NRC003

Safety Evaluation of the Early Site Permit Application in the Matter of PSEG Power, LLC and PSEG Nuclear, LLC for the PSEG 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 PSEG Power, LLC and PSEG Nuclear, LLC (PSEG or the applicant), for the proposed PSEG Site, in Salem County, New Jersey. Since the applicant did not apply for a limited work authorization (LWA), this SER does not include a technical review for an LWA.

In a May 25, 2010, letter, PSEG submitted an ESP application for the PSEG 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 proposed PSEG Site is located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey. The site is 24.1 kilometers (km) (15 miles (mi)) south of the Delaware Memorial Bridge, 28.97 km (18 mi) south of Wilmington, Delaware, 48.2 km (30 mi) southwest of Philadelphia, Pennsylvania, and 12.1 km (7.5 mi) southwest of Salem, New Jersey. The other nuclear facilities licensed by the NRC and located adjacent to this site are Salem Generating Station (SGS) Units 1 and 2 and Hope Creek Generating Station (HCGS) Unit 1.

PSEG has not selected a specific reactor technology, but used a plant parameter envelope (PPE) in developing its application. PSEG used technical information from various reactor designs to develop bounding parameters (i.e., PPE) that are intended to envelop the proposed facility characterization necessary to evaluate the suitability of the site for future construction and operation of a nuclear power plant.

In its application, PSEG seeks an ESP that could be referenced as part of a future application to construct and operate a nuclear plant at the PSEG Site. In order to utilize the finality on issues resolved in the ESP proceeding, a future application to build a plant on the PSEG Site may be for any of the reactor designs identified or a different design that falls within the site characteristics and design parameters set out in the ESP. According to the PPE, the bounding new plant will have a total nuclear generating capacity of 4,614 megawatts thermal (MWt) for a single unit or 6,830 MWt for a dual unit, with a capability of producing up to approximately 2,200 megawatts electric (MWe) net of electrical power. A future plant built on the PSEG Site would be built adjacent to and north of the existing SGS/HCGS units operated by PSEG Nuclear, LLC.

This SER presents the results of the staff's review of site safety analysis information submitted in conjunction with the ESP application. Appendix A to this SER identifies the proposed permit conditions, site characteristics, bounding design parameters, and inspections, tests, analyses and acceptance criteria (ITAAC) that the staff recommends be imposed, should an ESP be issued to the applicant. Appendix A to this SER also includes certain site related items (Combined License (COL) action items) that will need to be addressed at the COL or construction permit (CP) stage, should the applicant later apply to construct a new nuclear plant on the PSEG Site and references the PSEG Site ESP in its application. The staff concluded

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[1] This SER documents the NRC staff's position on all safety issues associated with the early site permit application. 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.

that addressing these items is not required for the staff to make its regulatory findings at the ESP stage and that, for reasons specified in Section 1.6, “Summary of Combined License Action Items,” of this SER, the COL action items are more appropriately addressed when the applicant has applied for a COL or CP.

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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 (SSAR). Numerous chapters and sections in the NUREG-0800 are not within the scope of, or addressed in, an early site permit (ESP) proceeding. The reader will, therefore, note these chapters and sections are not included in this document. The subjects of chapters and sections 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 plant that might be constructed on the PSEG Site.

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EXECUTIVE SUMMARY

The regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," contain requirements for licensing new nuclear power plants.[2] These regulations include the U.S. Nuclear Regulatory Commission (NRC) requirements for early site permits (ESPs), design certifications (DCs), and combined operating licenses (COLs). The ESP process discussed in 10 CFR Part 52, Subpart A, "Early Site Permits," is intended to address and resolve site-related issues. The DC 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 NRC authorization to construct and operate a new nuclear power plant. A COL applicant may reference an ESP, a certified design, both, or neither. A COL applicant referencing an ESP or certified design must resolve licensing issues that were not resolved as part of the referenced ESP or design certification proceeding before the NRC can issue a COL.

This safety evaluation report (SER) describes the results of a review by the NRC staff (the staff) of an ESP application submitted by PSEG for the proposed PSEG Site. The staff's review verified the applicant's compliance with the requirements of 10 CFR Part 52, Subpart A and other requirements referenced therein. This SER serves to identify the staff's conclusions with respect to the ESP safety review and to identify items to be addressed by a future COL applicant referencing the PSEG Site ESP. This SER also identifies the staff's conclusions with respect to the Fukushima Near-Term Task Force (NTTF) Recommendations that are applicable to, or expected of, an ESP applicant to address, or be voluntarily addressed by PSEG.

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 staff reviews the environmental report as part of the responsibilities under the National Environmental Policy Act of 1969, as amended. The staff presents the results of that review in a final environmental impact statement (FEIS), which is a report separate from this SER. The FEIS is provided to the U.S. Environmental Protection Agency (EPA). Upon publication, the staff's FEIS, NUREG-2168, "Final Environmental Impact Statement for an Early Site Permit (ESP) at the PSEG Site," for the ESP application can be accessed through the Agencywide Documents Access and Management System (ADAMS)[3] Accession No. ML15176A444.

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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.

3 ADAMS (Agencywide Documents Access and Management System) is the NRC 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.html. Documents may also be viewed by visiting the NRC Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland (MD). 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 new reactor licensing public web site at http://www.nrc.gov/reactors/new-reactors/esp/pseg.html.

In a May 25, 2010, letter, PSEG submitted an ESP application (ADAMS Accession No. ML101480484) for the PSEG Site. The PSEG Site is located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey (NJ). The site is 24.1 kilometers (km) (15 miles (mi)) south of the Delaware Memorial Bridge, 28.97 km (18 mi) south of Wilmington, Delaware (DE), 48.2 km (30 mi) southwest of Philadelphia, Pennsylvania (PA), and 12.1 km (7.5 mi) southwest of Salem, NJ. Nuclear facilities licensed by the NRC and located adjacent to the PSEG Site are Salem Generating Station (SGS), Units 1 and 2, and Hope Creek Generating Station (HCGS), Unit 1.

In accordance with 10 CFR Part 52, the PSEG Site ESP application includes, among other information: (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 assessment of the major structures, systems, and components (SSCs) that bear significantly on the acceptability of the site; (3) an assessment of any impediments to implementing an emergency plan at the PSEG Site, and a complete and integrated emergency plan with inspections, tests, analyses, and acceptance criteria (ITAAC); and (4) the quality assurance program under which ESP-related activities were performed. The ESP application describes how the site 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 applicant has not selected a particular reactor design for construction at the PSEG Site. To provide sufficient facility design information for the proposed site, the applicant used the plant parameter envelope (PPE) approach, selecting a set of bounding parameters to represent a surrogate plant, and included these parameters in the ESP application along with the site characteristics that form the basis for an ESP. The PPE approach has been accepted by the NRC in previous ESP applications.

This SER presents the conclusions of the staff's review of information submitted by the applicant to the NRC in support of the ESP application. The staff conducted a four-phase review of the application. The staff identified several open items during the first phase (i.e., Phase A, which included Requests for Additional Information (RAIs) and supplemental RAIs). During the second phase (i.e., Phase B) the staff received and reviewed the applicant's responses to all RAIs and all supplemental RAIs. In consideration of the applicant's responses to the RAIs and the results of the site audits conducted during Phases A and B, the staff issued chapter-specific Advanced Safety Evaluations (ASEs) with no open items at the end of Phase B. The staff presented the ASEs to the NRC Advisory Committee on Reactor Safeguards (ACRS) as part of Phase C of the review. Phase D is the issuance of the final safety evaluation report (FSER). Section 1.6 of this SER, provides a brief summary of the process used to resolve issues that arose during the review; specific details on the resolution for each open item are presented in the corresponding sections of this report.

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[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 this SER, 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.

Appendix A to this SER identifies the proposed permit conditions, site characteristics, bounding design parameters, and inspections, tests, analyses and acceptance criteria (ITAAC) that the staff recommends be imposed, should an ESP be issued to the applicant. Appendix A to this SER also includes certain site related items (COL action items) that will need to be addressed at the COL or construction permit (CP) stage, should the applicant later apply to construct a new nuclear plant on the PSEG Site and references the PSEG Site ESP in its application. The staff concluded that addressing these items is not required for the staff to make its regulatory findings at the ESP stage and that, for reasons specified in Section 1.6, "Summary of Combined License Action Items," of this SER, the COL action items are more appropriately addressed when the applicant has applied for a CP or COL.

Inspections, site visits, and regulatory audits conducted by the staff have verified, where appropriate, the conclusions in this SER. The inspections and audits focused on selected information in the ESP application and its references and are cited and discussed in the applicable sections of this SER.

The ACRS also reviewed the bases for the conclusions in this report, as required by 10 CFR 52.23, "Referral to the ACRS." The ACRS independently reviewed those aspects of the application that concern safety, as well as this SER, and provided the results of its review to the Commission in a June 25, 2015, report. Appendix E to this SER includes a copy of the ACRS report on the FSER.

ABBREVIATIONS

ΔP	pressure drop
$\Delta T/\Delta Z$	temperature change with height
°C	degree Celsius (Centigrade)
°F	degree Fahrenheit
µCi/cc	microcuries per cubic centimeter
σ_y	lateral plume spread
σ_z	vertical plume spread
χ/Q	atmospheric dispersion factor
1D	one-dimensional
1HD	one-horizontal-dimension
2D	two-dimensional
2HD	two-horizontal-dimension
ABWR	Advanced Boiling-Water Reactor
ac	alternating current
ACI	American Concrete Institute
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Management System
ADCIRC	ADvanced CIRCulation
AFCCC	Air Force Combat Climatology Center
Ag	Silver
AHEX-E	Atlantic Highly Extended crust
ALARA	as low as reasonably achievable
ALI	annual limit on intake
AMC	antecedent moisture condition
ANS	American Nuclear Society
ANSI/ANS	American National Standards Institute/American Nuclear Society
AOO	anticipated operational occurrence
AP1000	Advanced Passive 1000
ASCE	American Society of Civil Engineers
ASE	Advanced Safety Evaluation
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
AST	alternate source term
ASTM	American Society for Testing and Materials
Ba	barium
BBNPP	Bell Bend Nuclear Power Plant
BLEVE	boiling liquid expanding vapor explosion
bpf	blows per foot
BTP	Branch Technical Position
BWR	boiling water reactor
CAA	Clean Air Act
CAV	cumulative absolute velocity
CCDP	conditional core damage probability
CD	compact disc
CDE	committed dose equivalent

CDF	core damage frequency
CEM	Coastal Engineering Manual
CEUS	Central and Eastern United States
CEUS-SSC	Central and Eastern United States Seismic Source Characterization
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	curie
CL	clay
CLIMAPS	Climate Maps of the United States
cm	centimeter
CN	curve number
COL	combined operating license
COLA	combined operating license application
COMCOT	Cornell Multi-grid Coupled Tsunami Model
CP	construction permit
cpm	counts per minute
CRM	coastal relief model
CRR	cyclic resistance ratio
CRREL	Cold Regions Research and Engineering Laboratory
CSC	Coastal Services Center
CSR	cyclic stress ratio
CU	consolidated undrained
cu. ft.	cubic feet
cu. m.	cubic meter
CVSZ	Central Virginia Seismic Zone
CWS	circulating water system
D/Q	ground deposition factor
DAC	derived air concentration
DBA	design-basis accident
DBE	design-basis event
DBF	design-basis flood
DBT	dry-bulb temperature
DC	design certification
DCD	design control document
DDA	Delaware Department of Agriculture
DE	Delaware
deg	degrees
DEM	digital elevation model
DEMA	Delaware Emergency Management Agency
DEP	Department of Environmental Protection
DHSS	Department of Health and Social Services
DID	direct inward dial
DNREC	Department of Natural Resources and Environmental Control
DOE	U.S. Department of Energy
DPR	Division of Preparedness and Response
DRBC	Delaware River Basin Commission
EAB	exclusion area boundary
EAL	emergency action level
EAS	emergency alert system

