for decontamination. Section VII.E, "Contamination Action Levels," specifies action levels for determining the need for personnel and vehicle/equipment decontamination. Decontamination procedures for personnel, clothing, and vehicles are provided in Appendix 1 to Annex F, Sections VI, VII, and VIII, respectively. Monitoring and decontamination procedures for emergency workers, vehicles, and equipment are the same as those used for evacuees.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[K.3.a, K.3.b] Section IV.N, "Radiation Exposure Control," of the county plans states that emergency workers will be issued a direct-reading dosimeter and a permanent record TLD and that additional dosimetry is available at each county's emergency preparedness/management office. Each emergency worker is responsible for reading and recording his dose and submitting the accumulated dose number to his supervisor. **[K.4]** Exposure control, including authorization to exceed the EPA PAGs, will be in accordance with SCORERP Annex F and the guidelines in SCTRERP. County supervisors/service chiefs will closely monitor county personnel working in contaminated areas and will arrange for rotations to limit individual dose.

[K.5.a, K.5.b] Appendix 8, "Radiological Decontamination," to the Barnwell and Aiken County Plans (Appendix 9 to the Allendale County Plan) states that action levels for decontamination will be as outlined in SCTRERP, Appendix I. (See also SCORERP Section VII, discussed above.) The responsible county official will direct all county radiological monitoring teams, including the team at the local vehicle decontamination point. If necessary, the teams will perform decontamination as outlined in the county radiological monitoring and decontamination SOP. All decontamination will be in accordance with DHEC requirements.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for radiological exposure control, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard K of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(11), 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.12 Medical and Public Health Support (10 CFR 50.47(b)(12); NUREG-0654/FEMA-REP-1, planning standard L)

The regulation, as reflected in the planning standard, requires that arrangements be made for medical services for contaminated injured individuals.

In ESP Plan Section L, "Medical and Public Health Support," the applicant described the provisions to assist personnel who may be injured, receive high radiation doses, or be externally contaminated. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. In this evaluation, the staff's primary focus was on its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard L, "Medical and Public Health Support." Planning standard L provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(12).

[K.1, L.2, O.4.f & .h] In ESP Plan Section L.1, "On-Site Capability," the applicant stated that it has arranged for assistance to personnel who are injured, who may have received high radiation doses, or who have been externally contaminated. Decontamination materials and portable first aid kits are available at strategic locations throughout the VEGP site, and on-shift personnel in the ERO are trained in first aid and decontamination procedures and are available on a 24-hour basis. Health physics technicians assigned to the first aid teams will direct and assist in decontamination of injured persons, as necessary. An onsite first aid and decontamination area near the health physics stations is equipped with decontamination supplies and other specialized equipment. The staff reviewed other application sections that deal with the availability of 24-hour emergency communications and response and discusses those reviews in SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.5, 13.3.3.2.6, and 13.3.3.2.8.

[K.5, L.1] The applicant provides training for both onsite and offsite personnel (e.g., plant, EMS, and hospital personnel) in the handling and treatment of injured/contaminated patients through Radiation Management Corporation (RMC). Section 13.3.3.2.15 of this report and the February 15, 2005, letter of agreement between RMC and SNC address this training. The VEGP training department conducts training sessions at least once per calendar year, and drills and exercises are an integral part of the program. SER Section 13.3.3.2.14 addresses medical emergency drills.

[L.1, L.3] In ESP Plan Section L.3, "Offsite Support Services," the applicant stated that it has arranged with Doctors Hospital in Augusta, Georgia, and Burke County Hospital (Burke Medical Center) in Waynesboro, Georgia, for the treatment of externally contaminated patients. To facilitate the handling and treatment of contaminated individuals, each hospital has a radiation emergency area with a separate entrance adjacent to the emergency room complex, specialized supplies, and equipment (including radiation survey instruments) for decontamination, exposure evaluation, and contamination control. The medical staff of the hospitals are trained to treat externally contaminated patients or individuals who have received high exposures according to a hospital procedure entitled "Decontamination and Treatment of the Radioactively Contaminated Patient." The applicant has made additional arrangements with local doctors to render medical assistance, both on site and off site, and to assume responsibility for the medical supervision of the patient. These doctors will be on emergency call at all times and will respond to an accident when called. (SER Section 13.3.3.2.11 also discusses the treatment of contaminated injured persons.)

[K.1, L.4, O.4.d, .f & .h] In ESP Plan Section L.2, "Medical Transportation," the applicant stated that it has arranged with the Burke County ambulance service (also known as Ambulance Service Burke County) for the transport of victims of radiological accidents to Doctors Hospital or Burke County Hospital. The staff review of the structure of the local ambulance service available to VEGP, which included an Internet search and an examination of existing local resources, found that the Ambulance Service Burke County is one of 12 ambulance services in Burke County, which are provided by Burke County EMA. The staff also reviewed the letters of agreement with Burke County EMA (dated April 2, 2004, and April 17, 2006), which are included in the application, and finds that they address (in part) the Burke County EMA commitment to provide ambulance service for calls involving casualties arising from a radiation accident at VEGP. In addition, the letters commit to continuing participation in any further development of the emergency plan in support of the proposed Units 3 and 4.

In addition to reviewing the letters of agreement with Burke County EMA, the staff examined additional letters of agreement with local and backup hospitals and other medical support organizations (discussed above). The staff found that the detailed descriptions of contacts, arrangements, and committed resources provide a substantial and adequate medical and public health support capability in support of the VEGP site, including the addition of VEGP Units 3 and 4. The emergency facilities have emergency plans, staff training programs, and adequate equipment and supplies for receiving and handling injured and/or radiologically contaminated patients from the VEGP site. These specific agencies and organizations include the following:

- Burke County EMA/Burke County Ambulance Service (Waynesboro, Georgia)

- Burke Medical Center (Waynesboro, Georgia)
- Doctors Hospital (Augusta, Georgia)
- Dr. B. Lamar Murray (Waynesboro, Georgia)
- Joseph M. Still Burn Centers, Inc. (Augusta, Georgia)
- Medical Specialists, Inc. (Waynesboro, Georgia)
- RMC, Inc. (Philadelphia, Pennsylvania)

<u>State and Local Emergency Plans</u> [L.1, L.3, L.4]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard L of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard L are adequate. The following summarizes the FEMA findings for planning standard L.

a. State of Georgia

[L.1, L.3] GA REP–Base Plan, Section VI.K, "Medical and Public Health Support," states that local medical facilities and agencies will furnish required medical and public health support, provided that they are prepared, equipped, and trained to provide the required support. In situations where radiological accidents occur and radiation injury or contamination is involved, many local hospitals or medical agencies do not have the capability to handle such victims. In these cases, victims will be sent to hospitals or medical agencies with the necessary capabilities. Appendix 3, "Medical Facilities with Capabilities of Caring for Radiation Accident Victims," lists the following facilities:

- Meadows Regional Medical Center (Vidalia, Georgia)
- Appling Health Care System (Baxley, Georgia)
- Early Memorial Hospital (Blakely, Georgia)
- Doctors Hospital (Augusta, Georgia) – secondary facility
- Burke County Hospital (Waynesboro, Georgia) – primary facility
- Southeast Alabama Medical Center (Dothan, Alabama)

GA REP–Annex D, Section F, "Medical/Public Health Support," states that agreements have been made with Burke County Medical Center and Doctors Hospital for the care of radiologically contaminated injured victims in the event of an incident at VEGP. Burke County Hospital and Doctors Hospital have a licensed bed capacity of 40 and 374, respectively. These two hospitals have the necessary equipment and protective clothing to treat contaminated injured persons. If needed to supervise treatment of contaminated injuries, each hospital has at least one medical doctor and one registered nurse who are available within 2 hours if needed to supervise treatment of contaminated injuries. The hospitals can treat up to 30 ambulatory patients within a 24-hour period. (Letters of agreement for such support exist between GEMA and both hospitals.) If victims require more definitive care than that available at these two facilities, they may be transported to the ORHMC. Section F.7 describes health system resources in contiguous States and at military facilities, which can be requested if the State of Georgia's resources are depleted or a particular required resource does not exist in the State.

[L.4] GA REP–Annex D, Section F.3, "Transportation of Accident Victims," states that the Burke County Ambulance Service has agreed to transport accident victims to the primary and secondary medical facilities. If additional ambulances are needed, University Ambulance

Service in Augusta, Georgia, may be called. If a victim must be immediately transported a considerable distance, the services of MAST facilities at Fort Stewart (near Savannah, Georgia) will be requested; response will be handled on an availability basis.

b. Burke County, Georgia

[L.1. L.4] Section C, "Response," of Burke County Plan Attachment A states that the primary medical facility for the care of offsite victims of an incident at VEGP, including the contaminated injured, will be Burke County Hospital. If the capacity of this facility is exceeded, the secondary medical facility is Doctors Hospital. If a radiation victim requires more definitive care than that available at these facilities, the victim may be transported to the ORHMC. Burke County Plan Section V.F.8 states that Burke County Hospital will provide various services to support an emergency response, including coordinating with emergency medical support personnel and vehicles, and if necessary, procuring additional medical practitioners and medical service support. Attachment K, "Training and Exercises," states in Section C that checklists have been prepared for local officials and departments/agency personnel to enhance the training program and further ensure emergency operational readiness; a checklist has also been prepared for EMS. (SER Section 13.3.3.2.15 discusses RER training.)

c. State of South Carolina

[L.1] SCORERP–Part 5, Annex C, "Medical and Public Health Support," states that letters of agreement have been obtained from local (primary and backup) hospitals that have the capability to receive and care for victims of radiological incidents. Appendices 1 and 2 contain specific letters of agreement for services by designated medical facilities (Burke County Medical Center and Doctors Hospital, respectively), and similar letters appear in the Aiken, Allendale, and Barnwell County emergency operations plans. **[L.3]** Appendix 3, "Medical Facilities for Receiving Victims of a Radiation Incident," to SCORERP, Annex E identifies medical facilities in the vicinity of commercial and DOE facilities that have the capability to treat radiologically contaminated/injured individuals. If a radiological accident exhausts the State's available medical facilities, backup support is available from the States of Georgia and North Carolina and from the Radiation Emergency Assistance Center Training Site in Oak Ridge, Tennessee. **[L.4]** Section IV of Annex C and SCORERP Annex E (Section IV) state that ESF 8 ("[Public] Health and Medical Services") organizational resources will coordinate and provide emergency transportation for contaminated, injured individuals from the affected areas around each nuclear power plant in the State. (See also GEOP ESF, Annex 8.)

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[L.1, L.4] Section IV.O, "Medical," of the county plans states that Doctors Hospital will treat contaminated victims of a radiological accident at VEGP. DHEC is responsible for training persons who will provide medical services to contaminated victims. Section K, "Transportation," states that designated ambulances of the county emergency medical service will transport contaminated victims and that personnel will take protective measures to prevent the spread of any contamination from the victim. Upon arrival at the medical facility and removal of the victim from the ambulance, the ambulance and its attendants will go through a decontamination station.

<u>Conclusion</u>

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for medical and public health support, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard L of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(12) 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.13 Recovery and Reentry Planning and Post-accident Operations (10 CFR 50.47(b)(13); NUREG-0654/FEMA-REP-1, planning standard M)

The regulation, as reflected in the planning standard, requires that general plans for recovery and reentry be developed.

In ESP Plan Section M, "Recovery and Reentry Planning and Post-Accident Operations," the applicant described the steps it will take once the emergency situation has ended to mitigate the consequences of the event and to minimize any effects on the health and safety of the public and emergency workers. The staff reviewed this section, as well as other relevant portions, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard M. Planning standard M provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(13).

[M.1] In ESP Plan Section M.1, "Commencement of Recovery Phase," the applicant stated that the emergency director will determine when the recovery phase begins. Before terminating the emergency, the director will observe the various guidelines (or conditions) listed in that section. The staff reviewed these general conditions, which include consideration of the reactor stability, plant radiation levels, and releases of radioactive material to the environment, and finds that they are reasonable and generally include the most significant aspects of the plant's condition that should be considered before ending the formal emergency phase. For example, the staff reviewed the condition associated with a site area emergency or general emergency. For these two classifications, before terminating the emergency and beginning the recovery phase, the emergency director would discuss the situation with plant management; applicable members of the VEGP ERO; and offsite authorities, including the NRC, Georgia EMA, Burke County EMA director, South Carolina EMD director, and SRS emergency staff.

In ESP Plan Section M.3, "Reentry Planning," the applicant further stated that if the accident situation involved a release of radioactivity, it would monitor appropriate areas of the plant and site to determine contamination and radiation levels and that it would identify and control access to these areas in accordance with normal plant procedures. When reentry to a radiation area is required for inspection of work, the activity will be preplanned, and plant radiation work practices and ALARA program principles will be followed. The staff finds this acceptable, in that the applicant has developed general plans and procedures for reentry and recovery and has described the means by which decisions to relax protective measures are reached. These decisions will consider both existing and potential conditions.

[M.3] Once the conditions of the termination guidelines have been satisfied, the emergency director will announce that the emergency is terminated and the plant is in a recovery mode. He will direct that all elements of the ERO be advised of the change in status via the ENN, ENS, and other pertinent communications systems. At this time, the emergency director will designate a recovery manager to constitute the recovery organization. The staff finds this acceptable, in that it adequately provides for informing members of the response organization that a recovery operation is to be initiated and that changes in the organizational structure are possible.

[M.2] Initially, the recovery manager may direct operations from the EOF. The manager will structure the recovery organization to accomplish the general recovery objectives listed in ESP Plan Section M.2, "Recovery Operations," and will assign individuals to specific positions, depending on the nature and extent of damage to the plant. ESP Plan Figure M-1, "Recovery Organization," shows a representative organization for recovery operations. The staff reviewed Figure M-1 and the descriptions in ESP Plan Section M.2 of the roles of those holding key positions in the facility recovery organization and finds that the applicant has adequately described each position's authority and responsibilities. The staff also finds that the applicant included the appropriate technical personnel with responsibility for developing, evaluating, and directing recovery and reentry operations.

[M.4] In ESP Plan Section M.4, "Exposure Monitoring," the applicant stated that all personnel who require access to the plant or to radiation areas on site during the recovery phase will be issued dosimetry, as appropriate. The criteria for reading TLDs and assessing radiation dose will be in accordance with standard health physics practices. The results of the dosimeter readings, including integrated exposures (i.e., man-rems), will be reported to the recovery manager, the radcon/radwaste manager, and others in the plant organization who normally receive such reports.

[M.4] In ESP Plan Section M.4, the applicant also stated that the States of Georgia and South Carolina and SRS have the responsibility for determining population exposure of the public via plume exposure and ingestion pathways. [E.4.h-l] VEGP will provide radiological information including the estimated quantity of radioactivity released, isotopic composition of released material, and meteorological data to assist the governmental authorities in their determinations. By determining the affected population and by performing dose assessment calculations, including determination of the quantity of radioactivity released and release rate, VEGP personnel can estimate the population exposure, if necessary. Personnel can use data from monitoring stations (TLDs and air samplers) to confirm the exposure estimates.

The applicant referenced Appendix 6 to the ESP Plan, which addresses new ETEs for the VEGP (10-mile) plume exposure pathway in support of this application, in regard to determining the affected population. In RAI 13.3-11, the staff asked the applicant to explain the use of the ETE to determine the affected population for purposes of dose assessment and estimating the population exposure following a radioactive release. In addition, the staff asked the applicant to describe the method in the ESP Plan for periodically estimating total population exposure. The applicant responded that the MIDAS software had the ability and will be used to estimate population exposure, including total population exposure. The staff finds this acceptable. The applicant also stated that SNC will verify that the population numbers used in MIDAS are conservative compared to the updated ETE and, if necessary, will update the software to reflect the new population numbers. In the Safety Evaluation Report with open items, the staff identified the verification/updating of the MIDAS software by the applicant as Open Item 13.3-11. The staff reviewed the applicant's response in its submittal dated October 15, 2007 – which stated that the MIDAS code had been reviewed to determine the impact of the updated ETE, and that no programming changes are required – and finds it acceptable. Therefore, Open Item 13.3-11 is resolved.

State and Local Emergency Plans [M.1, M.3, M.4]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard M of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard M are adequate. The following summarizes the FEMA findings for planning standard M.

a. State of Georgia

[M.1] GA REP–Base Plan, Section VI.H, "Recovery and Reentry Planning," notes that the State disaster coordinator will control recovery to normal operations, and the radiation emergency coordinator will provide technical advice. EROs with pre-accident emergency response roles will assist in recovery operations and reentry planning and execution. During recovery operations, the radiation emergency coordinator, in consultation with radiological technical personnel, will provide technical expertise concerning the need for continued radiological evaluation and radiation evaluation and control. The DNR-EPD will arrange for the necessary radioanalytical service through the recovery phase, either by utilizing DNR-EPD personnel and equipment resources, or contract services, or both. Reentry into the area will be permitted only after a thorough radiological evaluation of the area by DNR-EPD, which has a mobile and fixed radiological laboratory capability. DNR-EPD will request Federal resources to assist with these evaluations through the FRMAC.

[M.3] GA REP–Base Plan, Section VI.H, also states that the roles and responsibilities of the various agencies will be similar to, or compatible with, their pre-accident or accident roles. The organization of various State agencies in the recovery effort will be similar, if not identical to, the organization depicted in the GEOP. The GEOP prescribes the general organization, role, responsibilities, and operating procedures for all State agencies involved in emergency operations. During the recovery phase, the State disaster coordinator and support agency coordinators/managers will meet periodically to determine progress, review current operations, approve new or proposed operations, keep communication lines open, and disseminate information relevant to needed changes or modifications to response activities. Should a unique situation present itself in a recovery operation that would require changes to the current plan of operation, the State disaster coordinator would direct those changes and provide written notice of the changes to the various response agencies.

[M.4] GA REP–Base Plan, Section VI.G, "Incident Assessment and Protective Response," states that after plume passage, assessment activities will focus on determining the consequences of any radioactive materials that the release may have deposited. Included in these activities are assessments of radiation doses to the general public resulting from reentry into evacuated areas and ingestion/inhalation of deposited materials from the incorporation of radioactive materials in food products and water. Details of these assessment activities and protective measures, which may be implemented to reduce the potential impact of deposited radioactive materials on agricultural pathways, appear in GA REP–Annex F, "Ingestion Pathway." GA REP–Base Plan, Section VI.H, discusses reentry monitoring and protective measures. GA REP–Annex D lists site-specific locations that may be monitored or sampled.

GA REP–Annex D, Section E.1.e, "Correlation of Dose Projections and Actual Dose Measurements," states that as an incident progresses, the radiation emergency coordinator will evaluate the need for correlation of dose projections and actual dose measurements. As soon as field measurements are made, they can be compared with projected values, but only after sufficient data are gathered will a decision be made as to whether correlation (or scaling) factors should be developed for use in the emergency dose projections. Population dose estimates will be made using release rate and meteorological data for the release period and data from the licensee, DNR-EPD, and TLDs, as well as DOE aerial measurements (as such data become available). This activity will be coordinated with the FRERP, which identifies the responsible agencies that will be involved in long-term dose assessment activities after an accident.

b. Burke County, Georgia

[M.1] Burke County Plan, Section IV.B.5.d (13), states that members of the evacuated population will be returned to their homes when the affected area is safe for reentry, in accordance with procedures described in GA REP–Base Plan, Section VI.H.2, "Reentry." The activities and functions of city and county officials, departments, and agencies will provide (1) traffic control to assure an orderly return of evacuees to their homes, (2) transportation to return nonambulatory persons to their homes, (3) technical assistance for necessary decontamination of homes and property, and (4) guidance on food and water supplies for people and livestock. Attachment A states that reentry and recovery operations will be initiated only when plant officials verify that the emergency situation has been eliminated, and State officials, acting on their field data, ascertain that there is no longer a threat to the health and safety of persons living nearby. Local officials will maintain coordination with GEMA and make decisions in accordance with EPA PAGs.

c. State of South Carolina

[M.1, M.3] SCTRERP, Appendix VII, "Recovery and Re-entry," states that radiological monitoring, exposure evaluation, and decisions concerning recovery and reentry will be the responsibility of the BLWM, DHEC. Before recommending reentry, the BLWM will consult with the NRC, nuclear facility officials, local government, and other technical agencies. SCORERP, Section IV.D, "Post-Accident Recovery," further describes recovery authorities and actions, stating that SCEMD will recommend to the Governor when reentry can be initiated for specific evacuated areas. With the Governor's concurrence, SCEMD will notify the RER organizations and local governments that reentry can begin. Decisions to relax protective measures and allow recovery and reentry into an evacuated area require a continuous estimate of the radiological situation. The estimate and calculation are accomplished by the analysis of radiological monitoring data from air samples, milk, water, and direct radiation measurements. Reentry will be authorized when projected doses fall below 20 percent of the appropriate PAG and when surface contamination is reduced below the applicable limits.

[M.1] SCORERP Section IV.B.6, "Law Enforcement," states that during recovery operations, SLED, in cooperation with all State and local law enforcement agencies, DHEC, Clemson University Extension Service, and the State Department of Agriculture, will develop and implement plans for maintaining access control to all evacuated areas and for long-term or permanent access control to restricted areas. (This is discussed further in SCORERP Appendix 5, "EPZ Access Control Identification Procedures.") To further support recovery operations, SLED will assist with the development and implementation of plans to embargo (or restrict) transportation of contaminated food products and will assist special groups such as farmers or other individuals performing missions involving maintenance and disposition of livestock and food products.

DHEC will continue to provide technical recommendations and accident assessment until the recovery phase is terminated and will coordinate closely with local governments throughout the post-accident recovery. Various media will disseminate extensive public information on recovery instructions, such as decontaminating foodstuffs, caring for livestock, and personal precautions. SCORERP Annex G describes specific activities associated with recovery and reentry. **[M.4]** SCTRERP Appendix III, "Environmental and Health Effects Assessment Plan," states that the total projected exposure resulting from actual (or projected) releases is the product of individual exposure and population affected. Sector population will be obtained from the SCORERP and the utility, with the use of the evacuation time study for the 10-mile EPZ evacuation zones.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[M.1] The counties will rely on DHEC for relaxation of protective measures, in accordance with the SCTRERP and its procedures. Notification to relax protective measures will come from the State EOC, and the counties will follow the procedures issued by the SCTRERP for general recovery plans.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for recovery and reentry planning and post-accident operations, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard M of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(13), 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.14 Exercises and Drills (10 CFR 50.47(b)(14); NUREG-0654/FEMA-REP-1, planning standard N)

The regulation, as reflected in the planning standard, requires that periodic exercises be conducted to evaluate major portions of emergency response capabilities, periodic drills be conducted to develop and maintain key skills, and deficiencies identified as a result of exercises or drills be corrected.

In ESP Plan Section N, "Exercises and Drills," the applicant described the conduct and frequency of emergency exercises and drills, including coordination between the VEGP site and offsite EROs. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard N, "Exercises and Drills." Planning standard N provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(14).

[N.1, N.2] In ESP Plan Section N, the applicant stated that emergency exercises and drills are conducted to test and evaluate the adequacy of emergency facilities, equipment, procedures, communication links, actions of emergency response personnel, and coordination between VEGP and offsite EROs. Some exercises and/or drills will be unannounced. **[N.1] Unit 3 ITAAC 8.1** states that "a full participation exercise (test) will be conducted within the specified time periods of 10 CFR Part 50, Appendix E." The specific acceptance criteria are provided in Table V2A3-1.

In RAI 13.3-46.h, the staff asked the applicant to provide a revised acceptance criterion 8.1.1 that identifies specific exercise objectives and associated acceptance criteria. In its response, the applicant provided a revised Table V2A3-1, which included numerous acceptance criteria for ITAAC 8.1. Many of these acceptance criteria used nonspecific language, such as stating that an action "should be" done rather than "is" done. Designating that an exercise action "should be" done allows for an acceptable outcome if nothing is done; that is, it implies that the action is optional. This nonspecific language is contrary to the intended purpose of ITAAC, in that meeting ITAAC acceptance criteria is not optional. The ITAAC should provide specific and objective goals, for which completion of the acceptance criteria is easily discernible. The staff had suggested revisions to the ITAAC 8.1 acceptance criteria 8.1.1: A.1.a, D.2.b, D.2.c, E.1.a, E.1.b, E.2.a, E.2.b, E.3.a, E.5.a, E.6.a, E.7.a, E.7.c, F.1.a, F.1.b, F.2.a, F.2.b, F.2.c, G.1.a, and G.1.b. In the Safety Evaluation Report with open items, the staff identified the revision of these acceptance criteria as Open Item 13.3-12. The staff reviewed the applicant's response in its submittal dated October 15, 2007, which made the suggested revisions, and finds it acceptable. Therefore, Open Item 13.3-12 is resolved.

In RAI 13.3-46.e, the staff asked the applicant to explain why there was no **Unit 4 ITAAC 8.1** comparable to the **Unit 3 ITAAC 8.1**. The applicant responded that since the Unit 3 exercise will be completed before fuel load for Unit 3, and the emergency plan elements for Unit 4 are identical to those for Unit 3, another full exercise is not required for Unit 4. The staff agrees that capabilities that are common to both Units 3 and 4 can be adequately demonstrated through the Unit 3 exercise; however, capabilities that are specific to a unit require unit-specific exercise evaluation. The proposed **Unit 3 ITAAC 8.1.1** includes, for example, acceptance criteria that would demonstrate performance associated with EAL parameters (see 8.1.1, A.1) and OSC activation (see 8.1.1, D.1), which are not totally common to Units 3 and 4 (i.e., they are not identical). The applicant must either explain why **Unit 3 ITAAC 8.1** will demonstrate the sufficiency of the ITAAC in relation to Unit 4, or supplement Table V2A4-1 with comparable Unit 4 ITAAC. In the Safety Evaluation Report with open items, the staff identified the resolution of this issue as Open Item 13.3-13. (See also SER Section 13.3.3.2.1, regarding **Unit 3 ITAAC 9.1**, and SER Section 13.3.3.2.9, regarding Unit 3 ITAAC 6.1 through 6.7.) The staff reviewed the applicant's response in its submittal dated October 15, 2007 – which provided comparable Unit 4 ITAAC in Table V2A4-1 – and finds it acceptable. Therefore, Open Item 13.3-13 is resolved.

Unit 3 ITAAC 8.1.2 states that onsite emergency response personnel are mobilized in sufficient number to fill the emergency positions identified in emergency plan Section B (VEGP Emergency Organization), and they successfully perform their assigned responsibilities, as outlined in criterion 8.1.1.D (Emergency Response Facilities). **Unit 3 ITAAC 8.1.3** states that the exercise is completed within the specified time periods of 10 CFR Part 50, Appendix E; offsite exercise objectives have been met; and there are [either] no uncorrected offsite deficiencies, or a license condition requires offsite deficiencies to be corrected prior to operation above 5% of rated power.

[N.1] Emergency preparedness exercises test integrated response capabilities and are conducted in accordance with NRC and FEMA guidance, as described below. Exercises are conducted every 2 calendar years and are designed to include the demonstration of response to a major portion of the basic elements of the emergency preparedness plans of the participating organizations. The planning and execution of the emergency exercise is coordinated with Federal, State, and local agencies, as appropriate.

Those exercises in which offsite response groups play a significant part include mobilization of Federal, State, and local personnel and resources adequate to verify the capability to respond to an accident situation. The exercise program for VEGP incorporates the following features:

- Scenarios are varied from year to year so that all major elements of the VEGP emergency preparedness program are tested within a 6-year period.

- VEGP starts an exercise between 6:00 p.m. and 4:00 a.m. once every 6 years.

- Since exercises are normally scheduled several months in advance, a variety of weather conditions is likely to occur.

[N.2] A drill is a supervised instruction period aimed at testing, developing, and maintaining skills in a particular operation. Drills may be incorporated into the biennial exercise; they will be supervised and evaluated by either a training instructor or designated controller/evaluator. The States of Georgia and South Carolina, including the counties of Burke, Aiken, Allendale, and Barnwell, will be permitted to participate in drills when requested by the State or county government.

[N.2] Drills shall be conducted (in the categories indicated below) to ensure that adequate emergency response capabilities are maintained in the interval between biennial exercises. At least one of these drills will be conducted during the calendar year when there is no biennial exercise and shall involve a combination of some of the principal functional areas of the onsite emergency response capabilities. The principal functional areas include activities such as command and control of emergency response, accident assessment, protective action decision-making, and plant system repair and corrective actions. Activation of all ERFs (TSC, OSC, and EOF) is not required during these drills. Supervised instruction, success paths, and accident management strategies may be included in these drills.

- <u>Communication Drills</u> – Communication drills will be conducted every 2 years (normally during the biennial exercise) to ensure that emergency communication channels between VEGP facilities, field monitoring teams, and offsite authorities are operable. In VEGP Section F.8, "Communications Systems Tests," the applicant described the testing of various communication channels, which are discussed in SER Section 13.3.3.2.6.

- <u>Fire Drills</u> – Quarterly fire drills are conducted in accordance with the respective FSAR and are scheduled so that each member of the fire brigade participates in at least two drills per year. An annual practice is conducted which requires extinguishing a fire.

- <u>Medical Emergency Drills</u> – A medical emergency drill involving a simulated contaminated person is conducted each calendar year and may be included as part of the biennial exercise. The simulated injured player is given initial treatment by the

VEGP first aid team and transported by ambulance to the hospital for subsequent treatment by the hospital staff.

- Radiological Monitoring Drills – Plant environs and radiological monitoring drills are conducted each calendar year perhaps as part of one of the semiannual health physics drills. A team is dispatched to obtain required measurements or samples, and the drill controller evaluates the proper use of survey instruments, recordkeeping, communications, and the collection of sample media (soil, air, water, and vegetation).

- Health Physics Drills – Semiannual health physics drills are conducted to simulate, as closely as possible, anticipated elevated airborne and liquid samples and radiation in the environment.

In ESP Plan Sections F and H (discussed in SER Sections 13.3.3.2.6 and 13.3.3.2.8, respectively), the applicant further addressed the operational checks and testing of emergency equipment and instruments, which include emergency communications systems.

[N.2] Drills will evaluate the proper response in accordance with EIPs. Use of sample techniques, survey techniques, monitoring methods, decontamination methods, and protective clothing and respirators will be demonstrated, as appropriate, during the drill, but these techniques and equipment may not be used throughout the drill (for example, field monitoring teams will not wear protective clothing). Exposure control considerations will also be exercised during the drill. Post-accident sampling under simulated accident conditions will be demonstrated each calendar year, and the post-accident analysis may be performed using available instrumentation or using laboratory equipment to demonstrate the methods employed under actual accident conditions.

[N.3] In VEGP Plan Section N.3, "Scenarios," the applicant stated that each drill and exercise is conducted in accordance with a scenario. The scenarios for the drills may be considerably less extensive than the scenario for the biennial exercise. The preparation of exercise scenarios is directed by the manager for training and the EPC, with assistance from other departments, and is coordinated with offsite authorities when they are participating in the exercise. The licensee and participating States submit a copy of the scenario to the NRC and FEMA, respectively.

[N.3] The exercise program is structured with sufficient flexibility to allow free play for decision-making processes, and free-play items may be included in the scenario to maintain player interest. The exercise scenario package identifies a specific accident sequence and includes messages that support the accident sequence. The exercise control organization receives general instructions concerning the deviation of plant personnel from procedural response and may restrict player action if the response would interfere with the time sequence or prevent demonstration of an exercise objective. [N.4, N.5] In VEGP Plan Section N.4, "Evaluations and Corrective Actions," the applicant stated that all drills and exercises are evaluated. For periodic drills, the process consists of the following steps:

- Drills will be evaluated by controllers/evaluators selected on the basis of expertise and availability.

- Improper or incorrect performance during the drill may be corrected by the controller/evaluator and the proper method pointed out or demonstrated.

- The exercise or drill controllers assemble the players at the conclusion of activities for critique. Players are encouraged to identify areas where improvements are required. The drill controllers also present their observations to the players.

- The site EPC submits a list of corrective actions, responsibilities, and schedule information to the general manager of the nuclear plant for approval.

- The EPC assigns action items and monitors the status of completion of corrective actions. Significant problems will be brought to the attention of appropriate plant management.

[N.4, N.5] Exercise evaluation and corrective action are carried out in similar fashion. Critiques with the players are conducted in each facility and coordinated by the controller/evaluator at that facility. Each controller/evaluator submits written reports to the exercise controller. An overall critique is presented to key players and to the control organization after the exercise. [N.5] The general manager of the nuclear plant approves the responsibilities for corrective actions and deadlines for completion. The site EPC monitors completion status. In addition to the internal critique and evaluation, Federal observers may observe, evaluate, and critique the biennial exercise. Corrective actions resulting from this critique, together with deadlines for completion, are assigned by the general manager of the nuclear plant. The general manager is periodically advised of the status of these open items. If VEGP fails to demonstrate with reasonable assurance that protective measures can and will be taken, a remedial exercise would be performed, as directed by the NRC.

The staff finds that the applicant has provided for an adequate exercise and drill program for the VEGP site, which includes the participation of local, State, and Federal personnel and resources. Exercise conduct will be consistent with NRC and FEMA rules, in that the program adequately addresses the areas of scope, participation, frequency, conditions, scenarios, and objectives. In addition, the exercise and drill program provides for the necessary control and observations, followed by formal critiques and the implementation of identified corrective actions and necessary improvements.

<u>State and Local Emergency Plans</u> [N.1, N.2.a, N.2.c, N.2.d, N.2.e(1), N.3, N.4, N.5]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard N of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard N are adequate. The following summarizes the FEMA findings for planning standard N.

a. State of Georgia

[N.1.a, N.1.b] GA REP–Base Plan, Section VII.A, "Exercises/Drills," states that periodic exercises will be conducted to evaluate major portions of emergency response capabilities and to develop and maintain key skills. Periodic exercises will be held in accordance with current FEMA requirements and will include mobilization of State and/or local emergency response personnel. **[N.2.a, N.2.d, N.2.e]** Drills may be a part of an exercise and generally consist of communication, medical emergency, radiological monitoring, and health physics drills. Sections VII.A.2.b(1)-(4) describe these drills in more detail.

[N.1.a, N.3.a-f] Exercise and drill scenarios will be written to include specific testing of various elements of response. Major exercises will occur every 2 years, with full participation of the State of Georgia at least every 6 years. The Burke County government is required to participate in a full exercise at least every 2 years. (See also GA REP–Annex D, Section G, "Drills/Exercises/Training and Review.") Additional conduct and responsibilities associated with exercises and drills are described in GEOP Sections V.B.5 and V.C.6, and Section II of ESFs 1 through 15 refer to participating in exercises and tests. **[N.4, N.5]** After each exercise/drill has been terminated, a critique will be held and recommendations for improvement discussed. On the basis of lessons learned, each individual State agency will implement recommendations, as appropriate.

b. Burke County, Georgia

[N.1.a, N.1.b] Burke County Plan Section V.B states that the EMA director will establish a training program and coordinate with the department and agency heads of local governments to make available appropriate personnel for training and participation in drills and exercises. Attachment K, Section B, "Exercises and Drills," states that to ensure that county emergency preparedness is kept at a high level of readiness, periodic local exercises and drills will be conducted to test plans and personnel and to identify any organizational or operational deficiencies. **[N.2.a, N.2.c, N.2.d, N.3.a-f]** Various drills and scenario development, including exercise/drill frequencies, are also discussed.

[N.4, N.5] The EMA director will coordinate with GEMA on the use of State and Federal agencies as observers or evaluators. GEMA will provide advance notification to Federal agencies if they become involved. Procedures and guidelines will be established to assist in evaluating the formal critique, and the EMA director (or designated planning coordinator) will be responsible for revising the county plan to reflect the critique findings.

c. State of South Carolina

[N.1.a, N.1.b] SCORERP Section V.A.4 (14) states that SCEMD is responsible for conducting RER drills and exercises as specified in NUREG-0654/FEMA-REP-1 and South Carolina Code of Regulations 58-1 and 58-101. In addition, SCORERP Annex D, "Exercises and Drills," states that exercises and drills are conducted, based on simulated incidents at nuclear power plants, to test and evaluate State and local offsite RER capabilities and to develop and maintain skills of emergency responders. The State will conduct an exercise at least biennially with each FNF to demonstrate all emergency-phase capabilities and to verify that State and county emergency plans and procedures are adequate to protect the health and safety of the public living within 10 miles of the plant. At least every 6 years, the State will conduct a full participation exercise to include a plume phase and ingestion exposure pathway exercise.[33]

[N.3.a-f] SCORERP Annex D states that the nuclear power plant will provide SCEMD with a scenario and radiological data no later than 75 days before the exercise, which will be submitted to DHS for approval no later than 60 days before the exercise. SCEMD will coordinate the extent of play with DHEC and the affected counties. **[N.2.a, N.2.d, N.2.e]** Various drills and scenario development, including exercise/drill frequencies, are also discussed in Annex D,

[33] The ingestion exposure pathway exercise is conducted once every 6 years, alternating between a site within the State boundary and a site where the State shares an ingestion pathway EPZ. Each year, the State will fully participate in at least one exercise.

Section III.C, “Drills.” (See also SCORERP–Part 5, Section IV.B.12, and SCTRERP, Appendix X, “Exercises and Drills.”) **[N.4, N.5]** SCEMD is responsible for coordinating and conducting the evaluation critique for each exercise.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[N.1.a, N.1.b] Section IV.R, “Exercises and Drills,” of the county plans states that the counties will participate in RER exercises in conjunction with exercises at the FNF and that these exercises will be conducted on a frequency and as set forth in FEMA and NRC regulations. **[N.2.a, N.2.c, N.2.d]** Communications between the county, VEGP, and SCEMD will be tested monthly. Medical emergency drills will be coordinated through VEGP and Doctors Hospital in Augusta, Georgia. Radiological monitoring drills will be conducted in coordination with DHEC.

[N.3.a-f] Exercises and drills will be designed and executed in a manner that allows free play for decision-making and meets the stated objectives. **[N.4, N.5]** SCEMD, DHEC, and VEGP will prepare the exercises, and Federal and/or State and local officials will observe and evaluate them. Each drill will be planned and prepared to include a description of arrangements for advanced materials to be issued to official observers. Every drill will be evaluated, and a critique will be made and retraining conducted, if required.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for exercises and drills, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard N of NUREG-0654/ FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(14), and Sections III, IV.F, and IV.G of Appendix E to 10 CFR Part 50, insofar as it describes the essential elements of advanced planning and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.15 Radiological Emergency Response Training (10 CFR 50.47(b)(15); NUREG-0654/FEMA-REP-1, planning standard O)

The regulation, as reflected in the planning standard, requires that RER training be provided to those who may be called on to assist in an emergency.

In ESP Plan Section O, “Radiological Emergency Response Training,” the applicant described the training that will be conducted for both onsite and offsite response organizations in support of an emergency at the VEGP site. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff’s primary focus was the evaluation of the emergency plan against NUREG-0654/FEMA-REP-1, planning standard O, “Radiological Emergency Response Training.” Planning standard O provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(15).

[O.1, O.4, O.5] In ESP Plan Section O, the applicant stated that emergency response training is provided at the following four levels:

1. All VEGP badged personnel will receive general employee training (GET) at the inception of onsite duties. GET will include emergency classification, individual response, signals, accountability, and site dismissal procedures.

2. All VEGP ERO personnel will receive specialized training per Table O-2, "Training Course Description."

3. Offsite response groups who may support onsite situations, such as fire or personnel injury, will be offered annual training in notification, expected roles, site orientation, security procedures, and basic radiation protection. [O.1.a]

4. Selected State and local emergency response management personnel with offsite emergency response roles will be offered a seminar/training course in the following specific areas for VEGP: [O.1.a]

    - emergency classification system
    - protective action recommendation criteria and relationship to plant conditions
    - emergency response organization

[O.1, O.5] These offsite management personnel will be offered initial training and annual retraining. Coordination with offsite authorities will include planning for and participation in VEGP exercises. All badged VEGP workers will receive general training in emergency preparedness. Selected individuals on site and off site will receive specialized annual training in the implementation of the VEGP Emergency Plan.

[H.2, H.4, O.1, O.4] In addition to ESP Plan Section O, ESP Plan Appendix 7 also addresses RER training. In Section A7A.1, "Purpose," of Appendix 7, the applicant presented the framework for operations of the EOF and SNC and stated that Appendix 7 is an integral part of the site-specific emergency plans. The applicant further stated in Section A7G.1.1, "Training," that corporate personnel identified in the ERO receive training, which consists of familiarization with the site emergency plans and applicable EIPs required to carry out their specific functions. The corporate emergency planning coordinator is responsible for assuring that training is conducted for corporate emergency response personnel each calendar year and documented in accordance with established practice. The applicant provided a training matrix for corporate personnel who are assigned to the ERO in Appendix 7, Table A7-2, "Corporate Emergency Response Organization Training Matrix," which cross-references each position with the three training subject areas (emergency plan overview, position-specific items, and offsite dose assessment). In Appendix 7, Table A7-3, "Description of Training Subject Areas," the applicant also described in detail the three subject areas. (Appendix 7 is also addressed in ESP Plan Sections A, B, and H and discussed in SER Sections 13.3.3.2.1, 13.3.3.2.2, and 13.3.3.2.8, respectively.)

[O.1, O.4] As a minimum, training will be provided in the subject areas shown in Table O-1, "ERO Qualification," to various personnel according to their emergency response position, also shown in Table O-2. These subject areas do not necessarily represent specific course titles, since several individual courses may be used to implement the training in each area. Also, both the content and depth of training may be varied slightly, depending on the particular audience, to tailor the presentation to the specific needs of the group. Table O-2, "Training Course Description," lists the following training courses and the description of each course:

- core damage assessment
- offsite communications
- emergency plan overview
- first aid standard Red Cross multimedia, or equivalent [O.3]
- management of radiological emergencies
- offsite dose assessment
- post-accident sampling
- repair and corrective actions
- field monitoring team
- radiological emergency team in plant
- security
- medical support of radiation emergencies
- self-contained breathing apparatus

[O.1] The training will be conducted in accordance with lesson plans. Lesson plans will incorporate classroom lectures, demonstration and use of equipment, and walkthroughs of facilities, as appropriate. A written examination or practical exercise may be administered at the conclusion of a lesson. Records of the attendance and examination scores will be retained in the training files. Those designated to receive training in each subject area are indicated in Table O-3, "Training Requirements for VEGP ERO Personnel."

[O.1, O.5] RER training is offered throughout the year, with each training course presented a least once per calendar year, or as often as necessary to ensure that ERO personnel remain qualified in accordance with training requirements in ESP Plan Section O.2, "Qualifications." Annual retraining consists of initial training material reinforcement and appropriate lessons learned from the previous year's operating experience. Lessons learned that are distributed by other methods may not be included in annual retraining. The general manager of the nuclear plant may receive credit for management of radiological emergencies requalification by participation in an integrated drill or annual exercise. **[O.2]** In addition, drills and exercises are an integral part of the training program and are conducted as specified in ESP Plan Section N and discussed in SER Section 13.3.3.2.14. During practical drills, on-the-spot corrections will be made if the situation and time allow. If not, the critique will indicate the corrections. Upon completion of each training session or drill, the participants will be asked to evaluate the training to ensure continued improvement.

The staff finds that the applicant has established an adequate training program, which includes initial and annual retraining, for members of the onsite emergency organization, and offsite emergency organizations who may be called on to assist in an emergency at the VEGP site. In addition, the training program for members of the onsite emergency organization includes classroom training, as well as practical drills and exercises in which each individual demonstrates the ability to perform his assigned emergency function.

<u>State and Local Emergency Plans</u> [O.1, O.1.b, O.4.a-h, j, O.5]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard O of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard O are adequate. The following summarizes the FEMA findings for planning standard O.

a. State of Georgia

[O.1, O.4, O.5] GEOP Section IV.A.2 states that preparedness activities occur before an emergency or disaster to support and enhance response and that these activities include planning, training, exercises, and community awareness and education. Section V, "Direction and Coordination," states that GEMA will provide disaster preparedness information, training, and exercises, including technical assistance and planning guidance to State and local agencies. The State agency heads will support and/or conduct training and exercises for State personnel who are assigned to execute ESF responsibilities. GEOP ESF-10, "Hazardous Materials," states in Section III.A.2.a.v that training in radiological monitoring for self-protection is provided for hospital and emergency personnel.

GA REP–Base Plan, Section IV.A.2.h, states that GEMA provides radiological monitoring training assistance. In addition, Section VII.B, "Training," states that Georgia considers adequately trained emergency response personnel at all levels of government to be absolutely essential to ensuring the protection of the public health and safety. Because of the turnover in personnel, improvements in technology, and the lack of actual emergencies to provide experience, it is necessary to continuously upgrade capabilities and retrain personnel. Training programs are implemented at all levels of government in the State. The success of the efforts is evaluated after various categories of personnel have responded to real situations or after participation in drills and exercises conducted on a statewide basis. The results of these evaluations are utilized by the respective organizations to improve their training programs. Section VII.B also describes Federal- and State-sponsored training for State and local personnel and local training for local personnel.

In addition to initial training programs on RER, the State plans to conduct retraining (i.e., refresher training) in essential program areas on an annual (or as needed) basis. The retraining will be provided to those individuals and organizations that provide a key role in RER. Emphasis will be given to various program areas, including emergency plans, protective actions, accident assessment techniques, notification procedures, and agency roles and responsibilities. GA REP–Base Plan, Section VIII.B, "Planner Training," states that personnel involved in RER planning will be required to receive periodic training on planning techniques. The principal source of training will be federally sponsored workshops and training sessions on emergency planning. Additionally, planning personnel may participate in planning training sessions sponsored by States, professional associations, or private organizations. Personnel selected for participation in such training programs will normally be State and local government personnel with key roles in the emergency planning process.

GA REP–Annex D, Section F.1.c, states that a private contract corporation provides training for hospital staff, and the State will provide initial and supplemental training for emergency medical technicians and hospital emergency room personnel. (See also Section F.4.) Section G.2, "Training," states that the DNR-EPD radiation program and GEMA will develop a joint radiological training program. This program will be oriented toward training support personnel involved in RER. The State will identify designated persons responsible for training, including scheduling and conducting drills. A typical training program will include the following elements:

- familiarization with emergency plan
- use of radiological survey instruments
- sample collection procedures
- health physics fundamentals

- notification and reporting procedures

b. Burke County, Georgia

[O.1, O.4, O.5] Burke County Plan Section IV.A.2 states that the Georgia DNR-EPD will monitor the situation at VEGP and be responsible for keeping the State disaster coordinator (i.e., GEMA director) and pertinent Federal agencies informed of planning, training, and operational requirements related to environmental health and safety matters. Section V.A states that the responsibility for overall RER planning, training, and operations in the county rests with the chairman of the County Board of Commissioners, who has the responsibility to initiate action and provide direction and control at the local level and to conduct emergency operations to cope with the effects of a nuclear incident (consistent with its classification).

Section V.B states that the EMA director is responsible for actual plan development and updating and establishment of a training program. In addition, the EMA director will coordinate with local department and agency heads to make available the appropriate personnel for training and participation in drills and exercises. Burke County Plan Attachment K, "Training and Exercises," states in Section A, "Training," that county EMA personnel, as well as other department/agency personnel and emergency workers, train regularly through State and locally sponsored programs. The GEMA training office assists and monitors local training activities. (News media training is discussed in SER Section 13.3.3.2.7.)

Training in radiological monitoring and decontamination is provided by the GEMA radiological programs and DNR-EPD (as needed) to local and other emergency management organizations – such as police, fire, EMS, and public works – including staff of reception and care centers and shelter and decontamination centers. Specialized initial training and periodic retraining programs are conducted for personnel involved in conducting RER operations. Training modules, which have been designed for local officials, provide objectives and scope related to the particular course of instruction. The local EMA director and staff, other local officials, and department/agency personnel receive emergency preparedness training through GEMA-sponsored professional development series courses. This program enhances the capabilities of these officials to carry out their responsibilities in administration, planning, and response.

c. State of South Carolina

[O.1, O.4, O.5] SCORERP Section V.A.4 (12) states that SCEMD is responsible for coordinating the RER training of State and local government personnel. SCORERP Annex B, "Training," states that accident assessment personnel and radiological monitoring teams are trained by DHEC, as outlined in SCTRERP Appendix IX, "Training." Appendix IX describes training programs and requirements and states that each member of the (DHEC) BLWM technical staff will be trained in basic health physics, radiation protection, and emergency response techniques during the first 6 months of employment. This training may consist of on-the-job and in-house training, and additional formal training in RER will be provided. The BLWM encourages the training of other response organizations, such as highway patrol, local law enforcement, firefighters, rescue squads, hospital emergency personnel, and emergency managers, and has a training unit assigned to give emergency radiological response training (on request) to outside agencies. SCORERP Annex D, "Exercises and Drills," describes the procedures for the periodic testing of State and county RER plans and evaluation of offsite response organizations' capabilities to respond to an FNF incident.

Annex B, Section III, "Concept of Operations," states that SCEMD is responsible for ensuring the availability of training opportunities for all agencies and individuals involved in emergency response to an incident at a nuclear power plant. At the State level, department or agency heads are responsible for ensuring that their personnel attend appropriate RER courses needed to accomplish all tasks assigned by this (and other applicable) documents. County emergency preparedness directors/coordinators are responsible for coordinating the training of local personnel and facilitating their attendance at SCEMD-sponsored training. SCEMD will make use of the train-the-trainer concept to ensure that State and local agencies and organizations have qualified instructors for maintenance of internal personnel capabilities. In support of State and county training, SCEMD will conduct an annual training needs assessment of State agencies and FNF counties to determine specific requirements for courses involving radiological monitoring and decontamination, medical services, and emergency worker safety. SCEMD will use the information derived from this assessment to develop an annual training program that will integrate initial RER training for new personnel, annual refresher training, on-the-job training, and periodic drills and exercises.

State and local directors/coordinators and key response personnel participate in relevant independent study courses, radiological courses, and Federal/State training workshops and seminars. SCEMD has developed the fundamentals course for radiological monitors and emergency workers, which fills the training requirements for local responders, and focuses on the unique aspects of South Carolina RER plans, procedures, equipment, and standards. Shelter managers complete a shelter operations course, conducted by the ARC, and participate in regularly scheduled drills, exercises, and refresher courses to maintain proficiency and shelter manager qualification. Training for medical support personnel involved in transport and treatment of radiologically contaminated individuals is conducted by hospital radiation safety officers, health physicists from the utility, and SCEMD personnel.

The Governor's Office (or authorized representative) and the utility information specialist will assure that State and local PIOs are trained on JIC operations, as well as transmission procedures. The EAS and the ETV networks will periodically test their abilities to disseminate emergency information to monitoring stations. In addition, SCORERP Section V.A.4(23) states that SCEMD will provide training and information briefings for news media, including State and local PIOs, to acquaint them with JIC operations, State and local RER plans, media communications, and measures to protect the public against radiation exposure. Section V of Annex B lists training frequencies for agencies and personnel.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[O.1, O.4, O.5] Section IV.S, "Radiological Emergency Response Training," of the county plans states that the county EMA is responsible for training offsite emergency personnel to respond effectively to an incident involving VEGP. Personnel who receive initial and follow-up training include law enforcement, fire, rescue, emergency medical, shelter management, and radiological defense personnel. The annual training program for offsite emergency response personnel consists of classroom training, tabletop exercises, and government conferences. In addition, emergency service and government officials with emergency assignments will participate in an annual exercise with VEGP.

The county EMA director will receive initial and follow-up training by SCEMD, which will address daily responsibilities and radiological defense and will include management seminars, workshops, and career development courses. The EMA director is responsible for county training and refresher courses, which address county government responsibilities and specific duties of the emergency services. Instructors take periodic refresher courses. Accident assessment, which is a State responsibility, is addressed in the STRERP. (See also SCORERP Annex B, "Training.)

Instructors take periodic refresher courses. To become a local radiological monitor, one must take the standard fundamentals course for radiological monitors and emergency workers. A refresher course is given every year, and monitors must take this refresher course to remain certified. Monitors must also participate in exercises and drills that involve radiological monitoring, which is provided to the following county and municipal agencies:

- county law enforcement and municipal police departments
- municipal and volunteer fire departments
- county EMS and volunteer rescue services
- local ARC workers

County personnel will be trained locally, with assistance from SCEMD and other appropriate State agencies. Annual training will cover responsibilities, notification and alert procedures, sector assignments, and familiarization with SOPs. Personnel will participate in government conferences, tabletop exercises, and an annual RER exercise with VEGP.

Conclusion

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for RER training, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard O of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(15) 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.3.2.16 Responsibility for the Planning Effort—Development, Periodic Review, and Distribution of Emergency Plans (10 CFR 50.47(b)(16); NUREG-0654/FEMA-REP-1, planning standard P)

The regulation, as reflected in the planning standard, requires that responsibilities for plan development and review and for distribution of emergency plans be established and that planners be properly trained.

In ESP Plan Section P, "Responsibility for the Planning Effort," the applicant described the responsibilities and authorities associated with developing and maintaining emergency preparedness for the VEGP site, including training and conducting audits of the emergency preparedness program. The staff reviewed this section, as well as other relevant portions of the application, to determine whether the application conforms to the applicable guidance and complies with the pertinent regulatory requirements. The staff's primary focus was its evaluation of the emergency plan compared to NUREG-0654/FEMA-REP-1, planning standard P, "Responsibility for the Planning Effort: Development, Periodic Review and Distribution of Emergency Plans." Planning standard P provides the detailed evaluation criteria that the staff should consider in determining whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(16).

[P.2] In ESP Plan Section P, the applicant stated that the executive vice-president/chief nuclear officer at SNC has overall responsibility and authority for all nuclear activities, including emergency preparedness programs. **[P.3]** The emergency planning supervisor is responsible for overseeing emergency planning activities off site and coordinating those activities with VEGP, Federal, State, and local response organizations. The EPC, stationed at the plant site, is responsible for coordinating emergency preparedness activities on site and in the vicinity of the plant. The emergency planning coordinator coordinates site input and involvement in emergency planning programs with the EPC. The EPC is responsible for the implementation of the emergency plan and procedure development and maintenance. Figure P-1, "Emergency Preparedness Organization," shows these individuals and other responsible members of the organization, along with the associated reporting chain and interfaces. The staff finds that the applicant has adequately identified those individuals (by title) who have the authority and responsibility for RER planning, as well as development and updating of the emergency plans and coordination with other response organizations.

[P.1] Individuals with emergency planning responsibilities are trained by self-study and by attending industry seminars, short courses, and workshops. In RAI 13.3-5.a, the staff asked the applicant to describe how SNC determines that the planners are properly trained. The applicant responded that the responsibility to ensure proper training of the emergency planning supervisor, emergency planning coordinator, EPC, and other individuals with emergency planning responsibilities is assigned to the respective individual's supervisor. SNC uses a management system that provides for the annual review of performance and associated individual training and qualification issues. All employees prepare an annual training plan and are held accountable for the execution of the training plan by their supervisors. The staff finds that the training and qualifications of VEGP personnel responsible for radiological emergency planning in support of the VEGP site are adequate.

The emergency plans are maintained by the fleet security and emergency planning manager with the emergency planning supervisor as the principal emergency planning contact. Onsite EIPs are maintained by the plant training and emergency preparedness manager, with the EPC as the principal emergency preparedness contact. EIPs for the corporate ERO are maintained by the emergency planning supervisor. (The submission of detailed emergency implementing procedures for VEGP Units 3 and 4 is addressed in **Unit 3 ITAAC 9.1**, and is further discussed in SER Sections 13.3.3.2.1, 13.3.3.2.2, 13.3.3.2.4, 13.3.3.2.8, 13.3.3.2.9, and 13.3.3.2.10.) [P.6] In addition to the VEGP Plan, several other formal emergency plans have been developed to support the overall emergency response effort. These supporting plans and their sources are listed in procedure NMP-EP-300, "SNC Corporate Emergency Planning Activities." [P.7] In RAI 13.3-5.e, the staff asked for a listing (by title) of procedures that will be required to implement the emergency plan, cross-referenced to the section(s) of the plan to be implemented by each procedure for VEGP Units 3 and 4. In its response, the applicant provided a proposed revision to Annex V2, Appendix 1, listing various EIPs, and stated that SNC intends to modify the existing EIPs to include the elements associated with Units 3 and 4. Further, the procedure naming and numbering convention may or may not be retained for the new units.

[P.4, P.9] The EPC reviews the site-specific emergency plan annually and all onsite EIPs biennially. The review includes the letters of agreement, which are updated as necessary. The emergency planning supervisor reviews the emergency plans for SNC once each calendar year. The review includes a comparison for consistency of all emergency plans for the specific sites including the security plan, State, county, and SRS plan as appropriate. [P.5] The emergency plan and EPIPs are revised in accordance with applicable site procedures. Emergency plan changes that are judged to reduce the effectiveness of the plan will be submitted to the NRC for approval before implementation. [P.10] In RAI 13.3-5.c, the staff asked the applicant to describe how telephone numbers in emergency procedures are updated on at least a quarterly basis. In its response, the applicant stated that procedures containing telephone numbers and documents/directories will be reviewed quarterly and the numbers verified/validated by either contacting the responsible agency/owner or calling the number directly to verify that it is operable.

[P.9] An annual independent audit of the emergency preparedness program is conducted by the SNC QA department. This audit is conducted as part of the standard audit program and will include a review of the emergency plan, its implementing procedures and practices, emergency preparedness training, annual exercises, equipment, and ERFs. In addition, an audit of the interfaces with offsite agencies is performed by the corporate SNC QA group. Each audit is nominally conducted every 12 months; the interval from the previous audit may be shortened but may not be extended beyond 15 months. Audits are performed in accordance with SNC QA department procedures. **[P.5]** Audit reports are written and distributed to management, and in addition, applicable portions of the corporate audit reports are made available to affected Federal, State, and local agencies, as appropriate, in accordance with 10 CFR 50.54(t). Appropriate departments are responsible for implementing corrective actions resulting from the audit findings. Records of these audits and exercise findings are maintained in accordance with plant procedures. In RAI 13.3-5.d, the staff asked the applicant to describe its procedures for retaining these records for a period of 5 years. In its response, the applicant stated that 10 CFR 50.54(t) audit results are made available by way of letter to State and local organizations, per distribution associated with procedure NMP-QA-105. Procedure NMP-QA-109 provides requirements for record retention, including maintaining the audits for the life of the plant.

[P.8] The ESP Plan contains a table of contents, which provides section designations consistent with the 16 planning standards of NUREG-0654/FEMA-REP-1. In addition, the applicant has provided the "VEGP Emergency Plan Correlation to NUREG 0654," which cross-references the ESP Plan to NUREG-0654/FEMA-REP-1.

<u>State and Local Emergency Plans</u> [P.1, P.2, P.3, P.4, P.5, P.6, P.7, P.8, P.10]

Pursuant to 10 CFR 52.17(b)(ii) and 10 CFR 50.47, the staff reviewed the FEMA findings and determinations associated with the relevant evaluation criteria in planning standard P of NUREG-0654/FEMA-REP-1. On the basis of its review, FEMA found that the application's State and local emergency plans associated with planning standard P are adequate. The following summarizes the FEMA findings for planning standard P.

a. State of Georgia

[P.1] GA REP–Base Plan, Section VII.B.1, "Federally Sponsored Training of State Personnel," states that training courses include radiological emergency planning, exercise evaluation, and dose assessment. The training is normally conducted at the FEMA Emergency Management Institute in Emmitsburg, Maryland. Section VII.B.5, "Retraining," states that in addition to initial RER training programs, the State plans to conduct annual (or as needed) retraining (i.e., refresher training) in essential program areas. The training of individuals responsible for the planning effort is addressed in Section VIII.B and in SER Section 13.3.3.2.15.a.

[P.2] GA REP–Base Plan, Section IV.A.2, states that GEMA is responsible for general State emergency planning, exercise control and direction, and control of emergency or disaster operations. GEOP Section V.A, "Responsibilities of GEMA and State Agencies and Organizations," states that the GEMA director is responsible for the State program of emergency management, will coordinate emergency management activities of all agencies/organizations within the State, and will serve as a liaison with other States and the Federal Government. This individual will assume responsibility for direction and coordination of ESFs at the SOC in Atlanta, Georgia. [P.1] GEOP Section V.B states that the GEMA director will provide training, technical assistance, and planning guidance to State agencies and local governments/agencies and will conduct and participate in periodic exercises to evaluate State and local plans in order to maintain a high standard of preparedness.

[P.3, P.4, P.5] GA REP–Base Plan, Section VIII.A, "Development Responsibility," states that the GA REP has been prepared by GEMA and DNR planners, in conjunction with the coordinated efforts of supporting State agencies. Section VIII.C, "Plan Review and Update," and GA REP–Annex D, Section G.3, state that the responsibility for review and update of the GA REP is vested with GEMA, in coordination with EPD. The EPD environmental radiation protection manager has the designated responsibility for ensuring that the technical portions of the plan are reviewed and updated. GEMA is responsible for the plan's overall coordination and distribution.

The GA REP (including annexes) will be reviewed annually, with the participation of appropriate State agencies, and updated (if required). Changes will be made based on such factors as experience gained in drills, exercises, response to incidents, changes in State or Federal statutes or planning guidance, and changes in operations procedures and mutual assistance/support agreements. A record of plan changes will be maintained by GEMA; revised pages will be dated, and the reason for changes will be reflected on the plan change instruction sheet. In addition, GEOP Section V.B states that the GEMA director will maintain, update, and distribute all plan revisions and initiate other actions necessary for effective plan implementation. GA REP–Annex D, Section G.3, further states that plan changes or revisions will be sent to all holders of the plan who either have a key role in RER planning or have asked to be on the plan distribution list. **[P.8]** (The GEOP, GA REP–Base Plan, and GA REP–Annex D all include a detailed table of contents.)

[P.6] GEOP Section V.A.4 states that ESFs are matched with the NRP to assure efficient and effective response. State agencies and organizations with primary ESF responsibilities will develop and maintain SOPs, in coordination with support agencies and organizations. Appendix 4 to the GA REP–Base Plan lists the supporting emergency response plans, which either augment or complement the GA REP. **[P.7]** Appendix 5 provides a list of emergency operations procedures and SOPs that may be implemented by the appropriate State agencies during a radiological emergency. These procedures, which are periodically reviewed and updated, are those that are most significant to RER. **[P.10]** GA REP-Annex D, Section B.7, states that emergency response telephone numbers will be updated quarterly and that all other telephone numbers will be verified during the annual plan review.

b. Burke County, Georgia

[P.1] Burke County Plan Attachment K states that the local EMA director and staff, other local officials, and department/agency personnel receive emergency preparedness training through GEMA-sponsored professional development series courses, which enhance the capabilities of these officials to carry out their responsibilities in administration, planning, and response.

(Additional training programs for enhancement of local emergency preparedness are discussed in GA REP Section VII.B and GA REP–Annex D, Section G.)

[P.2, P.3] Burke County Plan Section V.A identifies the Chairman of the Burke County Board of Commissioners as the individual with the overall authority and responsibility for RER planning in the county. The Burke County EMA Director is responsible for actual county plan development and updating the plan to keep it current with existing conditions and procedures. The director will establish a training program and coordinate with the local department and agency heads to make available appropriate personnel for training and participation in drills and exercises. (See also SER Section 13.3.3.2.1.b.)

[P.4, P.10] Section VI.D states that the plan will be reviewed, updated, or revised annually or as otherwise required. All changes will be dated by page, added to the plan, and recorded on the record of changes in GA REP–Annex D. Attachment C provides a roster of key emergency staff personnel, with their business and personal telephone numbers, which is available to the county EOC and communications office. (Attachment C was not included in the application in order to protect personal information and privacy.) **[P.5]** Attachment A, Section H, "Distribution," states that the Burke County EMA office will maintain a list of all parties receiving a copy of the county plan and will (as necessary) furnish all addresses with plan changes or revisions.

[P.6] Attachment A, Section G, "Supporting Plans and Documents," states that the county plan will be implemented and executed in accordance with the authority of State laws listed in GA REP–Base Plan, Section II, and the county and municipal laws listed in Section III. The county plan will be executed within the organizational and functional parameters of the following supporting State and local plans:

- Burke County Emergency Operations Plan
- State of Georgia Emergency Operations Plan
- State of Georgia Radiological Emergency Plan
- State of Georgia Radiological Emergency Plan, Annex D (Plant Vogtle)

[P.7] Attachment K, Section C, "Checklists," states that to enhance the training program and further ensure emergency operational readiness, checklists have been prepared for local officials and department/agency personnel. Each checklist has been developed to correspond with the EAL guidelines, in reference to an incident at the nuclear power plant. The checklists, which are listed in Section C, expand the functional responsibilities of local government departments/ agencies, as outlined in Section V of the plan. In addition, Section D, "Operational Procedures," lists procedures that address various areas, such as decontamination, KI, exposure control, communications, and care for handicapped personnel. [P.8] Finally, the plan contains a specific table of contents, which reflects the plan sections and attachments, including content descriptions.

c. State of South Carolina

[P.1, P.2] SCORERP states that SCEMD is the lead State agency for coordinating the State's offsite response to an incident at an FNF. SCEMD is responsible for coordinating State government activities with those of affected local governments, other States, and Federal agencies. SCEMD is responsible for ensuring the availability of training opportunities for all agencies and individuals involved in emergency response to an incident at a nuclear power plant. At the State level, department or agency heads are responsible for ensuring that their personnel attend appropriate RER courses needed to accomplish all assigned tasks. State and local directors/coordinators and key response personnel participate in independent study courses, radiological courses, and Federal and State training workshops and seminars. In addition, SCEOP Section III.F identifies the SCEMD director as the individual who is responsible for providing technical and planning support to State agencies and local governments.

[P.3] SCORERP states that the SCEMD is responsible for preparing and maintaining the State RER plans and procedures for State areas that can be affected by an FNF (incident) in South Carolina, Georgia, and North Carolina. **[P.4, P.10]** SCEMD will coordinate the development and revision of site-specific plans for each FNF in the State and will assist local governments in preparing and maintaining their local plans. The plans will be reviewed annually and updated (if required). If major changes occur that could affect State or local disaster operations before the annual revision, the plan will be immediately changed to reflect current capabilities.

SCTRERP, Section B.XIII, states that NREES will continuously review the contents of the SCTRERP and will annually verify it to be current. **[P.5]** The plan and approved changes will be forwarded to all organizations and individuals with responsibility for implementing the plan. Revised pages, sections, and appendices will be dated and/or marked to indicate the changes. **[P.8]** (Each South Carolina plan contains a detailed table of contents.) **[P.6, P.7]** SCORERP Appendix 1 and SCEOP Section IX list supporting plans and responsible organizations.

d. Aiken, Allendale, and Barnwell Counties, South Carolina

[P.1, P.2] Each county EMA director is assigned responsibility for planning and procedure preparation and review and will receive initial and follow-up training from SCEMD. This training will consist of daily responsibilities, radiological defense, government conferences, management seminars, workshops, and career development courses. (Training is also addressed in SCORERP Annex B and SER Section 13.3.3.2.15.c.)

[P.3, P.4, P.5] Plan annexes will be developed in conformity with the county plans and will provide for necessary plan changes and revisions, including preparation, coordination, publishing, and distribution. The plans will be reviewed/updated annually by the county office with primary plan responsibility. **[P.10]** Supporting SOPs will be reviewed/updated by the responsible agencies at the time of the county plan update, and all telephone numbers will be updated quarterly by the county EMA. **[P.6, P.7]** A detailed listing of supporting plans and their sources is provided in county base plans and in Annex Q2 (Sections IV and V and appendices). [P.8] (The county plans include a detailed table of contents.)

<u>Conclusion</u>

On the basis of its review of the onsite emergency plans and FEMA findings, as described above for the planning effort responsibility, the NRC staff concludes that the information provided in the ESP application is consistent with the guidelines in RS-002, Supplement 2, and planning standard P of NUREG-0654/FEMA-REP-1. Therefore, the information is acceptable and meets the relevant requirements of 10 CFR 50.47(b)(16) 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 and the provisions made to cope with emergency situations, as set forth above.

13.3.4 Conclusion

The staff has reviewed the complete and integrated RER plans provided in the VEGP ESP application for the proposed Vogtle Units 3 and 4. The staff reviewed the onsite emergency plan against the relevant requirements of 10 CFR 50.33, "Contents of Applications: General Information," 10 CFR 50.34, 10 CFR 50.47, Appendix E to 10 CFR Part 50, and 10 CFR 100.21, "Non-seismic Site Criteria," using the guidance criteria in NUREG-0654/FEMA-REP-1, Revision 1, and Supplement 1 to NUREG-0737. The staff concludes that, provided that the permit conditions identified below are adequately addressed, and the enumerated ITAAC are met, the VEGP onsite emergency plan establishes an adequate planning basis for an acceptable state of onsite emergency preparedness, and there is reasonable assurance that the plan can be implemented.

FEMA provided its findings and determinations concerning the adequacy of offsite emergency planning and preparedness, which are based on its review of State and local emergency plans. FEMA concluded that the offsite State and local emergency plans are adequate to cope with an incident at VEGP and that there is reasonable assurance that these plans can be implemented. On the basis of its review of these FEMA findings and determinations, the NRC staff concludes that, provided the permit conditions identified below are adequately addressed, and the enumerated ITAAC are met, the VEGP offsite emergency plans establish an adequate planning basis for an acceptable state of offsite emergency preparedness, and there is reasonable assurance that the plans can be implemented.

Pursuant to 10 CFR 52.17(b)(3), the VEGP ESP emergency plan includes the proposed inspections, tests, and analyses that the holder of a COL referencing the VEGP ESP shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, then the Vogtle Units 3 and 4 have been constructed and will operate in conformity with the license, the provisions of the Atomic Energy Act, and the NRC's regulations.

The staff concludes that the emergency plans provide an adequate expression of the overall concept of operation and describe the essential elements of advanced planning and the provisions made to cope with emergency situations. Thus, the staff concludes that the overall state of onsite and offsite emergency preparedness, when fully implemented, will meet the requirements of 10 CFR 50.33, 10 CFR 50.34, 10 CFR 50.47, Appendix E to 10 CFR Part 50, 10 CFR 52.17(b)(2)(ii), 10 CFR 52.17(b)(4), 10 CFR 52.18, and 10 CFR 100.21. Further, pursuant to 10 CFR 50.47(a), the staff concludes that, subject to the required conditions and limitations of the full-power license and satisfactory completion of the ITAAC, there is reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency at the VEGP site, and that emergency preparedness at Vogtle Units 3 and 4 is adequate to support full-power operations.

When referenced by a COL applicant pursuant to 10 CFR 52.73, "Relationship to Subparts A and B," this ESP is subject to the following permit conditions, and to the ITAAC contained in SER Sections 13.3.5 and 13.3.6, for full power for the emergency preparedness program:

Permit Conditions

2. An applicant for a combined license (COL) referencing this early site permit shall revise the EALs for Unit 3 to reflect the final revision of NEI 07-01. (See SER Section 13.3.3.2.4.)

3. An applicant for a combined license (COL) referencing this early site permit shall revise the EALs for Unit 4 to reflect the final revision of NEI 07-01. (See SER Section 13.3.3.2.4.)

4. An applicant for a combined license (COL) referencing this early site permit shall submit a fully developed EAL scheme for Unit 3 that reflects the completed AP1000 design details, subject to allowable ITAAC. (See SER Section 13.3.3.2.4.)

5. An applicant for a combined license (COL) referencing this early site permit shall submit a fully developed EAL scheme for Unit 4 that reflects the completed AP1000 design details, subject to allowable ITAAC. (See SER Section 13.3.3.2.4.)

6. An applicant for a combined license (COL) referencing this early site permit shall complete a fully developed set of EALs for Unit 3, which are based on in-plant conditions and instrumentation, including onsite and offsite monitoring, and which have been discussed and agreed on by the applicant or licensee and State and local governmental authorities, and shall include the full set of EALs in the COL application. If the EALs are not fully developed, the COL application shall contain appropriate ITAAC for the fully developed set of EALs for Unit 3. (See SER Section 13.3.3.2.4.)

7. An applicant for a combined license (COL) referencing this early site permit shall complete a fully developed set of EALs for Unit 4, which are based on in-plant conditions and instrumentation, including onsite and offsite monitoring, and which have been discussed and agreed on by the applicant or licensee and State and local governmental authorities, and shall include the full set of EALs in the COL application. If the EALs are not fully developed, the COL application shall contain appropriate ITAAC for the fully developed set of EALs for Unit 4. (See SER Section 13.3.3.2.4.)

8. An applicant for a combined license (COL) referencing this early site permit shall resolve the difference between the VEGP Units 3 and 4 common Technical Support Center (TSC), and the TSC location specified in the AP1000 certified design. (See SER Section 13.3.3.2.8.)

13.3.5 VEGP Unit 3 ITAAC

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
1.0 Emergency Classification System			
10 CFR 50.47(b)(4) – A standard emergency classification and action level scheme, the bases of which include facility system and effluent parameters, is in use by the nuclear facility licensee, and State and local plans call for reliance on information provided by facility licensees for determinations of minimum initial offsite response measures.	1.1 An emergency classification and emergency action level (EAL) scheme must be established by the licensee. The specific instruments, parameters, or equipment status shall be shown for establishing each emergency class, in the in-plant emergency procedures. The plan shall identify the parameter values and equipment status for each emergency class. [D.1]	1.1.1 An inspection of the control room, technical support center (TSC), and emergency operations facility (EOF) will be performed to verify that the displays for retrieving system and effluent parameters specified in Table Annex V2 D.2-1, *Hot Initiating Condition Matrix, Modes 1, 2, 3, and 4*; Table V2 D.2-2, *Cold Initiating Condition Matrix, Modes 5, 6, and De-fueled* are installed and perform their intended functions; and that emergency implementing procedures (EIPs) have been completed. 1.1.2 An analysis of the EAL technical bases will be performed to verify as-built, site-specific implementation of the EAL scheme.	1.1.1 The parameters specified in Table Annex V2 H-1, *Post Accident Monitoring Variables*, are retrievable in the control room, TSC, and EOF. The ranges of values of these parameters that can be displayed encompass the values specified in the emergency classification and EAL scheme. 1.1.2 The EAL scheme is consistent with Regulatory Guide 1.101, *Emergency Planning and Preparedness for Nuclear Power Reactors*.
3.0 Emergency Communications			
10 CFR 50.47(b)(6) – Provisions exist for prompt communications among principal response organizations to emergency personnel and to the public.	3.1 The means exists for communications between the control room, OSC, TSC, EOF, principal State and local emergency operations centers (EOCs), and radiological field monitoring teams. [F.1.d]	3.1 A test will be performed of the communications capabilities between the control room, OSC, TSC and EOF, and to the State and local EOCs, and radiological field monitoring teams.	3.1 Communications are established between the control room, OSC, TSC, and EOF. Communications are established between the control room, TSC, and Georgia Emergency Management Agency (GEMA) Operation Center; Burke County Emergency Operation Center (EOC); SRS Operations Center; South Carolina Warning Point; and Aiken, Allendale, and Barnwell County Dispatchers. Communications are established between the TSC and radiological monitoring teams.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
	3.2 The means exists for communications from the control room, TSC, and EOF to the NRC headquarters and regional office EOC (including establishment of the Emergency Response Data System (ERDS) between the onsite computer system and the NRC Operations Center. [F.1.f]	3.2 A test will be performed of the communications capabilities from the control room, TSC and EOF to the NRC, including ERDS.	3.2 Communications are established from the control room, TSC, and EOF to the NRC headquarters and regional office EOCs and an access port for the Emergency Response Data System (ERDS) is provided.
5.0 Emergency Facilities and Equipment			
10 CFR 50.47(b)(8) – Adequate emergency facilities and equipment to support the emergency response are provided and maintained.	5.1 The licensee has established a technical support center (TSC) and an onsite operations support center (OSC). [H.1]	5.1 An inspection of the as-built TSC and OSC will be performed, including a test of the capabilities.	5.1.1 The TSC has at least 2,175 square feet of floor space. 5.1.2 Communication equipment is installed in the TSC and OSC, and voice transmission and reception are accomplished. 5.1.3 The plant parameters listed in Table Annex V2 H-1, *Post Accident Monitoring Values*, can be retrieved and displayed in the TSC. 5.1.4 The TSC is located within the protected area, and no major security barriers exist between the TSC and the control room. 5.1.5 The OSC is located adjacent to the passage from the annex building to the control room. 5.1.6 The TSC ventilation system includes a high-efficiency particulate air (HEPA) and charcoal filter, and radiation monitors are installed. 5.1.7 A reliable and backup electrical power supply is available for the TSC.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
	5.2 The licensee has established an emergency operations facility (EOF). [H.2]	5.2 An inspection of the EOF will be performed, including a test of the capabilities.	5.2.1 Voice transmission and reception are accomplished between the EOF and the control room. 5.2.2 The plant parameters listed in Table Annex V2 H-1, *Post Accident Monitoring Values*, can be retrieved and displayed in the EOF.
6.0 Accident Assessment			
10 CFR 50.47(b)(9) – Adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use.	6.1 The means exists to provide initial and continuing radiological assessment throughout the course of an accident. [I.2]	6.1 A test of the emergency plan will be conducted by performing a drill to verify the capability to perform accident assessment.	6.1 Using selected monitoring parameters listed in Table Annex V2 H-1 of the VEGP emergency plan, simulated degraded plant conditions are assessed and protective actions are initiated in accordance with the following criteria: A. Accident Assessment and Classification 1. Demonstrate the ability to identify initiating conditions, determine emergency action level (EAL) parameters, and correctly classify the emergency throughout the drill. B. Radiological Assessment and Control 1. Demonstrate the ability to obtain onsite radiological surveys and samples. 2. Demonstrate the ability to continuously monitor and control radiation exposure to emergency workers. 3. Demonstrate the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. 4. Demonstrate the ability to

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			satisfactorily collect and disseminate field team data. 5. Demonstrate the ability to develop dose projections. 6. Demonstrate the ability to make the decision whether to issue radio-protective drugs (KI) to emergency workers. 7. Demonstrate the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development.
	6.2 The means exists to determine the source term of releases of radioactive material within plant systems, and the magnitude of the release of radioactive materials based on plant system parameters and effluent monitors. [I.3]	6.2 An analysis of the emergency implementing procedures (EIPs) and the Offsite Dose Calculation Manual (ODCM) will be completed to verify ability to determine the source term and magnitude of releases.	6.2 The EIPs and ODCM correctly calculate source terms and magnitudes of postulated releases.
	6.3 The means exists to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for various meteorological conditions. [I.4]	6.3 An analysis of the emergency implementing procedures (EIPs) and the Offsite Dose Calculation Manual (ODCM) will be completed to verify the relationship between effluent monitor readings, and onsite and offsite exposures and contamination.	6.3 The EIPs and ODCM calculate the relationship between effluent monitor readings, and onsite and offsite exposures and contamination.
	6.4 The means exists to acquire and evaluate meteorological information. [I.5]	6.4 A test will be performed to verify the ability to access meteorological information in the TSC and control room.	6.4 The following parameters are displayed in the TSC and control room: • Wind speed (at 10 and 60 meters) • Wind direction (at 10 and 60 meters) • Standard deviation of horizontal wind direction (at 10 meters) • Vertical temperature difference (between 10 and 60 meters) • Ambient temperature (at 10 meters) • Dew-point temperature (at 10 meters) • Precipitation (at the tower base)
	6.5 The means exists to make rapid	6.5 A test will be performed of the	6.5 Demonstrate the capability to make

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
	assessments of actual or potential magnitude and locations of any radiological hazards through liquid or gaseous release pathways, including activation, notification means, field team composition, transportation, communication, monitoring equipment, and estimated deployment times. [I.8]	capabilities to make rapid assessment of actual or potential radiological hazards through liquid or gaseous release pathways.	rapid assessment of actual or potential magnitude and locations of any radiological hazards through liquid or gaseous release pathways.
	6.6 The means exists to estimate integrated dose from the projected and actual dose rates, and for comparing these estimates with the EPA protective action guides (PAGs). [I.10]	6.6 An analysis of the methodology contained in the emergency implementing procedures (EIPs) for estimating dose and preparing protective action recommendations (PARs), and in the Offsite Dose Calculation Manual (ODCM) will be performed to verify the ability to estimate an integrated dose from projected and actual dose rates.	6.6 The EIPs and ODCM estimate an integrated dose.
7.0 Protective Response			
10 CFR 50.47(b)(10) – A range of protective actions has been developed for the plume exposure pathway EPZ for emergency workers and the public. In developing this range of actions, consideration has been given to evacuation, sheltering, and, as a supplement to these, the prophylactic use of potassium iodide (KI), as appropriate. Guidelines for the choice of protective actions during an emergency, consistent with Federal guidance, are developed and in place, and protective actions for the ingestion exposure pathway EPZ appropriate to the locale have been developed.	7.1 The means exists to warn and advise onsite individuals of an emergency, including those in areas controlled by the operator, including: • Employees not having emergency assignments • Visitors • Contractor and construction personnel • Other persons who may be in the public access areas, on or passing through the site, or within the owner controlled area [J.1]	7.1 A test of the onsite warning and communication capability emergency implementing procedures (EIPs) including protective action guidelines, assembly and accountability, and site dismissal will be performed during a drill.	7.1.1 Demonstrate the capability to direct and control emergency operations. 7.1.2 Demonstrate the ability to transfer emergency direction from the control room (simulator) to the technical support center (TSC) within 30 minutes from activation. 7.1.3 Demonstrate the ability to prepare for around-the-clock staffing requirements. 7.1.4 Demonstrate the ability to perform assembly and accountability for all onsite individuals within 30 minutes of an emergency requiring protected area assembly and accountability. 7.1.5 Demonstrate the ability to perform site dismissal.
8.0 Exercises and Drills			
10 CFR 50.47(b)(14) – Periodic exercises are (will be) conducted	8.1 The licensee conducts a full participation exercise to evaluate major	8.1 A full participation exercise (test) will be conducted within the specified	8.1.1 The exercise is completed within the specified time periods of Appendix E

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
to evaluate major portions of emergency response capabilities, periodic drills are (will be) conducted to develop and maintain key skills, and deficiencies identified as a result of exercises or drills are (will be) corrected.	portions of emergency response capabilities, which includes participation by each State and local agency within the plume exposure EPZ, and each State within the ingestion pathway EPZ. [N.1]	time periods of 10 CFR Part 50, Appendix E.	to 10 CFR Part 50, onsite exercise objectives listed below have been met and there are no uncorrected onsite exercise deficiencies. A. *Accident Assessment and Classification* 1. Demonstrate the ability to identify initiating conditions, determine emergency action level (EAL) parameters, and correctly classify the emergency throughout the exercise Standard Criteria: a. Determine the correct highest emergency classification level based on events which were in progress, considering past events and their impact on the current conditions, within 15 minutes from the time the initiating condition(s) or EAL is identified. B. *Notifications* 1. Demonstrate the ability to alert, notify, and mobilize site emergency response personnel. Standard Criteria: a. Complete the designated checklist and perform the announcement within 5 minutes of the initial event classification for an Alert or higher. b. Activate the emergency recall system within 5 minutes of the initial event classification for an Alert or higher. 2. Demonstrate the ability to notify responsible State and local government agencies within 15 minutes and the

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			NRC within 60 minutes after declaring an emergency. Standard Criteria: a. Transmit information using the designated checklist, in accordance with approved emergency implementing procedures (EIPs), within 15 minutes of event classification. b. Transmit information using the designated checklist, in accordance with approved EIPs, within 60 minutes of last transmittal for a follow-up notification to State and local authorities. c. Transmit information using the designated checklist within 60 minutes of event classification for an initial notification of the NRC. 3. Demonstrate the ability to warn or advise onsite individuals of emergency conditions. Standard Criteria: a. Initiate notification of onsite individuals (via plant page or telephone), using the designated checklist within 15 minutes of notification. 4. Demonstrate the capability of the Prompt Notification System (PNS), for the public, to operate properly when required. Standard Criteria: a. 90% of the sirens operate properly, as indicated by the Whelen feedback system.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			b. A NOAA tone alert radio is activated. C. *Emergency Response* 1. Demonstrate the capability to direct and control emergency operations. Standard Criteria: a. Command and control is demonstrated by the control room in the early phase of the emergency and the technical support center (TSC) within 60 minutes from TSC activation. 2. Demonstrate the ability to transfer emergency direction from the control room (simulator) to the TSC within 30 minutes from activation. Standard Criteria: a. Briefings were conducted prior to turnover responsibility. Personnel document transfer of duties. 3. Demonstrate the ability to prepare for around-the-clock staffing requirements. Standard Criteria: a. Complete 24-hour staff assignments. 4. Demonstrate the ability to perform assembly and accountability for all onsite individuals within 30 minutes of an emergency requiring protected area assembly and accountability. Standard Criteria: a. Protected area personnel assembly and accountability completed within 30 minutes of the Alert or higher

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			emergency declaration via public address announcement. D. *Emergency Response Facilities* 1. Demonstrate activation of the operational support center (OSC), and full functional operation of the TSC and EOF within 60 minutes of activation. Standard Criteria: a. The TSC, OSC, and EOF are activated within about 60 minutes of the initial notification. 2. Demonstrate the adequacy of equipment, security provisions, and habitability precautions for the TSC, OSC, EOF, and emergency news center (ENC), as appropriate. Standard Criteria: a. Demonstrate the adequacy of the emergency equipment in the emergency response facilities, including availability and general consistency with emergency implementing procedures (EIPs). b. The Security Shift Captain implements and follows applicable EIPs. c. The Health Physics Supervisor (TSC) implements the designated checklist if an onsite or offsite release has occurred. 3. Demonstrate the adequacy of communications for all emergency support resources. Standard Criteria:

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			a. Emergency response communications listed in emergency implementing procedures (EIPs) are available and operational. b. Communications systems are tested in accordance with TSC, OSC, and EOF activation checklists. c. Emergency response facility personnel are able to operate all specified communication systems. d. Clear primary and backup communications links are established and maintained for the duration of the exercise. E. *Radiological Assessment and Control* 1. Demonstrate the ability to obtain onsite radiological surveys and samples. Standard Criteria: a. HP Technicians demonstrate the ability to obtain appropriate instruments (range and type) and take surveys. b. Airborne samples are taken when the conditions indicate the need for the information. 2. Demonstrate the ability to continuously monitor and control radiation exposure to emergency workers. Standard Criteria: a. Emergency workers are issued self-reading dosimeters when radiation levels require, and exposures are

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			controlled to 10 CFR Part 20 limits (unless the Emergency Director authorizes emergency limits). b. Exposure records are available, either from the ALARA computer or a hard copy dose report. c. Emergency workers include Security and personnel within all emergency facilities. 3. Demonstrate the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. Standard Criteria: a. One field monitoring team is ready to be deployed within 60 minutes of being requested from the OSC, and no later than 90 minutes from the declaration of an Alert or higher emergency. 4. Demonstrate the ability to satisfactorily collect and disseminate field team data. Standard Criteria: a. Field team data to be collected is dose rate or counts per minute (cpm) from the plume, both open and closed window, and air sample (gross/net cpm) for particulate and iodine, if applicable. b. Satisfactory data dissemination is from the field team to the Dose Assessment Supervisor, via the field team communicator and field team coordinator. 5. Demonstrate the ability to develop dose projections.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			Standard Criteria: a. The on-shift HP/Chemistry Shared Foreman or Dose Assessment Supervisor performs timely and accurate dose projections, in accordance with emergency implementing procedures (EIPs). 6. Demonstrate the ability to make the decision whether to issue radioprotective drugs (KI) to emergency workers. Standard Criteria: a. KI is taken (simulated) if the estimated dose to the thyroid will exceed 25 rem committed dose equivalent (CDE). 7. Demonstrate the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development. Standard Criteria: a. Total effective dose equivalent (TEDE) and CDE dose projections from the dose assessment computer code are compared to emergency implementing procedures (EIPs). b. PARs are developed within 15 minutes of data availability. c. PARs are transmitted to responsible State and local government agencies via voice or fax within 15 minutes of PAR development.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			F. *Public Information* 1. Demonstrate the capability to develop and disseminate clear, accurate, and timely information to the news media, in accordance with EIPs. Standard Criteria: a. Media information (e.g., press releases, press briefings, electronic media) is made available within 60 minutes of notification of the on-call media representative. b. Follow-up information is provided, at a minimum, within 60 minutes of an emergency classification or PAR change. 2. Demonstrate the capability to establish and effectively operate rumor control in a coordinated fashion. Standard Criteria: a. Calls are answered in a timely manner with the correct information, in accordance with EIPs. b. Calls are returned or forwarded, as appropriate, to demonstrate responsiveness. c. Rumors are identified and addressed. G. *Evaluation* 1. Demonstrate the ability to conduct a post-exercise critique, to determine areas requiring improvement and corrective action. Standard Criteria:

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			a. An exercise time line is developed, followed by an evaluation of the objectives. b. Significant problems in achieving the objectives are discussed to ensure understanding of why objectives were not fully achieved. c. Recommendations for improvement in non-objective areas are discussed. 8.1.2 Onsite emergency response personnel are mobilized in sufficient number to fill the emergency positions identified in emergency plan Section B, *VEGP Emergency Organization*, and they successfully perform their assigned responsibilities as outlined in Acceptance Criterion 8.1.1.D, *Emergency Response Facilities*. 8.1.3 The exercise is completed within the specified time periods of Appendix E to 10 CFR Part 50, offsite exercise objectives have been met, and there are either no uncorrected offsite deficiencies, or a license condition requires offsite deficiencies to be corrected prior to operation above 5% of rated power.
9.0 Implementing Procedures			
10 CFR Part 50, Appendix E.V – No less than 180 days prior to the scheduled issuance of an operating license for a nuclear power reactor or a license to possess nuclear material, the applicant's detailed implementing procedures for its emergency plan shall be submitted to the Commission.	9.1 The licensee has submitted detailed implementing procedures for its emergency plan no less than 180 days prior to fuel load.	9.1 An inspection of the submittal letter will be performed.	9.1 The licensee has submitted detailed emergency implementing procedures (EIPs) for the onsite emergency plan no less than 180 days prior to fuel load.