ECFS	East Coast Fault System
ECG	event classification guide
ECL	effluent concentration limit
EERC	Energy and Environmental Resource Center
ELAP	extended loss of A/C power
EMRAD	emergency radio
EMT	emergency medical technician
ENC/JIC	Emergency News Center/Joint Information Center
ENE	east-northeast
ENS	emergency notification system
EOC	emergency operations center
EOF	emergency operations facility
EP	emergency planning
EPA	U.S. Environmental Protection Agency
EPIP	emergency plan implementing procedure
EP-ITAAC	emergency planning - inspections, tests, analyses, and acceptance criteria
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ER	environmental report
ERDS	emergency response data system
ERO	emergency response organization
ESE	east-southeast
ESP	early site permit
ESPA	early site permit application
ESSX	electronic switch system exchange
ETE	evacuation time estimate
EWD	engineering weather data
FAA	Federal Aviation Administration
FEIS	final environmental impact statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRS	foundation input response spectra
FR	Federal Register
FRMAC	Federal Radiological Monitoring and Assessment Center
FS	factor of safety
FSER	final safety evaluation report
ft	feet/foot
ft/s	feet per second
ft^3	cubic foot
FTS	Federal Telecommunications System
FVCOM	Finite Volume Coastal Ocean Model
g	acceleration due to gravity
gal	gallon
GDC	general design criterion/criteria
GEBCO	General Bathymetric Chart of the Oceans
GET	general employee training
GI-LLI	gastrointestinal tract-lower large intestine
GL	Generic Letter

GMPE	ground motion prediction equation
GMRS	ground motion response spectrum
HAB	hostile action based
HCGS	Hope Creek Generating Station
HEC-HMS	Hydrologic Engineering Center-Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center-River Analysis System
HEPA	high-efficiency particulate air
HF	high frequency
Hg	mercury
HHA	hierarchical hazards approach
HMR	hydrometeorological report
HPN	health physics network
hr	hour
Hs	significant wave height
Hz	hertz
IAP	international airport
IDLH	immediately dangerous to life or health
IEEE	Institute of Electrical and Electronics Engineers
in.	inch
INPO	Institute of Nuclear Power Operations
IPCC	Intergovernmental Panel on Climate Change
ISFSI	independent spent fuel storage installation
ISG	Interim Staff Guidance
ITAAC	inspection, test, analysis and acceptance criterion/criteria
ITS	intelligent transportation systems
JFD	joint frequency distribution
kg	kilogram
KI	potassium iodide
km	kilometer
km/hr	kilometers per hour
km^2	square kilometer
km^3	cubic kilometer
kPa	kilopascal
Kr	krypton
kt	knots
L	liter
LAN	local area network
lb	pound
lb/ft^3	pounds per cubic foot
lbf	pound force
LCD	local climatological data
LEL	lower explosive level
LF	low frequency
LLC	limited liability company
LOCA	loss-of-coolant accident
LPZ	low population zone
LWR	light-water reactor
m	meter
m/s	meters per second

m^3	cubic meter
Ma	million years old
mb	millibar
MCL	Management Counterpart Link
MD	Maryland
MEDRB	Maritime Exchange for the Delaware River and Bay
MEI	maximally exposed individual
mg/L	milligrams per liter
mGy	milligray
MHSC	Memorial Hospital of Salem County
mi	mile
mi^2	square mile
mi^3	cubic mile
mm	millimeter
MOST	Method of Splitting Tsunami
mph	miles per hour
mrad	millirad
mrem	millirem
mSv	millisievert
MW	megawatt
M	moment magnitude
MWIS	makeup water intake structure
MXITNS	maximum number of SWAN iterations
N	nitrogen
NAAQS	National Ambient Air Quality Standards
NAVD	North American Vertical Datum
NAVD88	North American Vertical Datum of 1988
NAWAS	National Attack Warning and Alert System
NCDC	National Climatic Data Center
ND	nuclear development
NE	northeast
NED	National Elevation Dataset
NEI	Nuclear Energy Institute
NETS	nuclear emergency telecommunications system
NGDC	National Geophysical Data Center
NID	National Inventory of Dams
NIRMA	Nuclear Information and Records Management Association
NIST	National Institute of Standards and Technology
NJ	New Jersey
NJGS	New Jersey Geological Survey
NJSP	New Jersey State Police
NLDN	National Lightning Detection Network
NM	nautical mile
NNE	north-northeast
NNW	north-northwest
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NOV	Notice of Violation
NPP	nuclear power plant

NQA	nuclear quality assurance
NRC	U.S. Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NRF	National Response Framework
NSIR	Nuclear Security and Incident Response
NSSL	National Severe Storms Laboratory
NTTF	Near-Term Task Force
NUREG	NRC technical report (Nuclear Regulatory Commission)
NW	northwest
NWS	National Weather Service
O3	ozone
OCA	owner controlled area
ODCM	Offsite Dose Calculation Manual
OEM	Office of Emergency Management
ORO	offsite response organization
OSC	operations support center
P	pressure
PA	protected area
PAG	protective action guide
PAR	protective action recommendation
PDF	portable document format
PGA	peak ground acceleration
PM	particulate matter
PMCL	protective measures counterpart link
PMF	probable maximum flood
PMH	probable maximum hurricane
PMP	probable maximum precipitation
PMSS	probable maximum storm surge
PMT	probable maximum tsunami
PMWP	probable maximum winter precipitation
PMWS	probable maximum wind storm
P_o	central pressure
PPE	plant parameter envelope
PRA	probabilistic risk assessment
PRM	Potomac-Raritan-Magothy
psf	pounds per square foot
PSHA	probabilistic seismic hazard analysis
psi	pounds per square inch
psia	pounds per square inch absolute
PSSA	probabilistic storm surge analysis
Pw	peripheral pressure
PWR	pressurized-water reactor
QA	quality assurance
QAP	quality assurance program
QAPD	Quality Assurance Program Description
QAR	quality assurance requirement
QCLCD	quality controlled local climatological data
R	radius of maximum winds
RAI	Request for Additional Information

RCTS	resonant column torsional shear
REAC/TS	Radiation Emergency Assistance Center/Training Site
rem	roentgen equivalent man
REP	radiological emergency preparedness
RERP	radiological emergency response plan
RG	Regulatory Guide
Rh	rhodium
RIS	Regulatory Issue Summary
RLME	repeated large magnitude earthquake
RM	river mile
RMS	radiation monitoring system
RS	Review Standard
RSCL	reactor safety counterpart link
RVT	random vibration theory
S	south
S/HC	Salem and Hope Creek
s/m^3	seconds per cubic meter
SBO	station blackout
SC	sand clay
SE	southeast
sec/m^3	seconds per cubic meter
SEI	Structural Engineering Institute
SER	safety evaluation report
SFP	spent fuel pool
SGS	Salem Generating Station
SLOSH	Sea, Lake, and Overland Surges from Hurricanes
SM	sand silt
SPDS	safety parameter display system
SPM	Shore Propulsion Model
SPT	standard penetration test
SRM	staff requirements memorandum
SRP	Standard Review Plan
SSAR	site safety analysis report
SSC	structures, systems, and components
SSE	safe shutdown earthquake
SSHAC	Senior Seismic Hazard Analysis Committee
SSI	soil structure interaction
SSW	south-southwest
Sv	sievert
SW	southwest
SWAN	Simulating WAves Nearshore
SWL	still water level
T	forward speed
TAC	technical assessment center
TEDE	total effective dose equivalent
TID	technical information document
TIN	triangular irregular network
TLD	thermoluminescent dosimeter
TR	technical release

TSC	technical support center
TSS	total suspended solids
U.S.	United States
UFSAR	updated final safety analysis report
UHRS	uniform hazard response spectra
UHS	ultimate heat sink
USACE	U.S. Army Corps of Engineers
US-APWR	U.S. Advanced Pressurized-Water Reactor
USCB	U.S. Census Bureau
USCG	U.S. Coast Guard
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
W	west
WBT	wet-bulb temperature
WNW	west-northwest
WSEL	water surface elevation level
WSW	west-southwest
Xe	xenon
ybp	years before present
yr	year

1.0 INTRODUCTION AND GENERAL DESCRIPTION

1.1 Introduction

In a May 25, 2010, letter, PSEG Power, LLC and PSEG Nuclear, LLC (PSEG or the applicant) submitted an early site permit (ESP) application (Agencywide Documents Access and Management System (ADAMS) Accession No. ML101480484) for the proposed PSEG Site.

The proposed site is located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey (NJ). The site is 24.1 kilometers (km) (15 miles (mi)) south of the Delaware Memorial Bridge, 28.97 km (18 mi) south of Wilmington, Delaware (DE), 48.2 km (30 mi) southwest of Philadelphia, Pennsylvania (PA), and 12.1 km (7.5 mi) southwest of Salem, NJ. The other nuclear facilities licensed by the NRC and located adjacent to this site are Salem Generating Station (SGS) Units 1 and 2 and Hope Creek Generating Station (HCGS) Unit 1. The NRC docketed the application on August 4, 2010. Pursuant to 10 CFR Part 52, Subpart A, PSEG requested an ESP with a permit duration of 20 years from the date of issuance.

The staff completed its review of the information presented in the PSEG Site ESP 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 at the site and evaluated whether the site would support adequate physical security measures for a nuclear power plant. The staff evaluated whether the applicant's quality assurance measures were in accordance with the measures discussed in 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." The staff reviewed the complete and integrated emergency plans that PSEG would implement if a nuclear plant is eventually constructed at the PSEG Site.

The PSEG Site ESP application includes the site safety analysis report (SSAR), which describes a safety assessment of the site, as required by 10 CFR 52.17, "Contents of Applications." The public may inspect the final revision of the ESP application in ADAMS (Accession Nos. ML15168A201, ML15169A276, ML15169A740, ML12146A110, ML15169A960, ML15169B024). The application is also available for public inspection at the NRC Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, MD 20852, at the Penns Grove-Carneys Point Public Library, 222 S. Broad Street, Penns Grove, NJ 08069, and at the Salem Free Public Library, 112 W. Broadway, Salem, NJ 08079.

This safety evaluation report (SER)[5] documents the staff's technical evaluation of the suitability of the proposed PSEG Site for construction and operation of either a single unit or dual unit light water reactor (LWR) nuclear power plant falling within the plant parameter envelope (PPE) that PSEG specified in its application. The applicant did not submit a request for a limited work authorization (LWA) and, therefore, was not required to submit a site redress plan. This SER delineates the scope of the technical matters that the staff considered in evaluating the suitability of the proposed nuclear power plant site. U.S. Nuclear Regulatory Commission

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[5] This SER documents the NRC staff's position on all safety issues associated with the early site permit application. 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.

(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). 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 PSEG 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 PSEG Site in a final environmental impact statement (FEIS) (NUREG-2168; ADAMS Accesion No. ML15176A444). The applicant did not submit a request for a limited work authorization (LWA) and, therefore, was not required to submit a site redress plan.

Appendix A to this SER contains the list of site characteristics, permit conditions, combined operating license (COL) action items, and the bounding design parameters, and inspections, tests, analyses and acceptance criteria (ITAAC) that the staff recommends the Commission include in any ESP 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 application for the PSEG 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

The PSEG Site is 24.1 km (15 mi) south of the Delaware Memorial Bridge, 28.97 km (18 mi) south of Wilmington, DE, 48.2 km (30 mi) southwest of Philadelphia, PA, and 12.1 km (7.5 mi) southwest of Salem, NJ. The site location is shown on SSAR Figures 1.2-1 and 1.2-2, which identify major towns, roads, and other prominent features within 9.6 km (6 mi) and 80 km (50 mi), respectively, of the PSEG Site. The existing 2.97 km^2 (734 acre) PSEG property is located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, NJ. With the land acquisition agreement, currently under negotiation with the U.S. Army Corps of Engineers (USACE), for an additional 0.34 km^2 (85 acres) immediately to the north of Hope Creek Generating Station (HCGS), the PSEG Site will be 3.31 km^2 (819 acres). PSEG stated that in absence of the specifics at the time of the ESP issuance, the agreement in principle with the USACE will serve to establish the basis for eventual land acquisition and Exclusion Area Boundary (EAB) control, necessary to support the issuance of a COL in the future.

Subsequent to the signing of the agreement in principle with the USACE, PSEG will develop a lease agreement for the USACE Confined Disposal Facility (CDF) land to the north of the PSEG Site, depicted on the Site Utilization Plan (SSAR Figure 1.2-3) for the concrete batch plant and temporary construction/laydown use. After the completion of construction, the leased land will be returned to the USACE, subject to any required long-term EAB control conditions.

The nearest population center is the city of Wilmington, DE, with its nearest boundary distance of 23.8 km (14.8 mi) having an estimated population of 72,868 people in 2007. The nearest railroad to the PSEG Site, the Southern Railroad Company of NJ, is located 13.2 km (8.2 mi) to

the northeast at its nearest point. The nearest highway, Delaware Route 9, is 5 km (3.1 mi) to the west, across the Delaware River from the PSEG Site. The nearest accessible highway, New Jersey Route 49, is 12.1 km (7.5 mi) to the northeast of the site. Land access to the site is limited to a road that PSEG constructed to connect its property with an existing secondary road 5.8 km (3.6 mi) to the east of the site. A new site access causeway is proposed by the applicant to support construction and operation of a new nuclear power plant.

Three operating nuclear reactors are located adjacent to the PSEG Site. Salem Generating Station (SGS) Units 1 and 2 are Westinghouse Pressurized Water Reactors (PWRs), rated at 3,459 MWt each. Hope Creek Unit 1, located north of the Salem units, is a General Electric Boiling Water Reactor (BWR), rated at 3,840 MWt. Hope Creek Unit 2 was partially constructed directly adjacent to Hope Creek Unit 1. Surrounding the Salem and Hope Creek units are many support facilities, including circulating and service water intake structures, switchyards, administration buildings, and an independent spent fuel storage installation (ISFSI).

The location selected for a new nuclear power plant on the PSEG Site is to the north of the Salem and Hope Creek operating units, as shown on the applicant's Site Utilization Plan, Figure 1.2-3. The applicant established a site layout for each of four different reactor technology types considered for the PSEG Site (see SSAR Section 1.2.2, "Site Development"). The primary power generation areas (e.g., power block area, switchyard, cooling tower area) are located in the same general area on the PSEG Site for each layout considered, and the bounding footprint for each specific area (e.g., power block area) was developed. The applicant stated that this approach provided a bounding depiction of overall land usage on the PSEG Site. In addition to the land acquired from the USACE, as documented above, PSEG will also obtain the right to temporarily use approximately an additional 0.18 km^2 (45 acres) of USACE property north of the current PSEG property boundary for temporary construction use.

1.3 Plant Parameter Envelope

The regulations in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria," that apply to an ESP do not require an ESP applicant to provide specific facility design information. However, some facility design information may be required to address 10 CFR 52.17(a)(1), which calls for "an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in 52.17(a)(1)(i)(x)(a) and 52.17(a)(1)(i)(x)(b) of this section."

In SSAR Section 1.2.2, "Site Development," the applicant stated that design parameter information from the following reactor designs was used in developing the PSEG Site ESP plant parameter envelope (PPE):

- Single Unit U.S. Evolutionary Power Reactor (U.S. EPR)
- Single Unit Advanced Boiling Water Reactor (ABWR)
- Single Unit U.S. Advanced Pressurized Water Reactor (US-APWR)
- Dual Unit Advanced Passive 1000 (AP1000)

In SSAR Section 1.3.1, "Plant Parameter Envelope Approach," the applicant stated that the PPE is a set of postulated parameters that bound the parameters of a reactor or reactors that might be deployed at the PSEG Site. This includes site parameters specified by the reactor vendor that must be met by the PSEG Site. The applicant stated that the PPE serves as a surrogate

for actual facility information. The applicant further stated that PPE parameters, along with information established by features of the site itself (i.e., “site characteristics”), support the 10 CFR Part 52.17 analyses required to demonstrate site suitability.

In SSAR Section 1.3.2, “PPE Development Process,” the applicant stated that for the PSEG Site ESP application, the PPE was developed by reviewing the information developed by the industry prior to the submittal of the Grand Gulf, Clinton, and North Anna ESP applications, reviewing the correspondence between the NRC and industry on the PPE approach, and reviewing safety evaluation reports, environmental impact statements, and RAIs associated with the first three ESP applications.

In SSAR Section 1.3.3, “PSEG Site Plant Parameter Envelope,” Tables 1.3-1 through 1.3-8, the applicant provided a list of postulated design parameters (i.e., PPE), which are developed considering the values provided by the reactor vendors, listed above, to characterize the surrogate facility. The applicant selected the most limiting (maximum or minimum) bounding value. The applicant stated that the site-dependent PPE data was either based on a typical site as provided by the vendors or was modified to take into account site specific conditions, as appropriate. The complete set of plant parameter values characterizes a surrogate plant at the PSEG Site. The applicant stated that SSAR Table 1.3-1 also provides a description or definition for the plant parameters used in evaluating the safety and/or environmental impact of locating the new plant at the PSEG Site.

The staff evaluated the PPE values in the context of applicable SSAR sections of the ESP application. All questions and issues associated with the PPE values that the staff identified during the review as well as their resolution, are discussed in individual sections of this SER.

The applicant provided, through its PPE, sufficient design information to allow it to perform the analysis required by 10 CFR 52.17(a)(1) to determine the adequacy of the proposed exclusion area boundary (EAB) and low population zone (LPZ) for the site. SSAR Chapter 15, “Transient and Accident Analyses” documents the results of this analysis. As stated in SSAR Section 15.1, “Selection of Accidents,” the applicant performed the analysis for a broad spectrum of representative postulated design basis accidents (DBAs) to determine the bounding radiological consequences that affect the safe design and siting of an advanced light-water reactor. The applicant selected accidents based on the LWR technologies being considered for development and the regulatory guidance for performing DBA analysis.

In addition to the information supporting the radiological dose consequence evaluation, the applicant provided other design information in its PPE. Since the applicant is not requesting that an ESP be issued referencing a specific reactor design, the staff’s review criterion for the PPE is that the PPE values should not be unreasonable for a reactor that might be constructed on the ESP site.

The staff reviewed the applicant’s PPE values and finds them reasonable as discussed in individual sections of this SER. As previously noted, the applicant identified certain PPE values as appropriate for inclusion in an ESP, should one be issued. The staff identified certain PPE values as bounding design parameters or controlling PPE values as discussed in the individual sections of this SER. A controlling PPE value, or bounding design parameter value, is one that necessarily depends on a site characteristic. As the PPE is intended to bound multiple reactor designs, the staff would review the actual design selected in a COL or construction permit (CP) application referencing any ESP that might be issued in connection with this application to

ensure that the design fits within the bounding parameter values. Appendix A to this SER lists the bounding design parameters identified for the PSEG ESP Site.

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

1.4 Identification of Agents and Contractors

In Part 1, "Administrative Information," of the ESP application, the applicant provided information about the agents and contractors. Section 3.1, "Name of Applicants" of Part 1 identifies PSEG Power, LLC and PSEG Nuclear, LLC as the applicants for the PSEG Site ESP. PSEG Power, LLC submitted the ESP application for itself and PSEG Nuclear, LLC. In Section 3.4, "Descriptions of Organization and Management of Applicants" of Part 1, the applicant stated that PSEG Power, LLC is a Delaware (DE) limited liability company, which is wholly owned by Public Service Enterprise Group Incorporated, a corporation formed under the laws of New Jersey (NJ) with its headquarters and principal place of business being in Newark, NJ. The applicant further stated that PSEG Nuclear, LLC is organized under the laws of DE with its principal place of business being in Hancock's Bridge, NJ. PSEG Nuclear, LLC is a wholly owned subsidiary of PSEG Power, LLC. The applicant described Public Service Enterprise Group Incorporated as a publicly traded corporation whose shares are widely traded on the New York Stock Exchange. The applicant stated that all of the Directors and principal officers of PSEG Nuclear, LLC, PSEG Power, LLC and Public Service Enterprise Group Incorporated are U.S. citizens. PSEG Nuclear, LLC, PSEG Power, LLC and its parent, Public Service Enterprise Group Incorporated, are not owned, controlled, or dominated by an alien, a foreign corporation, or a foreign government.

As described in Section 1.2 above, there are three existing facilities (HCGS unit 1, and SGS Units 1 and 2) adjacent to the PSEG Site. The applicant also stated in Section 3.4 of Part 1 that of these existing facilities, SGS is 57.41 percent owned by PSEG Nuclear, LLC and 42.59 percent by Exelon Generation LLC, and HCGS is solely owned by PSEG Nuclear, LLC. PSEG Nuclear, LLC is the licensed operator of SGS and HCGS at the PSEG Site, with complete authority to regulate any and all access and activity within the plant exclusion area boundary, and authority to act as the agent of the site owners.

Sargent & Lundy, LLC provided engineering, management, and consulting services to prepare the ESP application. This included project management and engineering services, developing SSAR and environmental report (ER) sections, developing the emergency plan, and preparing the ESP application.

Several subcontractors also assisted in the development of the ESP application. MACTEC Engineering and Consulting, Inc., performed hydrogeological, hydrological and geotechnical field investigations and laboratory testing in support of the ESP application for the PSEG Site.

This testing included performing standard penetration tests for the site, obtaining core samples, and installing groundwater observation wells. In June 2011, AMEC acquired MACTEC Engineering and Consulting, Inc. AMEC Environment and Infrastructure, Inc., provided hydrogeological, hydrological, and geotechnical engineering services in support of the ESP application for the PSEG Site.

William Lettis & Associates, Inc., performed geologic mapping and characterized seismic sources in support of SSAR Section 2.5, “Geology, Seismology, and Geotechnical Information,” including literature review, geologic field reconnaissance, review and evaluation of existing seismic source characterization models, identification and characterization of any new or different sources, and preparation of the related SSAR sections. In December 2007, William Lettis & Associates, Inc., was acquired by Fugro Consultants, Inc. William Lettis & Associates operated as a unit of Fugro Consultants until being integrated into Fugro Consultants. Fugro Consultants supported geoscience topics associated with SSAR Section 2.5.

1.5 Summary of Principal Review Matters

This SER documents the staff’s technical evaluation of the PSEG Site ESP application. 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 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 SGS and HCGS operating units

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

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

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

- quality assurance measures PSEG 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)

- the acceptability of the applicant's information related to the Fukushima NTTF Recommendations 2.1, and 9.3.

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

Appendix A to this SER includes a list of the site characteristics, bounding design parameters, permit conditions, COL action items, and ITAAC that the staff recommends be included in an ESP for the PSEG 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 design parameters set forth the postulated design parameters that provide design details to support the staff's review. An explanation of COL action items, permit conditions, and ITAAC is provided below in Sections 1.7, 1.8, and 1.9, respectively.

1.6 Summary of Open Items and Confirmatory Items

The staff conducted a 4-phase review of the PSEG Site ESP application. The staff identified several open items during the first phase (i.e., Phase A, which included requests for additional information (RAIs) and supplemental RAIs). For this phase, the staff considered an item as being Open if the applicant had not yet provided the requested information and the staff did not know what would ultimately be included in the applicant's response. During the second phase (i.e., Phase B), the staff received and reviewed the applicant's responses to all RAIs and all supplemental RAIs. In consideration of the applicant's responses to the RAIs and the results of the regulatory audits conducted in Phases A and B, the staff developed Advanced Safety Evaluations (ASEs) with no open items at the end of Phase B. The staff presented the ASEs with no open items to the Advisory Committee on Reactor Safeguards (ACRS) as part of Phase C of the review. Phase D is the issuance of this Final Safety Evaluation Report (FSER).

The staff identified confirmatory items to verify that the applicant incorporated all the necessary changes to which it had committed in RAI responses. An item was identified as confirmatory if the staff and the applicant agreed on a resolution of a particular item, but the resolution had not yet been formally documented in the subsequent revision of the application.

The staff has completed its review of Revision 4 to the PSEG Site ESP application, submitted by the applicant on June 5, 2015, and has verified that the applicant did incorporate those changes in Revision 4. Therefore, the staff considers all confirmatory items closed.

1.7 Summary of Combined License Action Items

The staff 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 a new nuclear plant on the PSEG Site and references the PSEG Site 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 applicant or

CP applicant referencing the PSEG Site ESP. An applicant for a COL or CP referencing the PSEG Site 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 application 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 and for reasons specified in this SER for each item, the COL action items are more appropriately addressed when the applicant has applied for a CP or COL.