13.3.6 VEGP Unit 4 ITAAC

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
1.0 Emergency Classification System			
10 CFR 50.47(b)(4) – A standard emergency classification and action level scheme, the bases of which include facility system and effluent parameters, is in use by the nuclear facility licensee, and State and local plans call for reliance on information provided by facility licensees for determinations of minimum initial offsite response measures.	1.1 An emergency classification and emergency action level (EAL) scheme must be established by the licensee. The specific instruments, parameters, or equipment status shall be shown for establishing each emergency class, in the in-plant emergency procedures. The plan shall identify the parameter values and equipment status for each emergency class. [D.1]	1.1.1 An inspection of the control room will be performed to verify that the displays for retrieving system and effluent parameters specified in Table Annex V2 D.2-1, *Hot Initiating Condition Matrix, Modes 1, 2, 3, and 4*; Table V2 D.2-2, *Cold Initiating Condition Matrix, Modes 5, 6, and De-fueled*; are installed and perform their intended functions; and that emergency implementing procedures (EIPs) have been completed. 1.1.2 An analysis of the EAL technical bases will be performed to verify as-built, site-specific implementation of the EAL scheme.	1.1.1 The parameters specified in Table Annex V2 H-1, *Post Accident Monitoring Variables*, are retrievable in the control room. The ranges of values of these parameters that can be displayed encompass the values specified in the emergency classification and EAL scheme. 1.1.2 The EAL scheme is consistent with Regulatory Guide 1.101, *Emergency Planning and Preparedness for Nuclear Power Reactors*.
3.0 Emergency Communications			
10 CFR 50.47(b)(6) – Provisions exist for prompt communications among principal response organizations to emergency personnel and to the public.	3.1 The means exists for communications between the control room, OSC, TSC, and EOF. [F.1.d]	3.1 A test will be performed of the communications capabilities between the control room, OSC, TSC and EOF, and to the State and local EOCs.	3.1 Communications are established between the control room, OSC, TSC, and EOF. Communications are established between the control room, Georgia Emergency Management Agency (GEMA) Operation Center; Burke County Emergency Operations Center (EOC); SRS Operations Center; South Carolina Warning Point; and Aiken, Allendale, and Barnwell County Dispatchers.
	3.2 The means exists for communications from the control room to the NRC headquarters and regional office EOC. [F.1.f]	3.2 A test will be performed of the communications capabilities from the control room, TSC and EOF to the NRC, including ERDS.	3.2 Communications are established from the control room, TSC, and EOF, to the NRC headquarters and regional office EOCs and an access port for the Emergency Response Data System (ERDS) is provided.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
5.0 Emergency Facilities and Equipment			
10 CFR 50.47(b)(8) – Adequate emergency facilities and equipment to support the emergency response are provided and maintained.	5.1 The licensee has established an onsite operations support center (OSC). [H.1]	5.1 An inspection of the as-built OSC will be performed, including a test of the capabilities.	5.1.1 Communication equipment is installed in the OSC, and voice transmission and reception are accomplished. 5.1.2 The plant parameters listed in Table Annex V2 H-1, *Post Accident Monitoring Values*, can be retrieved and displayed in the TSC. 5.1.3 The OSC is located adjacent to the passage from the annex building to the control room.
	5.2 The licensee has established an emergency operations facility (EOF). [H.2]	5.2 An inspection of the EOF will be performed, including a test of the capabilities.	5.2.1 Voice transmission and reception are accomplished between the EOF and the control room. 5.2.2 The plant parameters listed in Table Annex V2 H-1, *Post Accident Monitoring Values*, can be retrieved and displayed in the EOF.
6.0 Accident Assessment			
10 CFR 50.47(b)(9) – Adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use.	6.1 The means exists to provide initial and continuing radiological assessment throughout the course of an accident. [I.2]	6.1 A test of the emergency plan will be conducted by performing a drill to verify the capability to perform accident assessment.	6.1 Using selected monitoring parameters listed in Table Annex V2 H-1 of the VEGP emergency plan, simulated degraded plant conditions are assessed and protective actions are initiated in accordance with the following criteria: A. Accident Assessment and Classification 1. Demonstrate the ability to identify initiating conditions, determine emergency action level (EAL) parameters, and correctly classify the emergency throughout the drill. B. Radiological Assessment and Control

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			1. Demonstrate the ability to obtain onsite radiological surveys and samples. 2. Demonstrate the ability to continuously monitor and control radiation exposure to emergency workers. 3. Demonstrate the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. 4. Demonstrate the ability to satisfactorily collect and disseminate field team data. 5. Demonstrate the ability to develop dose projections. 6. Demonstrate the ability to make the decision whether to issue radio-protective drugs (KI) to emergency workers. 7. Demonstrate the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development.
	6.2 The means exists to determine the source term of releases of radioactive material within plant systems, and the magnitude of the release of radioactive materials based on plant system parameters and effluent monitors. [I.3]	6.2 An analysis of the emergency implementing procedures (EIPs) and the Offsite Dose Calculation Manual (ODCM) will be completed to verify ability to determine the source term and magnitude of releases.	6.2 The EIPs and ODCM correctly calculate source terms and magnitudes of postulated releases.
	6.3 The means exists to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for	6.3 An analysis of the emergency implementing procedures (EIPs) and the Offsite Dose Calculation Manual (ODCM) will be completed to verify the relationship between effluent monitor readings, and onsite and offsite exposures and contamination.	6.3 The EIPs and ODCM calculate the relationship between effluent monitor readings, and onsite and offsite exposures and contamination.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
	various meteorological conditions. [I.4]		
	6.4 The means exists to acquire and evaluate meteorological information. [I.5]	6.4 A test will be performed to verify the ability to access meteorological information in the TSC and control room.	6.4 The following parameters are displayed in the TSC and control room: • Wind speed (at 10 and 60 meters) • Wind direction (at 10 and 60 meters) • Standard deviation of horizontal wind direction (at 10 meters) • Vertical temperature difference (between 10 and 60 meters) • Ambient temperature (at 10 meters) • Dew-point temperature (at 10 meters) • Precipitation (at the tower base)
	6.5 The means exists to make rapid assessments of actual or potential magnitude and locations of any radiological hazards through liquid or gaseous release pathways, including activation, notification means, field team composition, transportation, communication, monitoring equipment, and estimated deployment times. [I.8]	6.5 A test will be performed of the capabilities to make rapid assessments of actual or potential radiological hazards through liquid or gaseous release pathways.	6.5 Demonstrate the capability to make rapid assessment of actual or potential magnitude and locations of any radiological hazards through liquid or gaseous release pathways.
	6.6 The means exists to estimate integrated dose from the projected and actual dose rates, and for comparing these estimates with the EPA protective action guides (PAGs). [I.10]	6.6 An analysis of the methodology contained in the emergency implementing procedures (EIPs) for estimating dose and preparing protective action recommendations (PARs), and in the Offsite Dose Calculation Manual (ODCM) will be performed to verify the ability to estimate an integrated dose from projected and actual dose rates.	6.6 The EIPs and ODCM estimate an integrated dose.
7.0 Protective Response			
10 CFR 50.47(b)(10) – A range of protective actions has been developed for the plume exposure pathway EPZ for emergency workers and the public. In developing this range of actions, consideration has been given to evacuation, sheltering, and, as a supplement to these, the prophylactic use of potassium	7.1 The means exists to warn and advise onsite individuals of an emergency, including those in areas controlled by the operator, including: • Employees not having emergency assignments • Visitors • Contractor and construction personnel	7.1 A test of the onsite warning and communication capability emergency implementing procedures (EIPs) including protective action guidelines, assembly and accountability, and site dismissal will be performed during a drill.	7.1.1 Demonstrate the capability to direct and control emergency operations. 7.1.2 Demonstrate the ability to transfer emergency direction from the control room (simulator) to the technical support center (TSC) within 30 minutes of activation.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
iodide (KI), as appropriate. Guidelines for the choice of protective actions during an emergency, consistent with Federal guidance, are developed and in place, and protective actions for the ingestion exposure pathway EPZ appropriate to the locale have been developed.	• Other persons who may be in the public access areas, on or passing through the site, or within the owner controlled area [J.1]		7.1.3 Demonstrate the ability to prepare for around-the-clock staffing requirements. 7.1.4 Demonstrate the ability to perform assembly and accountability for all onsite individuals within 30 minutes of an emergency requiring protected area assembly and accountability. 7.1.5 Demonstrate the ability to perform site dismissal.
8.0 Exercises and Drills			
10 CFR 50.47(b)(14) – Periodic exercises are (will be) conducted to evaluate major portions of emergency response capabilities, periodic drills are (will be) conducted to develop and maintain key skills, and deficiencies identified as a result of exercises or drills are (will be) corrected.	8.1 The licensee conducts a limited participation exercise to evaluate portions of emergency response capabilities, which includes participation by each State and local agency within the plume exposure EPZ that have not been tested in a previous exercise. [N.1]	8.1 A limited participation exercise (test) will be conducted within the specified time periods of 10 CFR Part 50, Appendix E.	8.1.1 The exercise is completed within the specified time periods of Appendix E to 10 CFR Part 50, onsite exercise objectives listed below have been met and there are no uncorrected onsite exercise deficiencies. A. *Accident Assessment and Classification* 1. Demonstrate the ability to identify initiating conditions, determine emergency action level (EAL) parameters, and correctly classify the emergency throughout the exercise Standard Criteria: a. Determine the correct highest emergency classification level based on events which were in progress, considering past events and their impact on the current conditions, within 15 minutes from the time the initiating condition(s) or EAL is identified. B. *Notifications* 1. Demonstrate the ability to alert, notify, and mobilize site emergency response personnel.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			Standard Criteria: a. Complete the designated checklist and perform the announcement within 5 minutes of the initial event classification for an Alert or higher. b. Activate the emergency recall system within 5 minutes of the initial event classification for an Alert or higher. 2. Demonstrate the ability to notify responsible State and local government agencies within 15 minutes and the NRC within 60 minutes after declaring an emergency. Standard Criteria: a. Transmit information using the designated checklist, in accordance with approved emergency implementing procedures (EIPs), within 15 minutes of event classification. b. Transmit information using the designated checklist, in accordance with approved EIPs, within 60 minutes of last transmittal for a follow-up notification to State and local authorities. c. Transmit information using the designated checklist within 60 minutes of event classification for an initial notification of the NRC. 3. Demonstrate the ability to warn or advise onsite individuals of emergency conditions. Standard Criteria:

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			a. Initiate notification of onsite individuals (via plant page or telephone) using the designated checklist, within 15 minutes of notification. C. *Emergency Response* 1. Demonstrate the capability to direct and control emergency operations. Standard Criteria: a. Command and control is demonstrated by the control room in the early phase of the emergency and by the TSC within 60 minutes from activation. 2. Demonstrate the ability to transfer emergency direction from the control room (simulator) to the TSC within 30 minutes from activation. Standard Criteria: a. Briefings were conducted prior to turnover responsibility. Personnel document transfer of duties. 3. Demonstrate the ability to prepare for around-the-clock staffing requirements. Standard Criteria: a. Complete 24-hour staff assignments. 4. Demonstrate the ability to perform assembly and accountability for all onsite individuals within 30 minutes of an emergency requiring protected area assembly and accountability. Standard Criteria:

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			a. Protected area personnel assembly and accountability completed within 30 minutes of the Alert or higher emergency declaration via public address announcement. D. *Emergency Response Facilities* 1. Demonstrate timely activation of the OSC. Standard Criteria: a. The OSC is activated within about 60 minutes of the initial notification. 2. Demonstrate the adequacy of equipment, security provisions, and habitability precautions for the OSC, as appropriate. Standard Criteria: a. Demonstrate the adequacy of the emergency equipment in the emergency response facilities, including availability and general consistency with emergency implementing procedures (EIPs). b. The Security Shift Captain implements and follows applicable EIPs. c. The Health Physics Supervisor (TSC) implements the designated checklist if an onsite or offsite release has occurred. 3. Demonstrate the adequacy of communications for all emergency support resources. Standard Criteria:

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			a. Emergency response communications listed in emergency implementing procedures (EIPs) are available and operational. b. Communications systems are tested in accordance with OSC activation checklist. c. Emergency response facility personnel are able to operate all specified communication systems. d. Clear primary and backup communications links are established and maintained for the duration of the exercise. E. *Radiological Assessment and Control* 1. Demonstrate the ability to obtain onsite radiological surveys and samples. Standard Criteria: a. HP Technicians demonstrate the ability to obtain appropriate instruments (range and type) and take surveys. b. Airborne samples are taken when the conditions indicate the need for the information. 2. Demonstrate the ability to continuously monitor and control radiation exposure to emergency workers. Standard Criteria: a. Emergency workers are issued self-

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			reading dosimeters when radiation levels require, and exposures are controlled to 10 CFR Part 20 limits (unless the Emergency Director authorizes emergency limits). b. Exposure records are available, either from the ALARA computer or a hard copy dose report. c. Emergency workers include Security and personnel within all emergency facilities. 3. Demonstrate the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. Standard Criteria: a. One field monitoring team is ready to be deployed within 60 minutes of being requested from the OSC, and no later than 90 minutes from the declaration of an Alert or higher emergency. 4. Demonstrate the ability to satisfactorily collect and disseminate field team data. Standard Criteria: a. Field team data to be collected is dose rate or counts per minute (cpm) from the plume, both open and closed window, and air sample (gross/net cpm) for particulate and iodine, if applicable. b. Satisfactory data dissemination is from the field team to the Dose Assessment Supervisor, via the field team communicator and field team coordinator.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			5. Demonstrate the ability to develop dose projections. Standard Criteria: a. The on-shift HP/Chemistry Shared Foreman or Dose Assessment Supervisor performs timely and accurate dose projections, in accordance with emergency implementing procedures (EIPs). 6. Demonstrate the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development. Standard Criteria: a. Total effective dose equivalent (TEDE) and CDE dose projections from the dose assessment computer code are compared to emergency implementing procedures (EIPs). b. PARs are developed within 15 minutes of data availability. c. PARs are transmitted to responsible State and local government agencies via voice or fax within 15 minutes of PAR development. 8.1.2 Onsite emergency response personnel are mobilized in sufficient number to fill the emergency positions identified in emergency plan Section B, *VEGP Emergency Organization,* and they successfully perform their assigned responsibilities as outlined in Acceptance Criterion 8.1.1.D, *Emergency Response Facilities*.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			8.1.3 The exercise is completed within the specified time periods of Appendix E to 10 CFR Part 50, offsite exercise objectives have been met, and there are either no uncorrected offsite deficiencies, or a license condition requires offsite deficiencies to be corrected prior to operation above 5% of rated power.
9.0 Implementing Procedures			
10 CFR Part 50, Appendix E.V – No less than 180 days prior to the scheduled issuance of an operating license for a nuclear power reactor or a license to possess nuclear material, the applicant's detailed implementing procedures for its emergency plans shall be submitted to the Commission.	9.1 The licensee has submitted detailed implementing procedures for its emergency plan no less than 180 days prior to fuel load.	9.1 An inspection of the submittal letter will be performed.	9.1 The licensee has submitted detailed emergency implementing procedures (EIPs) for the onsite emergency plan no less than 180 days prior to fuel load.

13.6 Physical Security

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

13.6.1 Introduction

In Section 13.6 of the SSAR, the applicant stated that there will be a protected area (PA) encompassing the new units and committed to implementing a vehicle barrier system at the appropriate standoff distance once construction is completed on the first new unit. The applicant stated 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 VEGP site, which is sufficiently large to provide adequate distance between vital areas and the probable location of a security boundary.

During a November 1–3, 2006, site safety review audit, the NRC staff asked the applicant to describe how the site characteristics are such that adequate security plans and measures can be developed to address (1) the applicable provisions of 10 CFR 73.55, "Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors Against Radiological Sabotage," (2) RG 4.7, Revision 2, issued April 1998, and (3) post-September 11, 2001, (post-9/11) NRC orders (see letter dated November 16, 2006, entitled, "NRC Information Needs from November 2006 Safety Review Site Audit for VEGP Application). Specifically, the NRC staff requested additional information from SNC to address segments of the planned physical protection program with respect to the following:

1. site characteristics that may require mitigation to control close approaches to the facility (e.g., cliffs, depression, hills, mounds, waterways)

2. existing PA boundary for the power block structures and safety-related cooling tower (e.g., enlargement, redesign)

3. existing owner controlled area (OCA) and PA vehicle checkpoint (e.g., proposed additions, relocation)

4. proposed location of the intake structure

5. barge slips within the OCA

6. navigable waterway access

7. integrated response provisions (e.g., memoranda of agreement/understanding with local law enforcement agencies)

8. OCA patrol revisions (e.g., patrol frequency, increased staffing, surveillance technology)

Section 13.6 of the SSAR states that VEGP has a security program in place for the existing units and notes that this program complies with current 10 CFR 73.55 requirements and post-9/11 NRC orders. The SSAR further concludes that SNC anticipates that it will continue to meet those requirements and will extend them to the new units. SSAR Section 13.6 also states that the COL application will address the specific security design features to ensure site security and will include the design of security monitoring equipment and screening methods for station operating personnel. Finally, SSAR Section 13.6 points out that no security hazards exist within the vicinity of the VEGP site.

13.6.2 Regulatory Basis

In Section 13.6 of the SSAR, the applicant identified 10 CFR 100.21(f) and 10 CFR 73.55 as applicable regulations and noted that RG 4.7, Revision 2, provides applicable guidance. The NRC staff reviewed this portion of the application for conformance with applicable regulations and considered the corresponding regulatory guidance as identified above.

According to the NRC regulations, applicants for an ESP must address characteristics of the proposed site that could affect security. Specifically, 10 CFR 52.17 requires that site characteristics comply with the requirements of 10 CFR Part 100, in particular, 10 CFR 52.17(a)(1)(x) (like 100.21(f)) states that site characteristics must be such that adequate security plans and measures can be developed. In RG 4.7, Revision 2, the NRC provides amplifying guidance and notes that 10 CFR 73.55 describes the physical protection requirements for nuclear power plants. The NRC staff reviewed this portion of the application for conformance with the applicable regulations and considered the corresponding regulatory guidance.

13.6.3 Technical Evaluation

The NRC staff reviewed the application and responses to the site safety review audit information requests and examined aspects of the application during an onsite visit. The proposed ESP site is located on the 3169-acre existing VEGP site on a coastal plain bluff on the southwest side of the Savannah River in eastern Burke County. The site exclusion area is bounded by River Road, Hancock Landing Road, and 1.7 miles of the Savannah River (river-miles 150.0 to 151.7). The proposed Units 3 and 4 would be located within the proposed power block area, which is the perimeter of a 775-foot-radius circle with the centroid at a point between the two units. The centerline of the proposed VEGP Unit 3 will be located approximately 1500 feet west and 200 feet south of the center of the existing VEGP Unit 2 containment building. The centerline of the proposed Unit 4 will be approximately 900 feet west of the proposed Unit 3 (see Figure 13.3-2 in the ESP application).

Using the criteria set forth in 10 CFR 100.21(f), the NRC staff identified and considered various characteristics of the site that could affect the establishment of adequate security plans and measures. The NRC staff considered pedestrian land approaches, vehicular land approaches, railroad approaches, water approaches, potential “high-ground” adversary advantage areas, integrated response provisions, and nearby road transportation routes.

With respect to potential high-ground adversary advantage areas and vehicular land approaches, the applicant stated that, based upon the current site plan for the proposed Units 3 and 4, it does not anticipate mitigation with respect to the topographical features of the site.

With respect to pedestrian land approaches, the NRC staff’s onsite evaluation, coupled with a review of the various pictorial figures in the application, identified that the location of the proposed Units 3 and 4 on the VEGP site map will include the power block area, within which all safety-related structures would be located if one or more reactors were to be constructed.

During the safety review site audit, the NRC staff asked the applicant to identify its plans to address the guidance in RG 4.7, Revision 2, which specifies that an applicant provide a minimum of 360 feet between PA barriers and vital areas to allow for appropriate barriers, detection equipment, isolation zones, and vehicle barriers to protect vital equipment. In its response, the applicant stated that the physical protection of both the proposed VEGP Units 3 and 4 and the existing VEGP Units 1 and 2 will rely upon time-proven elements of detection, delay, and response. The applicant anticipates that, during the operational phase, all four units will be circumscribed by a contiguous PA boundary. The NRC staff concluded that the distance from planned locations of vital equipment and structures (which might be located anywhere in the ESP site footprint because the complete design is not specified at the ESP stage) to the planned PA boundary can be made sufficiently large so that holders of a COL or a CP could appropriately locate delay barriers, isolation zones, detection equipment, and vehicle barriers to protect vital equipment and structures. Therefore, the NRC staff concludes that the site characteristics are such that adequate security plans and measures can be developed to address pedestrian land approaches.

As discussed above, the applicant does not anticipate the need for mitigation with respect to the topographical features of the site. However, based on preliminary calculations, the area surrounding the proposed site is adequate for the installation of an engineered vehicle barrier system designed to deny a close approach of unauthorized vehicles. Furthermore, the applicant stated that land-based close approaches to the facility have been addressed by prior NRC security orders that applied to the existing units.

The NRC staff concludes that the location of existing roads and site terrain features does not preclude the establishment of adequate vehicle control measures to (1) prevent the use of a land vehicle to gain unauthorized proximity to vital areas and (2) protect against a vehicle bomb. The NRC 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 to mitigate overpressure effects from a vehicle bomb. Furthermore, the NRC 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. Therefore, the NRC staff concludes that the site characteristics are such that adequate security plans and measures can be developed with respect to a vehicle barrier system.

With respect to water approaches, the NRC staff notes that vital equipment for the existing VEGP units is sufficiently far from the Savannah River that restrictions to river access are not required. The need for such restrictions for any new units will depend on the design of the units and their location on the proposed site. However, even if such restrictions to river access were necessary, the NRC staff finds that the site configuration would allow for the development of such restrictions.

With respect to integrated response provisions with local law enforcement agencies (LLEAs), the NRC staff identified that the applicant satisfactorily included in the application specific acknowledgment that stipulated the VEGP site, which is located in Burke County in the State of Georgia, has written letters of agreement with the Burke County Sheriff and the Georgia State Patrol to provide off-site armed response support in the event of a VEGP security (or radiological) emergency. The NRC staff finds that these acknowledgments and agreements demonstrate security plans and measures containing integrated response provisions can be developed.

With respect to roads and railroads that penetrate the OCA, the NRC staff identified an existing rail spur. The applicant advised that roads and railroads that penetrate the required vehicle access denial system will be provided with appropriate access control measures in accordance with existing regulations and the Physical Security Plan filed with the COL application. The COL or CP applicant will need to provide the specific access control measures to address the existing rail spur. **This is COL Action Item 13.6-1**.

13.6.4 Conclusion

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

13.7 <u>Fitness for Duty Program</u>

13.7.1 Introduction

On March 28, 2008, Southern Nuclear Operating Company (SNC or the applicant) submitted the "Vogtle Electric Generating Plant Units 3 and 4 Fitness for Duty Program during LWA Construction" as part of an early site permit application. SNC revised the document on June 16, 2008, to incorporate language from Title 10, Part 26, "Fitness for Duty Programs," of the Code of Federal Regulations (10 CFR Part 26) issued subsequent to March 28, 2008. Following a teleconference with the U.S. Nuclear Regulatory Commission (NRC) on July 7, 2008, SNC submitted Revision 3 to the original document on July 9, 2008, which will be referred to as the "FFD Program" throughout this document.

NRC recognizes the experience of this applicant with administering existing full-scope fitness for duty programs at multiple operating nuclear reactors located in the southeastern United States, and in the applicant's ability to meet regulatory expectations in its established FFD programs.

13.7.2 Regulatory Basis

The NRC staff reviewed the contents of the applicant's fitness for duty (FFD) program in accordance with the criteria found in 10 CFR 26.4(e) and in Subpart K, "FFD Programs for Construction," of 10 CFR Part 26, issued on March 31, 2008 (10 CFR 26.401 through 10 CFR 26.419).

13.7.3 Technical Evaluation

13.7.3.1 General

10 CFR 26.401 identifies applicants who can develop an FFD program using Subpart K, and individuals who must be included in the FFD program. Specifically, 10 CFR 26.3(c) describes the type of applicant, and 10 CFR 26.4(e) and (f) identify the individuals who are subject to FFD programs and under which subsection. 10 CFR 26.4(e) includes, but is not limited to, the following individuals who are subject to a full-scope FFD program, as identified in 10 CFR Part 26, Subparts A through H, N and O: Second line supervisors and above, quality assurance (QA) / quality control (QC) personnel, witnesses to tests and certifications, and individuals affiliated with the access authorization program. 10 CFR 26.4(f) specifically relates to individuals constructing or directing the construction of safety- or security-related structures (SSCs) at the construction site, who must be covered by an FFD program that meets the requirements of 10 CFR Part 26, Subpart K.

The applicant stated that its FFD program is applicable to the Vogtle Electric Generating Plant (VEGP) Units 3 and 4 construction site (defined in the applicant's proposed plan) and applies only to persons who will perform limited work authorization (LWA) construction activities on safety or security-related structures, systems, and components (SSCs) at the location where the nuclear plant will be constructed and operated. The applicant's document states that it "is intended to serve as the FFD Program description for VEGP Units 3 and 4 LWA construction site as required in 10 CFR 26.401(b)." The applicant identified the types of individuals specified in 10 CFR 26.4(e) and (f) in its FFD Program. The document specifies that the individuals specified in 10 CFR 26.4(e) will be subject to the same requirements as those individuals participating in a full operating plant FFD program under 10 CFR Part 26, Subparts A through H, N and O. The document also specifies that the individuals specified in 10 CFR 26.4(f) will be subject to the requirements in 10 CFR Part 26, Subpart K.

The staff finds this approach to be acceptable because the proposed FFD Program applies to the type of entity subject to Subpart K and identifies the individuals to be included in the program as identified in 10 CFR 26.4(e) and (f).

13.7.3.2 Written Policy and Procedures

10 CFR 26.403 states that "a policy statement must be written in sufficient detail to provide affected individuals with information on what is expected of them and what consequences may result from a lack of adherence to the policy." This section specifies the content of the applicant's written procedures, including the methods and techniques to be used to test for alcohol and drugs, procedures for protecting privacy and for ensuring the integrity of specimens, and actions and procedures for responding to specific FFD-related situations that could adversely affect the FFD program or an individual's ability to safely and competently perform his or her duties.

The applicant's proposed program includes this information in Section 5, "Drug and Alcohol Policy and Procedures." The applicant outlines expectations of individuals subject to the FFD program in their application, as well as the consequences for noncompliance with the policy. Prior to commencing work on SSCs, the applicant commits to the development, implementation, and maintenance of written site procedures that address the methods and techniques that will be used to test for alcohol and drugs. The applicant also commits to addressing privacy provisions for individuals subject to the program and response actions and procedures for individuals not complying with the applicant's FFD policy.

The staff finds this approach to be acceptable because the policies and procedures described in the applicant's proposed FFD Program meet the requirements of the regulations. The applicant defines a policy to inform individuals of the expectation that they must comply with the FFD Program and the associated consequences for violations of the program. The program identifies procedures that address the methods and techniques used in FFD testing and ensure that personal privacy is preserved during the process.

13.7.3.3 Drug and Alcohol Testing

Section 6, "Drug and Alcohol Testing Procedure," of the applicant's proposed FFD Program provides the means that will be used to detect and deter substance abuse through a drug and alcohol testing program.

10 CFR 26.405(b)(1)–(4) requires that the testing process (1) provide reasonable assurance that individuals are unable to predict the time periods during which specimens will be collected, (2) require individuals who are selected for random testing to report to the collection site as soon as reasonably practicable after notification, (3) ensure that all individuals in the population subject to random testing on a given day have an equal probability of being selected and tested, and (4) provide that an individual completing a test is immediately eligible for another random test.

Section 6.2.3 of the applicant's proposed FFD Program states that "testing will be conducted during all types of work periods including weekends and holidays at various times of the day throughout the calendar year." The applicant specifies that individuals will report for random FFD tests within one hour of notification. The applicant describes how it will develop a process that ensures that all individuals in the population subject to testing will have an equal probability of being selected and tested. Section 6.2.3 also states that individuals selected for testing will be immediately available to be selected the next time a random list is generated.

The staff finds this approach to be acceptable because the applicant's program meets the intent of the regulation, which is to provide reasonable assurance that individuals are not able to subvert the testing process by predicting testing frequencies; establishes a timetable for reporting to an FFD test from the time of notification; ensures that each individual has the same opportunity to be selected from the random testing pool; and ensures that each individual in the program is eligible each and every time a random pool of individuals is selected.

10 CFR 26.405(c) describes the conditions under which testing will be imposed by the licensee-preassignment, for cause, post-accident (significant illness or damage), and followup.

For clarification, in Section 6.2 the applicant uses the term "pre-access," which is equivalent to the term "preassignment" as specified in 10 CFR 26.405(c). Section 6.2 of the applicant's proposed FFD Program, which addresses "pre-access," states, in part, that "Each worker who will construct or direct the construction of safety- or security-related SSCs shall have negative drug and alcohol test results prior to constructing or directing the construction of safety- or security-related SSCs." Section 6.2.2 defines the parameters of for-cause testing as post-accident, occupational injury or illness, significant property damage, observed behavior, custodial arrest, and followup testing. Section 6.2.3 defines the random drug and alcohol testing program, including the selection process and the rate and frequency of tests that an individual must consent to in order to obtain and maintain unescorted access.

The staff finds this approach to be acceptable because the applicant's proposed FFD Program meets all of the requirements defined in 10 CFR 26.405(c)(1)–(4) by describing the conditions under which an individual must be tested.

10 CFR 26.405(d) specifies the substances, at a minimum, that shall be tested for and the threshold levels of each substance.

The applicant's program, under Section 5.3, provides tables that list the substances to be tested for and the threshold levels for both initial tests and confirmatory tests.

The staff finds this approach to be acceptable because the applicant's program includes all of the substances identified in 10 CFR Part 26. In addition, the applicant's threshold levels meet the levels specified in the 10 CFR Part 26.

10 CFR 26.405(e) requires that the specimen collection and FFD testing program protect the donor's privacy and the integrity of the specimen. The applicant must implement stringent quality controls to ensure that test results are valid and attributable to the correct individual. This regulation also provides for alternate testing sites under the requirements of 49 CFR Part 40, "Procedures for Transportation Workplace Drug and Alcohol Testing Programs," and subsequent amendments thereto.

The applicant has committed to creating drug and alcohol procedures that will require that construction site entities develop, implement, and maintain "methods and techniques to be used in testing for drugs and alcohol, including procedures for protecting the privacy of an individual who provides a specimen, procedures for protecting the integrity of the specimen, and procedures used to ensure that the test results are valid and attributable to the correct individual." The applicant also identifies alternative collection and testing facilities and associated requirements under 49 CFR Part 40.

The staff finds this approach to be acceptable based on the applicant's description of its plans to create and incorporate procedures that meet the requirements of administering an FFD program that protects individuals subject to its provisions, including the privacy of individuals, ensures the integrity of specimens taken from individuals, and identifies the requirements in the event an alternate testing facility is used.

10 CFR 26.405(f) specifies that "testing of urine specimens for drugs and validity, except validity screening and initial drug and validity tests that may be performed by licensee testing facilities, must be performed in a laboratory that is certified by the U.S. Department of Health and Human Services (HHS) for that purpose, consistent with its standards and procedures certification." Any initial drug test performed by a licensee or other entity subject to Subpart K of 10 CFR Part 26 must use an immunoassay that meets the requirements of the Food and Drug Administration (FDA) for commercial distribution. Urine specimens that yield invalid initial validity or drug test results must be subject to confirmatory testing by the HHS-certified laboratory, except for invalid specimens that cannot be tested. Other specimens that yield positive initial drug test results must be subject to confirmatory testing by a laboratory that meets stringent quality control requirements that are comparable to those required for certification by the HHS.

The applicant's proposed FFD Program states in section 6.3, "Initial analysis and validity testing may be performed by the construction site entity testing facility or by HHS-certified laboratories." Furthermore, "Testing for drugs and drug metabolites will be conducted through the analysis of urine specimens or other process which meets the requirements of the FDA." The applicant's program also discusses initial positive tests and states, "urine specimens that yield presumptive positive, adulterated, substituted, or invalid initial validity or drug test results must be confirmed using a HHS-certified laboratory, except for invalid specimens that cannot be tested." The application also states, "Confirmatory analysis is performed by a laboratory that meets stringent quality control requirements that are comparable to those required for certification by HHS."

The staff finds this approach to be acceptable in that the applicant has met the requirements for initial, validity, and initial positive tests citing quality control requirements of HHS laboratories and processes approved by the FDA, as required by the rule. It is also noted that this applicant currently manages successful FFD programs at multiple operating reactors which adds to its familiarity with acceptable practices and procedures.

10 CFR 26.405(g) specifies that "licensees and other entities shall provide for an MRO review of positive, adulterated, substituted, and invalid confirmatory drug and validity test results to determine whether the donor has violated the FFD policy, before reporting the results to the individual designated by the licensee or other entity to perform the suitability and fitness evaluations required under 10 CFR 26.419."

The applicant will use a medical review officer (MRO) as described in its proposed FFD Program. The MRO will be a licensed physician who is responsible for receiving laboratory results generated by an HHS-certified laboratory and who has the appropriate medical training to properly interpret and evaluate an individual's drug and validity test results, together with his or her medical history, and any other relevant biomedical information. Furthermore, the applicant states in Section 6.5 that, "All presumptive positive drug test results confirmed by the HHS certified laboratory as positive shall be reviewed by the MRO. The MRO will determine whether a legitimate medical reason exists for the positive result and will be the final determination as to whether an individual is in violation of the FFD program. If the MRO determines that there is a legitimate medical explanation for the confirmed positive result, the MRO shall report the result as negative. Substituted, adulterated or diluted test results will also be subject to MRO review for final determination. Invalid confirmatory drug and validity test results will be reviewed by the MRO to determine if the donor has violated the FFD policy." The applicant also states that the MRO shall report all positive results to the construction site management person responsible for the FFD program.

The staff finds this approach to be acceptable because the applicant has defined the MRO position and the MRO's role in the process. Specifically, the MRO will review positive, substituted, adulterated, or diluted tests results to determine whether the donor has violated the FFD policy. The applicant has also identified who the MRO will report to with the information, as required by 10 CFR Part 26.

13.7.3.4 Fitness Monitoring

10 CFR 26.406, "Fitness Monitoring" provides an alternative to random testing to deter substance abuse and detect indications of possible use, sale, or possession of illegal drugs; use or possession of alcohol while constructing SSCs; or impairment from any cause that if left unattended may result in a risk to public health and safety or the common defense and security. The fitness monitoring section of the rule only applies to those licensees who elect not to impose a random drug and alcohol testing program. Because the applicant plans to subject applicable individuals to random FFD testing for drugs and alcohol, the fitness monitoring requirement is not applicable to this applicant.

13.7.3.5 Behavioral Observation

10 CFR 26.407, "Behavioral Observation," is required when fitness monitoring is not the method used to ensure that applicable individuals are fit for duty at the site. This section states, "While the individuals specified in 10 CFR 26.4(f) are constructing safety- or security-related SSCs, licensees and other entities shall ensure that these individuals are subject to behavioral observation, except if the licensee or other entity has implemented a fitness monitoring program under 10 CFR 26.406."

The applicant describes its behavioral observation program (BOP) in section 6.7. It states that the BOP "is the primary means to detect behavior that may indicate possible use, sale, or possession of illegal drugs; use or possession of alcohol onsite or while on duty; or any physical impairment or any cause that, if left unattended, may constitute a risk to public health and safety or the common defense and security." Also, "supervisors that are responsible for observing individuals subject to a BOP shall report any FFD concerns about individuals to the personnel designated in the construction site entity's policy." The application also addresses the need for training of individuals participating in the BOP citing "Training shall communicate the expectation of promptly reporting noticeable changes in behavior or FFD concerns about other individuals to the construction site entity designated personnel for appropriate evaluation and action in accordance with the FFD policy."

The staff finds this approach to be acceptable because it requires observation of individuals working on safety- or security-related SSCs by individuals trained to detect possible impairment.

13.7.3.6 Sanctions

10 CFR 26.409, "Sanctions," states that sanctions must, "at a minimum, prohibit the individuals specified in 10 CFR 26.4(f) from being assigned to construct safety- or security-related SSCs unless or until the licensee or other entity determines that the individual's condition or behavior does not pose a potential risk to public health and safety or the common defense and security."

The applicant's proposed FFD Program states in section 5.2 that "employees who violate the FFD Policy by testing positive for drugs or alcohol are subject to discipline up to and including immediate discharge." The applicant also states that employees who refuse to submit to FFD tests as required are subject to discipline up to and including immediate discharge. Section 5.2 of the applicant's program describes "disciplinary actions," which include the requirement that individuals sign a Consent Form attesting to their understanding of the consequences for a violation of the FFD policy. These sanctions, at a minimum, prohibit individuals from being assigned to construct SSCs until the applicant ascertains that the individual's condition or behavior no longer poses a potential risk to public health and safety or the common defense and security.

The staff finds this approach to be acceptable because the proposed FFD Program contains the same prohibition as the rule, communicates the possibility of sanctions to individuals seeking unescorted access, and requires such individuals to acknowledge the possibility of sanctions by means of a consent letter. Together, these provisions of the applicant's FFD Program will reduce the risk of individuals violating the FFD Program.

13.7.3.7 Protection of Information

10 CFR 26.411, "Protection of Information," requires the establishment and maintenance of a system of files and procedures to protect the personal information collected about an individual for purposes of complying with Subpart K of 10 CFR Part 26 and the maintenance and use of such records "with the highest regard for personal privacy." Paragraph (b) of this section requires a signed consent authorizing the disclosure of the personal information except for disclosures to specific individuals.

Section 6.8 of the applicant's proposed FFD Program provides that "personal information, whether electronic or hard copy, must not be disclosed to unauthorized persons." This section lists personnel authorized to receive information and establishes limits on accessing personal data "to each authorized individual's area of responsibility."

10 CFR 26.411(b) states that "licensees and other entities shall obtain a signed consent that authorizes the disclosure of the personal information collected and maintained under this subpart before disclosing personal information, except for disclosures to the individuals and entities specified in 10 CFR 26.37(b)(1) through (b)(6), (b)(8), and persons deciding matters under review in 10 CFR 26.413." The applicant's proposed FFD Program description includes a sample consent form. The first page of the document provides the authorizations and

understandings to which the individual is consenting, and the second and third pages comprise the actual form. Individuals reading the form prior to signing it should gain a clear understanding of who is eligible to receive information that will be released on a strictly "need-to-know" basis in the event that the person does not conform to the FFD policy.

The staff finds this approach to be acceptable because the applicant fulfills the requirements of 10 CFR 26.411 by developing procedures that protect personal privacy, identifying individuals authorized for disclosure of personal information meeting requirements, and using a consent form that creates a written, signed, and dated agreement with the individual regarding personal privacy.

13.7.3.8 Review Process

10 CFR 26.413, "Review Process," states, in part, that licensees "shall establish and implement procedures for the review of a determination that an individual…has violated the FFD policy."

Section 6.6 of the applicant's proposed FFD Program states that the "construction site entity shall have an alternative review process that is objective and impartial." Furthermore, individuals "will be provided the opportunity to have the decision, together with any additional information, reviewed by another designated construction site entity manager who is equivalent or senior to and independent of the individual who made the decision to deny or terminate access."

The staff finds this approach to be acceptable as it meets the requirements and intent of the 10 CFR 26.413 by providing a review process for FFD policy violations.

13.7.3.9 Audits

10 CFR 26.415, "Audits," states, in part, that "audits are performed to assure the continuing effectiveness of the FFD program." In particular, 10 CFR 26.415(b) addresses the frequency of audits to ensure continued effectiveness and the need for action to be taken to resolve any identified problems. In addition, 10 CFR 26.415(c) explains the requirements for licensee audits of HHS-certified laboratories.

Section 6.9 of the applicant's proposed FFD Program states, "Construction site entities who implement an FFD program shall ensure that audits are performed to assure the continuing effectiveness of the FFD program." The applicant addresses 10 CFR 26.415(b) by stating that "these programs are audited at a frequency that assures their continuing effectiveness and that corrective actions are taken to resolve any problems identified." The applicant's proposed program to implement 10 CFR 26.415(c) states that "construction site entities need not audit HHS-certified laboratories or a specimen collection and alcohol testing service that meets the requirements of 49 CFR 40 on which the construction site entity may rely to meet the drug and alcohol testing requirements of 10 CFR 26."

The staff finds this approach to be acceptable because implementation of the applicant's proposed FFD Program, as written, will meet the requirements of 10 CFR 26.415. Based on the applicant's familiarity with FFD programs and associated audits, the staff has further confidence in its conclusion that a successful audit program will be implemented.

13.7.3.10 Recordkeeping and Reporting

As required by 10 CFR 26.417, "Recordkeeping and Reporting," the licensee must make records available for NRC inspection purposes and for any legal proceedings resulting from the administration of the program. As required by 10 CFR 26.417(b)(1), the licensee must report any intentional act that casts doubt on the integrity of the FFD program and any programmatic failure to the NRC Operations Center by telephone within 24 hours after discovery. As required by 10 CFR 26.417(b)(2), the licensee must submit to the NRC annual program performance reports for FFD programs.

The applicant states, in section 6.8 of its proposed FFD Program, that it will make records, electronic or hardcopy, available for NRC inspection and will disclose such records to appropriate law enforcement or judicial officials under procedures established in the FFD Program consistent with regulatory requirements. The applicant's proposed reporting requirements are consistent with 10 CFR 26.417(b)(1) and (2) since they use wording identical to that of the rule.

The staff finds this approach to be acceptable as the applicant's program is written in accordance with the 10 CFR 26.417.

13.7.3.11 Suitability and Fitness Evaluations

10 CFR 26.419, "Suitability and Fitness Evaluations," requires licensees and other entities who implement FFD programs to "develop, implement, and maintain procedures for evaluating whether to assign individuals to construct safety- and security-related SSCs. These procedures must provide reasonable assurance that the individuals are fit to safely and competently perform their duties, and are trustworthy and reliable, as demonstrated by the avoidance of substance abuse."

The applicant's proposed FFD Program describes policies, procedures, and processes to determine an individual's fitness to perform work on safety- or security-related SSCs at the construction site. The proposed program describes training and implementation procedures for managers and supervisors to observe an individual's behaviors and actions on an ongoing basis. Together, the applicant's proposed testing program and BOP serve as the means to evaluate and verify, with reasonable assurance, that the workforce is reliable and fit to perform duties safely and competently. Therefore, the staff finds this approach acceptable.

13.7.4 Conclusion

The applicant has defined an FFD program for LWA construction at the Vogtle site that meets the regulations found in 10 CFR Part 26. As a result, the staff finds the SNC FFD program for the requested LWA activities at Vogtle to be acceptable.