The staff identified 36 COL action items. Appendix A to this SER includes the COL action items that a future COL applicant or CP applicant referencing the PSEG Site ESP will need to address. These COL action items are documented in Appendix A to this SER 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 application or CP application referencing the ESP for the PSEG 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.

1.8 Summary of Permit Conditions

The staff identified certain permit conditions that it will recommend be imposed if an ESP is issued to the applicant. The permit conditions are associated with the review of the following areas of the ESP application: "Exclusion Area Authority and Control"; "Evaluation of Potential Accidents – Explosions and Flammable Vapor Clouds"; "Surface Faulting – Geologic Mapping"; "Stability of Subsurface Materials and Foundations – Liquefaction Potential"; and "Emergency Planning." In total, nine permit conditions are identified.

Appendix A to this SER summarizes these permit conditions. Each permit condition has been assigned a number based on the order in 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."

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

For the reasons explained in this SER, 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 of 1954, as amended, and Commission rules and regulations.

The staff has identified certain ITAAC that it will recommend be imposed with respect to an ESP issued to the applicant. As part of this SER, the staff reviewed and included ITAAC necessary for PSEG's Emergency Plans. 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.

1.10 Summary of Fukushima Near-Term Task Force (NTTF) Recommendations

After the March 2011 Fukushima Dai-ichi Nuclear Power Plant accident following the Great Tohoku earthquake and subsequent tsunami, the NRC formed a Near-Term Task Force that issued recommendations to reevaluate the safety of nuclear power plant facilities licensed by the NRC and located in the U.S. On March 12, 2012, the NRC issued an information letter[6] requiring all U.S. operating nuclear power plant licensees to provide further information to support the evaluation of the NRC staff recommendations for the NTTF review of the accident at the Fukushima Dai-ichi nuclear facility. As for the applications under review at the time, the NRC determined that applicants for a COL or an ESP should also provide information with respect to those NTTF recommendations that were applicable for their proposed sites and plants. For the PSEG Site ESP application, only NTTF Recommendation 9.3 (Emergency Preparedness) was determined to be appropriate for the applicant to address.

As for NTTF Recommendation 2.1, the applicant evaluated the seismic and flood hazards using current guidance and methodologies. The staff concluded that the applicant has already addressed the seismic and flood hazard reevaluation portion of Recommendation 2.1. Therefore, there are no additional requirements left to be addressed in Recommendation 2.1 for seismic and flooding reevaluations applicable to the PSEG Site ESP application.

Regarding NTTF Recommendation 9.3, the staff requested that PSEG address staffing and communications provisions to enhance emergency preparedness.

The staff's evaluation of the information submitted by PSEG related to the above mentioned NTTF recommendations (2.1 "Seismic and Flood Hazard Reevaluations" and 9.3 "Emergency Preparedness Regulatory Actions (staffing and communications)") is provided in Chapter 20 of this SER. All other NTTF recommendations will be addressed at the COL application stage and post-licensing stage, as appropriate.

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[6] NRC March 12, 2012, Letter, "Request for information pursuant to Title 10 of the *Code of Federal R*egulations 50.54(f) regarding NTTF Recommendations 2.1, 2.3, and 9.3, from the Fukushima Dai-ichi accident." (ADAMS Accession No. ML12053A340)

2.0 SITE CHARACTERISTICS

2.1 Geography and Demography

2.1.1 Site Location and Description

2.1.1.1 Introduction

The descriptions of the PSEG Site area and reactor location are used to assess the acceptability of the reactor site. The U.S. Nuclear Regulatory Commission (NRC) staff's review covers the following specific areas: (1) Specification of reactor location with respect to latitude and longitude, political subdivisions, and prominent natural and manmade features of the area; (2) map of the site area to determine the distance from the PSEG power block area to the boundary lines of the exclusion area, including consideration of the location, distance, and orientation of plant structures with respect to highways, railroads, and waterways that traverse or lie adjacent to the exclusion area; and (3) any additional information requirements prescribed in the applicable subparts to Title 10 of the *Code of Federal Regulations* (10 CFR) 52.17, "Contents of Applications; Technical Information." The purpose of the review is to ascertain the accuracy of the applicant's description of the PSEG Site for use in independent evaluations of the exclusion area authority and control, the surrounding population, and nearby manmade hazards.

2.1.1.2 Summary of Application

The applicant addressed the PSEG Site location and description in Site Safety Analysis Report (SSAR) Section 2.1.1, "Site Location and Description" of the Early Site Permit (ESP) application, in which the applicant provided site-specific information related to site location and description, including political subdivisions, natural and manmade features, population, highways, railways, waterways, and other significant features of the area. In SSAR Figure 1.2–1, "PSEG Site Location—6-Mile Radius," and SSAR Figure 1.2–2, "PSEG Site Location—50-Mile Radius," the applicant showed the PSEG Site location and the surrounding area within 9.6 kilometers (km) (6 miles (mi)) and 80 km (50 mi), respectively, and identified the prominent natural and manmade features, including the Delaware River, towns, and major transportation routes.

2.1.1.3 Regulatory Basis

The relevant requirements of NRC regulations for the site location and description and the associated acceptance criteria, are specified in NUREG-0800, Section 2.1.1, "Site Location and Description."

The applicable regulatory requirements for identifying site location and description are:

- 10 CFR 50.34(a)(1) (Contents of Applications; technical information), 10 CFR 52.17(a)(1) (Contents of Applications; technical information), and 10 CFR 52.79(a)(1) (Contents of Applications; technical information in final safety analysis report), as they relate to the inclusion in the safety analysis report (SAR) of a detailed description and safety assessment of the site where the facility will be located, with appropriate attention to features affecting facility design

- 10 CFR Part 100, “Reactor Site Criteria,” as it relates to the following: (1) Defining an exclusion area and setting forth requirements regarding activities in that area (10 CFR 100.3, “Definitions”); (2) addressing and evaluating factors that are used to determine the acceptability of the site as identified in 10 CFR 100.20, “Factors to be considered when evaluating sites,” subpart (b); (3) determining an exclusion area such that certain dose limits would not be exceeded in the event of a postulated fission product release as identified in 10 CFR 50.34(a)(1), as it relates to site evaluation factors identified in 10 CFR Part 100; and (4) requiring that the site location and the engineered features included as safeguards against the hazardous consequences of an accident, should one occur, would ensure a low risk of public exposure

2.1.1.4 Technical Evaluation

SSAR Section 2.1.1 addresses the following information:

The PSEG Site is approximately 48.3 km (30 mi) southwest of Philadelphia, PA, 24 km (15 mi) south of the Delaware Memorial Bridge, and 12 km (7.5 mi) southwest of Salem, NJ. The nearest population center is the city of Wilmington, DE, with its nearest boundary distance of 23.8 km (14.8 mi) having an estimated population of 72,868 in 2007. The PSEG Site consists of approximately 2.97 km^2 (734 acres) of land, and with an anticipated acquisition of an additional 0.34 km^2 (85 acres) land from the U.S. Army Corp of Engineers (USACE), the PSEG Site will be 3.3 km^2 (819 acres).

SSAR Figure 1.2–2 shows the PSEG Site location and the surrounding area within 80 km (50 mi). The site location, natural and manmade features, including rivers and major transportation routes within 9.6 km (6 mi), are shown in SSAR Figure 1.2-1. The nearest railroad to the PSEG Site, the Southern Railroad of New Jersey, is 13.2 km (8.2 mi) to the northeast at its nearest point. The nearest highway, Delaware Route 9, is about 5 km (3.1 mi) to the west of the Delaware River from the PSEG Site. The nearest accessible highway, New Jersey Route 49, is 12 km (7.5 mi) to the northeast of the PSEG Site. Land access to the PSEG Site is limited to a road that PSEG constructed to connect its property to an existing secondary road, 5.8 km (3.6 mi) to the east of the PSEG Site. A new access causeway is proposed to support construction and operation of the new plant.

The staff reviewed SSAR Section 2.1.1 related to site location and description, including natural and manmade features, highways, railways, waterways, and other significant features of the area. The staff confirmed that the information in the application addresses the requirements for identifying PSEG Site location and description.

Using maps publicly available, the staff independently estimated and confirmed the latitude and longitude that the applicant supplied. The staff then converted this latitude and longitude to Universal Transverse Mercator (UTM) coordinates and verified the UTM coordinates of the PSEG Site reference point in the SSAR.

Coordinates for the power block reference point are provided in geodetic and UTM systems. SSAR Section 2.1.1.2 (Paragraph 2) and SSAR Figure 1.2–3 identified the UTM coordinates without units, which appear to be measured in feet. Therefore, in RAI 9, Question 02.01.01-1, the staff requested that the applicant annotate the list of UTM coordinates in the SSAR and to do so in the marginal notes on SSAR Figure 1.2-3 with the correct units of measure. In a March 21, 2011, response to RAI 9, Question 02.01.01-1, the applicant provided a revision to

SSAR text in Section 2.1.1.2 and SSAR Figure 1.2-3 with the English unit of measurement (in feet), and committed to revise the SSAR with this information. The staff reviewed the applicant's response and subsequently confirmed that SSAR Revision 1, submitted on May 21, 2012, contained the information as committed in the RAI response. Accordingly, the staff finds the applicant's response acceptable and considers RAI 9, Question 02.01.01-1, resolved.

The geodetic and UTM coordinates are as follows:

Geodetic		**UTM Coordinates (NAD83, Zone 18 (in meters))**	
Latitude	**Longitude**	**Northing**	**Easting**
N39° 28' 23.744"	W75° 32' 24.332"	4,369,427.579 m	453,544.585 m
		(14,335,392.324 ft)	(1,488,007.170 ft)

The PSEG proposed Exclusion Area Boundary (EAB) is a circle at least 600 m (1968 ft) from the edge of the power block area in all directions as shown in SSAR Figure 1.2–3. As shown in SSAR Figure 2.1-23, the proposed EAB extends beyond the PSEG Site property line to west (into the Delaware River) and to the north and northeast. The total area that the EAB encompasses is 3.0 km^2 (743 acres), of which 0.91 km^2 (224 acres) is in the Delaware River and 1.17 km^2 (288 acres) is in land that PSEG currently owns. PSEG will own an additional 0.344 km^2 (85 acres) of land when it completes property acquisition with the USACE. The land within the EAB that PSEG does not own consists of 0.59 km^2 (146 acres), which the Federal Government owns. No public roads, railroads, or structures other than the existing PSEG power plant facilities are located within any part of the EAB. From the information in SSAR Section 2.1.1.2 and SSAR Figure 1.2–3, it appears to the staff that the additional 0.344 km^2 (85 acres) of land is bounded by the area, as described in "PSEG Proposed New Property Line." In RAI 9, Question 02.01.01–2, the staff requested that the applicant distinguish the different areas in EAB and clarify them in SSAR Section 2.1.1.2 and SSAR Figure 1.2–3 accordingly. In a March 21, 2011, response to RAI 9, Question 02.01.01-2, the applicant provided clarification along with proposed revisions to SSAR Section 2.1.1.2 and SSAR Figure 1.2–3. The staff reviewed the response and found the applicant's clarification appropriate and adequate, and therefore acceptable. The staff also confirmed the inclusion of the proposed revisions in SSAR Section 2.1.1.2 and SSAR Figure 1.2-3, Revision 1, submitted on May 21, 2012. Accordingly, the staff considers RAI 9, Question 02.01.01–2, resolved.