15.0 ACCIDENT ANALYSIS

15.0.3 Radiological Consequences of Design Basis Accidents

15.0.3.1 Introduction

In Chapter 15 of the SSAR submitted by SNC, as part of the ESP application for the VEGP site, the applicant analyzed and provided the radiological consequences of 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 10 CFR 52.17 and 10 CFR Part 100. The applicant used the Westinghouse AP1000 certified reactor design in its consideration of the proposed ESP site. The applicant used the AP1000 characteristics in conjunction with site characteristics for accident analysis purposes, to assess the suitability of the proposed ESP site. Using the source term developed for this design, the applicant performed and provided radiological consequence analyses for the following DBAs:

- PWR main steamline break
- PWR feedwater system pipe break
- reactor coolant pump shaft seizure (locked rotor)
- reactor coolant pump shaft break
- PWR rod cluster control assembly ejection accident
- failure of small lines carrying primary coolant outside containment
- steam generator tube rupture
- loss-of-coolant accident
- fuel handling accident

The applicant presented the dose consequence assessment results in a series of tables found in SSAR Chapter 15 which provide the postulated radiological consequences of the DBAs identified above at the proposed EAB and the LPZ. The dose consequence assessment results in the tables also demonstrate that any potential doses would be within the radiological 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 to the environment) and resulting site-specific dose consequences for each DBA in Tables 15-2 through 15-22 of the SSAR.

15.0.3.2 Regulatory Basis

In SSAR Table 1-2 and Chapter 15, 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
- RG 1.145, issued November 1982
- RG 1.183, issued July 2000
- NUREG-0800, Revision 3, issued June 1987

The NRC staff reviewed SSAR Chapter 15 for conformance with the applicable regulations and considered the corresponding guidance, as identified above in addition to RS-002 (May 3, 2004). The regulations at 10 CFR 52.17(a)(1) require that ESP applications contain an analysis and evaluation of the major SSCs of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in 10 CFR 52.17(a)(1)(ix). In addition, the ESP site characteristics must comply with the requirements of 10 CFR Part 100.21, which states that radiological dose consequences of postulated accidents shall meet the criteria set forth in 10 CFR 50.34(a)(1). In its evaluation, the NRC staff used the radiological consequence evaluation factors found in 10 CFR 52.17(a)(1) as a factor in determining the acceptability of the site. The radiological consequence evaluation factors for a postulated fission product release based on a major accident (Dose Factors) given both in 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1) are:

- 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 [roentgen equivalent man] TEDE.

- An individual located at any point on the outer 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.

The applicant used the AP1000 fission product release values in its assumed release from the ESP footprint to the environment; the NRC staff reviewed the applicant's dose evaluation based on this release.

15.0.3.3 Technical Evaluation

The applicant evaluated the suitability of the site under the Dose Factors using bounding reactor accident source terms and radiological consequences based on the AP1000 design, as well as site-specific atmospheric dispersion factor (χ/Q) values derived from the ESP footprint. The following sections describe the NRC staff's review of each aspect of the applicant's evaluation.

15.0.3.3.1 Selection of Design Basis Accidents

The applicant selected the DBAs listed in Chapter 15 of this SER on the basis of the AP1000 reactor design. The applicant selected the entire set of DBAs that the agency evaluated for the AP1000 reactor design and found to be acceptable in its approval of the AP1000 DCD. The AP1000 is an advanced light-water reactor of the PWR type. The AP1000 advanced design is not substantially different from the designs evaluated by the guidance in Chapter 15 of NUREG-0800 and in RG 1.183. On this basis, the NRC staff used the light-water reactor guidance in NUREG-0800 and RG 1.183 in its review and approval of the AP1000 DCD. The NRC staff finds that the applicant selected DBAs that are consistent with the DBAs listed and analyzed in Chapter 15 of NUREG-0800 and in RG 1.183 for PWRs. Therefore, the NRC 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 52.17(a)(1).

15.0.3.3.2 Design-Specific (Assumed) Short-Term Atmospheric Dispersion Factors

Short-term atmospheric dispersion factor values are used in the radiological consequences analyses to characterize the effect of the site-specific meteorological conditions, topography, and distance to either the EAB or LPZ on the radioactivity concentration in the accident release plume. The applicant compared the ESP site-specific short-term χ/Q values to the AP1000 DCD χ/Q values. This comparison ensured that the accident doses calculated in accordance with the AP1000 DCD Chapter 15 results, remain at or below the limiting values of RG 1.183 when taking into consideration the ESP site specific values. In lieu of site-specific meteorological data, the AP1000 DCD provided a set of hypothetical reference short-term χ/Q values for the EAB and LPZ to use in evaluating the AP1000 design. The AP1000 DCD states that the EAB and LPZ χ/Q values were selected to bound the majority of the operating U.S. nuclear power plant sites, but the values were not certified for this specific ESP site. Table 15.0.3-1 of this SER lists the AP1000 χ/Q values:

Table 15.0.3-1 - Design-Specific Short-Term χ/Q Values in s/m^3

Location	Time (hr)	DCD χ/Q (s/m^3)
EAB	0 - 2	0.00051
LPZ	0 - 8	0.00022
LPZ	8 - 24	0.00016
LPZ	24 - 96	0.0001
LPZ	96 - 720	0.00008

15.0.3.3.3 Site-Specific Short-Term Atmospheric Dispersion Factors

The NRC staff reviewed the applicant's site-specific short-term χ/Q values in accordance with the guidance provided in Section 2.3.4 of RS-002 and confirmed the applicant's results on atmospheric dispersion. The NRC staff finds the χ/Q values to be acceptable, as described in Section 2.3.4 of this SER. Table 15.0.3-2 of this SER lists the site-specific short-term χ/Q values used by the applicant and reviewed by the NRC staff. Table 15.0.3-2 also includes the ratio of the site-specific values to the DCD values as a comparison. The NRC staff intends to include these site-specific short-term χ/Qs as site characteristics in any ESP that the NRC may issue for the VEGP ESP site.

Table 15.0.3-2 - Site-Specific Short-Term χ/Q Values

Location	Time (hr)	Site χ/Q (s/m^3)	χ/Q Ratio (Site/DCD)
EAB	0 - 2	0.000349	0.684
LPZ	0 - 8	0.0000704	0.32
LPZ	8 - 24	0.0000525	0.328
LPZ	24 - 96	0.0000277	0.277
LPZ	96 - 720	0.0000111	0.139

15.0.3.3.4 Source Terms and Radiological Consequence Evaluations

To evaluate the suitability of the site using the Dose Factors, the applicant provided the reactor accident source terms from the AP1000 design and 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 radiological consequences are then derived from the source terms using established methods. The AP1000 accident-specific source term is 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 and were found acceptable to the NRC staff in its review of the AP1000 DCD for certification of the AP1000 design. The resulting doses calculated for the AP1000 design using assumed site parameters meet the Dose Factors.

In determining the potential radiological consequence doses resulting from DBAs at the proposed site, the applicant used the site-specific χ/Q values in conjunction with the DBA radiological consequences and the postulated χ/Q values provided in the certified AP1000 DCD.

The certified AP1000 design met the Dose Factors with the reference χ/Q values in the certified AP1000 DCD. 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 15-11 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 NRC 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.

The certified AP1000 design met the Dose Factors with its postulated χ/Q values. The estimated site-specific χ/Q values for the proposed site are lower than those postulated in the AP1000 DCD, as summarized in SSAR Table 15-12. The applicant used the ratios of the site-specific χ/Q values to those postulated in the AP1000 DCD to determine and demonstrate that the radiological consequences at the proposed site meet the requirements of 10 CFR 52.17. Accordingly, the resulting DBA radiological consequence doses at the proposed site are lower than those provided in the AP1000 DCD and, therefore, meet the requirements of 10 CFR 52.17.

The NRC staff evaluated the design-specific source terms the applicant provided and finds them to be consistent with those evaluated as part of the AP1000 design certification review. Furthermore, the NRC 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. The NRC 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 VEGP site.

Based on its evaluation of the applicant's DBA radiological consequences analysis methodology and the inputs to that analysis, the NRC staff finds that the applicant correctly concluded that the radiological consequences for the chosen design comply with the Dose Factors. Table 15.0.3-2 of this SER identifies the site-specific χ/Q values as appropriate for inclusion in any ESP that the NRC might issue for the VEGP ESP site.

The design-related inputs to the applicant's DBA radiological consequence calculation were directly extracted from design documentation previously submitted to and reviewed by the NRC in connection with design certification applications. Because the NRC staff performed this calculation in the DCD review, and the applicant simply used the ratio of the site-specific χ/Q values to the postulated design χ/Q values, the NRC staff did not consider an independent calculation to be useful or necessary and, therefore, did not perform one.

15.0.3.4 Conclusion

As set forth above, the applicant submitted its radiological consequence analyses using the site-specific χ/Q values and AP1000 source-term values and concluded that the proposed site meets the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1) for a design such as the AP1000. Based on the reasons set forth above, the NRC staff finds that the applicant's values for source terms included as inputs to the radiological consequence analyses are reasonable. Furthermore, the NRC staff finds that the applicant's site-specific χ/Q values and dose consequence evaluation methodology are acceptable.

For the reasons stated above, the source term values forming the basis of the dose consequence analysis in this Chapter are included in Appendix A of this SER, and would be included in any ESP issued for the Vogtle site. However, the staff notes that for COL or CP applications that reference a certified design, staff guidance in RG 1.206 permits an applicant to demonstrate compliance with the regulatory radiological consequence evaluation criteria by demonstrating that its site-specific χ/Q values are bounded by the postulated design χ/Q values analyzed in the approval of the certified design, thereby demonstrating that the postulated accident radiological consequences calculated in the design certification bound that for the site and meet the regulatory criteria. Accordingly, the staff proposes that the following permit condition be included in any ESP issued for the Vogtle site.

If a COL or CP application referencing this ESP also references a certified design, the COL or CP applicant may demonstrate compliance with the radiological consequence evaluation factors in 10 CFR 52.79(a)(1) or 10 CFR 50.34(a)(1), respectively, by demonstrating that the site-specific χ/Q values determined in the ESP fall within those evaluated in the approval of the referenced certified design. However, if a COL or CP referencing this ESP does not reference a certified design, the applicant would still need to demonstrate that its source term is bounded by the source term values included in the ESP. This is **Permit Condition 9**.

The NRC staff further 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, are adequate to provide reasonable assurance that the radiological consequences of the postulated DBAs will be within the dose consequence evaluation factors set forth at 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1) for the proposed ESP site.

The NRC staff further concludes that, with respect to the radiological consequences of design basis accidents: (1) the applicant demonstrated that the proposed ESP site is suitable for power reactors with source term characteristics bounded by those of the AP1000, as specified in Appendix A, without undue risk to the health and safety of the public; and (2) the applicant complies with the applicable requirements of 10 CFR 52.17 and 10 CFR Part 100.

As noted in the applicant's comments on the NRC staff's draft environmental impact statement (DEIS) (Southern 2007f), Westinghouse, the AP1000 reactor vendor, has submitted a revision to the AP1000 design to NRC for review (Westinghouse 2007, NRC 2008). The NRC staff is reviewing that request independently of the Vogtle ESP review. The source term information in the Westinghouse submission indicates that the doses from postulated accidents would decrease should the proposed design revision be accepted. However, the staff has not completed its review of the design changes or done a site-specific analysis of the radiological consequences of postulated design basis accidents for the revised design at the Vogtle site.

17.0 QUALITY ASSURANCE PROGRAM DESCRIPTION

17.1 Introduction

Southern Nuclear Operating Company (SNOC) submitted an Early Site Permit Application for the Vogtle site by letter, dated August 15, 2007. Chapter 17.0, Appendix 17.1A, "Nuclear Development Quality Assurance Manual" (QA Manual), establishes a quality assurance program that can be applied to the Early Site Permit application (ESP) and the limited work authorization (LWA) activities described in Supplement 2-S1.

This safety evaluation addresses Revision 6 of the Vogtle Early Site Permit Application QA Manual. Revision 6 of the QA manual incorporates the standard format and content of Nuclear Energy Institute (NEI) 06-14A, "Quality Assurance Program Description," and supersedes the staff's previous safety evaluation on Revision 3 of the Vogtle ESP QA Manual issued on August 30, 2007. NEI 06-14A covers a variety of applications, including combined licenses, construction, preoperation, and operation activities. However, this evaluation covers only those activities described in the Vogtle ESP Application and Supplement 2-S1.

17.2 Regulatory Evaluation

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," establishes the Commission's QA requirements for the design, fabrication, construction, and testing of the structures, systems and components (SSCs) of the facility. These requirements apply to all activities affecting the safety-related functions of those SSCs. This includes designing, purchasing, fabricating, handling, shipping, storing, cleaning, erecting, installing, inspecting, testing, operating, maintaining, repairing, refueling, and modifying.

Section 52.17, "Contents of Applications; Technical Information," of 10 CFR establishes the technical information requirements for ESP applications. Subsection 52.17(1)(a)(xi) requires that ESP applications provide a description of the QA program applied to site-related activities for the future design, fabrication, construction, and testing of the SSCs of a facility or facilities that may be constructed on the site.

17.3 Technical Evaluation

The staff used Standard Review Plan (SRP) Section 17.5, "Quality Assurance Program Description—Design Certification, Early Site Permit and New License Applicants," (NUREG-0800, Section 17.5, "Quality Assurance Program Description") to evaluate the applicant's QA program description (QAPD). In developing SRP Section 17.5, the staff used American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA) Standard NQA-1-1994, as supplemented by regulatory and industry guidance for nuclear operating facilities.

The QAPD is a top-level policy document that defines the quality policy and assigns major functional responsibilities. The QAPD applies to safety-related SSCs as well as selected elements of nonsafety-related SSCs that are nevertheless important to plant safety.

The QAPD cites a number of activities, such as operating, refueling, and decommissioning activities, that are outside the scope of this safety evaluation. This safety evaluation is limited to activities described by the Vogtle ESP application and LWA supplement.

17.3.1 Organization

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.A, for providing an organizational description that includes an organizational structure, functional responsibilities, levels of authority, and interfaces for establishing, executing, and verifying QAPD implementation. The QAPD establishes independence between the organization responsible for checking a function and the organization that performs the function. In addition, the QAPD allows management to size the quality assurance organization according to the duties and responsibilities assigned.

The applicant commits to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 1 and Supplement 1S-1.

17.3.2 Quality Assurance Program

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.B, to ensure that the QA Manual describes all aspects of work that are important to the safety of nuclear power plants. The quality assurance program comprises those planned and systematic actions necessary to provide confidence that SSCs will perform their intended safety function, as described in the applicant's final safety analysis report (FSAR). This includes certain nonsafety-related SSCs and activities that are important to plant safety. The appropriate facility maintains a list or system identifying SSCs and activities to which the QAPD applies.

The QAPD provides measures to assess its adequacy and to ensure its effective implementation at least once each year or at least once during the life of the activity, whichever is shorter. Consistent with SRP Section 17.5, paragraph II.B.8, the QAPD applies a grace period of 90 days to activities that must be performed on a periodic basis. The grace period does not allow the "clock" for a particular activity to be reset forward. However, the "clock" for an activity is reset backwards by performing the activity early.

The QAPD follows the guidance of SRP Section 17.5, paragraphs II.S and II.T, for establishing and maintaining training programs for personnel who perform, verify, or maintain activities within the scope of the QAPD. The QAPD provides the minimum training requirements for managers responsible for QAPD implementation. It also provides the minimum training requirements for the individual responsible for planning, implementing, and maintaining the QAPD.

The applicant commits to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 2 and Supplements 2S-1, 2S-2, 2S-3, and 2S-4, with the following clarifications and exceptions:

- ASME Standard NQA-1-1994, Supplement 2S-1, includes use of the guidance provided in Appendix 2A-1 to ASME Standard NQA-1-1994. The following alternatives may be applied to the implementation of this supplement and appendix:

As an alternative to the requirement in Appendix 2A-1 to be certified as Level I, II, or III; personnel performing independent quality verification inspections, examinations, measurements, or tests will be required to possess qualifications equal to or better than those required for performing the task being verified. In addition, the verification performed must be within the skills of these personnel and/or addressed by procedures. These personnel will not be responsible for planning quality verification inspections and tests (i.e., establishing hold points and acceptance criteria in procedures, and determining who will be responsible for performing the inspection), evaluating inspection training programs, or certifying inspection personnel. This alternative is consistent with SRP Section 17.5, paragraph II.T.5.

A qualified engineer may plan inspections, evaluate the capabilities of an inspector, or evaluate the training program for inspectors. For the purposes of these functions, a qualified engineer is one who has a baccalaureate degree in engineering in a discipline related to the inspection activity (such as electrical, mechanical, or civil engineering) and has at least 5 years of engineering work experience, with at least 2 years of this experience related to nuclear facilities. In accordance with Supplement 2S-1 to ASME Standard NQA-1-1994, the organization must designate those activities that require qualified inspectors and test personnel and establish written procedures for the qualification of these personnel. The U. S. Nuclear Regulatory Commission (NRC) staff determined that the designation of a qualified engineer to plan inspections, evaluate inspectors, or evaluate the inspector qualification programs is acceptable. The staff's review determined that this approach is consistent with regulatory guidance, ASME Standard NQA-1-1994, or other industry guidance in this subject area.

- ASME Standard NQA-1-1994, Supplement 2S-2, describes the qualification requirements of nondestructive examination personnel. As an alternative, the applicant's QAPD provides guidance to follow the applicable standard cited in the version(s) of Sections III and XI of the ASME Boiler and Pressure Vessel Code. The regulation in 10 CFR 50.55a, "Codes and Standards," requires use of the latest edition and addenda of ASME Boiler and Pressure Vessel Code Sections III and XI. Therefore, the staff accepts the use of Sections III and XI of the ASME Code for qualification of nondestructive examination personnel.

- ASME Standard NQA-1-1994, Supplement 2S-3 requires that prospective lead auditors must have participated in a minimum of five audits in the previous 3 years. As an alternative, the applicant's QAPD follows the guidance provided in SRP Section 17.5, paragraph II.S.4.c:

  The prospective lead auditor shall demonstrate his/her ability to properly implement the audit process, as implemented by the company, to effectively lead an audit team, and to effectively organize and report results, including participation in at least one nuclear audit within the year preceding the date of qualification.

17.3.3 Design Control

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.C, for controlling the design, design changes, and temporary modifications (e.g., temporary bypass lines, electrical jumpers and lifted wires, and temporary setpoints) of items that are subject to the provisions of the QAPD. The QAPD design process includes provisions to control design inputs, outputs, changes, interfaces, records, and organizational interfaces with the applicant and its suppliers. These provisions ensure that the design inputs (e.g., design bases and the performance, regulatory, quality, and quality verification requirements) are correctly translated into design outputs (e.g., analyses, specifications, drawings, procedures, and instructions). In addition, the QAPD provides for individuals knowledgeable in quality assurance principles to review design documents for the necessary quality assurance requirements.

The QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 3 and Supplement 3S-1, for establishing the program for design control and verification, ASME Standard NQA-1-1994 Subpart 2.20 for the subsurface investigation requirements and ASME Standard NQA-1-1994 Subpart 2.7 for the standards for computer software quality assurance controls.

17.3.4 Procurement Document Control

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.D, for ensuring that procurement documents include or reference applicable regulatory, technical, and quality assurance program requirements. These requirements (such as specifications, codes, standards, tests, inspections, special processes, and the regulation at 10 CFR Part 21, "Reporting of Defects and Noncompliance") are invoked for procurement of items and services.

The QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 4 and Supplement 4S-1, with the following clarifications and exceptions:

- ASME Standard NQA-1-1994, Supplement 4S-1, Section 2.3, states that procurement documents must require suppliers to have a documented quality assurance program that implements ASME Standard NQA-1-1994, Part I. As an alternative, the QAPD proposes that suppliers have a documented quality assurance program that meets Appendix B to 10 CFR Part 50, as applicable to the circumstances of the procurement. Criterion IV, "Procurement Document Control," of 10 CFR Part 50, Appendix B requires suppliers to have a quality assurance program consistent with Appendix B. Therefore, the staff accepted this clarification, as delineated in SRP Section 17.5, paragraph II.D.2.d.

- The QAPD proposes that procurement documents allow the supplier to work under the applicant's QAPD (in lieu of the supplier having its own quality assurance program). Criterion IV of 10 CFR Part 50, Appendix B requires suppliers to have a quality assurance program consistent with Appendix B. Therefore, the NRC staff accepted this clarification, as delineated in SRP Section 17.5, paragraph II.D.2.d.

- ASME Standard NQA-1-1994, Supplement 4S-1, Section 3, requires procurement documents to be reviewed before award of the contract. As an alternative, the QAPD proposes to conduct the quality assurance review of procurement documents through review of the applicable procurement specification, including the technical and quality procurement requirements, before contract award. In addition, procurement document changes (e.g., scope, technical, or quality requirements) will also receive quality assurance review.

- The NRC staff evaluated this proposed alternative and determined that it provides adequate quality assurance review of procurement documents before awarding the contract and after any change. Therefore, the NRC staff accepted this alternative.

- Procurement documents for commercial-grade items that the applicant or holder will procure as safety-related items shall contain technical and quality requirements such that the procured item can be appropriately dedicated. This alternative is consistent with NRC staff guidance in Generic Letter (GL) 89-02, "Actions to Improve the Detection of Counterfeit and Fraudulently Marked Products," dated March 21, 1989, and GL 91-05, "Licensee Commercial-Grade Procurement and Dedication Programs," dated April 9, 1991, as delineated in SRP Section 17.5, paragraphs II.U.1.d and II.U.1.e.

17.3.5 Instructions, Procedures, and Drawings

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.E, for establishing the necessary measures and governing procedures to ensure that activities affecting quality are prescribed by and performed in accordance with documented instructions, procedures, and drawings.

The QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 5, for establishing procedural controls.

17.3.6 Document Control

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.F, for controlling the preparation, review, approval, issuance, and changes of documents that specify quality requirements or prescribe measures for controlling activities affecting quality, including organizational interfaces. The QAPD provides measures to ensure that the same organization that performed the original review and approval also reviews and approves changes, unless other organizations are specifically designated. A listing of all controlled documents identifying the current approved revision or date is maintained so personnel can readily determine the appropriate document for use.

In establishing provisions for document control, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 6 and Supplement 6S-1.

17.3.7 Control of Purchased Material, Equipment, and Services

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.G, for controlling the procurement of items and services to ensure conformance with requirements. The program provides measures for evaluating prospective suppliers and selecting only those that are qualified. In addition, the program provides for auditing and evaluating suppliers to ensure that qualified suppliers continue to provide acceptable products and services.

The program provides for acceptance actions (e.g. source verification, receipt inspection, pre- and postinstallation tests) and review of documentation (e.g., certificates of conformance), to ensure that the procurement, inspection, and test requirements have been satisfied before relying on the item to perform its intended safety function. Purchased items (e.g., components, spares, and replacement parts necessary for plant operation, refueling, maintenance, and modifications) and services are subject to quality and technical requirements at least equivalent to those specified for original equipment or by properly reviewed and approved revisions to ensure that the items are suitable for the intended service and are of acceptable quality to maintain safety.

In establishing procurement verification control, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 7 and Supplement 7S-1, with the following clarifications and exceptions:

- The QAPD proposes that other 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," licensees (i.e., other than the applicant or holder), authorized nuclear inspection agencies, the National Institute of Standards and Technology (NIST), and other State and Federal agencies that may provide items or services to the applicant do not require evaluation or audit.

  The NRC staff acknowledges that 10 CFR Part 50 licensees, authorized nuclear inspection agencies, NIST, and other State and Federal agencies perform work under acceptable quality programs, and require no additional evaluation. The applicant or holder is still responsible for ensuring that the items or services conform to 10 CFR Part 50, Appendix B program, applicable ASME Code requirements, and other regulatory requirements and commitments. The applicant or holder is also responsible for ensuring and documenting that the items or services are suitable for the intended use. The NRC staff accepted a similar exception in a previous safety evaluation ("Approval of Relief Request RR-27," ADAMS No. ML003693241) and accepts the applicant's exception because it provides an appropriate level of quality and safety.

- The QAPD includes provisions consistent with the regulatory guidance provided in SRP Section 17.5, paragraph II.L.8, for the procurement of commercial-grade calibration services for safety-related applications. The QAPD proposes not to require procurement source evaluation and selection measures provided each of the following conditions are met:

  - Purchase documents impose additional technical and administrative requirements to satisfy QAPD and technical requirements.

  - Purchase documents require reporting as-found calibration data when calibrated items are found to be out of tolerance.

  - A documented review of the supplier's accreditation will be performed and will include a verification of the following:

    - The calibration laboratory holds a domestic accreditation by the National Voluntary Laboratory Accreditation Program (NVLAP) or by the American Association for Laboratory Accreditation, as recognized by NVLAP through the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement.

    - The accreditation is based on ANS/ISO/IEC 17025.

    - The published scope of the accreditation for the calibration laboratory covers the necessary measurement parameters, range, and uncertainties.

- ASME Standard NQA-1-1994, Supplement 7S-1, Section 8.1, describes requirements for documents to be available at the site. As an alternative, the QAPD proposes that documents may be stored in approved electronic media under the applicant's, holder's, or supplier's control and not physically located at the plant site, as long as they are accessible from the respective nuclear facility. Following completion of the construction period, sufficient as-built documentation will be turned over to the licensee to support operations. The NRC staff determined that this alternative meets 10 CFR Part 50, Appendix B, Criterion VII, "Control of Purchased Material, Equipment, and Services." Criterion VII requires documentary evidence that items conform to procurement documents to be available at the nuclear facility before installation or use. Therefore, this provision, which would allow for accessing and reviewing the necessary procurement documents at the site before installation and use, would meet this requirement.

- ASME Standard NQA-1-1994, Supplement 7S-1, Section 10, describes requirements for the control of commercial-grade items and services. As an alternative, the QAPD commits the applicant to follow NRC guidance discussed in GL 89-02 and GL 91-05 as delineated in SRP Section 17.5, paragraphs II.U.1.d and II.U.1.e.

- Consistent with the guidance mentioned above for commercial-grade items and services, the commercial-grade program provides for special quality verification requirements to provide the necessary assurance that the item will perform satisfactorily in service. In addition, the documents provide for determining critical characteristics to ensure that an item is suitable for its intended use. It also provides for technical evaluation of the item, receipt requirements, and quality evaluation of the item.

17.3.8 Identification and Control of Materials, Parts, and Components

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.H, for establishing the necessary measures for the identification and control of items such as materials, including consumables and items with limited shelf life, parts, components, and partially fabricated subassemblies. The identification of items is maintained throughout fabrication, erection, installation, and use so that the item can be traced to its documentation.

In establishing provisions for identification and control of items, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 8 and Supplement 8S-1.

17.3.9 Control of Special Processes

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.I, to assure that special processes requiring interim process controls (e.g. welding, heat treating, chemical cleaning, and nondestructive examinations), are quality controlled in accordance with the applicable codes, specifications, and standards of the specific work.

In establishing measures for the control of special processes, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 9 and Supplement 9S-1.

17.3.10 Inspection

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.J, to ensure that items, services, and activities that affect safety meet requirements and conform to specifications, instructions, procedures, and design documents. The inspection program establishes requirements for planning inspections, determining applicable acceptance criteria, setting the frequency of inspection, and identifying special tools needed to perform the inspection. Inspectors are properly qualified personnel who are independent of those who performed or directly supervised the work.

In establishing inspection requirements, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 10, Supplement 10S-1, and Subparts 2.4, 2.5 and 2.8, with the following clarifications and exceptions:

- ASME Standard NQA-1-1994, Subpart 2.4, commits the applicant or licensee to Institute of Electrical and Electronic Engineers (IEEE) Standard 336-1985, "IEEE Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities." IEEE 336-1985 refers to IEEE 498-1985, "IEEE Standard Requirements for the Calibration and Control of Measuring and Test Equipment Used in Nuclear Facilities." Both of these standards use the definition of "safety systems equipment" from IEEE 603-1980, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations." The QAPD commits the applicant or licensee, as applicable, to the definition of safety systems equipment from IEEE 603-1980 but does not commit the applicant or holder to the balance of IEEE 603-1980. This definition applies only to equipment in the context of ASME Standard NQA-1-1994, Subpart 2.4.

The following is the definition of safety system in IEEE 603-1980:

> Those systems (the reactor trip system, an engineered safety feature, or both, including all their auxiliary supporting features and other auxiliary feature) which provide a safety function. A safety system is comprised of more than one safety group of which any one safety group can provide the safety function.

The QAPD needs to commit to the definition of safety systems equipment from IEEE 603-1980 in order to appropriately implement Subpart 2.4 of ASME Standard NQA-1-1994. The clarification reinforces the fact that the QAPD is not committing to the entirety of IEEE 603-1980. The NRC staff accepts the definition of safety systems equipment in the context of ASME Standard NQA-1-1994, Subpart 2.4 because it clarifies the definition.

- As an alternative for sites that may not meet the requirement of ASME Standard NQA-1-1994, Supplement 10S-1, Section 3.1, for independent reporting, the QAPD proposes that the inspector must report to quality control management while performing the inspection. This alternative is consistent with NRC staff guidance provided in SRP 17.5, paragraph II.J.1.

17.3.11 Test Control

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.K, to demonstrate that items subject to the provisions of the QAPD will perform satisfactorily in service, that the plant can be operated safely as designed, and that the operation of the plant, as a whole, is satisfactory.

In establishing provisions for testing, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 11 and Supplement 11S-1.

In establishing provisions to ensure that computer software used in applications affecting safety is prepared, documented, verified, tested, and used such that the expected outputs are obtained and configuration control maintained, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Supplements 11S-2 and Subpart 2.7.

17.3.12 Control of Measuring and Test Equipment

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.L, for controlling the calibration, maintenance, and use of measuring and test equipment that provides safety information.

In establishing provisions for control of measuring and test equipment, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 12 and Supplement 12S-1, with the following clarifications and exceptions:

The QAPD clarifies that the out-of-calibration conditions, described in paragraph 3.2 of Supplement 12S-1 of ASME Standard NQA-1-1994, refer to cases where the measuring and test equipment are found to be out of the required accuracy limits (i.e., out of tolerance) during calibration. The NRC staff determined that the clarification for the out-of-calibration conditions is acceptable, on the basis that it clarifies a definition.

- ASME Standard NQA-1-1994, Subpart 2.4, Section 7.2.1 describes calibration labeling requirements. As an alternative, the QAPD proposes that for measuring and test equipment impractical to mark because of size or configuration, the required calibration information be maintained in suitable documentation traceable to the device. This alternative is consistent with the NRC staff guidance provided in SRP 17.5, paragraph II.L.3.

17.3.13 Handling, Storage, and Shipping

The applicant's QAPD follows the guidance of SRP Section 17.5, paragraph II.M, for controlling the handling, storage, packaging, shipping, cleaning, and preservation of items to prevent inadvertent damage or loss and to minimize deterioration.

In establishing provisions for handling, storage, and shipping, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 13 and Supplement 13S-1. The QAPD also commits the applicant, during the construction and preoperations phase of the plant, to comply with the requirements of

ASME Standard NQA-1-1994, Subparts 2.1, 2.2, and 2.15, with the following clarification and exception:

ASME Standard NQA-1-1994, Subpart 2.2, Section 6.6, “Storage Records,” contains requirements for the preparation of records containing information on personnel access to quality assurance records. As an alternative, the QAPD provides for documents to establish control of storage areas that describe those authorized to access the area and the requirements for recording access of personnel. The QAPD proposes not to consider these records as quality records. The plants will retain these records in accordance with the plants’ administrative controls. The NRC staff determined that the proposed alternative is acceptable, on the basis that these records do not meet the classification of a quality record as defined in ASME Standard NQA-1-1994, Supplement 17S-1, Section 2.7.

17.3.14 Inspection, Test, and Operating Status

The applicant’s QAPD follows the guidance of SRP Section 17.5, paragraph II.N, for identifying the inspection, test, and operating status of items and components subject to the QAPD. This maintains personnel and reactor safety and avoids inadvertent operation of equipment.

In establishing measures for control of inspection, test and operating status, the QAPD commits to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 14.

17.3.15 Nonconforming Materials, Parts, or Components

The QAPD follows the guidance of SRP Section 17.5, paragraph II.O, to control items, including services, which do not conform to specified requirements to prevent inadvertent installation or use. Instances of nonconformance are evaluated for their impact on operability of quality SSCs to ensure that the final condition does not adversely affect safety, operation, or maintenance of the item or service. Results of evaluations of conditions adverse to quality are analyzed to identify quality trends. They are then documented and reported to upper management.

In addition, the QAPD provides for establishing the necessary measures to implement a reporting program in accordance with the requirements of 10 CFR Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants”; 10 CFR 50.55(e), “Definitions”; and/or 10 CFR Part 21,” Reporting of Defects and Noncompliance.”

In establishing measures for nonconforming material, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 15 and Supplement 15S-1.

17.3.16 Corrective Action

The QAPD follows the guidance of SRP Section 17.5, paragraph II.P, to promptly identify, control, document, classify, and correct conditions adverse to quality. The QAPD requires personnel to identify conditions adverse to quality and find trends. Significant conditions adverse to quality are documented and reported to responsible management. In the case of suppliers working on safety-related activities or similar situations, the applicant or holder may delegate specific responsibility for the corrective action program, but the applicant or holder maintains responsibility for the program's effectiveness.

In addition, the QAPD provides for establishing the necessary measures to implement a program to identify, evaluate, and report defects and noncompliances in accordance with the requirements of 10 CFR 50.55(e) and/or 10 CFR Part 21, as applicable.

In establishing a corrective action program, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 16.

17.3.17 Quality Assurance Records

The applicant's QAPD follows SRP Section 17.5, paragraph II.Q to ensure that records of items and activities affecting quality are generated, identified, retained, maintained, and retrievable.

Concerning the use of electronic records storage and retrieval systems, the QAPD provides for compliance with NRC guidance given in Regulatory Issue Summary 2000-18, "Guidance on Managing Quality Assurance Records in Electronic Media," dated October 23, 2000; and associated Nuclear Information and Records Management Association (NIRMA) guidelines TG 11-1998, TG 15-1998, and TG 21-1998.

The QAPD commits the applicant to comply with the records standards described in ASME Standard NQA-1-1994, Basic Requirement 17 and Supplement 17S-1, with the following clarification and exception:

- ASME Standard NQA-1-1994, Supplement 17S-1, Section 4.2(b) requires records to be firmly attached in binders or placed in folders or envelopes for storage in steel file cabinets or on shelving in containers. As an alternative, the QAPD proposes that hard records be stored in steel cabinets or on shelving in containers, except that methods other than binders, folders, or envelopes may be used to organize records for storage. In a previous safety evaluation (ADAMS Accession No. ML052430024), the NRC staff accepted a similar alternative. Therefore this alternative is acceptable.

17.3.18 Quality Assurance Audits

The applicant's QAPD follows SRP Section 17.5, paragraph II.R, to audit activities covered by the QAPD. The audit program is reviewed as part of the overall audit process. The QAPD provides for the applicant or holder to conduct periodic internal and external audits. Internal audits determine the adequacy of the program and procedures and determine if they comply with the overall QAPD. Internal audits are performed with a frequency commensurate with safety significance. An audit of all applicable quality assurance program elements is completed for each functional area within 2 years after the program is well established. External audits determine the adequacy of a supplier's or contractor's quality assurance program. The responsible management documents and reviews audit results. Management responds to all audit findings and initiates corrective action. In addition, where corrective actions are indicated, documented followup of applicable areas through inspections, review, reaudits, or other means is conducted to verify corrective action.

In establishing the independent audit program, the QAPD commits the applicant to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 18 and Supplement 18S-1.

17.3.19 Non-safety-Related SSC Quality Assurance Control

17.3.19.1 Non-safety-Related SSCs Important to Plant Safety

The QAPD follows the guidance of SRP Section 17.5, paragraph II.V.1, for establishing specific program controls applied to nonsafety-related SSCs that are important to plant safety and to which 10 CFR Part 50, Appendix B does not apply. The QAPD applies specific controls to those items in a selected manner, targeting those characteristics or critical attributes that render the SSC important to plant safety consistent with applicable sections of the QAPD.

17.3.19.2 Nonsafety-Related SSCs Credited for Regulatory Events

The applicant's QAPD commitments refer to fire protection (10CFR 50.48, "Fire Protection"), anticipated transients without scram (10 CFR 50.62, "Requirements for Reduction of Risk from Anticipated Transients without Scram (ATWS) Events for Light-Water-Cooled Nuclear Power Plants"), and station blackout (10 CFR 50.63, "Loss of all Alternating Current Power"). These regulations are outside the scope of the application and, therefore, staff did not review them as part of this safety evaluation.

17.3.20 Regulatory Commitments

The QAPD follows the guidance of SRP Section 17.5, paragraph II.U, for establishing quality assurance program commitments. The QAPD commits the applicant to comply with the following NRC regulatory guides and other quality assurance standards to supplement and support the QAPD:

- Regulatory Guide 1.26, Revision 4, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," March 2007.

  The QAPD commits the applicant to comply with the regulatory positions of this guidance with the exception of Criteria C.1, C.1.a, C.1.b, and C.3. As documented in NUREG-1793, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," dated September 2000, and Supplement 1 to NUREG-1793, dated December 2005, the NRC staff determined that the proposed exceptions are acceptable for use with the AP1000 design.

- Regulatory Guide 1.29, Revision 3, "Seismic Design Classification," September 1978.

  The QAPD commits the applicant to comply with Regulatory Guide 1.29 with the exception of Criteria C.1.d, C.1.g, and C.1.n. As documented in NUREG-1793 and Supplement 1 to NUREG-1793, the NRC staff determined that the proposed exceptions are acceptable for use with the AP1000 design.

- ASME Standard NQA-1-1994, “Quality Assurance Requirements for Nuclear Facility Applications,” Parts I and II, as described in Sections 17.3.1 through 17.3.18 of this safety evaluation report (SER).

- NIRMA technical guides, as described in Section 17.3.17 of this SER.

17.4 Conclusion

- The NRC staff used the provisions of Appendix B to 10 CFR Part 50 and the guidance of SRP Section 17.5 to evaluate the QAPD. Staff concludes the following:

- The QAPD provides adequate guidance for an applicant to describe the authority and responsibility of management and supervisory personnel, performance/verification personnel, and self-assessment personnel.

- The QAPD provides adequate guidance for an applicant to provide for organizations and persons to perform verification and self-assessment functions with the authority and independence to conduct their activities without undue influence from those directly responsible for costs and schedules.

- The QAPD provides adequate guidance for an applicant to apply the QAPD to activities and items that are important to safety.

- The QAPD provides adequate guidance for establishing controls that, when properly implemented, comply with the requirements of 10 CFR Part 52, 10 CFR Part 50, Appendix B, 10 CFR Part 21, 10 CFR 50.55(e); with the acceptance criteria contained in SRP 17.5, and with the commitments to applicable regulatory guidance.

On the basis of its review, the NRC staff concludes that the applicant’s QAPD provides adequate guidance for establishing a quality assurance program that complies with Appendix B to 10 CFR Part 50 by following the guidance of ASME Standard NQA-1-1994, as supplemented by regulatory and industry guidance. Accordingly, the NRC staff concludes that the QAPD can be used by the applicant for ESP and activities authorized by the limited work authorization.

18.0 REVIEW BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The Advisory Committee on Reactor Safeguards (ACRS) completed its review of the application submitted by Southern Nuclear Operating Company (SNC) for an early site permit (ESP) and limited work authorization (LWA) for the Vogtle Electric Generating Plant (VEGP) ESP site. The ACRS also completed its review of the U.S. Nuclear Regulatory Commission (NRC) staff's safety evaluation report (SER).

The ACRS ESP subcommittee met with representatives from SNC and the staff on October 24, 2007. The ACRS held its full committee meeting on the SNC ESP SER with open items on November 1, 2007. The discussions during these meetings focused on the staff's ongoing review, in particular the development and the significance of the open items identified by the staff. On the basis of its review, the ACRS issued an interim letter report, dated November 20, 2007, which addressed the portions of the SNC ESP application that concern safety. The staff responded to the interim letter report in its letter dated December 28, 2007. This final safety evaluation report (FSER) documents the resolution of open items discussed in the SER with open items.

During its meeting with the ACRS on December 3rd and December 4th, 2008, the staff discussed the resolution of open items for the ESP review as well as the staff's review of SNC's LWA request. Since an LWA was requested by SNC a year after its request for an ESP, the staff had not been able to present the results of its review of the LWA request during the October and November 2007 ACRS meetings. At the 558th meeting of the ACRS, the full committee considered the staff's advanced SER with no open items, as well as SNC's ESP application and LWA request, and issued its final letter report to the NRC Chairman on December 22, 2008. That letter report is included as Appendix E to this report.

In its final letter report dated December 22, 2008, the ACRS stated that the application for an ESP and LWA for the VEGP ESP site were adequate, and found that the NRC staff's review of the application were adequate. The ACRS concluded that the ESP and the LWA should be granted.

19.0 CONCLUSIONS

In accordance with Subpart A, “Early Site Permits,” of Title 10 of the Code of Federal Regulations (10 CFR), Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” the staff of the U.S. Nuclear Regulatory Commission reviewed the site safety analysis report (SSAR), the emergency planning information, and the limited work authorization (LWA) request included in the early site permit (ESP) application submitted by Southern Nuclear Operating Company (SNC), for the Vogtle Electric Generating Plant (VEGP) ESP site. On the basis of its evaluation and its independent analyses as discussed in this safety evaluation report (SER), the staff concludes that the VEGP ESP site characteristics comply with the requirements of 10 CFR Part 100, “Reactor Site Criteria,” subject to 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, two reactors, having characteristics that fall within the parameters for the site, and which meet 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. The staff also finds that the proposed ITAAC for emergency planning are necessary and sufficient, within the scope of the ESP, to provide reasonable assurance that the facility has been constructed and will be operated in conformity with the license, the provisions of the Atomic Energy Act, and the Commission’s rules and regulations. For the reasons above, 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 VEGP ESP may be referenced in an application to construct and operate two nuclear power reactors with a total generating capacity of up to 6800 megawatts (thermal) at the ESP site, subject to the terms and conditions of the permit.

In addition, the staff also concludes that the VEGP LWA request meets the applicable standards and requirements of the Act and the Commission’s regulations. The staff finds that reasonable assurance has been established such that there is adequate protection to public health and safety, and that issuance of the LWA will also not be inimical to the common defense and security. The staff also finds that the proposed ITAAC for an LWA are necessary and sufficient, within the scope of the LWA, to provide reasonable assurance that the facility has been constructed and will be operated in conformity with the license, the provisions of the Atomic Energy Act, and the Commission’s rules and regulations.

APPENDIX A

PERMIT CONDITIONS, COL ACTION ITEMS, SITE CHARACTERISTICS, BOUNDING PARAMETERS, AND INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA

A.1 Permit Conditions

Permit Condition: The Commission's regulations at 10 CFR 52.24 require an ESP to specify any terms and conditions of the ESP the Commission deems appropriate. 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 nine permit conditions, which are set forth below, to control various safety matters.

Permit Condition No.	SER Section	Description
2.5 – Geology, Seismology, and Geotechnical Engineering		
1	2.5.4	The ESP holder shall either remove and replace, or shall improve, the soils directly above the blue bluff marl for soils under or adjacent to Seismic Category 1 structures, to eliminate any liquefaction potential.
13.3 – Emergency Planning		
2	13.3.3.2.4	An applicant for a combined license (COL) referencing this early site permit shall revise the EALs for Unit 3 to reflect the final revision of NEI 07-01.
3	13.3.3.2.4	An applicant for a combined license (COL) referencing this early site permit shall revise the EALs for Unit 4 to reflect the final revision of NEI 07-01.
4	13.3.3.2.4	An applicant for a combined license (COL) referencing this early site permit shall submit a fully developed EAL scheme for Unit 3 that reflects the completed AP1000 design details, subject to allowable ITAAC.
5	13.3.3.2.4	An applicant for a combined license (COL) referencing this early site permit shall submit a fully developed EAL scheme for Unit 4 that reflects the completed AP1000 design details, subject to allowable ITAAC.
6	13.3.3.2.4	An applicant for a combined license (COL) referencing this early site permit shall complete a fully developed set of EALs for Unit 3, which are based on in-plant conditions and instrumentation, including onsite and offsite monitoring, and which have been discussed and agreed on by the applicant or licensee and State and local governmental authorities, and shall include the full set of EALs in the COL application. If the EALs are not fully developed, the COL application shall contain appropriate ITAAC for the fully developed set of EALs for Unit 3.

Permit Condition No.	SER Section	Description
7	13.3.3.2.4	An applicant for a combined license (COL) referencing this early site permit shall complete a fully developed set of EALs for Unit 4, which are based on in-plant conditions and instrumentation, including onsite and offsite monitoring, and which have been discussed and agreed on by the applicant or licensee and State and local governmental authorities, and shall include the full set of EALs in the COL application. If the EALs are not fully developed, the COL application shall contain appropriate ITAAC for the fully developed set of EALs for Unit 4.
8	13.3.3.2.8	An applicant for a combined license (COL) referencing this early site permit shall resolve the difference between the VEGP Units 3 and 4 common Technical Support Center (TSC), and the TSC location specified in the AP1000 certified design.
15.0 – Accident Analysis		
9	15.0.3.4	If a COL or CP application referencing this ESP also references a certified design, the COL or CP applicant may demonstrate compliance with the radiological consequence evaluation factors in 10 CFR 52.79(a)(1) or 10 CFR 50.34(a)(1), respectively, by demonstrating that the site-specific χ/Q values determined in the ESP fall within those evaluated in the approval of the referenced certified design. However, if a COL or CP referencing this ESP does not reference a certified design, the applicant would still need to demonstrate that its source term is bounded by the source term values included in the ESP.

A.2 COL Action Items

COL Action Items: The COL action items set forth in the SER and incorporated herein identify certain matters that shall be addressed in the FSAR by an applicant for a CP or COL who submits an application referencing the Vogtle 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 governs the application. After issuance of a 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 VEGP site.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
		2.2 – Nearby Industrial, Transportation, and Military Facilities	
2.2-1	2.2.3.3	A COL or CP applicant should address the potential accidental release of hydrazine from onsite storage tanks that may have an impact on control room habitability for the new units.	Since the design of the control room at the proposed ESP site is not available, it is expected to be evaluated at the CP or COL stage.
2.2-2	2.2.3.3	A COL or CP applicant should identify the quantities of the chemicals that will be used for the proposed Units 3 and 4 at VEGP and address their potential impact on control room habitability.	Since the quantities of the chemicals used are not available, and the design of the control room is not available, it is expected to be evaluated at the CP or COL stage.
		2.3 – Meteorology	
2.3-1	2.3.1.3	If, at the COL or CP stage, the applicant chooses an alternative plant design that requires the use of a UHS cooling tower, the applicant will need to identify the appropriate meteorological site characteristics (i.e., maximum evaporation and drift loss and minimum water cooling conditions) used to evaluate the design of	The applicant has chosen a reactor design that does not use a cooling tower to release heat to the atmosphere following a loss of coolant accident.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
		the chosen UHS cooling tower.	
2.4 – Hydrology			
2.4-1	2.4.13	A COL or CP applicant will need to confirm that no chelating agents will be comingled with radioactive waste liquids and that such agents will not be used to mitigate an accidental release. Alternatively, the applicant should repeat the distribution coefficient experiments with chelating agents included, and incorporate these newly determined distribution coefficients into the analysis to demonstrate that 10 CFR Part 20, Appendix B, Table 2 is satisfied.	The detailed design of the radwaste treatment system was not available at the ESP stage, and the applicant, in response to an RAI, stated that comingling of chelating agents and radionuclides was highly unlikely. Subsequent analysis of radionuclide transport by staff indicate that either comingling must not occur, or additional data and further analysis is necessary. Therefore, the prospect for comingling chelating agents and radionuclides must be revisited at the CP or COL stage.
13.6 – Industrial Security			
13.6-1	13.6	The COL or CP applicant will need to provide the specific access control measures to address the existing rail spur.	Such measures are not required at the ESP stage.

A.3 Site Characteristics

<u>Site Characteristics</u>: 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 Vogtle.

Site Characteristic	Value	Definition
2.1 - Geography and Demography		
Exclusion Area Boundary	The EAB for the proposed Units 3 and 4 at the VEGP site is the same as the existing EAB for VEGP Units 1 and 2. The EAB is bounded by River Road, Hancock Landing Road, and 1.7 miles of the Savannah River (River miles 150.0 to 151.7). See Figure A3-1.	The area surrounding the reactor(s), 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	The area falling within a 2-mile radius circle from the midpoint between the Units 1 and 2 containment buildings.	The area immediately surrounding the exclusion area that contains residents.
Population Center Distance	- 2-2/3 miles (minimum allowable distance) - 26 miles (Augusta, GA) (current actual distance)	- The minimum allowable distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents. - The current distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents.

Site Characteristic		Value	Definition
2.3 - Meteorology			
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2% annual exceedance	92 ºF / 75 ºF	The ambient dry-bulb temperature (and mean coincident wet-bulb temperature) that will be exceeded 2% of the time annually
	0.4% annual exceedance	97 ºF / 76 ºF	The ambient dry-bulb temperature (and mean coincident wet-bulb temperature) that will be exceeded 0.4% of the time annually
	100-year return period	115 °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 temperatures will fall 0.4% of the time annually.
	100-year return period	-8 °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	0.4% annual exceedance	79 °F	The ambient wet-bulb temperature that will be exceeded 0.4% of the time annually.
	100-year return period	88 °F	The ambient wet-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval).

Site Characteristic	Value	Definition
Site Temperature Basis for AP1000		
Maximum Safety Dry-Bulb and Coincident Wet-Bulb	115 ºF / 77.7 ºF	These AP1000 specific site characteristics values represent a maximum dry-bulb temperature that exists for 2 hours or more, combined with the maximum wet-bulb temperature that exists in that population of dry-bulb temperatures.
Maximum Safety Wet-Bulb (Non-Coincident)	83.9 ºF	This AP1000 specific site characteristic value represents a maximum wet-bulb temperature that exists within a set of hourly data for a duration of 2 hours or more.
Maximum Normal Dry-Bulb and Coincident Wet-Bulb	94 ºF / 78 ºF	The dry-bulb temperature component of this AP1000 specific site characteristics pair is represented by a maximum dry-bulb temperature that exists for 2 hours or more, excluding the highest 1 percent of the values in an hourly data set. The wet-bulb temperature component is similarly represented by the highest wet-bulb temperature excluding the highest 1 percent of the data, although there is no minimum 2-hour persistence criterion associated with this wet-bulb temperature.
Maximum Normal Wet-Bulb (Non-Coincident)	78 ºF	This AP1000 specific site characteristic value represents a maximum wet-bulb temperature, excluding the highest 1 percent of the values in an hourly data set (i.e., a 1 percent exceedance), that exists for 2 hours or more.
Basic Wind Speed		
3-Second Gust	104 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

Site Characteristic	Value	Definition
		tornado having a probability of occurrence of 10^{-7} per year
Maximum Translational Speed	60 mi/h	Translation component of the maximum tornado wind speed
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	10 lb/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	28.3 inches of water	PMP during the winter months (to be used in conjunction with the 100-year snowpack in determining extreme winter precipitation loads for roofs)
Short-Term (Accident Release) Atmospheric Dispersion		
0–2 hr χ/Q Value @ EAB	3.49×10^{-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 hr χ/Q Value @ LPZ outer boundary	7.04×10^{-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 hr χ/Q Value @ LPZ outer boundary	5.25×10^{-5} s/m^3	The 8–24 hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne

Site Characteristic	Value	Definition
		releases at the LPZ.
1–4 day χ/Q Value @ LPZ outer boundary	2.77×10^{-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 outer boundary	1.11×10^{-5} 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 @ EAB, northeast, 0.5 mile	5.5×10^{-6} s/m^3	The maximum annual average EAB undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ EAB, northeast, 0.5 mile	5.5×10^{-6} s/m^3	The maximum annual average EAB undepleted/2.26 day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Depleted/8.00-Day Decay χ/Q Value @ EAB, northeast, 0.5 mile	5.0×10^{-6} s/m^3	The maximum annual average EAB depleted/8.00 day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average D/Q Value @ EAB, northeast and east-northeast, 0.5 mile	1.7×10^{-8} 1/m^2	The maximum annual average EAB relative deposition factor (D/Q) value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Resident, northeast, 0.67 mile	3.4×10^{-6} s/m^3	The maximum annual average resident undepleted/no decay atmospheric dispersion factor (χ/Q) value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Resident, northeast, 0.67 mile	3.4×10^{-6} s/m^3	The maximum annual average resident undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.

Site Characteristic	Value	Definition
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Resident, northeast, 0.67 mile	$3.0{\times}10^{-6}$ s/m^3	The maximum annual average resident depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average D/Q Value @ Nearest Resident, northeast, east-northeast, and east, 0.67 mile	$1.0{\times}10^{-8}$ 1/m^2	The maximum annual average resident relative deposition factor (D/Q) value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Meat Animal, northeast, 0.67 mile	$3.4{\times}10^{-6}$ s/m^3	The maximum annual average meat animal undepleted/no decay atmospheric dispersion factor (χ/Q) value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Meat Animal, northeast, 0.67 mile	$3.4{\times}10^{-6}$ s/m^3	The maximum annual average meat animal undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Meat Animal, northeast, 0.67 mile	$3.0{\times}10^{-6}$ s/m^3	The maximum annual average meat animal depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average D/Q Value @ Nearest Meat Animal, northeast, east-northeast, and east, 0.67 mile	$1.0{\times}10^{-8}$ 1/m^2	The maximum annual average meat animal relative deposition factor (D/Q) value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Vegetable Garden, northeast, 0.67 mile	$3.4{\times}10^{-6}$ s/m^3	The maximum annual average vegetable garden undepleted/no decay atmospheric dispersion factor (χ/Q) value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Vegetable Garden, northeast, 0.67 mile	$3.4{\times}10^{-6}$ s/m^3	The maximum annual average vegetable garden undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.

Site Characteristic	Value	Definition
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Vegetable Garden, northeast, 0.67 mile	3.0×10^{-6} s/m^3	The maximum annual average vegetable garden depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual.
Annual Average D/Q Value @ Nearest Vegetable Garden, northeast, east-northeast, and east, 0.67 mile	1.0×10^{-8} 1/m^2	The maximum annual average vegetable garden relative deposition factor (D/Q) value for use in determining gaseous pathway doses to the maximally exposed individual.
2.4 - Hydrology		
Hydrology		
Proposed Facility Boundaries	Appendix A Figure A3-1 (Figure 2.4.14-1)	The site boundary within which all safety-related SSC will be located.
Highest Ground Water Elevation	165 feet MSL at the Water Table Aquifer	The highest elevation of the water table within the site boundaries.
Maximum Flood Elevation (maximum hydrostatic water surface elevation due to a postulated upstream dam breach scenario)	166.79 feet MSL	The stillwater elevation, without accounting for wind-induced waves that the water surface reaches during a flood event.
Wind run-up (to add to the maximum flood elevation)	11.31 feet	The water surface elevation reached by wind-induced waves running up on the shore.
Combined Effects Maximum Flood Elevation	178.10 feet MSL	The water surface elevation obtained by adding wind run-up to the highest flood level.
Local Intense Precipitation	19.2 inches during 1 hour 6.2 inches during 5 minutes	The depth of PMP for duration of one hour on a one square-mile drainage area. The surface water drainage system should be designed for a flood produced by the local intense precipitation. The local intense precipitation is specified by SSAR Table 2.4.2-3 (SER Table 2.4.2-1).

Site Characteristic	Value	Definition
Frazil Ice	The ESP site does not have the potential for the formation of frazil and anchor ice	Ice crystals that form in turbulent, open waters in presence of supercooling. Frazil ice is very sticky and may lead to blockages of intake screens and trash racks.
2.5 – Geology, Seismology, and Geotechnical Engineering		
Basic Geologic and Seismic Information		
Capable Tectonic Structures	none	No fault displacement potential within the investigative area.
Vibratory Ground Motion		
Ground Motion Response Spectra (Site Safe Shutdown Earthquake)	Appendix A Figure A3-2	Site specific response spectra.
Stability of Subsurface Materials and Foundations		
Liquefaction	None at the site-specific SSE	Liquefaction potential for the subsurface material at the site.
Minimum bearing capacity (static and dynamic)	1627 kPa (34 ksf) – static 2010 kPa (42 ksf) - dynamic	Load-bearing capacity of bearing soil layer for plant structures.
Minimum shear wave velocity of the load bearing soil layers	Appendix A Tables A3-1 and A3-2	Soil property.

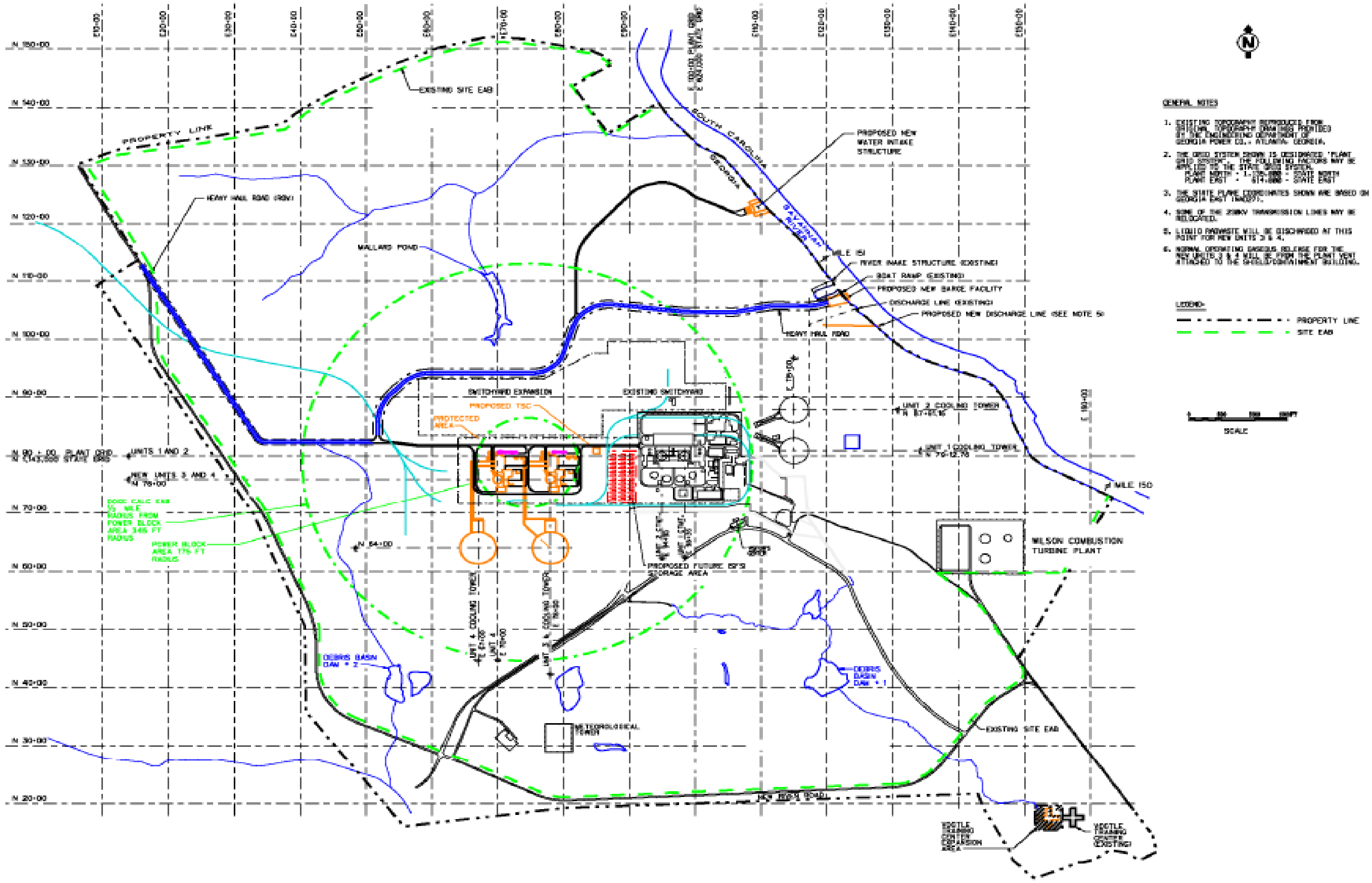

Figure A3-1 (Figure 2.4.14-1) – The proposed facility boundary for the VEGP site (Taken from SSAR Figure 1-4)

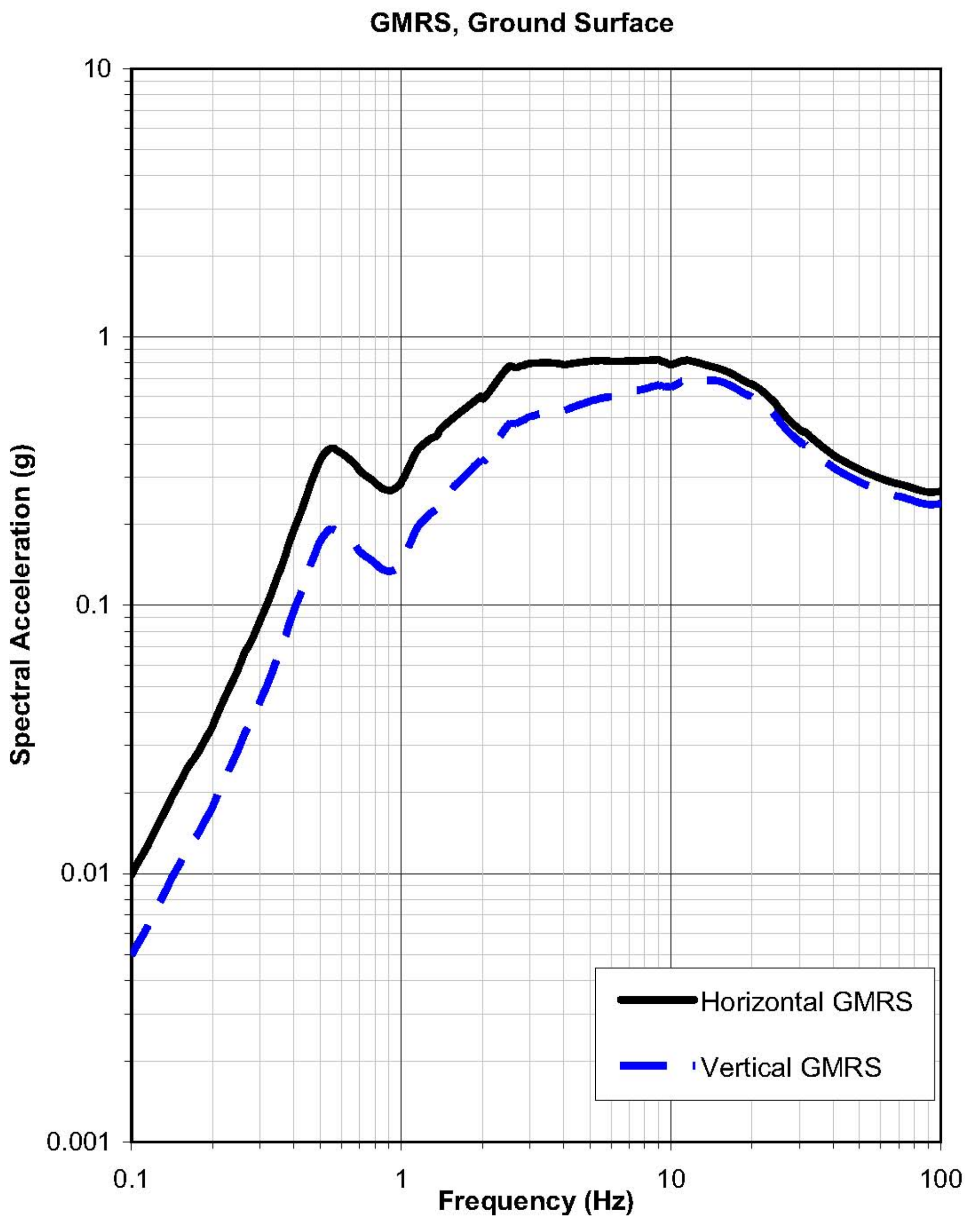

Figure A3-2 (SER Figure 2.5.2-25) - Plots of the horizontal and vertical GMRS (reproduced from SSAR Figure 2.5.2-44b).

Part A: Soil Shear-Wave Velocities (ESP)

Geologic Formation	Depth (feet)	V_s (fps)
Compacted Backfill	0 to 6	573
	6 to 10	732
	10 to 14	811
	14 to 18	871
	18 to 23	927
	23 to 29	983
	29 to 36	1,040
	36 to 43	1,092
	43 to 50	1,137
	50 to 56	1,175
	56 to 63	1,209
	63 to 71	1,232
	71 to 79	1,253
	79 to 86	1,273
Blue Bluff Marl (Lisbon Formation)	86 to 92	1,400
	92 to 97	1,700
	97 to 102	2,100
	102 to 105	1,700
	105 to 111	2,200
	111 to 123	2,350
	123 to 149	2,650
Lower Sand Stratum	149 to 156	2,000
(Still Branch)	156 to 216	1,650
(Congaree)	216 to 331	1,950
(Snapp)	331 to 438	2,050
(Black Mingo)	438 to 477	2,350
(Steel Creek)	477 to 587	2,650
(Gaillard/Black Creek)	587 to 798	2,850
(Pio Nono)	798 to 858	2,870
(Cape Fear)	858 to 1,049	2,710
Dunbarton Triassic Basin & Paleozoic Crystalline Rock	> 1,049	see Table 2.5.4-11, Part B

Table A3-1 - Shear Wave Velocity Values for Site Amplification Analysis (Taken from SSAR Table 2.5.4-11)

Part B: Rock Shear-Wave Velocities - Six Alternate Profiles

	Vs (ft/s)	
Depth (ft)	Gradient #1	Gradient #2
1,049 to 1,100	4,400	4,400
1,100 to 1,150	5,650	5,650
1,150 to 1,225	6,650	6,650
1,225 to 1,337.5	7,600	7,600
1,337.5 to 1,402.5	8,000	8,700
1,402.5 to 1,405	8,005	8,703
1,405 to 1,525	8,059	8,739
> 1,525	9,200	9,200

Rock Vs profile corresponding to the location midway between B-1002 and B-1003.

	Vs (ft/s)	
Depth (ft)	Gradient #1	Gradient #2
1,049 to 1,100	4,400	4,400
1,100 to 1,150	5,650	5,650
1,150 to 1,225	6,650	6,650
1,225 to 1,337.5	7,600	7,600
1,337.5 to 1,450	8,000	8,700
1,450 to 1,550	8,090	8,760
1,550 to 1,650	8,180	8,820
1,650 to 1,750	8,270	8,880
1,750 to 1,830	8,360	8,940
1,830 1,900	8,414	8,976
> 1,900	9,200	9,200

Rock Vs profile corresponding to the location of B-1003.

	Vs (ft/s)	
Depth (ft)	Gradient #1	Gradient #2
1,049 to 1,100	4,400	4,400
1,100 to 1,150	5,650	5,650
1,150 to 1,225	6,650	6,650
1,225 to 1,337.5	7,600	7,600
1,337.5 to 1,450	8,000	8,700
1,450 to 1,550	8,090	8,760
1,550 to 1,650	8,180	8,820
1,650 to 1,750	8,270	8,880
1,750 to 1,850	8,360	8,940
1,850 to 1,950	8,450	9,000
1,950 to 2,050	8,540	9,060
2,050 to 2,127.5	8,630	9,120
2,127.5 to 2,155	8,679.5	9,153
2,155 to 2,275	8,733.5	9,189
> 2,275	9,200	9,200

Table A3-1 (cont.) - Shear Wave Velocity Values for Site Amplification Analysis (Taken from SSAR Table 2.5.4-11)

Part A: Soil Shear-Wave Velocities (COL Soil Column)

Geologic Formation	Depth (feet) (ft)	V_s (fps) (fps)
Compacted Backfill	0	550
	5	724
	10	832
	20	975
	30	1064
	40	1130
	50	1183
	60	1228
	70	1267
	80	1302
	85	1318
	86.5	1327
	88	1327
Blue Bluff Marl (Lisbon Formation)	88 to 96	1,341
	96 to 102	1,747
	102 to 110	1,988
	110 to 122	2,300
	122 to 156	2,541
Lower Sand Stratum (Still Branch)	156 to 164	1,820
	164 to 220	1,560
(Congaree)	220 to 236	1,757
	236 to 280	2,000
	280 to 328	1,926
	328 to 340	1,727
(Snapp)	340 to 447	2,050
(Black Mingo)	447 to 486	2,350
(Steel Creek)	486 to 596	2,650
(Gaillard/Black Creek)	596 to 807	2,850
(Pio Nono)	807 to 867	2,870
(Cape Fear)	867 to 1,059	2,710

Table A3-2 - Shear Wave Velocity Values for Site Amplification Analysis (Taken from SSAR Table 2.5.4-11a)

A.4 Bounding Parameters (Including Accident Source Term)

Bounding Parameters: The bounding parameters set forth postulated values of design parameters that provide design details to support the NRC staff's review of an ESP application. Because the NRC staff is relying on certain design parameters specified in the ESP application to reach its conclusions on site suitability, these bounding parameters would be included in any ESP that might be issued for the VEGP site. A COL or CP application referencing an ESP must contain information sufficient to demonstrate that the actual characteristics of the design chosen by the COL or CP applicant falls within the bounding design parameters specified in the ESP.

Bounding Parameters	Value	Definition
2.4 – Hydrology		
Plant Grade	220 feet MSL	Finished plant grade at the ESP site.
15.0 – Accident Analysis		
Accident Source Term	See tables A4-1 through tables A4-9	The activity, by isotope, contained in post-accident airborne effluents.

Activity Releases for Steam System Piping Failure with Pre-Existing Iodine Spike

	Activity Release (Ci)				
Isotope	0-2 hr	2-8 hr	8-24 hr	24-72 hr	Total
Kr-85m	6.86E-02	1.14E-01	6.80E-02	6.18E-03	2.57E-01
Kr-85	2.82E-01	8.46E-01	2.25E+00	6.69E+00	1.01E+01
Kr-87	2.76E-02	1.34E-02	5.29E-04	8.60E-08	4.15E-02
Kr-88	1.12E-01	1.37E-01	4.04E-02	8.27E-04	2.91E-01
Xe-131m	1.28E-01	3.79E-01	9.81E-01	2.70E+00	4.19E+00
Xe-133m	1.59E-01	4.51E-01	1.04E+00	2.05E+00	3.70E+00
Xe-133	1.18E+01	3.45E+01	8.64E+01	2.16E+02	3.49E+02
Xe-135m	3.04E-03	1.33E-05	0.00E+00	0.00E+00	3.06E-03
Xe-135	3.10E-01	6.90E-01	8.35E-01	3.38E-01	2.17E+00
Xe-138	3.99E-03	1.14E-05	0.00E+00	0.00E+00	4.00E-03
I-130	3.59E-01	1.42E-01	2.09E-01	1.33E-01	8.44E-01
I-131	2.40E+01	1.21E+01	3.10E+01	8.22E+01	1.49E+02
I-132	3.05E+01	4.14E+00	8.06E-01	6.55E-03	3.55E+01
I-133	4.34E+01	1.90E+01	3.53E+01	3.98E+01	1.37E+02
I-134	6.74E+00	1.63E-01	1.43E-03	4.54E-09	6.91E+00
I-135	2.60E+01	8.16E+00	7.54E+00	1.71E+00	4.34E+01
Cs-134	1.90E+01	1.95E-01	5.19E-01	1.54E+00	2.12E+01
Cs-136	2.82E+01	2.86E-01	7.43E-01	2.06E+00	3.13E+01
Cs-137	1.37E+01	1.41E-01	3.74E-01	1.11E+00	1.53E+01
Cs-138	1.01E+01	1.02E-03	4.42E-07	0.00E+00	1.01E+01
Total	2.15E+02	8.15E+01	1.68E+02	3.56E+02	8.21E+02

Table A4-1 (SSAR Table 15-2)

Activity Releases for Steam System Piping Failure with Accident-Initiated Iodine Spike

	Activity Release (Ci)				
Isotope	0-2 hr	2-8 hr	8-24 hr	24-72 hr	Total
Kr-85m	6.86E-02	1.14E-01	6.80E-02	6.18E-03	2.57E-01
Kr-85	2.82E-01	8.46E-01	2.25E+00	6.69E+00	1.01E+01
Kr-87	2.76E-02	1.34E-02	5.29E-04	8.60E-08	4.15E-02
Kr-88	1.12E-01	1.37E-01	4.04E-02	8.27E-04	2.91E-01
Xe-131m	1.28E-01	3.79E-01	9.81E-01	2.70E+00	4.19E+00
Xe-133m	1.59E-01	4.51E-01	1.04E+00	2.05E+00	3.70E+00
Xe-133	1.18E+01	3.45E+01	8.64E+01	2.16E+02	3.49E+02
Xe-135m	3.04E-03	1.33E-05	0.00E+00	0.00E+00	3.06E-03
Xe-135	3.10E-01	6.90E-01	8.35E-01	3.38E-01	2.17E+00
Xe-138	3.99E-03	1.14E-05	0.00E+00	0.00E+00	4.00E-03
I-130	4.20E-01	9.95E-01	1.58E+00	1.01E+00	4.01E+00
I-131	2.60E+01	5.73E+01	1.56E+02	4.13E+02	6.53E+02
I-132	4.62E+01	9.74E+01	2.24E+01	1.82E-01	1.66E+02
I-133	4.91E+01	1.14E+02	2.27E+02	2.55E+02	6.45E+02
I-134	1.34E+01	1.86E+01	2.65E-01	8.42E-07	3.23E+01
I-135	3.24E+01	7.74E+01	7.83E+01	1.77E+01	2.06E+02
Cs-134	1.90E+01	1.95E-01	5.19E-01	1.54E+00	2.12E+01
Cs-136	2.82E+01	2.86E-01	7.43E-01	2.06E+00	3.13E+01
Cs-137	1.37E+01	1.41E-01	3.74E-01	1.11E+00	1.53E+01
Cs-138	1.01E+01	1.02E-03	4.42E-07	0.00E+00	1.01E+01
Total	2.51E+02	4.03E+02	5.78E+02	9.20E+02	2.15E+03

Table A4-2 (SSAR Table 15-3)

Activity Releases for Reactor Coolant Pump Shaft Seizure

	Activity Release (Ci)				
	No Feedwater	Feedwater Available			
Isotope	0-1.5 hr	0-2 hr	2-8 hr	6-8 hr	Total
Kr-85m	8.16E+01	1.05E+02	1.74E+02	4.13E+01	2.79E+02
Kr-85	7.58E+00	1.01E+01	3.03E+01	1.01E+01	4.04E+01
Kr-87	1.20E+02	1.43E+02	6.97E+01	5.43E+00	2.13E+02
Kr-88	2.08E+02	2.62E+02	3.20E+02	6.05E+01	5.82E+02
Xe-131m	3.77E+00	5.03E+00	1.49E+01	4.95E+00	1.99E+01
Xe-133m	2.02E+01	2.69E+01	7.64E+01	2.48E+01	1.03E+02
Xe-133	6.66E+02	8.87E+02	2.60E+03	8.57E+02	3.49E+03
Xe-135m	3.24E+01	3.28E+01	1.43E-01	2.68E-06	3.30E+01
Xe-135	1.59E+02	2.08E+02	4.64E+02	1.32E+02	6.72E+02
Xe-138	1.29E+02	1.30E+02	3.72E-01	3.01E-06	1.30E+02
I-130	8.45E-01	1.17E-01	1.33E+00	5.65E-01	1.45E+00
I-131	3.77E+01	5.39E+00	7.51E+01	3.46E+01	8.05E+01
I-132	2.79E+01	3.45E+00	1.48E+01	3.95E+00	1.83E+01
I-133	4.86E+01	6.86E+00	8.29E+01	3.64E+01	8.98E+01
I-134	2.88E+01	2.76E+00	2.98E+00	2.09E-01	5.74E+00
I-135	4.19E+01	5.68E+00	5.22E+01	2.05E+01	5.79E+01
Cs-134	1.29E+00	1.82E-01	2.40E+00	1.11E+00	2.59E+00
Cs-136	5.63E-01	8.45E-02	7.79E-01	3.47E-01	8.63E-01
Cs-137	7.74E-01	1.10E-01	1.41E+00	6.51E-01	1.52E+00
Cs-138	6.08E+00	7.29E-01	3.35E+00	1.13E+00	4.08E+00
Rb-86	1.33E-02	1.83E-03	2.73E-02	1.27E-02	2.91E-02
Total	1.62E+03	1.84E+03	3.99E+03	1.23E+03	5.82E+03

Note: The release period of 6-8 hr yields the maximum 2-hr EAB dose with feedwater available.

Table A4-3 (SSAR Table 15-4)

Activity Releases for Spectrum of Rod Cluster Control Assem
Ejection Accidents

	Activity Release (Ci)					
Isotope	0-2 hr	2-8 hr	8-24 hr	24-96 hr	96-720 hr	Total
Kr-85m	1.12E+02	6.48E+01	3.87E+01	1.77E+00	2.51E-05	2.18E+02
Kr-85	5.01E+00	5.60E+00	1.49E+01	3.35E+01	2.88E+02	3.47E+02
Kr-87	1.82E+02	2.60E+01	1.03E+00	8.37E-05	0.00E+00	2.09E+02
Kr-88	2.91E+02	1.18E+02	3.49E+01	3.59E-01	8.41E-09	4.45E+02
Xe-131m	4.94E+00	5.46E+00	1.42E+01	2.86E+01	1.16E+02	1.69E+02
Xe-133m	2.67E+01	2.81E+01	6.49E+01	8.45E+01	5.31E+01	2.57E+02
Xe-133	8.79E+02	9.58E+02	2.40E+03	4.27E+03	8.45E+03	1.70E+04
Xe-135m	7.34E+01	5.30E-02	4.33E-09	0.00E+00	0.00E+00	7.35E+01
Xe-135	2.15E+02	1.72E+02	2.09E+02	4.35E+01	1.79E-01	6.39E+02
Xe-138	2.99E+02	1.38E-01	3.19E-09	0.00E+00	0.00E+00	2.99E+02
I-130	4.90E+00	7.28E+00	4.32E+00	2.03E-01	2.95E-04	1.67E+01
I-131	1.36E+02	2.45E+02	2.31E+02	3.10E+01	1.68E+01	6.60E+02
I-132	1.53E+02	9.94E+01	9.85E+00	8.24E-03	0.00E+00	2.62E+02
I-133	2.72E+02	4.40E+02	3.18E+02	2.28E+01	2.41E-01	1.05E+03
I-134	1.66E+02	2.85E+01	1.37E-01	4.48E-08	0.00E+00	1.95E+02
I-135	2.39E+02	2.97E+02	1.19E+02	2.39E+00	7.32E-05	6.57E+02
Cs-134	3.08E+01	6.22E+01	6.03E+01	7.76E+00	5.16E+00	1.66E+02
Cs-136	8.79E+00	1.75E+01	1.67E+01	2.05E+00	6.58E-01	4.57E+01
Cs-137	1.79E+01	3.62E+01	3.51E+01	4.52E+00	3.05E+00	9.68E+01
Cs-138	1.09E+02	7.05E+00	1.68E-03	0.00E+00	0.00E+00	1.16E+02
Rb-86	3.62E-01	7.27E-01	6.96E-01	8.67E-02	3.42E-02	1.91E+00
Total	3.23E+03	2.62E+03	3.58E+03	4.53E+03	8.93E+03	2.29E+04

Table A4-4 (SSAR Table 15-5)

Activity Releases for Failure of Small Lines Carrying Primary Coolant Outside Containment

Isotope	Activity Release (Ci) 0-2 hr
Kr-85m	1.24E+01
Kr-85	4.40E+01
Kr-87	7.05E+00
Kr-88	2.21E+01
Xe-131m	1.99E+01
Xe-133m	2.50E+01
Xe-133	1.84E+03
Xe-135m	2.59E+00
Xe-135	5.20E+01
Xe-138	3.65E+00
I-130	1.89E+00
I-131	9.26E+01
I-132	3.49E+02
I-133	2.01E+02
I-134	1.58E+02
I-135	1.68E+02
Cs-134	4.16E+00
Cs-136	6.16E+00
Cs-137	3.00E+00
Cs-138	2.21E+00
Total	3.02E+03

Table A4-5 (SSAR Table 15-6)

Activity Releases for Steam Generator Tube Rupture with Pre-Existing Iodine Spike

	Activity Release (Ci)			
Isotope	0-2 hr	2-8 hr	8-24 hr	Total
Kr-85m	5.53E+01	1.93E+01	7.53E-03	7.46E+01
Kr-85	2.20E+02	1.09E+02	1.34E-01	3.29E+02
Kr-87	2.39E+01	3.61E+00	9.12E-05	2.75E+01
Kr-88	9.22E+01	2.65E+01	5.43E-03	1.19E+02
Xe-131m	9.96E+01	4.88E+01	5.91E-02	1.48E+02
Xe-133m	1.24E+02	5.91E+01	6.61E-02	1.83E+02
Xe-133	9.19E+03	4.47E+03	5.29E+00	1.37E+04
Xe-135m	3.44E+00	5.86E-03	0.00E+00	3.45E+00
Xe-135	2.46E+02	1.02E+02	7.10E-02	3.47E+02
Xe-138	4.56E+00	5.07E-03	0.00E+00	4.57E+00
I-130	1.79E+00	5.39E-02	2.68E-01	2.12E+00
I-131	1.21E+02	5.27E+00	3.06E+01	1.56E+02
I-132	1.42E+02	7.43E-01	1.92E+00	1.44E+02
I-133	2.16E+02	7.63E+00	4.06E+01	2.64E+02
I-134	2.74E+01	4.40E-03	4.23E-03	2.74E+01
I-135	1.27E+02	2.70E+00	1.17E+01	1.42E+02
Cs-134	1.63E+00	6.05E-02	2.16E-01	1.90E+00
Cs-136	2.42E+00	8.86E-02	3.14E-01	2.82E+00
Cs-137	1.17E+00	4.37E-02	1.56E-01	1.37E+00
Cs-138	5.64E-01	2.91E-06	5.73E-07	5.64E-01
Total	1.07E+04	4.85E+03	9.14E+01	1.56E+04

Table A4-6 (SSAR Table 15-7)

Activity Releases for Steam Generator Tube Rupture with Accident-Initiated Iodine Spike

	Activity Release (Ci)			
Isotope	**0-2 hr**	**2-8 hr**	**8-24 hr**	**Total**
Kr-85m	5.53E+01	1.93E+01	7.53E-03	7.46E+01
Kr-85	2.20E+02	1.09E+02	1.34E-01	3.29E+02
Kr-87	2.39E+01	3.61E+00	9.12E-05	2.75E+01
Kr-88	9.22E+01	2.65E+01	5.43E-03	1.19E+02
Xe-131m	9.96E+01	4.88E+01	5.91E-02	1.48E+02
Xe-133m	1.24E+02	5.91E+01	6.61E-02	1.83E+02
Xe-133	9.19E+03	4.47E+03	5.29E+00	1.37E+04
Xe-135m	3.44E+00	5.86E-03	0.00E+00	3.45E+00
Xe-135	2.46E+02	1.02E+02	7.10E-02	3.47E+02
Xe-138	4.56E+00	5.07E-03	0.00E+00	4.57E+00
I-130	8.87E-01	1.62E-01	8.24E-01	1.87E+00
I-131	4.36E+01	1.14E+01	6.76E+01	1.23E+02
I-132	1.47E+02	4.86E+00	1.29E+01	1.65E+02
I-133	9.33E+01	2.00E+01	1.08E+02	2.22E+02
I-134	5.59E+01	6.04E-02	5.94E-02	5.60E+01
I-135	7.61E+01	9.88E+00	4.38E+01	1.30E+02
Cs-134	1.63E+00	6.05E-02	2.16E-01	1.90E+00
Cs-136	2.42E+00	8.86E-02	3.14E-01	2.82E+00
Cs-137	1.17E+00	4.37E-02	1.56E-01	1.37E+00
Cs-138	5.64E-01	2.91E-06	5.73E-07	5.64E-01
Total	1.05E+04	4.88E+03	2.40E+02	1.56E+04

Table A4-7 (SSAR Table 15-8)

Activity Releases for Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary

	Activity Release (Ci)					
Isotope	**1.4-3.4 hr**	**0-8 hr**	**8-24 hr**	**24-96 hr**	**96-720 hr**	**Total**
I-130	5.64E+01	1.12E+02	5.37E+00	7.10E-01	1.27E-02	1.18E+02
I-131	1.68E+03	3.49E+03	2.66E+02	2.39E+02	7.19E+02	4.71E+03
I-132	1.23E+03	2.14E+03	1.64E+01	1.46E-02	0.00E+00	2.15E+03
I-133	3.23E+03	6.54E+03	3.83E+02	1.04E+02	1.04E+01	7.04E+03
I-134	6.60E+02	1.14E+03	2.96E-01	6.79E-08	0.00E+00	1.14E+03
I-135	2.56E+03	4.89E+03	1.58E+02	6.09E+00	3.16E-03	5.06E+03
Kr-85m	1.42E+03	3.77E+03	1.87E+03	8.56E+01	1.22E-03	5.73E+03
Kr-85	8.31E+01	2.97E+02	7.06E+02	1.59E+03	1.36E+04	1.62E+04
Kr-87	1.10E+03	1.95E+03	4.97E+01	4.05E-03	0.00E+00	1.99E+03
Kr-88	3.11E+03	7.26E+03	1.70E+03	1.75E+01	4.09E-07	8.97E+03
Xe-131m	8.26E+01	2.94E+02	6.79E+02	1.37E+03	5.57E+03	7.91E+03
Xe-133m	4.43E+02	1.54E+03	3.15E+03	4.11E+03	2.58E+03	1.14E+04
Xe-133	1.47E+04	5.19E+04	1.16E+05	2.06E+05	4.07E+05	7.80E+05
Xe-135m	1.06E+01	3.59E+01	2.14E-07	0.00E+00	0.00E+00	3.59E+01
Xe-135	3.15E+03	9.64E+03	1.01E+04	2.11E+03	8.68E+00	2.19E+04
Xe-138	3.11E+01	1.20E+02	1.58E-07	0.00E+00	0.00E+00	1.20E+02
Rb-86	3.04E+00	6.32E+00	2.99E-01	9.83E-02	5.13E-01	7.23E+00
Cs-134	2.58E+02	5.38E+02	2.57E+01	9.11E+00	7.74E+01	6.50E+02
Cs-136	7.33E+01	1.52E+02	7.16E+00	2.28E+00	9.88E+00	1.72E+02
Cs-137	1.51E+02	3.13E+02	1.50E+01	5.32E+00	4.57E+01	3.79E+02
Cs-138	1.50E+02	3.30E+02	2.18E-03	0.00E+00	0.00E+00	3.30E+02
Sb-127	2.42E+01	4.80E+01	2.29E+00	5.67E-01	7.82E-01	5.16E+01
Sb-129	5.10E+01	8.94E+01	1.51E+00	4.95E-03	4.90E-08	9.09E+01
Te-127m	3.15E+00	6.30E+00	3.16E-01	1.11E-01	8.71E-01	7.60E+00
Te-127	2.05E+01	3.83E+01	1.15E+00	2.75E-02	1.33E-04	3.94E+01
Te-129m	1.07E+01	2.15E+01	1.07E+00	3.65E-01	2.36E+00	2.52E+01

Table A4-8 (SSAR Table 15-9)

(cont.) Activity Releases for Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary

	Activity Release (Ci)					
Isotope	**1.4-3.4 hr**	**0-8 hr**	**8-24 hr**	**24-96 hr**	**96-720 hr**	**Total**
Te-129	1.88E+01	2.83E+01	2.69E-02	3.54E-08	0.00E+00	2.84E+01
Te-131m	3.17E+01	6.20E+01	2.64E+00	3.35E-01	7.81E-02	6.50E+01
Te-132	3.23E+02	6.40E+02	3.02E+01	7.04E+00	7.83E+00	6.85E+02
Sr-89	9.23E+01	1.85E+02	9.24E+00	3.19E+00	2.26E+01	2.20E+02
Sr-90	7.95E+00	1.59E+01	7.99E-01	2.84E-01	2.44E+00	1.94E+01
Sr-91	9.68E+01	1.81E+02	5.46E+00	1.35E-01	7.06E-04	1.87E+02
Sr-92	6.83E+01	1.13E+02	1.01E+00	5.15E-04	0.00E+00	1.14E+02
Ba-139	5.44E+01	8.30E+01	1.49E-01	9.91E-07	0.00E+00	8.32E+01
Ba-140	1.63E+02	3.25E+02	1.61E+01	5.11E+00	2.17E+01	3.68E+02
Mo-99	2.15E+01	4.25E+01	1.98E+00	4.29E-01	3.78E-01	4.53E+01
Tc-99m	1.47E+01	2.66E+01	6.05E-01	5.27E-03	1.33E-06	2.72E+01
Ru-103	1.73E+01	3.46E+01	1.73E+00	5.93E-01	3.99E+00	4.09E+01
Ru-105	8.18E+00	1.44E+01	2.48E-01	8.86E-04	1.17E-08	1.46E+01
Ru-106	5.70E+00	1.14E+01	5.73E-01	2.03E-01	1.70E+00	1.39E+01
Rh-105	1.03E+01	2.02E+01	8.81E-01	1.29E-01	4.14E-02	2.12E+01
Ce-141	3.89E+00	7.78E+00	3.88E-01	1.32E-01	8.45E-01	9.15E+00
Ce-143	3.46E+00	6.78E+00	2.93E-01	4.05E-02	1.14E-02	7.13E+00
Ce-144	2.94E+00	5.89E+00	2.96E-01	1.05E-01	8.68E-01	7.15E+00
Pu-238	9.16E-03	1.83E-02	9.21E-04	3.27E-04	2.82E-03	2.24E-02
Pu-239	8.06E-04	1.61E-03	8.10E-05	2.88E-05	2.48E-04	1.97E-03
Pu-240	1.18E-03	2.37E-03	1.19E-04	4.22E-05	3.63E-04	2.89E-03
Pu-241	2.66E-01	5.31E-01	2.67E-02	9.48E-03	8.14E-02	6.49E-01
Np-239	4.48E+01	8.87E+01	4.08E+00	8.15E-01	5.70E-01	9.41E+01
Y-90	8.08E-02	1.60E-01	7.44E-03	1.59E-03	1.35E-03	1.70E-01
Y-91	1.19E+00	2.37E+00	1.19E-01	4.12E-02	3.00E-01	2.83E+00
Y-92	7.89E-01	1.35E+00	1.80E-02	2.86E-05	0.00E+00	1.37E+00

Table A4-8 Cont. (SSAR Table 15-9 cont)

(cont.) Activity Releases for Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary

	Activity Release (Ci)					
Isotope	1.4-3.4 hr	0-8 hr	8-24 hr	24-96 hr	96-720 hr	Total
Y-93	1.21E+00	2.28E+00	7.08E-02	1.98E-03	1.42E-05	2.35E+00
Nb-95	1.60E+00	3.19E+00	1.59E-01	5.44E-02	3.56E-01	3.76E+00
Zr-95	1.59E+00	3.18E+00	1.59E-01	5.52E-02	4.08E-01	3.80E+00
Zr-97	1.43E+00	2.74E+00	1.03E-01	6.73E-03	3.71E-04	2.85E+00
La-140	1.67E+00	3.29E+00	1.46E-01	2.36E-02	9.62E-03	3.47E+00
La-141	1.03E+00	1.79E+00	2.71E-02	6.41E-05	2.01E-10	1.81E+00
La-142	5.38E-01	8.31E-01	2.09E-03	3.39E-08	0.00E+00	8.33E-01
Nd-147	6.16E-01	1.23E+00	6.06E-02	1.90E-02	7.29E-02	1.38E+00
Pr-143	1.39E+00	2.78E+00	1.37E-01	4.40E-02	1.94E-01	3.15E+00
Am-241	1.20E-04	2.39E-04	1.20E-05	4.27E-06	3.68E-05	2.92E-04
Cm-242	2.82E-02	5.65E-02	2.83E-03	9.98E-04	8.08E-03	6.84E-02
Cm-244	3.46E-03	6.93E-03	3.48E-04	1.24E-04	1.06E-03	8.47E-03
Total	3.53E+04	9.85E+04	1.35E+05	2.15E+05	4.30E+05	8.79E+05

Table A4-8 Cont. (SSAR Table 15-9 cont)

Activity Releases for Fuel Handling Accident

Isotope	Activity Release (Ci) 0-2 hr
Kr-85m	3.42E+02
Kr-85	1.11E+03
Kr-87	6.00E-02
Kr-88	1.07E+02
Xe-131m	5.54E+02
Xe-133m	2.80E+03
Xe-133	9.66E+04
Xe-135m	1.26E+03
Xe-135	2.49E+04
I-130	2.51E+00
I-131	3.76E+02
I-132	3.01E+02
I-133	2.40E+02
I-135	3.94E+01
Total	1.29E+05

Table A4-9 (SSAR Table 15-10)

A.5 INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA

Inspections, Tests, Analyses, and Acceptance Criteria: An ESP application proposing complete and integrated emergency plans for review and approval should propose the inspections, tests, and analyses that the holder of a COL referencing the ESP shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will be operated in conformity with the emergency plans, the provisions of the Atomic Energy Act, and the Commission's rules and regulations. Likewise, a request for a limited work authorization (LWA) to be issued in conjunction with an ESP should propose the inspections, tests, and analyses that the ESP holder authorized to conduct LWA activities shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the approved construction activities will have been completed in conformity with the provisions of the Atomic Energy Act and the Commission's rules and regulations.