The land boundary, on which technical specification limits for release of gaseous radioactive effluents are based, is the PSEG Site property line shown in SSAR Figure 1.2–3. The minimum distance from the center point to the property line is 265.8 m (872 ft) in the west direction. The staff notes this suggests that it is one of the site boundary receptor locations being considered for dose evaluation. However, in a September 9, 2011, response to RAI 35, Question 02.03.05-04 (on SSAR Section 2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases"), the applicant stated that although X/Q and D/Q values have been calculated for all 16 radial directions at the PSEG Site boundary including the PSEG Site boundary location receptor addressed above at 265.8 m (872 ft) in the west direction, sectors adjacent to the Delaware River (sectors SE to NW in clockwise direction) are not considered in the dose evaluations. Therefore, in follow up RAI 49, Question 02.01.01-3, the staff requested that the applicant update the information in SSAR Section 2.1.1.3 for clarity and consistency. In a February 24, 2012, response, the applicant provided information clarifying and justifying

why sectors adjacent to the Delaware River are not considered in the dose evaluations. The applicant also committed to revise SSAR Section 2.1.1.3 with this information. The applicant specifically stated in the February 24, 2012, response to RAI 49, Question 02.01.01-3, that the X/Q and D/Q values (SSAR Table 2.3-37) at the PSEG Site boundary, adjacent to the Delaware River (sectors SE to NW in clockwise direction), are not considered in the associated analyses for radiological exposure from routine gaseous effluents, and that excluding the area adjacent to the Delaware River is acceptable because of the negligible time any individual is expected to spend in this area during any one-year period. The applicant further stated that the X/Q and D/Q values considered in the associated analyses for radiological exposure due to the routine gaseous effluents are those in sectors NNW to ESE (clockwise direction). The staff reviewed the applicant's response, clarification, and conclusion that doses resulting from radiological exposure will be negligible based on short-term presence of individuals in this area during any one-year period. The staff finds the applicant's clarification appropriate and adequate, and therefore acceptable. The staff also confirmed the inclusion of the proposed revision in SSAR Section 2.1.1.3, Revision 1, submitted on May 21, 2012. Accordingly, the staff considers RAI 49, Question 02.01.01–3, resolved.

The staff reviewed the site area map in the SSAR (Figure 1.2–3) for the proposed PSEG Site to verify that the distance from the proposed power block to the boundary line of the exclusion area meets the guidance in NUREG-0800, Section 2.1.1. Based on its review of the information in the SSAR, and confirmatory review of prominent, natural, and manmade features of the area as found in publicly available documentation, the staff finds the information provided by the applicant with regard to the PSEG Site location and description adequate and acceptable.

2.1.1.5 Conclusion

As discussed above, the applicant presented and substantiated information to establish the PSEG Site location and description, which includes the information submitted by the applicant in response to RAIs. The staff reviewed the information that the applicant submitted and for the reasons given above, concludes that the applicant has established site characteristics and design parameters acceptable to meet the requirements of 10 CFR 52.17(a)(1), 10 CFR 100.3, and the radiological consequence evaluation factors in 10 CFR 50.34(a)(1). The staff also affirms that the applicant provided sufficient details about the PSEG Site location and site area, as documented in SSAR Sections 2.1.2, 2.1.3, and 13.3 and SSAR Chapter 15. These details allowed the staff to conclude that the applicant met the requirements in 10 CFR 52.17(a)(1) and 10 CFR Part 100 regarding site location and description.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Introduction

The descriptions of exclusion area authority and control are used to verify that the applicant's legal authority to determine and control activities within the designated exclusion area, as provided in the application, is sufficient to allow reviewers to assess the acceptability of the reactor site. The staff's review covers the following specific areas:

- establishing the applicant's legal authority to determine all activities within the designated exclusion area
- validating the applicant's authority and control to exclude or remove personnel and property from the area in the event of an emergency

- establishing that proposed or permitted activities in the exclusion area that are unrelated to operation of the reactor do not result in a significant hazard to public health and safety

- requesting any additional information requirements prescribed in 10 CFR 52.17

2.1.2.2 Summary of Application

The applicant identified the exclusion area boundary and addressed the authority and control of the area in the case of an emergency. The applicant addressed the information pertaining to ownership, activities, authority and control, including arrangements for traffic control.

2.1.2.3 Regulatory Basis

The relevant requirements of NRC regulations for exclusion area authority and control and the associated acceptance criteria, are specified in NUREG-0800, Section 2.1.2, "Exclusion Area Authority and Control," as well as Review Standard (RS)-002, "Processing Applications for Early Site Permits."

The applicable regulatory requirements for verifying exclusion area authority and control are:

- 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1), as they relate to the inclusion in the site SAR of a detailed description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design

- 10 CFR Part 100, as it relates to the following: (1) Defining an exclusion area and setting forth requirements regarding activities in that area (10 CFR 100.3); (2) addressing and evaluating factors that are used to determine the acceptability of the site as identified in 10 CFR 100.20(b); and (3) determining an exclusion area such that certain dose limits would not be exceeded in the event of a postulated fission product release as identified in 10 CFR 50.34(a)(1) as it relates to site evaluation factors identified in 10 CFR Part 100

2.1.2.4 Technical Evaluation

In SSAR Section 2.1.2.1, the applicant stated that PSEG owns 1.17 km^2 (288 acres) of the land within the proposed EAB with mineral rights. In addition, PSEG is working with the USACE to acquire 0.34 km^2 (85 acres) of land, including mineral rights that will be within the proposed EAB. When the property acquisition is completed, PSEG will have ownership of 1.51 km^2 (373 acres) of land within the proposed EAB, as shown in SSAR Figure 2.1–23. The only land within the proposed EAB that PSEG will not own is the 0.59 km^2 (146 acres) located to the north and northeast of the PSEG property line. The Federal Government owns this land, and the USACE controls it. On March 10, 2014, the NRC staff conducted a public meeting with PSEG (teleconference format) in order to discuss the regulatory considerations relating to ownership and control of land within the EAB and to clarify corresponding information in the SSAR. Subsequently, on April 3, 2014, PSEG submitted clarifying revisions to SSAR Section 2.1.2 describing ownership and control arrangements within the EAB and proposing Permit Condition 1, which is presented in Section 2.1.2.5 of this report. According to the submitted information and as memorialized in Permit Condition 1, with respect to the 0.59 km^2 (146 acres) parcel owned by the Federal government and currently controlled by the USACE, PSEG commits to obtaining legal authority from the USACE to either allow PSEG and its surrogates to determine all activities including exclusion or removal of personnel and property from the area or require that the USACE exercise control in a specified manner. The agreement will specify

that no residences are allowed within the Exclusion Area. Some public uses of the land may be allowed, but PSEG will acquire the ability to remove and subsequently exclude people. The staff finds PSEG's descriptions of its arrangements for exclusion area authority and control, including proposed Permit Condition 1, acceptable because they ensure that PSEG will have appropriate authority to determine or control access and exclusion to areas within the EAB. Prior to issuance of a COL, PSEG, or other COL applicant referencing the ESP, shall complete the activities called for in Permit Condition 1 and submit notification of their completion to the NRC for staff verification. PSEG committed to revise SSAR Section 2.1.2 in a future update of the ESP application to incorporate the changes provided in Enclosure 1 to its April 3, 2014, letter. The staff identified this as Confirmatory Item 2.1-1. The staff verified that in Revision 4 to the PSEG Site ESP application (June 5, 2015), the applicant incorporated the changes. Therefore, the staff considers Confirmatory Item 2.1-1 closed.

According to the emergency plan (EP) submitted with the PSEG Site ESP application, the U.S. Coast Guard (USCG) is responsible for warning people in boats, assisting in traffic control of boats, and notifying people swimming, fishing, and boating on the Delaware River in the PSEG Site vicinity in the event of a radiological emergency. This agreement will be extended to address all open-water areas within the proposed EAB for the new plant. The USACE and USCG are the two primary agencies that interface with PSEG to establish control of the EAB. In the event of an emergency, other agencies, such as State and local police, fire departments, and State and county emergency management agencies will be activated in accordance with the emergency plan. They can be called upon to support PSEG's response during emergencies. PSEG Site EP, which is Part 5 of the PSEG Site ESP application, lists the roles and responsibilities of PSEG as well as those of all offsite agencies during an emergency.

The NRC guidance for the review of an ESP applicant's implementation of these requirements is provided in Review Standard (RS)-002, "Processing Applications for Early Site Permits," Attachment 2, Section 2.1.2, "Exclusion Area Authority and Control," and in NUREG-0800, "Standard Review Plan," Section 2.1.2, "Exclusion Area Authority and Control." In Section 2.1.2 of both RS-002 and NUREG-0800, the review guidance states that, in order to meet the requirements of 10 CFR Part 100, the applicant must demonstrate, before issuance of an ESP, that it has the authority within the exclusion area as 10 CFR 100.3 requires, otherwise, the applicant must provide reasonable assurance that such authority will be obtained prior to the start of construction. Absolute ownership of all lands within the exclusion area, including mineral rights, is considered to carry with it the required authority to determine all activities on the land and is acceptable.

In SSAR Section 2.1.2.2, the applicant addressed control of activities unrelated to plant operation. The applicant discussed planned acquisition of the 0.34 km^2 (85 acres) of land from the USACE, a confined disposal facility (CDF) that the USACE uses and which stretches into the EAB. The Federal Government owns this land area of the proposed EAB that includes CDF area of 0.34 km^2 plus another 0.25 km^2 totaling 0.59 km^2 (146 acres), all of which the USACE controls. The applicant's discussion of control of the EAB also included negotiations with the USACE and USCG; however, finalization of agreements on land acquisition was unclear to the staff. Therefore, in RAI 10, Questions 02.01.02-1, 02.01.02-2, and 02.01.02-3, the staff requested that the applicant update the discussions in SSAR Subsection 2.1.2, including any associated current or new figure(s) that confirm whether the area, annotated on SSAR Figure 1.2-3 (Site Utilization Plan) as "Dike Area," represents the CDF; and that the applicant explain personnel involvement logistics in the dredged material disposal activity. In a March 22, 2011, response to RAI 10, Questions 02.01.02-1, 02.01.02-2, and 02.01.02-3, the applicant

clarified each item and also proposed a revision to SSAR Section 2.1.2.2. The staff reviewed the applicant's response and finds the response acceptable as the applicant provided adequate clarifying information. However, the applicant did not submit with the response a markup of the proposed revision of or a regulatory commitment to revise SSAR Section 2.1.2.2, or Section 2.1.2 in general. Therefore, in follow up RAI 58, Questions 02.01.02-4, 02.01.02-5, and 02.01.02-6, the staff requested that the applicant integrate the applicable portions of the response to RAI 10, Questions 02.01.02-1, 02.01.02-2, and 02.01.02-3, into SSAR Section 2.1.2. The information expected in the applicant's response would clarify, and also allow the staff to evaluate, if the applicant would acquire appropriate legal authority and control over EAB, including the exclusion and removal of personnel and property in the event of an accident. In a March 30, 2012, response to RAI 58, Questions 02.01.02-4, 02.01.02-5, and 02.01.02-6, the applicant provided the proposed revisions to SSAR Section 2.1.2. The staff confirmed that the applicant's committed revisions are included in SSAR Revision 1, submitted on May 21, 2012. The staff finds that the information provided by the applicant adequately addressed the staff's request in RAI 10, Questions 02.01.02-1, 02.01.02-2, and 02.01.02-3, as well as in RAI 58, Questions 02.01.02-4, 02.01.02-5, and 02.01.02-6, thereby conforming to the guidance provided. Accordingly, the staff considers the RAI 10, Questions 02.01.02-1, 02.01.02-2, and 02.01.02-3, and RAI 58, Questions 02.01.02-4, 02.01.02-5, and 02.01.02-6, resolved.

The operating Salem Generating Station (SGS) and Hope Creek Generating Station (HCGS) have provisions to notify people in the EAB of the need to evacuate the area in an emergency. These provisions include sirens, plant page, and an agreement with the USCG. Provisions similar to those that are in effect for SGS and HCGS will be established for the new plant at the proposed PSEG Site. The USCG is responsible for controlling traffic on the Delaware River in the event of an emergency. No other arrangements for traffic control are required because no public roads, railways, or other waterways traverse the proposed EAB.

The applicant supplied the following information and the staff verified it: There are no residences and unauthorized commercial activities within the exclusion area; no public highways or railroads traverse the exclusion area, and there are no residents in the exclusion area. The staff verified for consistency that the EAB is the same as being considered for the radiological consequences in SSAR Chapter 15, "Transient and Accident Analysis" and SSAR Chapter 13, "Conduct of Operations," Section 13.3, "Emergency Plan."

The staff used publicly available maps and satellite pictures to verify that no publicly used transportation mode crosses the EAB; therefore, arrangements for the control of traffic in the event of an emergency are not required.