A.5.1 ITAAC for the LWA

Backfill ITAAC

Design Requirement	Inspections, Tests, Analyses	Acceptance Criteria
Backfill material under Seismic Category 1 structures is installed to meet a minimum of 95 percent modified Proctor compaction.	Required testing will be performed during placement of the backfill materials.	A report exists that documents that the backfill material under Seismic Category 1 structures meets the minimum 95 percent modified Proctor compaction.
Backfill shear wave velocity is greater than or equal to 1,000 fps at the depth of the NI foundation and below.	Field shear wave velocity measurements will be performed when backfill placement is at the elevation of the bottom of the Nuclear Island foundation and at finish grade.	A report exists and documents that the as-built backfill shear wave velocity at the NI foundation depth and below is greater than or equal to 1,000 fps.

Waterproof Membrane ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
The friction coefficient to resist sliding is 0.7 or higher	Testing will be performed to confirm that the mudmat-waterproofing-mudmat interface beneath the Nuclear Island basemat has a minimum coefficient of friction to resist sliding of 0.7	A report exists and documents that the as-built waterproof system (mudmat-waterproofing-mudmat interface) has a minimum coefficient of friction of 0.7 as demonstrated through material qualification testing.

A.5.2 ITAAC for the ESP

VEGP Unit 3 Emergency Planning ITAAC

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
1.0 Emergency Classification System			
10 CFR 50.47(b)(4) – A standard emergency classification and action level scheme, the bases of which include facility system and effluent parameters, is in use by the nuclear facility licensee, and State and local plans call for reliance on information provided by facility licensees for determinations of minimum initial offsite response measures.	1.1 An emergency classification and emergency action level (EAL) scheme must be established by the licensee. The specific instruments, parameters, or equipment status shall be shown for establishing each emergency class, in the in-plant emergency procedures. The plan shall identify the parameter values and equipment status for each emergency class. [D.1]	1.1.1 An inspection of the control room, technical support center (TSC), and emergency operations facility (EOF) will be performed to verify that the displays for retrieving system and effluent parameters specified in Table Annex V2 D.2-1, *Hot Initiating Condition Matrix, Modes 1, 2, 3, and 4*; Table V2 D.2-2, *Cold Initiating Condition Matrix, Modes 5, 6, and De-fueled* are installed and perform their intended functions; and that emergency implementing procedures (EIPs) have been completed. 1.1.2 An analysis of the EAL technical bases will be performed to verify as-built, site-specific implementation of the EAL scheme.	1.1.1 The parameters specified in Table Annex V2 H-1, *Post Accident Monitoring Variables*, are retrievable in the control room, TSC, and EOF. The ranges of values of these parameters that can be displayed encompass the values specified in the emergency classification and EAL scheme. 1.1.2 The EAL scheme is consistent with Regulatory Guide 1.101, *Emergency Planning and Preparedness for Nuclear Power Reactors*.
3.0 Emergency Communications			
10 CFR 50.47(b)(6) – Provisions exist for prompt communications among principal response organizations to emergency personnel and to the public.	3.1 The means exists for communications between the control room, OSC, TSC, EOF, principal State and local emergency operations centers (EOCs), and radiological field monitoring teams. [F.1.d]	3.1 A test will be performed of the communications capabilities between the control room, OSC, TSC and EOF, and to the State and local EOCs, and radiological field monitoring teams.	3.1 Communications are established between the control room, OSC, TSC, and EOF. Communications are established between the control room, TSC, and Georgia Emergency Management Agency (GEMA) Operation Center; Burke County Emergency Operation Center (EOC); SRS Operations Center; South Carolina Warning Point; and Aiken, Allendale, and Barnwell County Dispatchers. Communications are established between the TSC and radiological monitoring teams.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
	3.2 The means exists for communications from the control room, TSC, and EOF to the NRC headquarters and regional office EOC (including establishment of the Emergency Response Data System (ERDS) between the onsite computer system and the NRC Operations Center. [F.1.f]	3.2 A test will be performed of the communications capabilities from the control room, TSC and EOF to the NRC, including ERDS.	3.2 Communications are established from the control room, TSC, and EOF to the NRC headquarters and regional office EOCs and an access port for the Emergency Response Data System (ERDS) is provided.
5.0 Emergency Facilities and Equipment			
10 CFR 50.47(b)(8) – Adequate emergency facilities and equipment to support the emergency response are provided and maintained.	5.1 The licensee has established a technical support center (TSC) and an onsite operations support center (OSC). [H.1]	5.1 An inspection of the as-built TSC and OSC will be performed, including a test of the capabilities.	5.1.1 The TSC has at least 2,175 square feet of floor space. 5.1.2 Communication equipment is installed in the TSC and OSC, and voice transmission and reception are accomplished. 5.1.3 The plant parameters listed in Table Annex V2 H-1, *Post Accident Monitoring Values*, can be retrieved and displayed in the TSC. 5.1.4 The TSC is located within the protected area, and no major security barriers exist between the TSC and the control room. 5.1.5 The OSC is located adjacent to the passage from the annex building to the control room. 5.1.6 The TSC ventilation system includes a high-efficiency particulate air (HEPA) and charcoal filter, and radiation monitors are installed. 5.1.7 A reliable and backup electrical power supply is available for the TSC.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
	5.2 The licensee has established an emergency operations facility (EOF). [H.2]	5.2 An inspection of the EOF will be performed, including a test of the capabilities.	5.2.1 Voice transmission and reception are accomplished between the EOF and the control room. 5.2.2 The plant parameters listed in Table Annex V2 H-1, *Post Accident Monitoring Values*, can be retrieved and displayed in the EOF.
6.0 Accident Assessment			
10 CFR 50.47(b)(9) – Adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use.	6.1 The means exists to provide initial and continuing radiological assessment throughout the course of an accident. [I.2]	6.1 A test of the emergency plan will be conducted by performing a drill to verify the capability to perform accident assessment.	6.1 Using selected monitoring parameters listed in Table Annex V2 H-1 of the VEGP emergency plan, simulated degraded plant conditions are assessed and protective actions are initiated in accordance with the following criteria: A. Accident Assessment and Classification 1. Demonstrate the ability to identify initiating conditions, determine emergency action level (EAL) parameters, and correctly classify the emergency throughout the drill. B. Radiological Assessment and Control 1. Demonstrate the ability to obtain onsite radiological surveys and samples. 2. Demonstrate the ability to continuously monitor and control radiation exposure to emergency workers. 3. Demonstrate the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. 4. Demonstrate the ability to satisfactorily collect and disseminate field team data.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			5. Demonstrate the ability to develop dose projections. 6. Demonstrate the ability to make the decision whether to issue radio-protective drugs (KI) to emergency workers. 7. Demonstrate the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development.
	6.2 The means exists to determine the source term of releases of radioactive material within plant systems, and the magnitude of the release of radioactive materials based on plant system parameters and effluent monitors. [I.3]	6.2 An analysis of the emergency implementing procedures (EIPs) and the Offsite Dose Calculation Manual (ODCM) will be completed to verify ability to determine the source term and magnitude of releases.	6.2 The EIPs and ODCM correctly calculate source terms and magnitudes of postulated releases.
	6.3 The means exists to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for various meteorological conditions. [I.4]	6.3 An analysis of the emergency implementing procedures (EIPs) and the Offsite Dose Calculation Manual (ODCM) will be completed to verify the relationship between effluent monitor readings, and onsite and offsite exposures and contamination.	6.3 The EIPs and ODCM calculate the relationship between effluent monitor readings, and onsite and offsite exposures and contamination.
	6.4 The means exists to acquire and evaluate meteorological information. [I.5]	6.4 A test will be performed to verify the ability to access meteorological information in the TSC and control room.	6.4 The following parameters are displayed in the TSC and control room: • Wind speed (at 10 and 60 meters) • Wind direction (at 10 and 60 meters) • Standard deviation of horizontal wind direction (at 10 meters) • Vertical temperature difference (between 10 and 60 meters) • Ambient temperature (at 10 meters) • Dew-point temperature (at 10 meters) • Precipitation (at the tower base)
	6.5 The means exists to make rapid assessments of actual or potential magnitude and locations of any radiological hazards through liquid or gaseous release pathways, including activation, notification means, field	6.5 A test will be performed of the capabilities to make rapid assessment of actual or potential radiological hazards through liquid or gaseous release pathways.	6.5 Demonstrate the capability to make rapid assessment of actual or potential magnitude and locations of any radiological hazards through liquid or gaseous release pathways.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
	team composition, transportation, communication, monitoring equipment, and estimated deployment times. [I.8]		
	6.6 The means exists to estimate integrated dose from the projected and actual dose rates, and for comparing these estimates with the EPA protective action guides (PAGs). [I.10]	6.6 An analysis of the methodology contained in the emergency implementing procedures (EIPs) for estimating dose and preparing protective action recommendations (PARs), and in the Offsite Dose Calculation Manual (ODCM) will be performed to verify the ability to estimate an integrated dose from projected and actual dose rates.	6.6 The EIPs and ODCM estimate an integrated dose.
7.0 Protective Response			
10 CFR 50.47(b)(10) – A range of protective actions has been developed for the plume exposure pathway EPZ for emergency workers and the public. In developing this range of actions, consideration has been given to evacuation, sheltering, and, as a supplement to these, the prophylactic use of potassium iodide (KI), as appropriate. Guidelines for the choice of protective actions during an emergency, consistent with Federal guidance, are developed and in place, and protective actions for the ingestion exposure pathway EPZ appropriate to the locale have been developed.	7.1 The means exists to warn and advise onsite individuals of an emergency, including those in areas controlled by the operator, including: • Employees not having emergency assignments • Visitors • Contractor and construction personnel • Other persons who may be in the public access areas, on or passing through the site, or within the owner controlled area [J.1]	7.1 A test of the onsite warning and communication capability emergency implementing procedures (EIPs) including protective action guidelines, assembly and accountability, and site dismissal will be performed during a drill.	7.1.1 Demonstrate the capability to direct and control emergency operations. 7.1.2 Demonstrate the ability to transfer emergency direction from the control room (simulator) to the technical support center (TSC) within 30 minutes from activation. 7.1.3 Demonstrate the ability to prepare for around-the-clock staffing requirements. 7.1.4 Demonstrate the ability to perform assembly and accountability for all onsite individuals within 30 minutes of an emergency requiring protected area assembly and accountability. 7.1.5 Demonstrate the ability to perform site dismissal.
8.0 Exercises and Drills			
10 CFR 50.47(b)(14) – Periodic exercises are (will be) conducted to evaluate major portions of emergency response capabilities, periodic drills are (will be) conducted to develop and maintain key skills, and deficiencies identified as a result of exercises or drills are (will be) corrected.	8.1 The licensee conducts a full participation exercise to evaluate major portions of emergency response capabilities, which includes participation by each State and local agency within the plume exposure EPZ, and each State within the ingestion pathway EPZ. [N.1]	8.1 A full participation exercise (test) will be conducted within the specified time periods of 10 CFR Part 50, Appendix E.	8.1.1 The exercise is completed within the specified time periods of Appendix E to 10 CFR Part 50, onsite exercise objectives listed below have been met and there are no uncorrected onsite exercise deficiencies. A. *Accident Assessment and Classification*

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			1. Demonstrate the ability to identify initiating conditions, determine emergency action level (EAL) parameters, and correctly classify the emergency throughout the exercise Standard Criteria: a. Determine the correct highest emergency classification level based on events which were in progress, considering past events and their impact on the current conditions, within 15 minutes from the time the initiating condition(s) or EAL is identified. B. *Notifications* 1. Demonstrate the ability to alert, notify, and mobilize site emergency response personnel. Standard Criteria: a. Complete the designated checklist and perform the announcement within 5 minutes of the initial event classification for an Alert or higher. b. Activate the emergency recall system within 5 minutes of the initial event classification for an Alert or higher. 2. Demonstrate the ability to notify responsible State and local government agencies within 15 minutes and the NRC within 60 minutes after declaring an emergency. Standard Criteria: a. Transmit information using the designated checklist, in accordance with approved emergency implementing procedures (EIPs), within 15 minutes of event classification.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			b. Transmit information using the designated checklist, in accordance with approved EIPs, within 60 minutes of last transmittal for a follow-up notification to State and local authorities. c. Transmit information using the designated checklist within 60 minutes of event classification for an initial notification of the NRC. 3. Demonstrate the ability to warn or advise onsite individuals of emergency conditions. Standard Criteria: a. Initiate notification of onsite individuals (via plant page or telephone), using the designated checklist within 15 minutes of notification. 4. Demonstrate the capability of the Prompt Notification System (PNS), for the public, to operate properly when required. Standard Criteria: a. 90% of the sirens operate properly, as indicated by the Whelen feedback system. b. A NOAA tone alert radio is activated. C. *Emergency Response* 1. Demonstrate the capability to direct and control emergency operations. Standard Criteria: a. Command and control is demonstrated by the control room in the early phase of the emergency and the technical support center (TSC) within 60

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			minutes from TSC activation. 2. Demonstrate the ability to transfer emergency direction from the control room (simulator) to the TSC within 30 minutes from activation. Standard Criteria: a. Briefings were conducted prior to turnover responsibility. Personnel document transfer of duties. 3. Demonstrate the ability to prepare for around-the-clock staffing requirements. Standard Criteria: a. Complete 24-hour staff assignments. 4. Demonstrate the ability to perform assembly and accountability for all onsite individuals within 30 minutes of an emergency requiring protected area assembly and accountability. Standard Criteria: a. Protected area personnel assembly and accountability completed within 30 minutes of the Alert or higher emergency declaration via public address announcement. D. *Emergency Response Facilities* 1. Demonstrate activation of the operational support center (OSC), and full functional operation of the TSC and EOF within 60 minutes of activation. Standard Criteria: a. The TSC, OSC, and EOF are activated within about 60 minutes of the initial notification.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			2. Demonstrate the adequacy of equipment, security provisions, and habitability precautions for the TSC, OSC, EOF, and emergency news center (ENC), as appropriate. Standard Criteria: a. Demonstrate the adequacy of the emergency equipment in the emergency response facilities, including availability and general consistency with emergency implementing procedures (EIPs). b. The Security Shift Captain implements and follows applicable EIPs. c. The Health Physics Supervisor (TSC) implements the designated checklist if an onsite or offsite release has occurred. 3. Demonstrate the adequacy of communications for all emergency support resources. Standard Criteria: a. Emergency response communications listed in emergency implementing procedures (EIPs) are available and operational. b. Communications systems are tested in accordance with TSC, OSC, and EOF activation checklists. c. Emergency response facility personnel are able to operate all specified communication systems. d. Clear primary and backup communications links are established and maintained for the duration of the exercise.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			E. *Radiological Assessment and Control* 1. Demonstrate the ability to obtain onsite radiological surveys and samples. Standard Criteria: a. HP Technicians demonstrate the ability to obtain appropriate instruments (range and type) and take surveys. b. Airborne samples are taken when the conditions indicate the need for the information. 2. Demonstrate the ability to continuously monitor and control radiation exposure to emergency workers. Standard Criteria: a. Emergency workers are issued self-reading dosimeters when radiation levels require, and exposures are controlled to 10 CFR Part 20 limits (unless the Emergency Director authorizes emergency limits). b. Exposure records are available, either from the ALARA computer or a hard copy dose report. c. Emergency workers include Security and personnel within all emergency facilities. 3. Demonstrate the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. Standard Criteria: a. One field monitoring team is ready to be deployed within 60 minutes of being requested from the OSC, and no later

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			than 90 minutes from the declaration of an Alert or higher emergency. 4. Demonstrate the ability to satisfactorily collect and disseminate field team data. Standard Criteria: a. Field team data to be collected is dose rate or counts per minute (cpm) from the plume, both open and closed window, and air sample (gross/net cpm) for particulate and iodine, if applicable. b. Satisfactory data dissemination is from the field team to the Dose Assessment Supervisor, via the field team communicator and field team coordinator. 5. Demonstrate the ability to develop dose projections. Standard Criteria: a. The on-shift HP/Chemistry Shared Foreman or Dose Assessment Supervisor performs timely and accurate dose projections, in accordance with emergency implementing procedures (EIPs). 6. Demonstrate the ability to make the decision whether to issue radioprotective drugs (KI) to emergency workers. Standard Criteria: a. KI is taken (simulated) if the estimated dose to the thyroid will exceed 25 rem committed dose equivalent (CDE). 7. Demonstrate the ability to develop appropriate protective action

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			recommendations (PARs) and notify appropriate authorities within 15 minutes of development. Standard Criteria: a. Total effective dose equivalent (TEDE) and CDE dose projections from the dose assessment computer code are compared to emergency implementing procedures (EIPs). b. PARs are developed within 15 minutes of data availability. c. PARs are transmitted to responsible State and local government agencies via voice or fax within 15 minutes of PAR development. F. *Public Information* 1. Demonstrate the capability to develop and disseminate clear, accurate, and timely information to the news media, in accordance with EIPs. Standard Criteria: a. Media information (e.g., press releases, press briefings, electronic media) is made available within 60 minutes of notification of the on-call media representative. b. Follow-up information is provided, at a minimum, within 60 minutes of an emergency classification or PAR change. 2. Demonstrate the capability to establish and effectively operate rumor control in a coordinated fashion. Standard Criteria: a. Calls are answered in a timely

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			manner with the correct information, in accordance with EIPs. b. Calls are returned or forwarded, as appropriate, to demonstrate responsiveness. c. Rumors are identified and addressed. G. *Evaluation* 1. Demonstrate the ability to conduct a post-exercise critique, to determine areas requiring improvement and corrective action. Standard Criteria: a. An exercise time line is developed, followed by an evaluation of the objectives. b. Significant problems in achieving the objectives are discussed to ensure understanding of why objectives were not fully achieved. c. Recommendations for improvement in non-objective areas are discussed. 8.1.2 Onsite emergency response personnel are mobilized in sufficient number to fill the emergency positions identified in emergency plan Section B, *VEGP Emergency Organization*, and they successfully perform their assigned responsibilities as outlined in Acceptance Criterion 8.1.1.D, *Emergency Response Facilities*. 8.1.3 The exercise is completed within the specified time periods of Appendix E to 10 CFR Part 50, offsite exercise objectives have been met, and there are either no uncorrected offsite deficiencies, or a license condition requires offsite deficiencies to be

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			corrected prior to operation above 5% of rated power.
9.0 Implementing Procedures			
10 CFR Part 50, Appendix E.V – No less than 180 days prior to the scheduled issuance of an operating license for a nuclear power reactor or a license to possess nuclear material, the applicant's detailed implementing procedures for its emergency plan shall be submitted to the Commission.	9.1 The licensee has submitted detailed implementing procedures for its emergency plan no less than 180 days prior to fuel load.	9.1 An inspection of the submittal letter will be performed.	9.1 The licensee has submitted detailed emergency implementing procedures (EIPs) for the onsite emergency plan no less than 180 days prior to fuel load.

VEGP Unit 4 Emergency Planning ITAAC

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
1.0 Emergency Classification System			
10 CFR 50.47(b)(4) – A standard emergency classification and action level scheme, the bases of which include facility system and effluent parameters, is in use by the nuclear facility licensee, and State and local plans call for reliance on information provided by facility licensees for determinations of minimum initial offsite response measures.	1.1 An emergency classification and emergency action level (EAL) scheme must be established by the licensee. The specific instruments, parameters, or equipment status shall be shown for establishing each emergency class, in the in-plant emergency procedures. The plan shall identify the parameter values and equipment status for each emergency class. [D.1]	1.1.1 An inspection of the control room will be performed to verify that the displays for retrieving system and effluent parameters specified in Table Annex V2 D.2-1, *Hot Initiating Condition Matrix, Modes 1, 2, 3, and 4*; Table V2 D.2-2, *Cold Initiating Condition Matrix, Modes 5, 6, and De-fueled*; are installed and perform their intended functions; and that emergency implementing procedures (EIPs) have been completed. 1.1.2 An analysis of the EAL technical bases will be performed to verify as-built, site-specific implementation of the EAL scheme.	1.1.1 The parameters specified in Table Annex V2 H-1, *Post Accident Monitoring Variables*, are retrievable in the control room. The ranges of values of these parameters that can be displayed encompass the values specified in the emergency classification and EAL scheme. 1.1.2 The EAL scheme is consistent with Regulatory Guide 1.101, *Emergency Planning and Preparedness for Nuclear Power Reactors*.
3.0 Emergency Communications			
10 CFR 50.47(b)(6) – Provisions exist for prompt communications among principal response organizations to emergency	3.1 The means exists for communications between the control room, OSC, TSC, and EOF. [F.1.d]	3.1 A test will be performed of the communications capabilities between the control room, OSC, TSC and EOF, and to the State and local EOCs.	3.1 Communications are established between the control room, OSC, TSC, and EOF. Communications are established between the control room,

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
personnel and to the public.			Georgia Emergency Management Agency (GEMA) Operation Center; Burke County Emergency Operations Center (EOC); SRS Operations Center; South Carolina Warning Point; and Aiken, Allendale, and Barnwell County Dispatchers.
	3.2 The means exists for communications from the control room to the NRC headquarters and regional office EOC. [F.1.f]	3.2 A test will be performed of the communications capabilities from the control room, TSC and EOF to the NRC, including ERDS.	3.2 Communications are established from the control room, TSC, and EOF, to the NRC headquarters and regional office EOCs and an access port for the Emergency Response Data System (ERDS) is provided.
5.0 Emergency Facilities and Equipment			
10 CFR 50.47(b)(8) – Adequate emergency facilities and equipment to support the emergency response are provided and maintained.	5.1 The licensee has established an onsite operations support center (OSC). [H.1]	5.1 An inspection of the as-built OSC will be performed, including a test of the capabilities.	5.1.1 Communication equipment is installed in the OSC, and voice transmission and reception are accomplished. 5.1.2 The plant parameters listed in Table Annex V2 H-1, *Post Accident Monitoring Values*, can be retrieved and displayed in the TSC. 5.1.3 The OSC is located adjacent to the passage from the annex building to the control room.
	5.2 The licensee has established an emergency operations facility (EOF). [H.2]	5.2 An inspection of the EOF will be performed, including a test of the capabilities.	5.2.1 Voice transmission and reception are accomplished between the EOF and the control room. 5.2.2 The plant parameters listed in Table Annex V2 H-1, *Post Accident Monitoring Values*, can be retrieved and displayed in the EOF.
6.0 Accident Assessment			
10 CFR 50.47(b)(9) – Adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use.	6.1 The means exists to provide initial and continuing radiological assessment throughout the course of an accident. [I.2]	6.1 A test of the emergency plan will be conducted by performing a drill to verify the capability to perform accident assessment.	6.1 Using selected monitoring parameters listed in Table Annex V2 H-1 of the VEGP emergency plan, simulated degraded plant conditions are assessed and protective actions are initiated in accordance with the following criteria: A. Accident Assessment and

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			Classification 1. Demonstrate the ability to identify initiating conditions, determine emergency action level (EAL) parameters, and correctly classify the emergency throughout the drill. B. Radiological Assessment and Control 1. Demonstrate the ability to obtain onsite radiological surveys and samples. 2. Demonstrate the ability to continuously monitor and control radiation exposure to emergency workers. 3. Demonstrate the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. 4. Demonstrate the ability to satisfactorily collect and disseminate field team data. 5. Demonstrate the ability to develop dose projections. 6. Demonstrate the ability to make the decision whether to issue radio-protective drugs (KI) to emergency workers. 7. Demonstrate the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development.
	6.2 The means exists to determine the source term of releases of radioactive material within plant systems, and the magnitude of the release of radioactive materials based on plant system	6.2 An analysis of the emergency implementing procedures (EIPs) and the Offsite Dose Calculation Manual (ODCM) will be completed to verify ability to determine the source term	6.2 The EIPs and ODCM correctly calculate source terms and magnitudes of postulated releases.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
	parameters and effluent monitors. [I.3]	and magnitude of releases.	
	6.3 The means exists to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for various meteorological conditions. [I.4]	6.3 An analysis of the emergency implementing procedures (EIPs) and the Offsite Dose Calculation Manual (ODCM) will be completed to verify the relationship between effluent monitor readings, and onsite and offsite exposures and contamination.	6.3 The EIPs and ODCM calculate the relationship between effluent monitor readings, and onsite and offsite exposures and contamination.
	6.4 The means exists to acquire and evaluate meteorological information. [I.5]	6.4 A test will be performed to verify the ability to access meteorological information in the TSC and control room.	6.4 The following parameters are displayed in the TSC and control room: • Wind speed (at 10 and 60 meters) • Wind direction (at 10 and 60 meters) • Standard deviation of horizontal wind direction (at 10 meters) • Vertical temperature difference (between 10 and 60 meters) • Ambient temperature (at 10 meters) • Dew-point temperature (at 10 meters) • Precipitation (at the tower base)
	6.5 The means exists to make rapid assessments of actual or potential magnitude and locations of any radiological hazards through liquid or gaseous release pathways, including activation, notification means, field team composition, transportation, communication, monitoring equipment, and estimated deployment times. [I.8]	6.5 A test will be performed of the capabilities to make rapid assessments of actual or potential radiological hazards through liquid or gaseous release pathways.	6.5 Demonstrate the capability to make rapid assessment of actual or potential magnitude and locations of any radiological hazards through liquid or gaseous release pathways.
	6.6 The means exists to estimate integrated dose from the projected and actual dose rates, and for comparing these estimates with the EPA protective action guides (PAGs). [I.10]	6.6 An analysis of the methodology contained in the emergency implementing procedures (EIPs) for estimating dose and preparing protective action recommendations (PARs), and in the Offsite Dose Calculation Manual (ODCM) will be performed to verify the ability to estimate an integrated dose from projected and actual dose rates.	6.6 The EIPs and ODCM estimate an integrated dose.
7.0 Protective Response			
10 CFR 50.47(b)(10) – A range of protective actions has been developed for the plume exposure pathway EPZ for emergency workers and the public. In	7.1 The means exists to warn and advise onsite individuals of an emergency, including those in areas controlled by the operator, including:	7.1 A test of the onsite warning and communication capability emergency implementing procedures (EIPs) including protective action guidelines, assembly and accountability, and site	7.1.1 Demonstrate the capability to direct and control emergency operations. 7.1.2 Demonstrate the ability to transfer

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
developing this range of actions, consideration has been given to evacuation, sheltering, and, as a supplement to these, the prophylactic use of potassium iodide (KI), as appropriate. Guidelines for the choice of protective actions during an emergency, consistent with Federal guidance, are developed and in place, and protective actions for the ingestion exposure pathway EPZ appropriate to the locale have been developed.	• Employees not having emergency assignments • Visitors • Contractor and construction personnel • Other persons who may be in the public access areas, on or passing through the site, or within the owner controlled area [J.1]	dismissal will be performed during a drill.	emergency direction from the control room (simulator) to the technical support center (TSC) within 30 minutes of activation. 7.1.3 Demonstrate the ability to prepare for around-the-clock staffing requirements. 7.1.4 Demonstrate the ability to perform assembly and accountability for all onsite individuals within 30 minutes of an emergency requiring protected area assembly and accountability. 7.1.5 Demonstrate the ability to perform site dismissal.
8.0 Exercises and Drills			
10 CFR 50.47(b)(14) – Periodic exercises are (will be) conducted to evaluate major portions of emergency response capabilities, periodic drills are (will be) conducted to develop and maintain key skills, and deficiencies identified as a result of exercises or drills are (will be) corrected.	8.1 The licensee conducts a limited participation exercise to evaluate portions of emergency response capabilities, which includes participation by each State and local agency within the plume exposure EPZ that have not been tested in a previous exercise. [N.1]	8.1 A limited participation exercise (test) will be conducted within the specified time periods of 10 CFR Part 50, Appendix E.	8.1.1 The exercise is completed within the specified time periods of Appendix E to 10 CFR Part 50, onsite exercise objectives listed below have been met and there are no uncorrected onsite exercise deficiencies. A. *Accident Assessment and Classification* 1. Demonstrate the ability to identify initiating conditions, determine emergency action level (EAL) parameters, and correctly classify the emergency throughout the exercise Standard Criteria: a. Determine the correct highest emergency classification level based on events which were in progress, considering past events and their impact on the current conditions, within 15 minutes from the time the initiating condition(s) or EAL is identified. B. *Notifications* 1. Demonstrate the ability to alert, notify, and mobilize site emergency

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			response personnel. Standard Criteria: a. Complete the designated checklist and perform the announcement within 5 minutes of the initial event classification for an Alert or higher. b. Activate the emergency recall system within 5 minutes of the initial event classification for an Alert or higher. 2. Demonstrate the ability to notify responsible State and local government agencies within 15 minutes and the NRC within 60 minutes after declaring an emergency. Standard Criteria: a. Transmit information using the designated checklist, in accordance with approved emergency implementing procedures (EIPs), within 15 minutes of event classification. b. Transmit information using the designated checklist, in accordance with approved EIPs, within 60 minutes of last transmittal for a follow-up notification to State and local authorities. c. Transmit information using the designated checklist within 60 minutes of event classification for an initial notification of the NRC. 3. Demonstrate the ability to warn or advise onsite individuals of emergency conditions. Standard Criteria: a. Initiate notification of onsite individuals (via plant page or telephone) using the designated checklist, within

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			15 minutes of notification. C. *Emergency Response* 1. Demonstrate the capability to direct and control emergency operations. Standard Criteria: a. Command and control is demonstrated by the control room in the early phase of the emergency and by the TSC within 60 minutes from activation. 2. Demonstrate the ability to transfer emergency direction from the control room (simulator) to the TSC within 30 minutes from activation. Standard Criteria: a. Briefings were conducted prior to turnover responsibility. Personnel document transfer of duties. 3. Demonstrate the ability to prepare for around-the-clock staffing requirements. Standard Criteria: a. Complete 24-hour staff assignments. 4. Demonstrate the ability to perform assembly and accountability for all onsite individuals within 30 minutes of an emergency requiring protected area assembly and accountability. Standard Criteria: a. Protected area personnel assembly and accountability completed within 30 minutes of the Alert or higher emergency declaration via public address announcement. D. *Emergency Response Facilities*

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			1. Demonstrate timely activation of the OSC. Standard Criteria: a. The OSC is activated within about 60 minutes of the initial notification. 2. Demonstrate the adequacy of equipment, security provisions, and habitability precautions for the OSC, as appropriate. Standard Criteria: a. Demonstrate the adequacy of the emergency equipment in the emergency response facilities, including availability and general consistency with emergency implementing procedures (EIPs). b. The Security Shift Captain implements and follows applicable EIPs. c. The Health Physics Supervisor (TSC) implements the designated checklist if an onsite or offsite release has occurred. 3. Demonstrate the adequacy of communications for all emergency support resources. Standard Criteria: a. Emergency response communications listed in emergency implementing procedures (EIPs) are available and operational. b. Communications systems are tested in accordance with OSC activation checklist. c. Emergency response facility

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			personnel are able to operate all specified communication systems. d. Clear primary and backup communications links are established and maintained for the duration of the exercise. E. *Radiological Assessment and Control* 1. Demonstrate the ability to obtain onsite radiological surveys and samples. Standard Criteria: a. HP Technicians demonstrate the ability to obtain appropriate instruments (range and type) and take surveys. b. Airborne samples are taken when the conditions indicate the need for the information. 2. Demonstrate the ability to continuously monitor and control radiation exposure to emergency workers. Standard Criteria: a. Emergency workers are issued self-reading dosimeters when radiation levels require, and exposures are controlled to 10 CFR Part 20 limits (unless the Emergency Director authorizes emergency limits). b. Exposure records are available, either from the ALARA computer or a hard copy dose report. c. Emergency workers include Security and personnel within all emergency facilities. 3. Demonstrate the ability to assemble

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			and deploy field monitoring teams within 60 minutes from the decision to do so. Standard Criteria: a. One field monitoring team is ready to be deployed within 60 minutes of being requested from the OSC, and no later than 90 minutes from the declaration of an Alert or higher emergency. 4. Demonstrate the ability to satisfactorily collect and disseminate field team data. Standard Criteria: a. Field team data to be collected is dose rate or counts per minute (cpm) from the plume, both open and closed window, and air sample (gross/net cpm) for particulate and iodine, if applicable. b. Satisfactory data dissemination is from the field team to the Dose Assessment Supervisor, via the field team communicator and field team coordinator. 5. Demonstrate the ability to develop dose projections. Standard Criteria: a. The on-shift HP/Chemistry Shared Foreman or Dose Assessment Supervisor performs timely and accurate dose projections, in accordance with emergency implementing procedures (EIPs). 6. Demonstrate the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development.

Planning Standard	EP Program Elements (From NUREG-0654/FEMA-REP-1)	Inspections, Tests, Analyses	Acceptance Criteria
			Standard Criteria: a. Total effective dose equivalent (TEDE) and CDE dose projections from the dose assessment computer code are compared to emergency implementing procedures (EIPs). b. PARs are developed within 15 minutes of data availability. c. PARs are transmitted to responsible State and local government agencies via voice or fax within 15 minutes of PAR development. 8.1.2 Onsite emergency response personnel are mobilized in sufficient number to fill the emergency positions identified in emergency plan Section B, *VEGP Emergency Organization,* and they successfully perform their assigned responsibilities as outlined in Acceptance Criterion 8.1.1.D, *Emergency Response Facilities*. 8.1.3 The exercise is completed within the specified time periods of Appendix E to 10 CFR Part 50, offsite exercise objectives have been met, and there are either no uncorrected offsite deficiencies, or a license condition requires offsite deficiencies to be corrected prior to operation above 5% of rated power.
9.0 Implementing Procedures			
10 CFR Part 50, Appendix E.V – No less than 180 days prior to the scheduled issuance of an operating license for a nuclear power reactor or a license to possess nuclear material, the applicant's detailed implementing procedures for its emergency plans shall be submitted to the Commission.	9.1 The licensee has submitted detailed implementing procedures for its emergency plan no less than 180 days prior to fuel load.	9.1 An inspection of the submittal letter will be performed.	9.1 The licensee has submitted detailed emergency implementing procedures (EIPs) for the onsite emergency plan no less than 180 days prior to fuel load.

APPENDIX B

CHRONOLOGY OF AN EARLY SITE PERMIT APPLICATION AND LIMITED WORK AUTHORIZATION REQUEST FOR THE VEGP SITE

This appendix lists correspondence, including between the Southern Nuclear Operating Company, Inc. and the U.S. Nuclear Regulatory Commission, regarding the Vogtle Early Site Permit application through November 4, 2008, with the exception of legal fillings related to the hearing. It also contains correspondence regarding the LWA request through November 4, 2008. Source: Agencywide Documents Access and Management System (ADAMS).