Using maps and satellite pictures, the staff verified that no public roads cross the exclusion area; therefore, neither relocation nor abandonment of roads is needed.

2.1.2.5 Permit Condition

Permit Condition 1

> An applicant for a combined license (COL) or construction permit (CP) referencing this early site permit shall notify the U.S. Nuclear Regulatory Commission staff when the COL applicant has acquired the required authority and control over the Exclusion Area

(prior to issuance of any combined license that references this ESP) and shall provide confirmation that the basis for that conclusion includes the following:

1. The COL or CP applicant shall complete the acquisition of 0.34 km^2 (85 ac.) of land, including mineral rights, from the USACE that is currently part of the confined disposal facility north of the site.

2. The COL or CP applicant shall modify the existing PSEG Site Radiological Emergency Response Plan and the existing PSEG Site Security Plan, and reach agreements with the U.S. Coast Guard (USCG), to extend the protections for the Delaware River portion of the existing Salem and Hope Creek Exclusion Area to cover the Delaware River portion of the Exclusion Area related to the ESP.

3. The COL or CP applicant shall reach agreement with the USACE for any land within the EAB that will not be owned by the COL applicant to obtain legal authority from the U.S. Army Corps of Engineers (USACE) to either allow the COL applicant and its surrogates to determine all activities including exclusion or removal of personnel and property from the area or require that the USACE exercise that control in the manner specified by the COL or CP applicant.

2.1.2.6 Conclusion

As discussed above, the applicant presented and substantiated information concerning its plan to obtain legal authority and control of all activities within the designated exclusion area boundary. The staff reviewed the information and, for the reasons stated above, concludes that the applicant’s designated exclusion area meets the requirements of 10 CFR 50.34(a)(1), 10 CFR 52.17(a)(1), 10 CFR Part 100, and 10 CFR 100.3 in determining the acceptability of the PSEG Site. The staff based its conclusion on the following:

- the applicant appropriately described the plant exclusion area

- the authority under which all activities within the exclusion area can be controlled

- the methods by which the relocation or abandonment of public roads that lie within the proposed exclusion area can be accomplished, if necessary

- 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

The staff also considered that the applicant has or, prior to COL issuance as required by Permit Condition 1, will obtain the required authority to determine or control activities within the designated exclusion area, including the exclusion and removal of persons and property, and will establish acceptable methods for control of the designated exclusion area as described in the SSAR.

As discussed above, the applicant has provided details on current and future agreements in its SSAR and in proposed Permit Condition 1 concerning its plans to acquire land and/or legal authority to determine or control all activities within the designated exclusion area. The staff reviewed SSAR Section 2.1.2 along with responses to requests for additional information (RAIs), and for the reasons stated above and subject to Permit Condition 1 and consistent with the resolution of Confirmatory Item 2.1-1, concludes that the applicant’s designated exclusion

area meets the requirements of 10 CFR 50.34(a)(1), and 10 CFR 52.17(a)(1), and 10 CFR Part 100 in determining the acceptability of the PSEG Site.

2.1.3 Population Distribution

2.1.3.1 Introduction

The description of population distributions addresses the need for information about the following:

- population in the site vicinity, including transient populations
- population in the exclusion area
- whether appropriate protective measures could be taken on behalf of the populace in the specified low-population zone (LPZ) in the event of a serious accident
- whether the nearest boundary of the closest population center having 25,000 or more residents is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ
- whether the population density in the site vicinity is consistent with the guidelines given in Regulatory Guide (RG) 4.7, “General Site Suitability Criteria for Nuclear Power Stations,” Regulatory Position C.4
- any additional information requirements prescribed in the applicable subparts to 10 CFR 52.17, “Contents of Applications; Technical Information”

2.1.3.2 Summary of Application

The applicant addressed the population distribution surrounding the PSEG Site to an 80 km (50 mi) radius based on 2000 U.S. Census data, which was the most recent data at the time of submission of the ESP application. The population distribution was estimated in 10 concentric rings for 16 cardinal directional sectors. The 2010 populations were projected by using U.S. Census Bureau (USCB) growth rates for the years 2000 through 2008. From 2010 onward, population growth rates were derived from county population projections developed by the states of Delaware, Maryland, New Jersey, and Pennsylvania. The county population growth rates derived from these projections were used to extrapolate the baseline 2010 projections to 2021 and 2031 for appropriate counties within each of the four states. Population projections beyond 2031 were based on county-specific annual growth rates calculated for each county between 2021 and 2031. The county-specific growth rates for this 10-year period were used to obtain the population projections for each successive 10-year period (2041, 2051, 2061, 2071, and 2081). The applicant also addressed the transient population, low population zone, population center, and population density.

2.1.3.3 Regulatory Basis

The relevant requirements of NRC regulations for population distribution and the associated acceptance criteria are specified in NUREG-0800, Section 2.1.3, “Population Distribution,” as well as RS-002.

The applicable regulatory requirements pertinent to the review of population distribution are:

- 10 CFR 50.34(a)(1), as it relates to consideration of the site evaluation factors identified in 10 CFR 100.3.
- 10 CFR Part 100 (including consideration of population density), and 10 CFR 52.17, as they relate to provision by the applicant in the SSAR of the existing and projected future population profile of the area surrounding the site.
- 10 CFR 100.20, "Factors To Be Considered When Evaluating Sites," and 10 CFR 100.21, "Non-Seismic Site Criteria," requirements, as they relate to determining the acceptability of a site. In 10 CFR 100.3, 10 CFR 100.20(a), and 10 CFR 100.21(b), the NRC provides definitions and other requirements to determine an exclusion area, LPZ, and population center distance.

The related acceptance criteria from NUREG-0800, Section 2.1.3 and RS-002 are as follows:

Population Data: The information on population data that the applicant supplied in the SSAR is acceptable under the following conditions: SSAR (1) includes present and future population data for the life of the plant from the latest census data and projected population; (2) describes the methodology and sources used to obtain the population data, including the projections; and (3) includes information on transient populations in the site vicinity.

Exclusion Area: The exclusion area should not have any residents or such residents should be subject to ready removal if necessary.

Low-Population Zone: 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.

Nearest Population Center Boundary: The nearest boundary of the closest population center having 25,000 or more residents is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ.

Population Density: If the population density exceeds the guidelines given in RG 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Regulatory Position C.4, the applicant must give special attention to considering alternative sites with lower population densities.

2.1.3.4 Technical Evaluation

The staff reviewed SSAR Section 2.1.3 and confirmed that the application addressed the required information relating to population distribution.

The staff reviewed the data on the population in the PSEG Site environs, as presented in SSAR Sections 2.1.1, 2.1.2, and 2.1.3, to determine whether the exclusion area, LPZ, and nearest population center distance for the proposed site comply with the requirements of 10 CFR Part 100. The staff also evaluated whether, consistent with RG 4.7, Regulatory Position C.4, the applicant should consider alternative sites with lower population densities. Further, the staff reviewed whether appropriate protective measures could be taken on behalf of the enclosed populace within the Emergency Planning Zone (EPZ), which encompasses the LPZ, in the event of a serious accident.

Based on the 2000 U.S. Census data, an estimated 33,871 residents are located within 16.2 km (10 mi) of the PSEG Site. No population exists within 3.2 km (2 mi) of the PSEG Site, and it is estimated that 75 individuals are within 3.2 to 4.8 km (2 to 3 mi). Based on population projections, the population within 16.1 km (10 mi) of the PSEG Site is expected to increase to 42,743 in 2010, 45,527 in 2021 (first year of operation), and 60,892 in 2081 (end of plant operating life). The population projections, including those for residents and transients, within 16.1 km (10 mi) of the PSEG Site for the years 2010 through 2081 are presented in SSAR Figures 2.1-4 through 2.1-11.

Based on the 2000 U.S. Census data, an estimated 5,230,454 residents are located within 80 km (50 mi) of the PSEG Site. The population within 16.1 to 80 km (10 to 50 mi) of the PSEG Site is projected to increase to 5,418,212 in 2010, 5,760,985 in 2021, and 8,077,743 in 2081. The population projections between 16.1 and 80 km (10 and 50 mi) from the PSEG Site for the years 2000 through 2081 are presented in SSAR Figures 2.1-12 through 2.1-20.

In addition to the permanent residents within 16.1 km (10 mi) of the PSEG Site, there are people who are considered transient that enter this area on a regular basis for employment, education, recreation, and medical care. SSAR Table 2.1-3 provides the sources of transient populations within 16.1 km (10 mi) of the PSEG Site and provides estimated populations for 2008. SSAR Table 2.1-4 presents estimated projected transient populations for 2010 and 2081, with the assumption that the transient populations grow at the same rate as that of resident populations. The total transient population within 16.1 km (10 mi) is projected to be 12,549 in 2010, increasing to 13,378 in 2021 and 18,063 in 2081.

The transient population within 16.1 and 80 km (10 and 50 mi) include major employment centers (Philadelphia, PA; Camden, Vineland, Millville, and Bridgeton, NJ; and Wilmington, Newark, and Dover, DE), major public recreation areas, shopping malls, Delaware Park (a casino and racetrack) located in Wilmington, DE. The estimated total 2008 employment figure for the metropolitan areas is 1,676,400 as shown in SSAR Table 2.1-5. Visitors to the recreation areas are 5,814,971 annually, as shown in SSAR Table 2.1-6. Annual visitors to the shopping malls are estimated to be 17,000,000, and to Delaware Park (a casino and racetrack) are approximately 2,900,000.

The proposed LPZ consists of an 8 km (5 mi) radius around the center point of the new plant as shown in SSAR Figure 2.1-21, along with a projected 2010 resident population. SSAR Table 2.1-7 lists facilities and institutions identified within the LPZ and 2008 transient populations. The staff noted that relative locations of facilities and institutions listed in SSAR Table 2.1-7 are inconsistent with SSAR Figure 2.1-21. Therefore, in RAI 32, Question 02.01.03-3, the staff requested that the applicant clarify the figure appropriately to identify facilities and routes. In an October 5, 2011, response, the applicant provided a revision to SSAR Section 2.1.3. Based on its review, the staff considers the response adequate and acceptable as it satisfies the guidance in NUREG-0800. The staff also confirmed that the applicant included the committed revision in SSAR Revision 1. Accordingly, the staff considers RAI 32, Question 02.01.03-3, resolved.

A list of the population centers (population of greater than 25,000) located within 80 km (50 mi) of the PSEG Site is presented in SSAR Table 2.1-8. The nearest population center is the city of Wilmington, DE, with the nearest boundary 23.8 km (14.8 mi) north of the proposed plant's center point. In distance, this point is greater than the required one and one-third times the distance from the center of the reactor to the LPZ boundary of 10.8 km (6.7 mi). Based on

independent review of the 2010 USCB population of 25,349 people, the staff identified Bridgeton, NJ, as another population center for consideration. Therefore, in RAI 32, Question 02.01.03-4, the staff requested that the applicant clarify the exclusion of Bridgeton, NJ, and also consider other population centers, such as Atlantic City, Cape May, and Wildwood areas of New Jersey. In an October 5, 2011, response, the applicant provided a revision to SSAR Section 2.1.3 to include Bridgeton, NJ, as a population center at a distance of 24.9 km (15.5 mi) and confirmed that Wilmington, DE, is still the nearest population center from the PSEG Site. Based on its review, the staff considers the applicant's response adequate and acceptable as it satisfies the guidance in NUREG-0800. The staff also confirmed that the applicant included the revision to SSAR Section 2.1.3, Revision 1. Accordingly, the staff considers RAI 32, Question 02.01.03-4, resolved.

In SSAR Section 2.1.3.5, the applicant stated that the city of Wilmington, DE, with its nearest boundary 23.8 km (14.8 mi) north of the proposed plant's center, is the closest population center. The applicant stated that one and one-third times the distance from the proposed plant's center point to the proposed LPZ boundary is 10.8 km (6.7 mi). The applicant also stated that none of the distance or direction segments within 16 km (10 mi), as shown in SSAR Figure 2.1-11, has projected resident and transient population in the year 2081 that exceeds 25,000, although the segment from 8 to 16 km (5 to 10 mi) to the west of the PSEG Site approaches this 25,000 people criterion. Based on its review of information provided by the applicant and independent assessment of population data, the staff considers that Middletown, DE, with its nearest boundary 11.3 km (7.0 mi) west from the PSEG Site could be the nearest population center. Therefore, in RAI 32, Questions 02.01.03-5 and 02.01.03-6, the staff requested that the applicant analyze this information and population data and clarify based on growth rates from 2000 to 2010 U.S. Census, whether Middletown, DE, could be a future population center. If so, the staff requested that the applicant demonstrate compliance with population distance requirement in 10 CFR 100.21(b), such that the future growth and developments of Middletown, DE will not be closer than 11.3 km (7 mi) west of the PSEG Site, including growth into and around Odessa, DE, or discuss any changes to the current LPZ boundary. In an October 5, 2011, response, the applicant acknowledged Middletown, DE, as a potential future population center closer to the proposed plant than the existing population centers. The applicant provided detailed responses addressing the future growth of Middletown, DE, referring to zoning, growth, and development trends in the Middletown Comprehensive Plan, which stated that the potential for population growth to extend from Middletown, DE, into or around Odessa, DE, is severely restricted by zoning policies and physical barriers. The applicant also stated that PSEG does not intend to make any changes to the current LPZ boundary distance. The applicant proposed a revision to SSAR Section 2.1.3.5. The staff confirmed that the applicant's committed revisions are incorporated in SSAR Section 2.1.3.5, Revision 1. Based on its review of the applicant's responses and independent assessment of 2010 population census data, the staff considers the applicant's information reasonable and acceptable, as it satisfies the guidance in NUREG-0800. Accordingly, the staff considers RAI 32, Questions 02.01.03-5 and 02.01.03-6, resolved.

The applicant determined population density by using the estimated projected populations to the years 2010, 2021, 2061, and 2081. The applicant estimated population density of 497 people per square mile within 32.2 km (20 mi) of the PSEG Site, for year 2021, which is considered the first year of operation, and concluded that the density is within the guideline value of 500 people per square mile within 32.2 km (20 mi) of the PSEG Site. Based on its review of population projection data and independent assessment of the applicant's population projection estimates, the staff calculated the density of 508 people per square mile for the year

2021 without including the transient population between 16.1 and 32.2 km (10 and 20 mi). In addition, the staff notes that SSAR Section 2.1.3 does not clarify how transient population estimates are accounted for in determining population density. Therefore, in RAI 21, Questions 02.01.03-1 and 02.01.03-2, the staff requested that the applicant identify, clarify, and confirm as appropriate, the assumptions, methodologies, and rationale used to determine the population density. Since the applicant's determined density of 497 persons per square mile approaches the RG 4.7 criteria (500 persons per square mile) and any minor change in any of the assumptions may result in the density to be exceeding the criterion, in the same RAI, the staff also requested that the applicant address the evaluation of alternate sites with lower population densities in accordance with guidance specified in RG 4.7, Regulatory Position C.4. In a June 7, 2011, response to RAI 21, Questions 02.01.03-1 and 02.01.03-2, the applicant provided responses to the staff's concern with detailed information and clarification along with proposed revisions to SSAR Sections 2.1.3.3.2 and 2.1.3.6, and SSAR Tables 2.1-5 and 2.1-6. Based on its review and independent assessment of data, the staff considered the applicant's response adequate and reasonable as it satisfies the guidance in NUREG-0800 and meets the regulatory requirements. However, as a part of the June 7, 2011, response to RAI 21, Question 02.01.03-2, item (e), the applicant referred to the PSEG Site ESP Application, Part 3, "Environmental Report," Section 9.3 for alternative sites evaluation. The staff considers that this was not adequately addressed in SSAR Section 2.1.3. Therefore, in RAI 59, Question 02.01.03-7, which superseded RAI 21, Question 02.01.03-1, item (e), the staff requested that the applicant give a rationale for and justify the selection of this high-density site by providing information about the Alternative Site Evaluation analysis summary in SSAR Section 2.1.3. In a March 29, 2012, response to RAI 59, Question 02.01.03-7, the applicant provided adequate information and a proposed revision to SSAR Section 2.1.3.6. The staff reviewed the applicant's response and considers the information reasonable and acceptable as it conforms to the guidance in NUREG-0800. The staff also confirmed that the applicant's committed revisions are included in SSAR Revision 1. Accordingly, the staff considers RAI 21, Questions 02.01.03-1 and 02.01.03-2; and RAI 59, Question 02.01.03-7, resolved.

2.1.3.5 Conclusion

As discussed above, the applicant provided an acceptable description of current and projected population distribution, low population zone, population center distances, and population densities in and around the PSEG Site. The staff reviewed the information provided and, for the reasons stated above, concludes that the applicant has provided population data acceptable to meet the applicable requirements of 10 CFR 50.34(a)(1), 10 CFR 52.17(a)(1), 10 CFR 100.20(a), and 10 CFR 100.21(a) and (b). This conclusion is based on the applicant providing an acceptable description and safety assessment of the PSEG Site. The site area contains present and projected population densities that conform to the guidelines of RG 4.7, Regulatory Position C.4, and the applicant properly specified the low-population zone and population center distance. Additionally, by assessing the population data independently, the staff reviewed and confirmed the applicant's estimates of the present and projected populations surrounding the PSEG Site, including transients. The applicant also calculated the radiological consequences of design-basis accidents at the outer boundary of the LPZ (Standard Review Plan (SRP), Chapter 15, Section 15.0.3) and has provided reasonable assurance that appropriate protective measures can be taken within the LPZ to protect the population in the event of a radiological emergency. Therefore, the staff finds that the PSEG Site ESP applicant has provided sufficient information to comply with the applicable requirements of 10 CFR 50.34(a)(1),10 CFR 52.17(a)(1), and 10 CFR Part 100.

2.2 Nearby Industrial, Transportation, and Military Facilities

2.2.1 Identification of Potential Hazards in Site Vicinity (Locations and Routes)

2.2.1.1 Introduction

In the identification of potential hazards in the site vicinity, the description of locations and routes refers to potential external hazards or hazardous materials that are present or may reasonably be expected to be present during the projected lifetime of the proposed plant. The purpose of the staff's review of this section is to determine the adequacy of information in meeting regulatory requirements concerning the presence and magnitude of potential external hazards so that the staff can perform technical review and evaluation consistent with the guidance provided in NUREG-0800, Sections 2.2.3, 3.5.1.5, and 3.5.1.6. The staff's review covers the following specific areas: (1) The locations of, and separation distances to, transportation facilities and routes, including airports and airways, roadways, railways, pipelines, and navigable bodies of water; (2) the presence of military and industrial facilities, such as fixed manufacturing, processing, and storage facilities; and (3) any additional information requirements prescribed in the applicable subparts to 10 CFR 52.17, "Contents of Applications; Technical Information."

2.2.1.2 Summary of Application

The applicant identified potential hazardous facilities and routes within the 8-km (5-mi) vicinity of the PSEG Site and airports within 16.1 km (10 mi) of the PSEG Site, along with significant facilities at a greater distance. The applicant provided detailed description of these facilities and routes for further consideration of hazards evaluation. There are four industrial facilities, three road transport routes, two waterways, three airways, six slow speed low-altitude military training routes, and a helipad within 8 km (5 mi) of the PSEG Site. There are 9 industrial facilities, 2 pipelines, 10 road transportation routes, 2 railroads, 2 waterways, and 13 airport or airways identified within 8 to 16.1 km (5 to 10 mi) of the PSEG Site.

2.2.1.3 Regulatory Basis

The acceptance criteria for identification of potential hazards in the site vicinity 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 identification of potential hazards in the PSEG Site vicinity.

- 10 CFR 52.17, as it relates 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), as it relates to the requirement that the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, and 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), as it relates to the requirement 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.

Both NUREG-0800 and RS-002, Sections 2.2.1-2.2.2, specify 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 agree with the 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 related 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.

2.2.1.4 Technical Evaluation

The staff reviewed the SSAR using the review procedures described in NUREG-0800, Section 2.2.1-2.2.2. This section identifies and provides information that would help in evaluating potential hazards due to industrial, transportation, mining, and military installations in the PSEG Site area on the safe operation of the proposed nuclear facility.

In the SSAR, the applicant identified the following potential hazard facilities and operations within 8 km (5 mi) of the PSEG Site for further analysis.

Industrial facilities

- Hope Creek Generating Station (HCGS)
- Salem Generating Station (SGS) Units 1 and 2
- Port Penn Sewage Treatment Plant
- Lower Alloways Creek Township Buildings

Transportation Routes

- Alloway Creek Neck Road
- Delaware Route 9
- Quinton Hancocks Bridge Road

Waterways

- Delaware River
- Alloway Creek

Airports and Airways

- Airway V123-312

- Airway V29
- Jet Route J42-150
- Salem/Hope Creek Generating Station Helipad
- Slow speed low-altitude Military Routes (SR800, SR805, SR844, SR845, SR846, and SR847)

The identified facilities and transportation routes between 8 and 16.1 km (5 and10 mi) from the PSEG Site are as follows:

Industrial facilities

- Air Liquide
- Anchor Glass Container Corporation
- Cooper Interconnect
- Delaware City Wastewater Treatment Plant
- Formosa Plastics Corporation
- Johnson Controls Inc. Battery Division
- Mannington Mills
- Quaker City Motor Parts/NAPA Distribution Center
- Valero Delaware City Refinery

Pipelines

- Hazardous Liquid Pipeline
- Natural Gas Pipeline

Transportation Routes

- Delaware Route 1
- Delaware Route 299
- Delaware Route 72
- Delaware Route 7
- Delaware Route 71
- Delaware Route 896
- New Jersey Route 49
- New Jersey Route 45
- U.S. Route 13
- U.S. Route 301
- The Southern Railroad Company of NJ
- Norfolk Southern Railroad

Waterways

- Chesapeake and Delaware Canal
- Salem River

Airports and Airways

- Airway V157

- Airway V213
- Airway V214
- Hidden Acres Airport
- Jet Route J191
- Jet Route J51
- Okolona Plantation Airport
- Paruszewski Farm Strip Airport
- PSEG Training Center Heliport
- Salem Airport
- Scotty's Airport
- Stoe Creek Farm Airport
- Townsend Airport

The applicant identified nearby industrial facilities, transportation, and military facilities in SSAR Section 2.2.1 and presented the descriptions of these facilities in SSAR Section 2.2.2. The staff noted that some information depicted in SSAR Figure 2.2-1 is missing in SSAR Section 2.2.2 text, and some information as presented by the applicant in SSAR Section 2.2.2, is not consistent with the information as depicted in SSAR Figure 2.2-1. Therefore, in RAI 50, Question 02.02.01-02.02.02-1, the staff requested that the applicant provide clarification regarding the apparent inconsistencies, and update the information that may be used further in evaluating potential hazards in SSAR Section 2.2.3. In a March 9, 2012, response, the applicant clarified and updated the information pertaining to all items of the RAI 50, Question 02.02.01-02.02.02-1, except item (5), which the applicant committed to provide by July 20, 2012, after obtaining information from the USCG. The applicant also provided a revision to SSAR Section 2.2.1 and SSAR Figure 2.2-1. The staff confirmed that the committed revision was included in SSAR Revision 1, dated May 21, 2012. Accordingly, the staff considers RAI 50, Question 02.02.01-02.02.02-1 pertaining to all items except item (5), resolved. Subsequently, in a July 17, 2012, response to RAI 50, Question 02.02.01-02.02.02-1, item (5), the applicant provided adequate information and analysis. The applicant also committed to revise SSAR Sections 2.2.2.3.2, 2.2.3.2.2, and 2.2.3.2.3 in the subsequent revision of the application. The location of identified industrial and transportation facilities, and airports and airways within 16.1 km (10 mi) of the PSEG Site are shown in SSAR Revision 1, Figures 2.2-1 and 2.2-2, respectively. However, the staff noted that contrary to a commitment by the applicant in a March 13, 2012, response to RAI 40, Question 03.05.01.06-1 (which is discussed in Chapter 3, Section 3.5.1.6 of this report), Figure 2.2-2 was not revised based on revised airways information, and this revised Figure was not included in SSAR Revision 1, dated May 21, 2012. Subsequently, following a clarification communication by the staff, the applicant included Figure 2.2-2 in Revision 2 of the SSAR, dated March 27, 2013, and therefore, the staff considers RAI 50, Question 02.02.01-02.02.02-1, resolved.