Revisions to the VEGP Application

Revision	Date	Accession Number
0	August 14, 2006	ML062290246
1	November 13, 2006	ML063210516
2	May 5, 2007	ML071710055
3	November 30, 2007	ML073470849
4	March 28, 2008	ML081020073
5	December 23, 2008	ML090280033

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
11/02/1972	ML071710091	Alvin W. Vogtle Nuclear Plant Units 1, 2, 3, 4, Drilling Log of Standby Makeup Test Well, Figure 3K-6. (1 Pages)	Graphics incl Charts and Tables	- No Known Affiliation	US Atomic Energy Commission (AEC)	05000424 05000425 05000426 05000427 05200011
05/13/1974	ML071710071	Alvin W. Vogtle Nuclear Plant - Excavation Dewatering. (2 Pages)	Letter	- No Known Affiliation	Bechtel Power Corp US Atomic Energy Commission (AEC)	05000424 05000425 05200011
04/30/1978	ML070780691	Sprays Wash Fish to Safety from Traveling Screens. (1 Pages)	Journal Article News Article	Power Engineering	NRC/NRO	05200011
09/09/1985	ML053250010	DPST-85-782, "Oxalic Acid Cleaning of Tank 24H." (12 Pages)	Letter Report, Technical	E. I. duPont de Nemours & Co, Inc	NRC/FSME NRC/NMSS	PROJ0737
09/27/1985	ML071710081	Calculation G-008, "Vogtle Nuclear Power Plant, Flow Rate in Mathes Pond Stream & West Branch Stream." (18 Pages)	Calculation	Bechtel Corp	NRC/NRO	05000424 05000425 05200011
03/31/1986	ML071840378	DPST-86-798, "Distribution and Abundance of Ichthyoplankton in the Mid-reaches of the Savannah River and Selected Tributaries." (227 Pages)	Report, Technical	Environmental & Chemical Sciences, Inc	NRC/NRO	05200011
06/30/1986	ML071841017	Report, ECS-SR-28, "Effects of Thermal Discharges on the Distribution and Abundance of Adult Fishes in the Savannah River and Selected Tributaries," Annual Report for Period November 1984 through August 1985. (154 Pages)	Annual Report Report, Technical	Environmental & Chemical Sciences, Inc	NRC/NRO	05200011
12/31/1988	ML073370310	Techniques of Water-Resources Investigations of the United States Geological Survey, Chapter A1, A Modular Three-Dimensional Finite Difference Ground-Water Flow Model, Book 6 Modeling Techniques. (586 Pages)	Report, Technical	US Dept of Interior, Geological Survey (USGS)	NRC/NRO	05200011

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
08/18/1992	ML071841001	Transmittal of Final Report, WSRC-TR-92-179, "Ichthyoplankton Entrainment Study at the SRS Savannah River Water Intakes for Westinghouse Savannah River Company," for classification and technical approvals for external release. (412 Pages)	Letter Report, Technical	Westinghouse Savannah River Co	NRC/NRO US Dept of Energy, Savannah River Operations Office	05200011
01/21/1993	ML071840383	Letter re Request for Approval to Release Scientific/Technical Information. (21 Pages)	Letter	Westinghouse Savannah River Co	NRC/NRO US Dept of Energy (DOE)	05200011
03/01/1994	ML070800052	General Highway Map Burke County Georgia (1 Pages)	Map	NRC/NRO/DSER		05200011
03/03/1999	ML070871038	WSRC-TR-98-00424, "Potential Effect of Increased SRS River Water Withdrawal on the Savannah River Shortnose Sturgeon Population." (8 Pages)	Report, Technical	Westinghouse Savannah River Co	NRC/NRO	05200011
07/31/1999	ML070871012	USFWS 99 Savannah River Study (22 Pages)	Report, Miscellaneous	US Dept of Interior, Fish & Wildlife Service	NRC/NRO	05200011
09/05/2000	ML071710097	Layne Christensen Company, Vogtle Electric - Well #2A. (1 Pages)	- No Document Type Applies	Layne Christensen Co	NRC/NRO	05200011
04/23/2003	ML073330950	"Precipitation, Ground-Water Use, and Ground-Water Levels in the Vicinity of the Savannah River Site, Georgia and South Carolina, 1992-2002." (6 Pages)	Conference/Symposium/Workshop Paper Technical Paper	US Dept of Interior, Geological Survey (USGS)	NRC/NRO	05200011
05/31/2005	ML062340411	Georgia Radiological Emergency Plan Annex D - Plant Vogtle. (605 Pages)	Emergency Preparedness-Emergency Plan License-Application for Construction Permit DKT 50	State of GA	NRC/NRO	PROJ0737
08/17/2005	ML080220556	Letter for Beasley, Chairman, President & CEO of Southern Nuclear Operating Co. to Commissioner Jaczko, re: Early site Permit and combined Operating Licenses at Vogtle Site. (2 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/OCM	05200011 PROJ0737

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
08/17/2005	ML080220556	Letter for Beasley, Chairman, President & CEO of Southern Nuclear Operating Co. to Commissioner Jaczko, re: Early site Permit and combined Operating Licenses at Vogtle Site. (2 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/OCM	05200011 PROJ0737
08/17/2005	ML052340478	Southern Nuclear Early Site Permit Pre-Application Review - Summary of Telephone Call Held on August 17, 2005 to Discuss the Quality Assurance Controls Audit. (2 Pages)	Memoranda Note to File incl Telcon Record, Verbal Comm	NRC/NRR/DRIP	NRC/NRR/DRIP	PROJ0737
08/17/2005	ML052300507	Southern Nuclear Early Site Permit Pre-Application Review - Summary of Telephone Call Held on August 17, 2005, to Discuss the Quality Assurance Controls Audit. (2 Pages)	Memoranda Note to File incl Telcon Record, Verbal Comm	NRC/NRR/DRIP/RNR P		PROJ0737
08/24/2005	ML052350535	09/08/2005 Notice of Meeting with the Southern Nuclear Operating Company to Discuss Southern's Plans for an Early Site Permit at the Vogtle Site. (8 Pages)	Meeting AgendaMeeting NoticeMemoranda	NRC/NRR/DRIP/RNR P	NRC/NRR/DRIP/RNR P	PROJ0737
09/12/2005	ML073470880	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, GEOVision Job 5492, Appendix F, "Report of SPT Energy Measurements by GRL Engineers," through References. (104 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	GRL Engineers, Inc Southern Nuclear Operating Co, Inc	MACTEC Engineering & Consulting, Inc NRC/NRO	05200011
09/13/2005	ML052350677	G20050573/LTR-05-0417 - J. B. Beasley Ltr re: Provides Formal Notification that Georgia Power Company has Directed Southern Nuclear Operating Company to Pursue an Early Site Permit and Combined License at Vogtle Site (1 Pages)	Letter	NRC/Chairman	Southern Nuclear Operating Co, Inc	PROJ0737
10/18/2005	ML052910023	Pre-application Site Visit to Vogtle Nuclear Plant to Observe Early Site Permit (ESP) Pre-application Subsurface Investigation Activities (Project No. 737). (8 Pages)	Memoranda	NRC/RGN-II/DRS/EB3	NRC/NRR/DRIP/RNR P	PROJ0737

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numb
10/18/2005	ML052710018	09/08/2005-Summary of Category 1 Meeting with SNC to Discuss Southern's Plans for an ESP at the Vogtle Site. (8 Pages)	Meeting Summary	NRC/NRR/DRIP/RNRP		PROJ0737
11/10/2005	ML053140298	Pre-Application Review of Southern Nuclear Company Early Site Permit Quality Assurance Program. (6 Pages)	Memoranda	NRC/NRR/ADES/DE/EQVA	NRC/NRR/ADRA/DNRL/NRBA	PROJ0737
12/02/2005	ML053210182	Pre-Application Review of Southern Nuclear Operating Company Early Site Permit Quality Assurance Program. (9 Pages)	Letter	NRC/NRR/ADRA/DNRL	Southern Nuclear Operating Co, Inc	PROJ0737
12/19/2005	ML073470877	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, GEOVision Job 5492, Appendix E through TP-4: Unit Weight of Sample. (315 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	GEOVision Geophysical Services Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
12/19/2005	ML073470875	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, GEOVision Job 5492, Appendix A through GEOVision Suspension Logging Field Notes. (80 Pages)	Final Safety Analysis Report (FSAR)License-Application for Construction Permit DKT 50	GEOVision Geophysical ServicesSouthern Nuclear Operating Co, Inc	NRC/NRO	05200011
01/16/2006	ML062700467	Map, "Surveyed Areas Southern Half of Vogtle-Thalmann, Vogtle Electric Generating Plant Transmission Corridors," Exhibit 2D (Sheet 4 of 4). (1 Pages)	Map	Third Rock Consultants	NRC/NRO	PROJ0737
01/16/2006	ML062700455	Map, "Surveyed Areas Northern Half of Vogtle-Thalmann, Vogtle Electric Generating Plant Transmission Corridors," Exhibit 2C (Sheet 3 of 4). (1 Pages)	Map	Third Rock Consultants	NRC/NRO	PROJ0737
01/16/2006	ML062700441	Map, "Surveyed Areas Western Half of Vogtle-Scherer, Vogtle Electric Generating Plant Tramsmission Corridors," Exhibit 2B (Sheet 2 of 4). (1 Pages)	Map	Third Rock Consultants	NRC/NRO	PROJ0737

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
01/16/2006	ML062700420	Map, "Surveyed Areas Voglte-Scherer Vogtle-Goshen Vogtle- Thalmann & Vogtle-Savannah Rive Site Vogtle Electric Generating Plant Transmission Corridors," Exhibit 2A (Sheet 1of 4). (1 Pages)	Map	Third Rock Consultants	NRC/NRO	PROJ0737
01/16/2006	ML062700408	"Threatened and Endangered Species Survey Final Report - Vogtle Electric Generating Plant and Associated Transmission Corridors." (106 Pages)	Report, Technical	Third Rock Consultants	NRC/NRO Tetra Tech NUS, Inc	PROJ0737
02/16/2006	ML063490419	Drawing H-993-4, "Plant Vogtle New Unit Early Permit Study, Savannah River Hydrographic Study - Topographic Map Burke County, Georgia." (1 Pages)	Drawing	Georgia Power Co	NRC/NRO	05200011
02/16/2006	ML070930496	Drawing H-993-4, "Plant Vogtle New Unit Early Permit Study Savannah River Hydrographic Study - Topographic Map Burke County, Georgia." (1 Pages)	Drawing	Georgia Power Co	NRC/NRO	05200011
02/28/2006	ML071710171	1013080, "EPRI-GTC Overhead Electric Transmission Line Siting Methodology." A-4 through End. (93 Pages)	Report, Technical	Electric Power Research Institute (EPRI) Georgia Transmission Corp	NRC/NRO	05200011
02/28/2006	ML071710168	1013080, "EPRI-GTC Overhead Electric Transmission Line Siting Methodology." Cover through A-3. (100 Pages)	Report, Technical	Electric Power Research Institute (EPRI) Georgia Transmission Corp	NRC/NRO	05200011
03/20/2006	ML061090076	Southern Nuclear/Vogtle Early Site Permit Pre-Application Scouting Trip, Project 737. (5 Pages)	Trip Report	Southern Nuclear Operating Co, Inc	NRC/NRR	05000424 05000425 PROJ0737
04/12/2006	ML061010773	05/11/2006 - Forthcoming Meeting to Discuss the Review Process for Southern Nuclear Operating Company's Early Site Permit Application for the Vogtle Site. (10 Pages)	Meeting Agenda Meeting Notice	NRC/NRR/ADRA/DNRL/NRBA	NRC/NRR/ADRA/DNRL/NRBA	PROJ0737

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
04/19/2006	ML061080679	05/10/2006, Forthcoming open house meeting to discuss the NRC's process for reviewing an Early Site Permit (ESP) in regards to the future SNC ESP application. (7 Pages)	Meeting Notice	NRC/NRR/ADRA/DNR L/NRBA	NRC/NRR/ADRA/DNR L/NRBA	PROJ0737
04/25/2006	ML061380621	Trip Summary - Vogtle/Southern Nuclear Operating Company Early Site Permit Pre-Application Alternate Site Visits April 25 and 26, 2006. (4 Pages)	Trip Report	NRC/NRR		05000424 05000425 PROJ0737
04/28/2006	ML061180493	Southern Nuclear Early Site Permit Pre-Application Review - Summary of Telephone Call Held on January 27, 2006, to Discuss the Information Required for Complete Emergency Plans. (4 Pages)	Meeting Summary Memoranda	NRC/NRR/ADRA/DNR L	NRC/NRR/ADRA/DNR L	PROJ0737
05/10/2006	ML061530411	Attachment 1-List of Meeting Attendees for May 10th Open House at Burke County Library in Waynesboro, GA. (1 Pages)	- No Document Type Applies	NRC/NRR/ADRA/DNR L		PROJ0737
05/16/2006	ML061380639	Attachment 4 - NRC Slides for May 11th Public Meeting at the Augusta Technical College in Waynesboro, GA in regards to SNC ESP. (26 Pages)	Meeting Briefing Package/Handouts Slides and Viewgraphs	NRC/NRR/ADRA/DNR L		PROJ0737
05/16/2006	ML061380596	Attachment 2 - List of Meeting Attendees for May 11th public Meeting at Augusta Technical College in Waynesboro, GA in regards to SNC ESP. (6 Pages)	- No Document Type Applies	NRC/NRR/ADRA/DNR L		PROJ0737
05/18/2006	ML061380615	Attachment 3- Agenda for May 11th Public Meeting at the Augusta Technical College in Waynesboro, GA in regards to SNC ESP. (1 Pages)	Meeting Agenda	NRC/NRR/ADRA/DNR L		PROJ0737
06/12/2006	ML061530285	Meeting Summary for an Open House on May 10th and a Public Meeting on May 11th in Regards to the Expected SNC Early Permit (ESP) Application for the Vogtle Site. (8 Pages)	Meeting Summary	NRC/NRR/ADRA/DNR L		05000424 05000425 PROJ0737

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
06/23/2006	ML061860165	Southern Nuclear Operating Company, Pre-Docketing Phase for Early Site Permit Application. (40 Pages)	Letter Report, Miscellaneous	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	PROJ0737
06/30/2006	ML070220073	CD-ROM File: APP-GW-GLR-021, Rev. 0, "AP1000 Standard Combined License Technical Report, AP1000 As-Build COL Information Items." (35 Pages)	Report, Technical	Westinghouse Electric Co	NRC/NRO	05200006 05200018 05200019 05200022 05200023 PROJ0737 PROJ0738 PROJ0740 PROJ0742 PROJ0743 PROJ0744 PROJ0745
07/01/2006	ML072080257	Information Summary July 2006 SERC Reliability Corporation. (23 Pages)	Brochure Organization Chart Report, Miscellaneous Slides and Viewgraphs	SERC Reliability Corp	NRC/NRO	05200011
07/27/2006	ML062080413	Inspection of Southern Nuclear Company Quality Assurance Program Implementation for Early Site Permit. (7 Pages)	Letter	NRC/RGN-II/DRS	Southern Nuclear Operating Co, Inc	PROJ0737
08/09/2006	ML062220548	Maintenance of Documents at the Burke County Library Related to Application by SNC for an ESP For the Vogtle Site (5 Pages)	Letter	NRC/NRR/ADRA/DNRL	Burke County, GA	PROJ0737
08/11/2006	ML063600278	Map P-9-1, "Plant Vogtle Early Site Permit, Topographic Map Burke County, Georgia." Sheet 6 of 6. (1 Pages)	Map	Metro Engineering & Surveying Co, Inc	Georgia Power Co NRC/NRO	05200011
08/11/2006	ML063600276	Map P-9-1, "Plant Vogtle Early Site Permit, Topographic Map Burke County, Georgia." Sheet 5 of 6. (1 Pages)	Map	Metro Engineering & Surveying Co, Inc	Georgia Power Co NRC/NRO	05200011
08/11/2006	ML063600273	Map P-9-1, "Plant Vogtle Early Site Permit, Topographic Map Burke County, Georgia." Sheet 4 of 6. (1 Pages)	Map	Metro Engineering & Surveying Co, Inc	Georgia Power Co NRC/NRO	05200011

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
08/11/2006	ML063600270	Map P-9-1, "Plant Vogtle Early Site Permit, Topographic Map Burke County, Georgia." Sheet 3 of 6. (1 Pages)	Map	Metro Engineering & Surveying Co, Inc	Georgia Power Co NRC/NRO	05200011
08/11/2006	ML063600222	Map P-9-1, "Plant Vogtle Early Site Permit, Topographic Map Burke County, Georgia." Sheet 2 of 6. (1 Pages)	Map	Metro Engineering & Surveying Co, Inc	Georgia Power Co NRC/NRO	05200011
08/11/2006	ML063600220	Map P-9-1, "Plant Vogtle Early Site Permit, Topographic Map Burke County, Georgia." Sheet 1 of 6. (1 Pages)	Map	Metro Engineering & Surveying Co, Inc	Georgia Power Co NRC/NRO	05200011
08/14/2006	ML062290246	Transmittal of Vogtle Electric Generating Plant Early Site Permit Application. (17 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	PROJ0737
08/15/2006	ML062220689	Request For DHS Review Of Early Site Permit (ESP) Application Southern Nuclear Company / Vogtle Site. (3 Pages)	Letter	NRC/NSIR/DPR/DDE P/ICB	US Dept of Homeland Security	PROJ0737
08/16/06	ML062150004	Meeting Summary, Forthcoming Meeting for Southern Nuclear to Brief the Staff on the Early Site Permit (ESP) Application for Plant Vogle (Pages)	Meeting Summary	NRC/NRR/ADRA/DNR L/NEPB	NRC/NRR/ADRA/DNR L/NEPB	05200011
08/17/2006	ML062340406	South Carolina Operational Radiological Emergency Response Plan & Georgia Emergency Response Plan. (669 Pages)	Emergency Preparedness-Emergency Plan License-Application for Construction Permit DKT 50	State of GA State of SC	NRC/NRO	PROJ0737
08/17/2006	ML062340401	Transmittal of Vogtle Early Site Permit Application Supplemental Emergency Planning Information. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	PROJ0737
08/18/2006	ML062350371	08/18/2006-Enclosure 3 - Meeting Slides for Public Meeting to Discuss ESP Application for Plant Vogtle, Units 3 and 4. (79 Pages)	Meeting Briefing Package/Handouts Slides and Viewgraphs	NRC/NRR/ADRA/DNR L/NEPB		PROJ0737
08/18/2006	ML062350363	08/18/2006-Enclosures 1 and 2 - Agenda and Attendee List for Plant Vogtle ESP Application Briefing. (3 Pages)	Meeting Agenda Meeting Briefing Package/Handouts	NRC/NRR/ADRA/DNR L/NEPB		PROJ0737

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
08/22/2006	ML062330240	Letter of Acknowledgement of the Receipt of Vogtle ESP Application. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL	Southern Nuclear Operating Co, Inc	PROJ0737
08/25/2006	ML062330165	Memorandum Transmitting a Notice for Publication into the Federal Register. (3 Pages)	Memoranda	NRC/NRR/ADRA/DNRL	NRC/ADM/DAS/RDB	PROJ0737
08/28/2006	ML061440582	Letters to Potential Applicants on Security Clearances. (31 Pages)	Letter	NRC/NRR/ADRA/DNRL/NAPB	Dominion Resources Services, Inc Duke Power Co Entergy Nuclear, Inc Florida Power & Light Group, Inc NuStart Energy Development, LLC Progress Energy Co South Carolina Electric & Gas Co Southern Nuclear Operating Co, Inc UniStar Nuclear	05200018 05200019 05200022 05200023 PROJ0737 PROJ0738 PROJ0740 PROJ0741 PROJ0742 PROJ0743 PROJ0744 PROJ0745 PROJ0746
08/31/2006	ML073320844	Science and Democratic Action, Volume 14, Number 2. (24 Pages)	Report, Miscellaneous	Institute for Energy & Environmental Research	NRC/NRO	05200011
08/31/2006	ML073240571	Drawing Vogtle, Units 1 and 2, "Figure 5.2-4 River Cross Sections at Existing Discharge Location." (1 Pages)	Drawing	Southern Nuclear Operating Co, Inc	NRC/NRR	05000424 05000425 PROJ0737
08/31/2006	ML062290307	Vogtle Electric Generating Plant Early Site Permit Application, Part 5 - Emergency Plan. (273 Pages)	Emergency Preparedness-Emergency Plan License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290305	Vogtle Electric Generating Plant Early Site Permit Application, Part 4 - Site Redress Plan. (21 Pages)	License-Application for Construction Permit DKT 50 Operating Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737

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08/31/2006	ML062290297	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report. Chapter 3 "Design of Structures, Components, Equipment, and Systems." (160 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290278	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Appendix E "Caliper, Natural Gamma, Resistively, and Spontaneous Potential Logs." (41 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50 Report, Technical	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290277	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Appendix A "Suspension Velocity Measurement Quality Assurance Suspension Source to Receiver Analysis Results." (80 Pages)	Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables License-Application for Construction Permit DKT 50 Report, Technical	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290275	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Appendix B "CPT Testing Report From Applied Research Services." (129 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50 Report, Technical	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290274	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Appendix 2.5A "Geotechnical Investigation & Laboratory Testing Data Report." (90 Pages)	Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables Letter License-Application for Construction Permit DKT 50 Report, Miscellaneous	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290272	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Section 2.5.2 "Vibratory Ground Motion" Through Section 2.5.6 "Embankments and Dams." (242 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737

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08/31/2006	ML062290271	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Figure 2.5.1-32 "Site Topographic Map (0.6-Mile Radius)." (50 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50 Map	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290269	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Figure 2.5.1-1 "Physiographic Provinces of the Southeastern United States" Through Figure 2.5.1-31 "Site Geologic Map (0.6-Mile Radius)." (50 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50 Map	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290267	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Section 2.4 "Hydrologic Engineering." (424 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290263	Vogtle Electric Generating Plant Early Site Permit Application, Part 2 - Site Safety Analysis Report, Table of Contents Through Section 2.3 "Meteorology." (216 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
08/31/2006	ML062290260	Vogtle Electric Generating Plant Early Site Permit Application, Cover Page Through Part 1 - Administrative Information, Chapter 3. (34 Pages)	License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	PROJ0737
09/06/2006	ML062510149	Vogtle Electric Generating Plant Early Site Permit Application Site Safety Analysis Report Section 2.2 Supplement 1. (31 Pages)	Final Safety Analysis Report (FSAR) Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	PROJ0737
09/06/2006	ML062510145	Vogtle Early Site Permit Application Site Safety Analysis Report Table 2.5.2-23, Supplement S2. (6 Pages)	Final Safety Analysis Report (FSAR) Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	PROJ0737
09/06/2006	ML062490219	Acceptance Review Results for the Vogtle Early Site Permit Application (Section 13.6). (2 Pages)	Memoranda	NRC/NSIR/DSP/DDRSR/RSB	NRC/NRR/ADRA/DNRL/NAPB	05000424 05000425 PROJ0737

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09/13/2006	ML062580074	Vogtle Electric Generating Plant Early Site Permit Application Site Safety Analysis Report Section 2.5.2, Supplement 3. (146 Pages)	Final Safety Analysis Report (FSAR) Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011 PROJ0737
09/13/2006	ML062580074	Vogtle Electric Generating Plant Early Site Permit Application Site Safety Analysis Report Section 2.5.2, Supplement 3. (146 Pages)	Final Safety Analysis Report (FSAR) Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011 PROJ0737
09/14/2006	ML062430262	08/18/06 Summary of Briefing by Southern Nuclear Operating Company to the U.S. Nuclear Regulatory Commission Staff on the Vogtle Site Early Site Permit Application. (6 Pages)	Meeting Summary	NRC/NRR/ADRA/DNRL/NEPB		PROJ0737
09/14/2006	ML062000273	Southern Nuclear Early Site Permit Pre-Application Review- Summary of Telephone call Held on July 5, 2006, To Discuss Potential Limited Work Authorization (LWA) Activities. (4 Pages)	Letter Note to File incl Telcon Record, Verbal Comm	NRC/NRR/ADRA/DNRL	NRC/NRR/ADRA/DNRL	PROJ0737
09/19/2006	ML062580107	Review Schedule for the Southern Nuclear Operating Company Early Site Permit Application (ESP) for the Vogtle ESP Site. (1 Pages)	Schedule and Calendars	NRC/NRR		05200011
09/19/2006	ML062570460	J. A. Miller Ltr re: Acceptance of the Southern Nuclear Operating Company Application for an Early Site Permit (ESP) for the Vogtle ESP Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL	Southern Nuclear Operating Co, Inc	05200011
09/19/2006	ML062570431	FRN: General Notice. Notice of Acceptance of an Application for an Early Site Permit (ESP) for the Vogtle ESP Site. (3 Pages)	Federal Register Notice	NRC/NRO/DNRL		05200011
09/19/2006	ML062570424	M. T. Lesar Memo re: Notice of Acceptance of an Application for an Early Site Permit (ESP) for the Vogtle ESP Site. (3 Pages)	Memoranda	NRC/NRO/DNRL	NRC/ADM/DAS/RDEB	05200011
09/22/2006	ML062700066	Vogtle Electric Generating Plant Early Site Permit Application Additional Meteorological Data Transmittal. (4 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011

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09/25/2006	ML073050490	Principles for Safeguarding Nuclear Waste at Reactors. (5 Pages)	- No Document Type Applies	Public Citizen, Inc	NRC/FSME	05200011 WM-00011
09/26/2006	ML062720158	Vogtle ESP Application, 10 CFR 2.101 Affidavit. (4 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
10/04/2006	ML062790298	Southern Nuclear Operating Company AR-06-2295, List of Enclosures, Including State of SC Radiological Emergency Response Plan, State of SC Technical Radiological Emergency Response Plan & VEGP Site Specific Plant, Part 5. (1279 Pages)	Emergency Preparedness-Emergency Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05000261 05000269 05000270 05000287 05000395 05000413 05000414 05000424 05000425 05200011
10/04/2006	ML062790292	Vogtle Early Site Permit Application Supplemental Emergency Planning Information in Electronic Format. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
10/04/2006	ML062720273	Application by Southern Nuclear Operating Company for an Early Site Permit for the Vogtle Site. (4 Pages)	Letter	NRC/NRR/ADRA/DNRL	Burke County, GA	PROJ0737
10/05/2006	ML062830466	IR 05200011-06/001 on 08/28-09/01/06, Southern Nuclear Operating Company Applicant and Contractor Quality Assurance Activities Involved With the Preparation of the Application for an Early Site Permit. (56 Pages)	Inspection Report Inspection Report Correspondence Letter	NRC/RGN-II/DCI	Southern Nuclear Operating Co, Inc	05200011
10/06/2006	ML063610007	Vogtle Early Site Permit Application Public Meeting. (166 Pages)	Meeting Transcript	NRC/OGC		05200011
10/12/2006	ML062850345	Absentee-Shawnee Tribe Letter Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Absentee-Shawnee Tribe of Oklahoma	05200011 PROJ0737
10/12/2006	ML062850266	Seminole Tribe of Florida Letter Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Seminole Tribe of Florida	05200011 PROJ0737
10/12/2006	ML062850260	Alabama-Coushatta Letter (2) Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Alabama-Coushatta Tribe of Texas	05200011 PROJ0737
10/12/2006	ML062850187	Cherokee Nation Letter Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Cherokee Nation	05200011 PROJ0737

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10/12/2006	ML062850139	Miccosukee Tribe Letter Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Miccosukee Indian Tribe	05200011 PROJ0737
10/12/2006	ML062850057	NOAA Letter Regarding ESP Review of the Vogtle ESP Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	US Dept of Commerce, National Marine Fisheries Service	05200011 PROJ0737
10/12/2006	ML062850034	US Fish and Wildlife Service Letter for ESP Review for the Vogtle ESP Site. (6 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	US Dept of Interior, Fish & Wildlife Service	05200011 PROJ0737
10/12/2006	ML062850030	SHPO Alabama Letter Regarding ESP Review for the Vogtle ESP Site. (5 Pages)	Letter	NRC/NRR/ADRA/DNRL/NESB	State of AL, Historical Commission	05200011 PROJ0737
10/12/2006	ML062850019	ACHP Letter for ESP Review for the Vogtle ESP Site. (6 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	US Advisory Council On Historic Preservation	05200011 PROJ0737
10/12/2006	ML062840610	Catawba Indian Tribe - Early Site Permit (ESP) Review for the Vogtle Site. (8 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Catawba Indian Nation	05200011 PROJ0737
10/12/2006	ML062850345	Absentee-Shawnee Tribe Letter Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Absentee-Shawnee Tribe of Oklahoma	05200011 PROJ0737
10/12/2006	ML062850266	Seminole Tribe of Florida Letter Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Seminole Tribe of Florida	05200011 PROJ0737
10/12/2006	ML062850260	Alabama-Coushatta Letter (2) Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Alabama-Coushatta Tribe of Texas	05200011 PROJ0737
10/12/2006	ML062850187	Cherokee Nation Letter Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Cherokee Nation	05200011 PROJ0737
10/12/2006	ML062850139	Miccosukee Tribe Letter Regarding ESP Review for the Vogtle Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Miccosukee Indian Tribe	05200011 PROJ0737
10/12/2006	ML062850057	NOAA Letter Regarding ESP Review of the Vogtle ESP Site. (7 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	US Dept of Commerce, National Marine Fisheries Service	05200011 PROJ0737
10/12/2006	ML062850034	US Fish and Wildlife Service Letter for ESP Review for the Vogtle ESP Site. (6 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	US Dept of Interior, Fish & Wildlife Service	05200011 PROJ0737
10/12/2006	ML062850030	SHPO Alabama Letter Regarding ESP Review for the Vogtle ESP Site. (5 Pages)	Letter	NRC/NRR/ADRA/DNRL/NESB	State of AL, Historical Commission	05200011 PROJ0737
10/12/2006	ML062850019	ACHP Letter for ESP Review for the Vogtle ESP Site. (6 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	US Advisory Council On Historic Preservation	05200011 PROJ0737

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10/12/2006	ML062840610	Catawba Indian Tribe - Early Site Permit (ESP) Review for the Vogtle Site. (8 Pages)	Letter	NRC/NRR/ADRA/DNRL/NEPB	Catawba Indian Nation	05200011 PROJ0737
10/17/2006	ML062960036	G20060857/LTR-06-0530 - Senator Saxby Chambliss and Johnny Isakson Ltr re: Support of Southern Nuclear Operating Company's Application for an ESP for Two Additional Reactors on the Site of the Vogtle Electric Generating Plant. (3 Pages)	Letter	US SEN (Senate)	NRC/Chairman	05200011
10/19/2006	ML063610055	10/19/06- Slides -Summary of Public Scoping Meetings to Support Review of Vogtle Electric Generating Plant Early Site Permit Application (TAC NO. MD 3010) (20 Pages)	Meeting Briefing Package/Handouts	NRC/NRO/DSER/EPB1		05200011
10/19/2006	ML070860200	Vogtle Early Site Permit Application Public Meeting. (166 Pages)	Meeting Transcript	NRC/NRO/DSER/EPB1		05200011
10/19/2006	ML070850341	Public Scoping Meeting on the Early Site Permit Application for the Plant Vogtle ESP Site. (20 Pages)	Slides and Viewgraphs	NRC/NRO/DSER/EPB1		05200011
10/19/2006	ML073060111	Resolution from Board of Commissioners of Burke County. (1 Pages)	- No Document Type Applies	- No Known Affiliation	NRC/NRO	05200011
10/25/2006	ML062980350	Ltr to Vanessa E. Quinn - Vogtle Early Site Permit (ESP) Application - Supplemental Emergency Planning Information (Compact Disc). (2 Pages)	Letter	NRC/NSIR/DPR/DDEP/ICB	US Dept of Homeland Security	05200011
11/13/2006	ML063210569	Vogtle Early Site Permit Application Revision 1, Part 5, Emergency Plan. (275 Pages)	Emergency Preparedness-Emergency Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210568	Vogtle Early Site Permit Application Revision 1, Part 4, Site Redress Plan. (21 Pages)	Site Characterization Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210554	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Pages 3.5-1 through 17.1A-2 and Quality Assurance Manual. (160 Pages)	Final Safety Analysis Report (FSAR) Report, Technical	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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11/13/2006	ML063210551	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Appendix 2.5A - MACTEC Geotechnical Investigation and Laboratory Testing Data Report, Appendix F Through Appendix G, Cover Only. (60 Pages)	Final Safety Analysis Report (FSAR) Report, Technical	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210549	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Appendix 2.5A - MACTEC Geotechnical Investigation and Laboratory Testing Data Report, Appendix D through Appendix E. (274 Pages)	Final Safety Analysis Report (FSAR)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210546	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Appendix 2.5A - MACTEC Geotechnical Investigation and Laboratory Testing Data Report, Appendix C, Page 127 of 167 Through Page 167 of 167. (41 Pages)	Final Safety Analysis Report (FSAR)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210544	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Appendix 2.5A - MACTEC Geotechnical Investigation and Laboratory Testing Data Report, Appendix C, Page 47 of 167 Through Page 126 of 167. (80 Pages)	Final Safety Analysis Report (FSAR)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210543	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Appendix 2.5A - MACTEC Geotechnical Investigation and Laboratory Testing Data Report, Appendix B Through Appendix C, Page 46 of 167. (129 Pages)	Final Safety Analysis Report (FSAR)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210542	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Appendix 2.5A - MACTEC Geotechnical Investigation and Laboratory Testing Data Report, Table of Contents Through Appendix A. (90 Pages)	Final Safety Analysis Report (FSAR) Report, Technical	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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11/13/2006	ML063210541	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Pages 2.5.2-1 through 2.5.6-2. (248 Pages)	Final Safety Analysis Report (FSAR)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210537	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Pages 2.5.1-133 through 2.5.1-182. (50 Pages)	Final Safety Analysis Report (FSAR) Map	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210535	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Pages 2.5.1-82 through 2.5.1-132. (50 Pages)	Final Safety Analysis Report (FSAR) Map	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210533	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Pages 2.5.1-1 through 2.5.1-82. (82 Pages)	Final Safety Analysis Report (FSAR)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210530	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Pages 2.4.1-1 through 2.4A-228. (424 Pages)	Final Safety Analysis Report (FSAR)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210528	Vogtle Early Site Permit Application Revision 1, Part 2, Site Safety Analysis Report, Table of Contents through Page 2.3-112. (224 Pages)	Final Safety Analysis Report (FSAR)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/13/2006	ML063210525	Vogtle Early Site Permit Application Revision 1, Part 1, Administrative Information. (40 Pages)	License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/16/2006	ML063240171	Vogtle - Early Site Permit Application Safety Review Site Audit Information Needs. (11 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
11/16/2006	ML070930446	AR-06-2684 Enclosure Attachment A-8 #47, "Burke County, Georgia - QT-H 14. Value, Mortgage Status, and Selected Conditions: 2000." (7 Pages)	- No Document Type Applies	US Dept of Commerce, Bureau of Census	NRC/NRO	05200011
11/16/2006	ML070930428	AR-06-2684 Enclosure Attachment A-4 #28. (6 Pages)	Memoranda	Troutman Sanders, LLP	NRC/NRO	05200011

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11/22/2006	ML063040583	Southern Nuclear Operating Company's Application for an Early Site Permit for Additional Reactors on the Site of the Alvin W. Vogtle Electric Generating Plant Near Waynesboro, GA. (2 Pages)	Letter	NRC/OCA	US SEN (Senate)	PROJ0737
11/27/2006	ML062750453	Request for Additional Information Letter No. 1 - Southern Nuclear Operating Company Early Site Permit (ESP) Application for the Vogtle ESP Site. (8 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1000B1	Southern Nuclear Operating Co, Inc	05200011
11/28/2006	ML063310422	Southern Nuclear Operations Company Early Site Permit Application for the Vogtle ESP Site - Summary of Telephone Call Held on November 1, 2006. (3 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
12/06/2006	ML070930493	AR-06-2664 Enclosure C-3 #177 Soil A. (14 Pages)	Graphics incl Charts and Tables Memoranda Report, Technical	Southern Co Services	NRC/NRO Southern Co Services	05200011
12/06/2006	ML070930491	Memo re Plant Vogtle Soil Analysis. (11 Pages)	Memoranda	Southern Co Services	NRC/NRO Southern Co Services	05200011
12/07/2006	ML070580268	Vogtle ESP - Meterology Site Audit 12/6 - 7/2006 Tour Layout. (5 Pages)	Slides and Viewgraphs	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
12/08/2006	ML063540103	Letter from PNNL to Robert Moody dated December 8, 2006. (1 Pages)	Letter	Battelle Memorial Institute, Pacific Northwest National Lab	NRC/NSIR/DPR	05200011
12/11/2006	ML070930506	AR-06-2684 Enclosure Attachment B-3 #123 ER Total Porosity and Grain size Distribution. (2 Pages)	- No Document Type Applies	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
12/11/2006	ML070930498	AR-06-2684 Enclosure Attachment C-2 #157 Savanna River Hydrographic Study Map. (2 Pages)	Map	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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12/11/2006	ML070930443	AR-06-2684 Enclosure Attachment A-7 #45. (12 Pages)	- No Document Type Applies	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
12/11/2006	ML070930436	AR-06-2684 Enclosure Attachment A-6 #42. (8 Pages)	- No Document Type Applies	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
12/11/2006	ML070930434	AR-06-2684 Enclosure Attachment A-5 #33. (6 Pages)	- No Document Type Applies	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
12/11/2006	ML070930431	AR-06-2684 Enclosure Attachment A-2 #25. (6 Pages)	- No Document Type Applies	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
12/11/2006	ML070930426	Map of Native American Tribes and Groups in South Carolina. (1 Pages)	Map	SCIway, LLC	NRC/NRO	05200011
12/14/2006	ML063380162	Request for Additional Information Letter No. 2 - Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application for the Vogtle ESP Site. (7 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1000B1	Southern Nuclear Operating Co, Inc	05200011
12/15/2006	ML063540102	Vogtle Early Site Permit Application - Response to Requests for Additional Information on Quality Assurance. (6 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
12/15/2006	ML063540098	Vogtle Early Site Permit Application - Safety Review Audit Site Hazard Analysis Information Needs. (10 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
12/18/2006	ML063320207	Regulatory Drivers of Part 52 for Early Site Permit Applications and Determination of Reasonable Assurance. (4 Pages)	Memoranda	NRC/NRR/ADRO/DIRS/IHPB	NRC/NRO/DNRL	05200011
01/10/2007	ML063530196	10/19/2006 Summary of Public Scoping Meetings to Support Review of Vogtle Electric Generating Plant Early Site Application (TAC No. MD3010). (16 Pages)	Meeting Summary	NRC/NRO/DSER	Southern Nuclear Operating Co, Inc	05200011
01/10/2007	ML070580264	Vogtle ESP - Hydrology Site Audit on 01/10-12/2007, Tour Layout. (8 Pages)	- No Document Type Applies	- No Known Affiliation	NRC/NRO	05200011
01/10/2007	ML070580258	Vogtle ESP - Geologic Site Audit, Jan 10-12, 2007, Tour Layout. (10 Pages)	Meeting Agenda Photograph	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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01/12/2007	ML072290172	Projections with Allotments Monthly System Enrollment 07-08 after Re-zoning (Revised on 01/12/2007). (2 Pages)	Spreadsheet File	NRC/NRO		05200011
01/18/2007	ML070460522	Map 2 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 6 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460517	Map 1 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 6 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460513	Map 2 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 5 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460503	Map 1 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 5 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460497	Map 2 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 4 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460490	Map 1 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 4 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460484	Map 2 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 3 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460479	Map 1 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 3 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460476	Map 2 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 2 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460402	Map 1 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 2 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML070460382	Map 2 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 1of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
01/18/2007	ML070460376	Map 1 of 2, "Thomson - Vogtle 500kV Transmission Line Alternative Corridors Map." Sheet 1 of 6. (1 Pages)	Map	Georgia Power Co	NRC/NRO	05200011
01/18/2007	ML063610091	12/14/2006 Summary of Telephone Call with Southern Nuclear Operating Company (SNC) Pertaining to Vogtle Early Site Permit Application Site Safety Analysis Report Requests for Additional Information. (3 Pages)	Meeting Summary Memoranda Note to File incl Telcon Record, Verbal Comm	NRC/NRO/DNRL/AP1 000B1	NRC/NRO/DNRL/AP1 000B1	05200011
01/19/2007	ML070260264	Southern Nuclear and Vogtle - Response to Requests for Additional Information on Vibratory Ground Motion. (85 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
01/19/2007	ML070170387	Letter - Vogtle Early Site Permit (ESP) Application - Request For DHS Concurrence On Request For Additonal Information (RAIs) & Provide Supplemental PSER Information. (4 Pages)	Letter	NRC/NSIR	US Dept of Homeland Security	05200011
01/30/2007	ML070460537	Map, "Areas of VEGP Property Searched in 2005 Threatened and Endangered Surveys." (1 Pages)	Map	- No Known Affiliation	NRC/NRO	05200011
01/30/2007	ML070330054	Vogtle Early Site Permit Application - Safety Review Site Audit Meteorology Information Needs. (21 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
01/30/2007	ML070460540	Map, "Disturbed Areas." (1 Pages)	Map	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
01/31/2007	ML070110487	Trip Report - November 6 through 9, 2006, Tour of the Hatch, Farley, and the Barton Alternative Site. (23 Pages)	Memoranda Trip Report	NRC/NRO/DSER NRC/NRO/DSER/ETS B	NRC/NRR/ADRO/DO RL	05200011
01/31/2007	ML070110460	Trip Report- October 17 through 19, 2006, Vogtle Electric Generating Plant (VEGP) Early Site Permit (ESP), Units 3 & 4. (28 Pages)	Memoranda Trip Report	NRC/NRO/DSER	NRC/NRO/DSER	05200011
01/31/2007	ML072070271	FEMA 06/05/07 Letter Enclosure: Concurrence on Vogtle ESP PSER (Misc. Enclosure: GA RERP, Standard Operating Procedure, January 2007, 27 Pages. (28 Pages)	Emergency Preparedness- Emergency Plan	State of GA, Office of Homeland Security	NRC/NRO	05200011

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02/01/2007	ML070330513	Request for Additional Information and Preliminary Safety Analysis Report Input for the Vogtle Early Site Permit Application. (2 Pages)	Memoranda Request for Additional Information (RAI)	NRC/NRR/ADES/DRA /AADB	NRC/NRO/DNRL/AP1 000B1	05200011
02/09/2007	ML070430110	Site Visit to Vogtle to Observe Combined License Pre-Application Subsurface Investigation Activities (Project No. 755.). (8 Pages)	Letter	NRC/RGN-II/DCI/CIB1	Southern Nuclear Operating Co, Inc	05200011 PROJ0755
02/12/2007	ML070430088	Vogtle, Memo, Preliminary Safety Evaluation Report (PSER) Input and Request for Additional Information for the Vogtle Early Site Permit Chapter 2.3. (2 Pages)	Memoranda Safety Evaluation Report	NRC/NRO/DSER/RSA C	NRC/NRO/DNRL/AP1 000B1	05200011
02/13/2007	ML070570039	Enclosure 1, List of RAI # 2.4.1-1 Response Data Files and Enclosure 2 - Hard Copy Data, Part 1. (254 Pages)	- No Document Type Applies	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
02/13/2007	ML070570036	Transmittal of Vogtle Early Site Permit Application - Supplemental Information for Response to Requests for Additional Information on Hydrology. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
02/13/2007	ML070470008	Vogtle Early Site Permit Application, Safety Review Site Audit Hydrology Information Needs. (31 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
02/16/2007	ML070360248	Request for Additional Information Letter No. 3 - Southern Nuclear Operating Company Early Site Permit Application for the Vogtle ESP Site. (17 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1 000B1	Southern Nuclear Operating Co, Inc	05200011
02/23/2007	ML070470270	Request for Additional Information Letter No. 4 - Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application for the Vogtle ESP Site. (9 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1 000B1	Southern Nuclear Operating Co, Inc	05200011

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02/26/2007	ML070310063	Letter to US Army Corps of Engineers-Savannah District, Early Site Permit for the Plant Vogtle Site. (13 Pages)	Letter	NRC/NRO/DSER/ETS B	US Dept of the Army, Corps of Engineers, Savannah District	PROJ0737
03/01/2007	ML070650557	Vogtle Early Site Permit Application re Supplemental Information Concerning Emergency Action Levels and Generic Communications. (302 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
03/06/2007	ML070650427	Draft Technical Information for Preliminary Site Evaluation Report (PSER). (2 Pages)	Memoranda	NRC/NRO/DSER/GG EB1	NRC/NRO/DNRL/AP1 000B1	05200011
03/06/2007	ML070370019	Vogtle Electric Generating Plant, Letter, Request for Withholding Information from Public Disclosure. (13 Pages)	Letter Proprietary Information Review	NRC/NRO/DSER/ETS B	Southern Nuclear Operating Co, Inc	PROJ0737
03/08/2007	ML070780689	River Intake Structure Canal General Arrangement. (4 Pages)	Drawing Map	Bechtel Corp	Georgia Power Co NRC/NRO	05200011
03/15/2007	ML070740727	Press Release-07-035 - NRC Issues First-Ever Early Site Permit for Clinton Site in Illinois. (2 Pages)	Press Release	NRC/OPA		05200007 05200008 05200009 05200011
03/15/2007	ML070660266	Early Site Permit (ESP) Application for the Vogtle Esp Site, RAI Number 6 regarding Site Safety Analysis Report (SSAR) Sections 2.4 and 2.5. (32 Pages)	Letter Request for Additional Information (RAI) Weekly Activities/LEAP (WAR)	NRC/NRO/DNRL	Southern Nuclear Operating Co, Inc	05200011
03/15/2007	ML070650577	Request for Additional Information Letter No. 5 - Southern Nuclear Operating Company Early Site Permit (ESP) Application for the Vogtle ESP Site. (37 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1 000B1	Southern Nuclear Operating Co, Inc	05200011
03/16/2007	ML070810213	Vogtle Early Site Permit Application, Response to Requests for Additional Information Letter No. 3. (114 Pages)	Letter Updated Final Safety Analysis Report (UFSAR)	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
03/19/2007	ML070180445	Trip Report from Site Visit to the Vogtle Early Site Permit (ESP) Site and Audit of Section 2.3, Meteorology, of the Vogtle ESP Application. (21 Pages)	Memoranda Trip Report	NRC/NRO/DNRL/AP1 000B1	NRC/NRO/DNRL/AP1 000B1	05200011

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03/19/2007	ML070580302	Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application for the Vogtle ESP Site- Summary of Telephone Call Held on February 23, 2007. (7 Pages)	Memoranda Note to File incl Telcon Record, Verbal Comm	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
03/19/2007	ML070580295	02/20/2007 Summary of Telephone Call Re: Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application for the Vogtle ESP Site. (8 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
03/19/2007	ML070470611	Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application for the Vogtle ESP Site - Summary of Telephone Call Held on February 8, 2007. (17 Pages)	Memoranda Note to File incl Telcon Record, Verbal Comm	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
03/22/2007	ML070780677	The Altamaha River, The Nature Conservancy. (3 Pages)	News Article	The Nature Conservancy	NRC/NRO	05200011
03/26/2007	ML070880685	Vogtle Early Site Permit Application Response to Requests for Additional Information Letter No. 4. (81 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
03/30/2007	ML070720622	03/09/2007 Summary of Teleconference Between the NRC & Southern Nuclear Operating Company (SNC) to Discuss Site Safety Analysis Report (SSAR) Section 2.5 for the Early Site Permit (ESP) Application for the Vogtle ESP Site. (28 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
04/03/2007	ML070740099	Trip Report - March 7 through 9, 2007, Vogtle Electric Generating Plant (VEGP) Early Site Permit (ESP), Site Visit. (14 Pages)	Memoranda Trip Report	NRC/NRO/DSER/ETSB	NRC/NRO/DSER/EPB1	05200011
04/15/2007	ML070720368	Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application for the Vogtle ESP Site- Summary of Telephone Call Held on March 9, 2007 to Discuss Site Safety Analysis Report (SSAR) Section 2.4. (8 Pages)	Meeting Summary Memoranda Note to File incl Telcon Record, Verbal Comm	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numb
04/30/2007	ML071710169	Vogtle Early Site Permit Application, Revision 2, Part 5 - Emergency Plan. Cover through Page V2A4-4. (301 Pages)	Emergency Preparedness-Emergency Plan Graphics incl Charts and Tables License-Application for Construction Permit DKT 50 Map Organization Chart	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710165	Vogtle Early Site Permit Application, Revision 2, Part 4 - Site Redress Plan. Cover Through Page 1-15. (21 Pages)	License-Application for Construction Permit DKT 50 Site Redress Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710112	Vogtle Early Site Permit Application, Revision 2, Part 5 - Emergency Plan. Cover Through Page V2A4-4. (301 Pages)	Emergency Preparedness-Emergency Plan License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710111	Vogtle Early Site Permit Application, Revision 2, Part 4 - Site Redress Plan. Pages Cover Through 1-15. (21 Pages)	License-Application for Construction Permit DKT 50 Site Redress Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710100	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Pages 3.5-1 Through Nuclear Development Quality Assurance Manual (182 Pages)	Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables License-Application for Construction Permit DKT 50 Manual Quality Assurance Program	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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04/30/2007	ML071710098	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Pages 2.5B-1 Through 2.5B-29. (29 Pages)	Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables License-Application for Construction Permit DKT 50 Photograph	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710095	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Appendix F Through Appendix G Cover Page. (60 Pages)	Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710092	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Appendix D Through Appendix E. (274 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710089	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Appendix E Through Appendix F. (41 Pages)	Calculation Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710086	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Appendix C, Pages 47 Through 167. (80 Pages)	Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables License-Application for Construction Permit DKT 50 Operating Procedures	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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04/30/2007	ML071710084	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Appendix B Through Appendix C, Page 46. (129 Pages)	Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710083	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Appendix 2.5A. (90 Pages)	Final Safety Analysis Report (FSAR) Graphics incl Charts and Tables License-Application for Construction Permit DKT 50 Map	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710079	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Pages 2.5.2-1 Through 2.5.6-1. (256 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710077	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Pages 2.5.1-125 Through 2.5.1-186. (62 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50 Map	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710074	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Pages 2.5 1-1 Through 2.5.1-124. (124 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710072	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Pages 2.4.13 Through 2.4A-228. (230 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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04/30/2007	ML071710067	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Pages 2.4.1-1 Through 2.4.12-104. (230 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710064	Vogtle Early Site Permit Application, Revision 2, Part 2 - Site Safety Analysis Report. Cover Through Page 2.3-122. (242 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/30/2007	ML071710060	Vogtle Early Site Permit Application, Revision 2, Part 1 - Administrative Information. Cover through Chapter 3. (40 Pages)	License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
05/14/2007	ML073330039	Out of Control - On Purpose, DOE's Dispersal of Radioactive Waste Into Landfills and Consumer Products. (122 Pages)	Report, Miscellaneous	Nuclear Information & Resource Service (NIRS)	NRC/NRO	05200011
05/31/2007	ML073470893	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment C, "Cone Penetrometer Test Results," Volume 1 of 1. (120 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
05/31/2007	ML073470895	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment D, "Geophysical Test Data (Downhole) Field Electrical Resistivity," Volume 1 of 1. (329 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
06/06/2007	ML072070273	FEMA 06/06/07 Letter Enclosure: Concurrence on Vogtle ESP PSER (Misc. Enclosures: Burke County, GA Emergency Response Procedural Checklists, Various). (90 Pages)	Emergency Preparedness-FEMA Correspondence to NRC	US Federal Emergency Mgmt Agency (FEMA)	NRC/NRO	05200011

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06/20/2007	ML073330046	Health Risks of Adding New Reactors To The Vogtle Nuclear Plant. (25 Pages)	Report, Miscellaneous	Blue Ridge Environmental Defense League	NRC/NRO	05200011
06/27/2007	ML071770619	07/11/07 - Notice of Forthcoming Meeting with Southern Nuclear Operating Company to Discuss Southern's Potential Limited Work Authorization (LWA) - 2 Request for the Vogtle Early Site Permit Application to Discuss Southern's Upcoming LWA. (7 Pages)	Meeting Agenda Meeting Notice	NRC/NRO/DNRL/AP1 000B1	NRC/NRO/DNRL/AP1 000B1	05200011
06/27/2007	ML073470891	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Report of SPT Energy - MACTEC Charlotte Diedrich D-50 ATV Hammer Serial No. 100 Automatic Hammer, Work Instruction VGCOL 152. (85 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50 Memoranda	MACTEC Engineering & Consulting, Inc	MACTEC Engineering & Consulting, Inc NRC/NRO	05200011
07/02/2007	ML071300019	Letter to G. Jackson: Revision Two Application by Southern Nuclear Operating Company for an Early Site Permit (ESP) for the Vogtle Site. (5 Pages)	Letter	NRC/NRO/DSER	Burke County, GA	05200011 PROJ0737
07/20/2007	ML072080259	Supplemental Information on Water Treatment Chemical Residuals in the Vogtle Unit 3 and 4 Final Discharge. (3 Pages)	Report, Miscellaneous	- No Known Affiliation	NRC/NRO	05200011
07/30/2007	ML072340525	Vogtle Early Site Permit Application, Supplement 2-S1, Part 2, Site Safety Analysis Report, Chapter 1 (Drawings 0-CY-0000-00001, Rev. 4 & 0-CY-0000-00002, Rev. 5). (3 Pages)	Drawing Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
08/06/2007	ML072280100	V. out. (160 Pages)	Spreadsheet File	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
08/07/2007	ML072280108	1-Mile Early Fatality Risk. (1 Pages)	Spreadsheet File	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
08/07/2007	ML072280085	VEarly. (7 Pages)	Spreadsheet File	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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08/08/2007	ML072360369	Vogtle Early Site Permit Application - Addendum Report for Archaeological Survey of Water Line Corridor for Proposed Intake Structure. (4 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRR	05200011
08/10/2007	ML072270305	Vogtle ESP Tornado Statistics. (5 Pages)	Graphics incl Charts and Tables Map Report, Miscellaneous	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO	05200011
08/10/2007	ML072270048	Vogtle Early Site Permit Application, Supplement Information on Savannah River at Risk Water Quality Study. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
08/10/2007	ML072260257	Vogtle ESP Hail and Tornado Reports 2.3.1.3.3.6. (1 Pages)	Graphics incl Charts and Tables Report, Miscellaneous	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO	05200011
08/10/2007	ML072260248	The Climate Atlas of the United States for the Vogtle ESP. (7 Pages)	Report, Miscellaneous	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO	05200011
08/10/2007	ML072260084	One Hundred Year Return Temperatures 2.3.1.3.5. (7 Pages)	Graphics incl Charts and Tables	- No Known Affiliation	NRC/NRO	05200011
08/10/2007	ML072260074	Vogtle ESP Hurricane Trends 2.3.1.3.7. (4 Pages)	Graphics incl Charts and Tables	- No Known Affiliation	NRC/NRO	05200011
08/15/2007	ML072330245	Transmittal of Vogtle Early Site Permit Application, Supplement to Include Limited Work Authorization 2 Activities. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
08/16/2007	ML072280160	08/20/07 - 09/24/07 Commission Meetings - FRN. (3 Pages)	Federal Register Notice	NRC/SECY		05200011 07200026
08/21/2007	ML072330552	8/27/07 - 9/3/07 Commission Meetings - Special FRN. (1 Pages)	Federal Register Notice	NRC/SECY		05200011 07200026
08/29/2007	ML072350413	Letter to Charles Hardigree, Responding to Help Defining the Wages for Skilled Crafts in the Augusta, Georgia Area. (6 Pages)	Letter	NRC/NRO/DSER	- No Known Affiliation	05200011

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08/30/2007	ML072040363	Vogtle Early Site Permit Safety Evaluation Report, Section 2.4, Hydrologic Engineering. (85 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML071970283	Vogtle Early Site Permit Safety Evaluation Report, 13.0 Conduct of Operations. (147 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML071800270	Vogtle Early Site Permit Safety Evaluation Report, 2.0 Site Characteristics, Sections 2.1 - 2.3. (86 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML071770255	Vogtle Early Site Permit Safety Evaluation Report, 11.0 Radiological Effluent Release Dose Consequences from Normal Operations. (7 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML072420139	M070830 - Affirmation Session: SECY-07-0113 - Final Rule: 10 CFR Pts 30, 31, 32, 150 Exempt fm Licensing, Gen Licenses & Dist of Byproduct Material: Licensing & Reporting Rqmts; II. SECY-07-0137 Southern Nuclear Op Co. (Early Site Permit for Vogtle). (5 Pages)	Commission Meeting Transcript/Exhibit	NRC/OCM		05200011
08/30/2007	ML072420114	SRM-M070830 - Affirmation Session: I - SECY-07-0113 - Final Rule: 10 CFR Parts 30, 31, 32, and 150 Governing Distribution of Byproduct Material; (2) SECY-07-0137 - Early Site Permit for Vogtle ESP Site. (3 Pages)	Commission Staff Requirements Memo (SRM)	NRC/SECY	NRC/EDO NRC/OCAA	05200011
08/30/2007	ML072400469	Letter, Vogtle Safety Evaluation Report for the Vogtle Early Site Permit Application. (7 Pages)	Letter	NRC/NRO/DNRL	Southern Nuclear Operating Co, Inc	05200011
08/30/2007	ML072330246	Vogtle Early Site Permit Application, Supplement 2-S1, Part 2, Site Safety Analysis Report, Chapter 1 (Pages 1-1 through 1-38), Section 2.5.4 (Pages 2.5.4-1 through 2.5.4-100), and Appendix 2.5.C, Attachment A. (226 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
08/30/2007	ML072260173	Vogtle Early Site Permit Safety Evaluation Report, Appendix A, Permit Conditions, COL Action Items, Site Characteristics, Bounding Parameters, and Inspections, Tests, Analyses, and Acceptance Criteria	Safety Evaluation Report	NRC/NRO		05200011

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		Tables. (55 Pages)				
08/30/2007	ML072250595	Vogtle Early Site Permit Safety Evaluation Report, 19.0 Conclusions. (1 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML072250593	Vogtle Early Site Permit Safety Evaluation Report, 18.0 Review By the Advisory Committee on Reactor Safeguards. (1 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML072250471	Vogtle Early Site Permit Safety Evaluation Report, Abstract, Table of Contents, Appendices, Figures, Tables. and Executive Summary. (27 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML072250444	Vogtle Early Site Permit Safety Evaluation Report, Appendix D, Principal Contributors. (1 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML072220271	Vogtle Early Site Permit Safety Evaluation Report, Appendix C, References. (22 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/30/2007	ML072220065	Vogtle Early Site Permit Safety Evaluation Report, Appendix B, Chronology. (24 Pages)	Safety Evaluation Report	NRC/NRO		05200011
08/31/2007	ML073320852	Science and Democratic Action, Volume 15, Number 1, "Carbon-Free and Nuclear-Free, A Roadmap for US Energy Policy". (16 Pages)	Newsletter	Institute for Energy & Environmental Research	NRC/NRO	05200011
08/31/2007	ML072340543	Vogtle Early Site Permit Application, Supplement 2-S1, Part 4, Site Redress Plan, Chapter 1 (Pages 1-1 through 1-14). (21 Pages)	License-Application for Construction Permit DKT 50 Site Redress Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
08/31/2007	ML072330252	Vogtle Early Site Permit Application, Supplement 2-S1, Part 2, Site Safety Analysis Report, Appendix 2.5.C, Attachment D, Geophysical Test Data (Downhole) Field..., Section 3.8.5, Foundations, Section 13.7, Fitness for Duty, and Appendix 17.1A. (386 Pages	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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08/31/2007	ML072330249	Vogtle Early Site Permit Application, Supplement 2-S1, Part 2, Site Safety Analysis Report, Appendix 2.5.C, Attachment C, Penetrometer Test Results. (121 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
08/31/2007	ML072330248	Vogtle Early Site Permit Application, Supplement 2-S1, Part 2, Site Safety Analysis Report, Appendix 2.5.C, Attachment B, Geotechnical Boring Logs. (713 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
09/04/2007	ML072470645	Letter to Dr. W. Ray Luce, Early Site Permit Review for the Vogtle Electric Generating Plant (VEGP) Site. (15 Pages)	Letter	NRC/NRO/DSER	State of GA, Dept of Natural Resources	05200011
09/06/2007	ML080100039	Transmittal of Materials for the Subcommittee on Early Site Permit Regarding the Vogtle Early Site Permit (ESP) Application on October 24, 2007, In Rockville, Maryland. (1 Pages)	Memoranda Status Report	NRC/ACRS	NRC/ACRS	05200011
09/10/2007	ML072430133	Letter to US Geological Survey, NRC Staff Review of "Simulation and Particle-Tracking Analysis of Selected Ground-Water Pumping Scenarios at Plant Vogtle, Burke County, Georgia", Task Order 2, Contract Q-4109/J-3332. (10 Pages)	Letter	NRC/NRO/DSER/EPB 1	US Dept of Interior, Geological Survey (USGS)	05200011
09/12/2007	ML072550271	Press Release-07-118 - NRC Seeks Public Input on Vogtle Early Site Permit Application; Meeting to be Held Oct. 4. (5 Pages)	Press Release	NRC/OPA		05200011
09/12/2007	ML072530510	Revision to the Vogtle Early Site Permit Application Review Schedule to Incorporate a Limited Work Authorization Request-2 Review Provided by Southern Nuclear Operating Company. (8 Pages)	Letter	NRC/NRO/DNRL/AP1 000B1	Southern Nuclear Operating Co, Inc	05200011
09/13/2007	ML072620268	Vogtle, Early Site Permit Application Response to Safety Evaluation Report. (2 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
09/20/2007	ML072180315	W. Burton Memo re: Conference Call Summary - July 18, 2007, Discussion with Southern Nuclear Operating Company (SNC) Concerning Staff Questions for the	Meeting Summary Memoranda	NRC/NRO/DSER/EPB 1	NRC/NRO/DSER/EPB 1	05200011

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		Early Site Permit Plant Vogtle Site. (4 Pages)				
09/20/2007	ML072180214	W. Burton Memo re: Conference Call Summary - July 13, 2007; Discussion with Southern Nuclear Operating Company (SNC) Concerning the Input and Output Files for the MACCS-2 Code Runs for the Early Site Permit for the Plant Vogtle Site. (5 Pages)	Meeting Summary Memoranda	NRC/NRO/DSER/EPB 1	NRC/NRO/DSER/EPB 1	05200011
09/20/2007	ML072200030	W. Burton Memo re: Conference Call Summary - August 6, 2007, Discussion with Southern Nuclear Operating Company (SNC) Concerning the Output Files for the MACCS-2 Code Runs for the ESP for the Plant Vogtle Site Submitted to the NRC on July 18, 2007. (4 Pag	Meeting Summary Memoranda	NRC/NRO/DSER/EPB 1	NRC/NRO/DSER/EPB 1	05200011
09/26/2007	ML072690127	FRN - Early Site Permits, October 24, 2007 (4 Pages)	Federal Register Notice Memoranda	NRC/ACRS	NRC/ACRS	05200011
10/01/2007	ML073440163	Attachment 2 - Vogtle ESP Resolution. (10 Pages)	- No Document Type Applies Letter	State of GA, Senate	NRC/ADM NRC/NRO	05200008 05200011
10/01/2007	ML072681210	Request for Additional Information Letter No. 8 - Southern Nuclear Operating Company Early Site Permit Application for the Vogtle ESP Site. (11 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1 000B1	Southern Nuclear Operating Co, Inc	05200011
10/02/2007	ML073050440	Resolution of the Mayor and Council of the City of Sylvania, Georgia Supporting Plant Vogtle Expansion. (1 Pages)	- No Document Type Applies	City of Sylvania, GA City of Sylvania, GA, City Council	NRC/NRO	05200011
10/02/2007	ML073050437	Resolution of the Screven County Board of Commissioners Supporting an Expansior to Plant Vogtle. (1 Pages)	- No Document Type Applies	Screven County, GA	NRC/NRO	05200011
10/02/2007	ML072750195	Transmittal of Safety Evaluation Report for the Vogtle Electric Generating Plant Early Site Permit Application. (2 Pages)	Memoranda	NRC/NRO/DNRL	NRC/ACNW NRC/ACRS	05200011
10/03/2007	ML073060361	Letter from US Senators Isakson and Chambliss in Support of Plant Vogtle Early Site Permit. (1 Pages)	Letter	US SEN (Senate)	NRC/ADM/DAS/RDEB	05200011

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10/04/2007	ML073060366	A Resolution Of Support for Expansion at Plant Vogtle. (1 Pages)	- No Document Type Applies	City of Waynesboro, GA	NRC/NRO	05200011
10/15/2007	ML072900349	Vogtle Early Site Permit Application - Response to Safety Evaluation Report Open Items. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
10/15/2007	ML072900252	Enclosure - 1 of 2, Vogtle Early Site Permit Application, Response to Safety Evaluation Report Open Items. (24 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
10/18/2007	ML072900259	Enclosure - 2 of 2, SER Open Item Responses, Vogtle Early Site Permit Application. (148 Pages)	Graphics incl Charts and Tables Report, Technical	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
10/26/2007	ML072910730	Southern Nuclear Operating Company, Inc., Request for Additional Information Letter No. 9 - Southern Nuclear Operating Company Early Site Permit Application for the Vogtle ESP Site. (11 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1 000B1	Southern Nuclear Operating Co, Inc	05200011
11/05/2007	ML073240570	Drawing H-993-3, "Plant Vogtle New Unit Early Permit Study Savannah River hydrographic Study - Proposed Discharge Burke County, Georgia." (3 Pages)	Drawing	Georgia Power Co	NRC/NRR	05000424 05000425 PROJ0737
11/06/2007	ML073120135	Vogtle Early Site Permit Application - Response to Request for Additional Information Involving Quality Assurance Controls for Limited Work Authorization-2. (11 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
11/08/2007	ML073130628	Vogtle Early Site Permit Application, New and Significant Information Review. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
11/09/2007	ML073470888	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment B, "SPT Energy Ratio Measurements." (101 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/09/2007	ML073470884	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment B, "Geotechnical Boring Logs, Geotechnical Test Pit Logs, SPT Energy Ratio Measurements," Volume 1 of 1. (538 Pages)	Final Safety Analysis Report (FSAR) License-Application for (Amend/Renewal/New) for DKT 30, 40, 70	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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11/09/2007	ML073470936	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 18 of 18, "Unconsolidated Undrained Triaxial Test by ASTM D4767". (105 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/09/2007	ML073470935	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 17 of 18, "Unconsolidated Undrained Triaxial Test by ASTM D2850". (100 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/09/2007	ML073470931	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 16 of 18, "Consolidation Test Data". (76 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/09/2007	ML073470926	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 15 of 18, "Consolidation Test Data". (100 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/09/2007	ML073470924	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 14 of 18, "Consolidation Test Data". (102 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/09/2007	ML073470923	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 13 of 18, "Consolidation Test Data". (100 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/09/2007	ML073470921	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 12 of 18, "Consolidation Test Data". (76 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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11/09/2007	ML073470918	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 11 of 18, "Consolidation Test Data". (103 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/09/2007	ML073470896	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 1 of 18, "Laboratory Testing Data (Geotechnical)," Volume 1 of 2. (72 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/16/2007	ML073470883	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Appendix 2.5C, "Geotechnical Investigation and Laboratory Testing Data Report - COL," through Quality Assurance Reports. (269 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/16/2007	ML073470872	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Appendix 2.5A, "Geotechnical Investigation and Laboratory Testing Data Report," through Table 7, "Boring C-1005A, Suspension R1-R2 Depths and P-and SH-Wave... (223 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/19/2007	ML073470937	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, Addendum to Geotechnical Data Report. (17 Pages)	Final Safety Analysis Report (FSAR) Letter License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc	Georgia Power Co NRC/NRO Southern Nuclear Operating Co, Inc	05200011
11/28/2007	ML073331123	Vogtle Early Site Permit Application - Response to Request for Additional Information Involving Limited Work Authorization-2 Supplement. (59 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
11/30/2007	ML073470869	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Section 2.4, "Hydrologic Engineering," through Appendix J, "Site Photos". (477 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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11/30/2007	ML073470867	Vogtle Early Site Permit Application - Revision 3, Part 1 - Administrative Information, Cover through Part 2 - Site Safety Analysis Report. (266 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470948	Vogtle Early Site Permit Application - Revision 3, Part 5, Emergency Plan, NEI 07-01, "Emergency Action Levels Technical Basis." (91 Pages)	Emergency Preparedness-Emergency Plan License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470941	Vogtle Early Site Permit Application - Revision 3, Part 4 - Site Redress Plan and Part 5 - Emergency Plan, Cover to Page V2A4-14. (369 Pages)	Emergency Preparedness-Emergency Plan License-Application for Construction Permit DKT 50 Site Redress Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470938	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Chapter 3, "Design of Structures, Components, Equipment, and Systems," through Chapter 17, "Quality Assurance." (220 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470915	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 10 of 18, "Consolidation Test Data". (101 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470912	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 9 of 18, "Unconfined Compression Test Report". (121 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470910	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 8 of 18, "Liquid and Plastic Limits Test Report". (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Development Corp Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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11/30/2007	ML073470908	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 7 of 18, "Particle Size Distribution Report". (89 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470904	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 6 of 18, "Particle Size Distribution Report". (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470903	Vogtle Early Site Permit Application - Revision 3, part 2 - Site Safety Analysis Report, Attachment F, 5 of 18, "Particle Size Distribution Report." (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470900	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 4 of 18, "Particle Size Distribution Report". (81 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470899	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 3 of 18, "Particle Size Distribution Report". (79 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
11/30/2007	ML073470897	Vogtle Early Site Permit Application - Revision 3, Part 2 - Site Safety Analysis Report, Attachment F, 2 of 18, "Particle Size Distribution Reports". (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	MACTEC Engineering & Consulting, Inc Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
12/07/2007	ML080070436	10/24/2007 Minutes on Meeting of the ACRS Early Site Permits Subcommittee, Rockville, Maryland. (28 Pages)	Meeting Minutes	NRC/ACRS	NRC/ACRS	05200011
12/11/2007	ML073461084	Vogtle Early Site Permit Application Supplemental Information Regarding Safety Evaluation Report Open Items. (13 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
12/12/2007	ML073390235	Vogtle Extended Service Mailing List. (10 Pages)	- No Document Type Applies	NRC/NRO/DSER/EPB 1	Nuclear Information & Resource Service (NIRS)	05200011

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12/13/2007	ML073520352	Vogtle ESP: Open Item 2.3.1 Resolution. (4 Pages)	Graphics incl Charts and Tables	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO	05200011
12/18/2007	ML081510795	Meeting Minutes of the ACRS Early Site Permits Subcommittee, October 24, 2007. (246 Pages)	Meeting Minutes	NRC/ACRS		05200011
12/28/2007	ML073480252	G20070834/EDATS: OEDO-2007-0713 - William J. Shack Ltr re: Interim Letter: Southern Nuclear Operating Company Application for the Vogtle Early Site Permit and the Associated NRC Safety Evaluation Report with Open Items (2 Pages)	Letter	NRC/EDO	NRC/ACRS	05200011
01/08/2008	ML073450602	Trip Report from Visit to Bechtel Office in Support of the Vogtle Early Site Permit (ESP) Site and Audit of Meteorological Aspects of the Vogtle ESP Application. (3 Pages)	Memoranda Trip Report	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
01/11/2008	ML080040228	Request For Additional Information Letter No. 10 - Southern Nuclear Operating Company Early Site Permit Application For The Vogtle Esp Site. (10 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1000B1	Southern Nuclear Operating Co, Inc	05200011
01/18/2008	ML080230701	Vogtle Early Site Permit Application, Submittal Date for Application Revision 4. (2 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
01/23/2008	ML080310359	Vogtle Early Site Permit Application, Response to Hydrology Safety Evaluation Report Open Item Followup Questions. (36 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
01/25/2008	ML080070538	Biological Assessment for Threatened and Endangered Species and Designated Critical Habitat for the Vogtle Electric Generating Plant Early Site (ESP) Application. (8 Pages)	Letter	NRC/NRO/DSER/EPB1	State of FL, National Marine Fisheries Services	05200011

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01/25/2008	ML080070534	Biological Assessment for Threatened and Endangered Species and Designated Critical Habitat for the Vogtle Electric Generating Plant Early Site Permit (ESP) Application. (8 Pages)	Letter	NRC/NRO/DSER/EPB 1	US Dept of Interior, Geological Survey (USGS)	05200011
01/28/2008	ML080370283	Vogtle Expansion Documentation Review. (1 Pages)	Letter	State of GA, Dept of Natural Resources	NRC/NRO Southern Nuclear Operating Co, Inc	05200011
02/12/2008	ML080590496	Vogtle Early Site Permit Application, Part 5, Emergency Plan, Revision 4. (214 Pages)	Emergency Preparedness-Emergency Plan License-Early Site Permit (ESP)	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
02/12/2008	ML080590481	Vogtle Early Site Permit Application, Supplemental Information Regarding Safety Evaluation Report Open Items. (4 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
02/12/2008	ML080420653	2/28/08 - FORTHCOMING PUBLIC MEETING WITH SOUTHER NUCLEAR OPERATING COMPANY (SNC) TO DISCUSS THEIR BACKFILL PROGRAM IN SUPPORT OF THEIR LIMITED WORK AUTHORIZATION REQUEST (5 Pages)	Meeting Agenda Meeting Notice	NRC/NRO/DNRL	NRC/NRO/DNRL	05200011
02/13/2008	ML080430469	02/28/08 - Forthcoming Public Meeting with Southern Nuclear Operating Company (SNC) to Discuss Their Backfill Program in Support of Their Limited Work Authorization Request. (7 Pages)	Meeting Agenda Meeting Notice	NRC/NRO/DNRL/AP1 000B1	NRC/NRO/DNRL/AP1 000B1	05200011
02/27/2008	ML080650414	Southern Nuclear - Rev. 4 to Emergency Plan, Part 5, "Vogtle Early Site Permit." (361 Pages)	Emergency Preparedness-Emergency Plan Graphics incl Charts and Tables Slides and Viewgraphs	Southern Nuclear Operating Co, Inc	NRC/NRR	05200011
02/27/2008	ML080650391	Vogtle Early Site Permit Application Part 5 - Draft Revision 4. (7 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011

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02/28/2008	ML080640235	SNC Presentations, Slides for Public Meeting to Discuss SNC's LWA Backfill Program for the Vogtle ESP. (112 Pages)	Meeting Briefing Package/Handouts Slides and Viewgraphs	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
02/28/2008	ML080640218	Presentation Slides from Public Meeting to Discuss SNC's LWA Backfill Program for the Vogtle ESP - 2/28/2008 (6 Pages)	Slides and Viewgraphs	NRC/NRO/DSER		05200011
03/19/2008	ML080810497	Vogtle Early Site Permit Application, Part 5, Emergency Plan, Draft Revision 4. (214 Pages)	Emergency Preparedness-Emergency Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/19/2008	ML080810495	Vogtle Early Site Permit Application, Transmittal of Supplemental Information Regarding Safety Evaluation Report Open Items. (4 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
03/25/2008	ML080850047	04/08/08 - Notice of Meeting with Southern Nuclear (Snc) to Discuss the Hydrology Modeling for the Vogtle Early Site Permit. (8 Pages)	Meeting Agenda Meeting Notice Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
03/25/2008	ML080770517	02/22/2008 Summary of Telephone Call with Southern Nuclear Operating Company (SNC) Regarding Early Site Permit (ESP) Application for the Vogtle ESP Site. (8 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
03/28/2008	ML081020171	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Mactec 2.5C, Attachment F, 17 of 18. (100 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020170	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Mactec 2.5C, Attachment F, 16 of 18. (76 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020169	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Mactec 2.5C, Attachment F,	Final Safety Analysis Report (FSAR) License-Application for Construction Permit	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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		15 of 18. (100 Pages)	DKT 50			
03/28/2008	ML081020117	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 14 of 18. (102 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020116	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 13 of 18. (100 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020115	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 12 of 18. (76 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020114	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 11 of 18. (104 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020112	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 10 of 18. (100 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020111	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 9 of 18. (122 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020108	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 8 of 18. (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numb
03/28/2008	ML081020107	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 7 of 18. (88 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020106	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 6 of 18. (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020104	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 5 of 18. (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020102	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 4 of 18. (82 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020101	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 3 of 18. (78 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020100	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 2 of 18. (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020099	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment F, 1 of 18. (72 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
03/28/2008	ML081020097	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, MACTEC Attachment D and Attachment E. (330 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020096	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, MACTEC Attachment C. (120 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020095	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment B. (86 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020094	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment B. (102 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020092	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, MACTEC Attachment B. (538 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020091	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, MACTEC, Attachment A. (270 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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03/28/2008	ML081020090	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5A, MACTEC Appendix F through Appendix 2.5B. (103 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020089	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5A, Appendix E through MACTEC Appendix E. (316 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020087	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5A, Appendix A through Appendix D. (80 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020086	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5A. (224 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML080910423	Vogtle, Units 3 and 4 - COL Application Physical Security Plan. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011 PROJ0755
03/28/2008	ML081020274	Transmittal of Vogtle Early Site Permit Application, Revision 4. (23 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
03/28/2008	ML081020227	Vogtle Early Site Permit Application, Revision 4, Part 2, Site Safety Analysis Report, Table of Contents. (24 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numbe
03/28/2008	ML081020226	Vogtle Early Site Permit Application, Revision 4, Part 5 - Emergency Plan. (364 Pages)	Emergency Preparedness-Emergency Plan License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020225	Vogtle Early Site Permit Application, Revision 4, Part 4 - Site Redress Plan. (16 Pages)	License-Application for Construction Permit DKT 50 Site Redress Plan	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020224	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.5.6. (4 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020223	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.5.5. (4 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020222	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.5.4. (114 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020221	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.5.3. (30 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020220	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.5.2. (190 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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03/28/2008	ML081020218	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.5.1. (164 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020217	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5E. (74 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020216	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.5, Table of Contents. (1 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020215	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.4. (478 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020214	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.3. (124 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020213	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.2. (30 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020212	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Section 2.1. (28 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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03/28/2008	ML081020211	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 17, "Quality Assurance." (63 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020210	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 15, "Accident Analyses." (26 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020209	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 13, "Conduct of Operations." (106 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020208	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 11, "Radioactive Waste Management." (24 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020207	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 3, "Design of Structures, Components, Equipment, and Systems," Sections 3.5 Through 3.8-4. (14 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020206	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 1, "Introduction and General Description." (32 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020205	Vogtle Early Site Permit Application, Revision 4, Part 1, Administrative Information. (30 Pages)	License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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03/28/2008	ML081020204	Vogtle Early Site Permit Application, Revision 4, Cover and Table of Contents. (4 Pages)	License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020203	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 9 of 9. (89 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020202	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 8 of 9. (65 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020201	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 7 of 9. (64 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020199	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 6 of 9. (61 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020198	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 5 of 9. (40 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020196	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 4 of 9. (85 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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03/28/2008	ML081020195	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 3 of 9. (26 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020194	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 2 of 9. (74 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020193	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment E, 1 of 9. (47 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020192	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment D. (26 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020191	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment C, 8 of 8. (182 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020189	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment C, 7 of 8. (118 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020188	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment C, 6 of 8. (104 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

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03/28/2008	ML081020187	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment C, 5 of 8. (77 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020186	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment C, 4 of 8. (86 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020185	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment C, 3 of 8. (60 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020184	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment C, 2 of 8. (96 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020183	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment C, 1 of 8. (29 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020182	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment B. (88 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020181	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Attachment A. (26 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Numb
03/28/2008	ML081020178	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5D, Sections 1 Through 3. (86 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020176	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment G, 2 of 2. (214 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020175	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Attachment G, 1 of 2. (298 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020174	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Mactec 2.5C, Attachment F - Addendum. (18 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
03/28/2008	ML081020173	Vogtle Early Site Permit Application, Revision 4, Part 2 - Site Safety Analysis Report, Chapter 2, "Site Characteristics," Appendix 2.5C, Mactec 2.5C, Attachment F, 18 of 18. (105 Pages)	Final Safety Analysis Report (FSAR) License-Application for Construction Permit DKT 50	Southern Nuclear Operating Co, Inc	NRC/NRO	05200011
04/02/2008	ML080920468	4/8/08 - Notice of Revised Meeting with Southern Nuclear (SNC) to Discuss the Hydrology Modeling for the Vogtle Early Site Permit. (8 Pages)	Meeting Agenda Meeting Notice Memoranda	NRC/NRO/DNRL/AP1 000B1	NRC/NRO/DNRL/AP1 000B1	05200011
04/08/2008	ML081000526	Southern Nuclear Vogtle Groundwater Model Review Meeting Handout. (11 Pages)	Meeting Briefing Package/Handouts Slides and Viewgraphs	Battelle Memorial Institute, Pacific Northwest National Lab	NRC/NRO	05200011

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04/08/2008	ML081000502	04/08/2008 Meeting Handouts "Vogtle Units 3 & 4 Groundwater Model Overview." (43 Pages)	Graphics incl Charts and Tables Meeting Briefing Package/Handouts Slides and Viewgraphs	NRC/NRO/DNRL/AP1000B1		05200011
04/17/2008	ML081120048	Vogtle Early Site Permit Application, Supplemental Information Regarding Request for Additional Information No. 2.5.2-3 and Safety Evaluation Report Open Item No. 2.5-5. (30 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
04/18/2008	ML080780345	Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application for the Vogtle ESP Site - Summary of Telephone Call Held on March 5, 2008 to Discuss GMRS. (3 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
04/24/2008	ML081060305	Acknowledgment of Receipt of The Combined License Application for Vogtle Electric Generating Plant Unit 3 and 4 and Associated Federal Register Notice. (8 Pages)	Federal Register Notice Letter	NRC/NRO/DNRL/AP1000B1	Southern Nuclear Operating Co, Inc	05200011 PROJ0755
05/01/2008	ML080780306	02/28/2008 - Summary of Category 1 Public Meeting with Southern Nuclear Operating Company to Discuss Southern's Backfill Program for a Limited Work Authorization Request Under their Vogtle Early Site Permit Application. (10 Pages)	Meeting Agenda Meeting Summary	NRC/NRO/DNRL/AP1000B1		05200011
05/14/2008	ML082070066	Vogtle, Early Site Permit Application, Phase II Testing at Archaelogical Site 9BK416 Within Proposed Water Line and Intake Structure. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/NRO State of GA, Dept of Natural Resources	05200011
05/19/2008	ML081350199	04/08/2008-Summary of Meeting with Southern Nuclear Operating Company to Discuss Vogtle Hydrology Modeling Topics. (5 Pages)	Meeting Briefing Package/Handouts Meeting Summary	NRC/NRO/DNRL/AP1000B1		05200011

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05/27/2008	ML081510022	Vogtle Early Site Permit Application, Impingement and Entrainment Monitoring. (8 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
06/10/2008	ML081720197	Vogtle Electric Generating Plant Expansion, Burke County, Georgia HP-060428-001. (1 Pages)	Letter	State of GA, Dept of Natural Resources	NRC/NRO Southern Nuclear Operating Co, Inc	05200011
06/16/2008	ML081700563	Vogtle, Early Site Permit Application - Revised Fitness-For-Duty Program During Limited Work Authorization. (36 Pages)	Letter License-Fitness for Duty (FFD) Performance Report	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
06/18/2008	ML081510740	05/05/2008-Summary of Vogtle ESP Site Telephone Call to Discuss Appendix 2.5 E of the ESP Application. (3 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
06/18/2008	ML081510661	04/28/2008-Summary of Telephone Call to Review Hydrology Modeling Progress. (3 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
06/18/2008	ML081400433	Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application For The Vogtle ESP Site- Summary Of Telephone Call Held On April 11, 2008 To Discuss Site Response Damping Curves. (4 Pages)	Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
06/18/2008	ML081400268	Trip Report From Visit To Bechtel Office In Support Of The Vogtle Early Site Permit (ESP) And Audit Of Hydrology Modeling. (4 Pages)	Memoranda Trip Report	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
06/19/2008	ML081750239	Vogtle Early Site Permit Application, Revised Response to Draft Safety Evaluation Report Open Item Involving Hydrology. (6 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011

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06/26/2008	ML081820118	Vogtle Early Site Permit Application Supplement to Provide Additional Hydrology Information. (130 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
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07/03/2008	ML081850151	Press Release-08-125: NRC Meeting July 17 in Waynesboro, GA., to Discuss Review Process for Vogtle New Reactor Application. (2 Pages)	Press Release	NRC/OPA		05200011
07/07/2008	ML081080553	Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application for the Vogtle ESP Site - Summary of Telephone Call Held on March 11, 2008 to Discuss Meteorological and Emergency Planning Topics. (5 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1 000B1	NRC/NRO/DNRL/AP1 000B1	05200011
07/07/2008	ML081080535	Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application For The Vogtle ESP Site - Summary Of Telephone Call Held On March 10, 2008 To Discuss Geological And Geotechnical Topics. (5 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1 000B1	NRC/NRO/DNRL/AP1 000B1	05200011

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07/07/2008	ML081080529	Southern Nuclear Operating Company (SNC) Early Site Permit (ESP) Application For The Vogtle ESP Site - Summary Of Telephone Call Held On March 24, 2008 To Discuss ITAAC For Backfill And Waterproof Membrane; And GMSR Hazard Curves. (3 Pages)	Meeting Summary Memoranda	NRC/NRO/DNRL/AP1000B1	NRC/NRO/DNRL/AP1000B1	05200011
07/09/2008	ML081960194	Vogtle Early Site Permit Application - Further Revised Fitness-For-Duty Program During Limited Work Authorization. (27 Pages)	Letter License-Fitness for Duty (FFD) Performance Report	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
07/22/2008	ML081960368	Request For Additional Information Letter No. 11 - Southern Nuclear Operating Company Early Site Permit Application For The Vogtle ESP Site. (12 Pages)	Letter Request for Additional Information (RAI)	NRC/NRO/DNRL/AP1000B1	Southern Nuclear Operating Co, Inc	05200011
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08/21/2008	ML082410440	Vogtle Early Site Permit Application, Response to Request for Additional Information Letter No. 11 Involving Groundwater. (35 Pages)	Drawing Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
08/27/2008	ML082560527	Letter from K.C. Hairston to Lawrence D. Sanders and Patrick A. Moulding re Twelfth Supplemental Disclosures Pursuant to 10CFR2.336 for Contentions EC 1.2 and EC 1.3 Admitted on March 12,2007 (LBP-07-03). (4 Pages)	Letter	Balch & Bingham, LLP Southern Nuclear Operating Co, Inc	Emory Univ School of Law NRC/OGC Turner Environmental Law Clinic	05200011
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09/10/2008	ML082590048	Vogtle Early Site Permit Application, Request to Rescind Reinforcing Bar Installation in Limited Work Authorization. (3 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011
09/10/2008	ML082590003	Joseph M. Farley, Units 1 and 2, Edwin I. Hatch, Units 1 and 2, Vogtle, Units 1, 2, 3 and 4 - Management Organization Change. (2 Pages)	Letter	Southern Nuclear Operating Co, Inc	NRC/Document Control Desk NRC/NRO	05200011 05200025 05200026
09/11/2008	ML082550558	Vogtle ESP Final SER Section 02.5.4 - Stability of Subsurface Materials and Foundations (104 Pages)	Safety Evaluation Report	NRC/NRO/DNRL/AP1 000B1		05200011
09/11/2008	ML082550517	Vogtle ESP Final SER Section 02.5.2 - Vibratory Ground Motion (84 Pages)	Safety Evaluation Report	NRC/NRO/DNRL/AP1 000B1		05200011
09/19/2008	ML082760694	USFWS Log # 08-FA-0473. (1 Pages)	Letter	US Dept of Interior, Fish & Wildlife Service	NRC/NRO	05200011
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APPENDIX D
PRINCIPAL CONTRIBUTORS

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Araguas, Christian	Project Management
Bauer, Laurel	Geology and Seismology
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Brooks, Marc	Security
Cheng, Thomas	Geotechnical Engineering
Concepcion-Robles, Milton	Quality Assurance
Dehmel, Jean-Claude	Normal Radiological Dose Analysis
George, James	Geotechnical Engineering
Gonzalez, Sarah	Geology and Seismology
Hart, Michelle	Accident Analysis
Harvey, R. Brad	Meteorology
Heck, Kenneth	Quality Assurance
Hoch, Joseph	Meteorology
Li, Yong	Geology and Seismology
Ma, John	Structural Engineering
Mazza, Jan	Project Management
McCune, Timothy	Fitness for Duty
McGuire, Josh	Accident Analysis
Monarque, Stephen	Project Management
Moody, Robert	Emergency Planning
Munson, Clifford	Geology and Seismology
Musico, Bruce	Emergency Planning
Patel, Pravin	Structural Engineering
Schaffer, Steven	Normal Radiological Dose Analysis
Shropshire, Alan	Fitness for Duty
Stirewalt, Gerry	Geology and Seismology
Tammara, Seshagiri	Site Hazards
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Brookhaven National Laboratory	Geotechnical Engineering
Department of Homeland Security	Emergency Planning
Pacific Northwest Laboratory	Emergency Planning and Hydrology
US Geologic Survey	Geology and Seismology

APPENDIX E

REPORT BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

December 22, 2008

The Honorable Dale E. Klein
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: FINAL REVIEW OF THE VOGTLE ELECTRIC GENERATING PLANT EARLY SITE PERMIT APPLICATION AND LIMITED WORK AUTHORIZATION REQUEST AND THE ASSOCIATED SAFETY EVALUATION REPORT

Dear Chairman Klein:

During the 558^{th} meeting of the Advisory Committee on Reactor Safeguards, December 4-6, 2008, we completed our review of the Vogtle early site permit application submitted by the Southern Nuclear Operating Company (Southern Nuclear or "applicant") and the associated Safety Evaluation Report (SER) prepared by the NRC staff. An interim report on our review of this early site permit application was issued November 20, 2007. We also completed review of the applicant's limited work authorization request for initiating work on the proposed site. Our Subcommittee on Early Site Permits reviewed these matters at its meeting on December 3, 2008. During our reviews, we had the benefit of discussions with representatives of the NRC staff and Southern Nuclear Operating Company. We also had the benefit of the documents referenced.

CONCLUSIONS AND RECOMMENDATION

1. The early site permit and the limited work authorization should be granted.

2. The predicted ground motion response spectrum for the proposed site is not bounded by the certified seismic design response spectrum for the AP1000 reactor. This will have to be addressed in any combined license application for reactors at the proposed site.

3. The requested limited work authorization delineates activities that can be undertaken without degrading the safety of the AP1000 reactors proposed for installation at the site.

DISCUSSION

The Southern Nuclear Operating Company has applied for an early site permit for a location adjacent to the sites of the operating reactors, Vogtle Units 1 and 2. The application is unusual in that it references the certified design for the AP1000 reactor rather than plant parameter envelopes, as has been done by other early site permit applications. Also, the application provides a complete and integrated emergency plan rather than specifying just the major features of such a plan, as has been done in previous early site permit applications.

The permit application, as amended in response to review by the NRC staff, adequately characterizes the proposed site. Seismicity is the most important site safety issue. Seismicity at the proposed site is dominated by the Charleston seismic zone. Together, the work by the applicant as well as the review and critique of this work by the NRC staff have advanced the understanding of the Charleston seismic zone and the potential ground motion at the proposed site.

The predicted ground-motion response spectrum at the proposed site is not bounded by the certified seismic design response spectrum for the AP1000 reactor. The design spectrum is exceeded in frequency ranges below one Hertz and above about seven Hertz. These differences between the predicted spectrum and the design spectrum will have to be addressed in any combined license application for reactors at the proposed site.

Surface soils in the east coast piedmont at the proposed site are susceptible to liquefaction in seismic events of sufficient intensity. The applicant plans to excavate the surface soils to a depth of about ninety feet and replace it with an engineering backfill much as was done for Vogtle Units 1 and 2. To expedite this significant engineering undertaking, the applicant has applied for a limited work authorization. Staff review has verified that the engineered backfill, waterproof membrane, and mechanically stabilized earthen walls proposed by the applicant can be safely installed and will yield a site where seismic events will not cause foundations of the AP1000 reactors to slide or overturn.

The complete and integrated emergency plan proposed by the applicant has been found to be adequate. It has been necessary to specify permit conditions on emergency action levels that cannot be completely specified until details of plant design come available. A permit condition has been imposed concerning the applicant's proposal to locate a technical support center for reactors at the proposed site differently than is specified in the AP1000 design.

The applications for the early site permit and the limited work authorization and the reviews of these applications by the NRC staff are adequate. The early site permit and the limited work authorization should be granted.

Dr. Said Abdel-Khalik did not participate in the Committee's deliberations regarding this matter.

Sincerely,

/RA/

William J. Shack
Chairman

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3. Letter from Joseph A. Miller, Senior Vice President, Southern Nuclear Operating Company, to U.S. Nuclear Regulatory Commission, "Vogtle Plant Early Site Permit Application, Supplement to Include Limited Work Authorization Activities," dated August16, 2007 (ML072430208)

4. U.S. Nuclear Regulatory Commission, Safety Evaluation with Open Items, "Safety Evaluation Report for the Vogtle Early Site Permit Application," August 2007 (ML071581032)

5. Letter from William J. Shack, Chairman, Advisory Committee on Reactor Safeguards, to Luis A. Reyes, Executive Director for Operations, "Interim Letter Southern Nuclear Operating Company Application for the Vogtle Early Site Permit and the Associated NRC Safety Evaluation Report with Open Items," dated November 20, 2007 (ML073070005)