The applicant provided detailed descriptions of the identified facilities and routes in SSAR Section 2.2.2 in accordance with NUREG-0800, RS-002, and RG 1.206, "Combined License Applications for Nuclear Power Plants."

2.2.1.4.1 Industrial Facilities

Four facilities are identified within 8 km (5 mi) of the PSEG Site, and nine facilities are identified within 8 to 16.1 km (5 to 10 mi). A concise description of these facilities is presented in SSAR Table 2.2-1.

The centerline of the HCGS reactor building is located 527 m (1,730 ft) south of the nearest edge of the power block area of the new plant. The HCGS chemicals identified for analysis and their locations are presented in SSAR Tables 2.2-2a and 2.2-3.

The centerline of the SGS Unit 1 reactor building is located 990 m (3,249 ft) of the nearest edge of the power block area of the new plant. The SGS chemicals identified for analysis and their locations are presented in SSAR Tables 2.2-2b and 2.2-3.

The Port Penn Sewage Treatment Plant is located in Delaware, 5.5 km (3.4 mi) northwest of the new plant power block area. The facility receives chemicals by truck with the closest possible approach being on Delaware Route 9, which is 5 km (3.1 mi) west of the new plant power block area. The chemicals identified for analysis and their locations associated with Port Penn Sewage Treatment Plant are presented in SSAR Table 2.2-4.

Lower Alloways Township has several buildings that perform functions such as government administration, vehicle maintenance, and storage for the township. The chemicals identified are presented in SSAR Table 2.2-5.

2.2.1.4.2 Pipelines

The nearest pipeline is a gas transmission line that runs along the U.S. Route 13 corridor in Delaware, 9.5 km (5.9 mi) west of the new plant power block area.

2.2.1.4.3 Waterways

The Delaware River, Alloway Creek, the Chesapeake and Delaware Canal, and the Salem River are the only navigable waterways within 16.1 km (10 mi) of the PSEG Site.

The Delaware River is adjacent to the PSEG Site and is used for commercial freight traffic to and from ports in New Jersey, Delaware, and Pennsylvania. The waterway has a channel depth maintained at 12 m (39.3 ft) at low tide. The shipping channel's closest approach to the PSEG Site is 1.4 km (0.9 mi). The total quantities of chemicals transported on the Delaware River are presented in SSAR Table 2.2-6, the number of shipments is summarized in SSAR Table 2.2-7, and largest maximum net tonnage of chemicals transported is presented in SSAR Table 2.2-8. Several small marinas and docks exist along the Delaware River within 16.1 km (10 mi) of the PSEG Site. Two general anchorage areas are shown in SSAR Figure 2.2-3 within 8 km (5 mi) of the PSEG Site, the closest being 1.1 km (0.7 mi) away. However, these facilities are not addressed in SSAR Section 2.2.1. Therefore, in RAI 50, Question 02.02.01-02.02.02-1, item (5), the staff requested that the applicant address and evaluate, as appropriate, the impact of these facilities. On July 17, 2012, the applicant provided adequate response to clarify, analyze, and update the information. The staff reviewed the response and finds it acceptable as it meets the NUREG-0800 guidance and satisfies the acceptance criteria. The applicant provided changes to SSAR Sections 2.2.2.3.2, 2.2.3.2.2, and 2.2.3.2.3, with commitment to revise the ESP application with these changes. The staff finds the SSAR changes appropriate and acceptable. The staff confirmed that in Revision 2 of the application, submitted on March 27, 2013, the applicant has incorporated the committed changes, and, therefore, considers RAI 50, Question 02.02.01-02.02.02-1, item (5) resolved.

Alloway Creek is located 3.06 km (1.9 mi) northeast of the PSEG site and there is no commercial freight traffic in this navigable waters.

The Chesapeake and Delaware Canal carries commercial freight traffic between the Delaware River and the Chesapeake Bay. The canal's nearest approach to the new plant power block area is 9.5 km (5.9 mi) to the north-northwest. The canal has a mean low-water depth of 10.7 m (35 ft). The total quantities of chemicals transported on the Chesapeake and Delaware Canal are presented in SSAR Table 2.2-9.

The mouth of the Salem River is 10.6 km (6.6 mi) northeast of the new plant power block area. The largest two quantities of commodities shipped on the river are soil or fill dirt and food products.

2.2.1.4.4 Mining Operations

There are no mining activities within 8 km (5 mi) of the PSEG Site. The nearest mine is a sand-and-gravel mine, located just east of Middletown, DE, 11.3 km (7 mi) west of the new plant power block area.

2.2.1.4.5 Highways

Alloways Creek Neck Road is a secondary road that provides access to the PSEG Site, Mad Horse Creek Wildlife Management Area, and several farms. Facing the PSEG Site access road, Alloway Creek Neck Road runs east to the Town of Hancocks Bridge, where it connects to Quinton Hancocks Bridge Road. New Jersey Route 49 is the closest highway east of the PSEG Site, at its closest approach is 12.1 km (7.5 mi). A new second road is proposed to be constructed for dedicated vehicular access to the PSEG Site. The proposed causeway's land approach to the PSEG Site is depicted in SSAR Figure 1.2-3. Delaware Route 9 is the only highway within 8 km (5 mi) of the PSEG Site, at its closest approach 5 km (3.1 mi) west of the new plant power block area. A maximum of 36,364 kg (80,000 lbs) is estimated for chemical transportation on this route.

2.2.1.4.6 Railroads

There are no railroads within 8 km (5 mi) of the PSEG Site. The closest railroad is the Southern Railroad Company of New Jersey, which connects Salem to Alloway, and has the closest approach at 13.2 km (8.2 mi) to the northeast to this site. Norfolk Southern Railroad is also beyond 8 km (5 mi) of the PSEG Site. Therefore, neither the Southern Railroad Company of NJ nor the Norfolk Southern Railroad is required to be addressed and evaluated by the applicant.

2.2.1.4.7 Airports, Airways, and Military Training Routes

Airports: The helipad for SGS and HCGS is the only heliport or airport within 8 km (5 mi) of the PSEG Site. Additionally, there are seven airports and one heliport located within 8 to 16.1 km (5 to 10 mi) of the site. The estimated operations at these facilities are presented in SSAR Table 2.2-11. The nearest public airport is the Summit Airport, which is located 16.7 km (10.4 mi) from the proposed new plant's power block area. An evaluation of aircraft hazards is addressed in SSAR Section 3.5.1.6.

Airways: There are four Federal airways—V123-312, V29, V157, and V213—within 16.1 km (10 mi) of the PSEG Site. There are two high-altitude routes, J42–150 and J191. The closest six slow-speed low-altitude military training routes, as indicated in SSAR Figure 2.2-2, are SR800, SR805, SR844, SR845, SR846, and SR847. The nearest edges of the military training routes are within 8 km (5 mi) of the PSEG Site. The centerline of Airway V123–312 is 0.8 km

(0.5 mi) northwest of the PSEG Site. Additionally, Airway V29 is 1.8 km (1.1 mi) west of the PSEG Site. Airway V157 is 11.4 km (7.1 mi) east of the PSEG Site. The centerline of jet way J42-150 is 1.3 km (0.8 mi) east of the PSEG Site with additional jet way, J191, located 15.6 km (9.7 mi) east of the PSEG Site. As shown in SSAR Figure 2.2-2, Airway V214 and jet way J51 are beyond 16.1 km (10 mi) and not considered for evaluation.

Military Facilities: There are no military facilities within 16.2 km (10 mi) of the PSEG Site. New Castle Airport is the closest facility with military operations (the Air National Guard) and is 23.3 km (14.5 mi) northeast of the PSEG Site. The closest dedicated military facility is Dover Air Force Base, which is 38.3 km (23.8 mi) south of the PSEG Site.

The nature and extent of activities involving potentially hazardous materials at nearby industrial, military, and transportation facilities have been evaluated to identify any such activities that have the potential for adversely affecting plant safety-related structures. Based on its review of the information in the SSAR as well as information obtained independently, the staff concludes that all potentially hazardous activities on site and in the vicinity of the plant have been identified. The staff has reviewed the hazards associated with these activities and discussed in Sections 2.2.3, 3.5.1.5, and 3.5.1.6 of this report. Based on its review of relevant information available in the public domain and applicable data, the staff verified the location and usage information that the applicant supplied.

2.2.1.4.8 Projections of Industrial Growth

No industrial growth projections are available in Salem County, NJ. However, the Salem County Utilities Authority identified areas in the county that are expected to undergo economic development. The projects include a recycling center in the city of Salem and a business and industrial park addition in Oldmans Township and Carneys Point, NJ. The projects identified in Salem County are more than 8 km (5 mi) from the PSEG Site.

The New Castle County, DE, Comprehensive Plan indicates that most of the land in the county is expected to remain agricultural or open space. A new wastewater treatment plant is planned at 9.5 km (5.9 mi) west of the PSEG Site, situated along U.S. Route 13. The planned wastewater treatment plant chemical delivery is not expected to approach any closer to the site than the existing facilities in New Castle County.

A review of available Salem and New Castle County planning documents indicate no significant expansion of military or transportation facilities located within 8 km (5 mi) of the PSEG Site. Based on its review of the information provided by the applicant in SSAR Sections 2.2.1-2.2.2, as well as information obtained independently, the staff did not identify any potential source of additional hazards beyond those that the applicant has identified and described.

2.2.1.5 Conclusion

As discussed above, the applicant presented and substantiated information to establish the identification of potential hazards in the PSEG Site vicinity. The staff reviewed the information provided and, for the reasons described above, concludes that the applicant has provided information with respect to identification of potential hazards in conformance to the guidance in NUREG-0800, as described in the “Regulatory Basis” section above, and in compliance with the requirements of 10 CFR 52.17(a)(1)(vii), 10 CFR 52.17(a)(1)(ix), as well as 10 CFR 100.20(b) and 10 CFR 100.21(e). The nature and extent of activities involving potentially hazardous materials that are conducted at nearby industrial, military, and transportation facilities have been

evaluated to identify any such activities that have the potential for adversely affecting plant safety-related structures. On the basis of an evaluation of information in the SSAR as well as information obtained independently, the staff concludes that all potentially hazardous activities on site and in the vicinity of the plant have been identified. The hazards associated with these activities have been reviewed and are discussed in Sections 2.2.3, and 3.5.1.6 of this report.

2.2.2 Descriptions of Locations and Routes

The staff's review and conclusion involving SSAR Section 2.2.2 of the PSEG Site ESP application is documented in Section 2.2.1 of this report.

2.2.3 Evaluation of Potential Accidents

2.2.3.1 Introduction

The staff's evaluation of potential accidents considers the applicant's probability analyses of potential accidents involving hazardous materials or activities on the PSEG Site and in the vicinity of the proposed PSEG Site to confirm that appropriate data and analytical models have been used. The review covers the following specific areas: (1) Hazards associated with nearby industrial activities, such as manufacturing, processing, or storage facilities; (2) hazards associated with nearby military activities, such as military bases, training areas, or aircraft flights; and (3) hazards associated with nearby transportation routes (aircraft routes, highways, railways, navigable waters, and pipelines). Each hazard review area includes consideration of the following principal types of hazards:

- toxic vapors or gases and their potential for incapacitating nuclear plant control room operators
- overpressure resulting from explosions or detonations involving materials such as munitions, industrial explosives, or explosive vapor clouds resulting from the atmospheric release of gases (such as propane and natural gas or any other gas) with a potential for ignition and explosion
- missile effects attributable to mechanical impacts, such as aircraft impacts, explosion debris, and impacts from waterborne items such as barges
- thermal effects attributable to fires

2.2.3.2 Summary of Application

The applicant evaluated potential accidents based on the information compiled for the identified facilities in SSAR Section 2.2.1-2.2.2, in accordance with regulatory requirements in 10 CFR 52.17, "Contents of Application," 10 CFR 100.20, "Factors To Be Considered When Evaluating Sites," and 10 CFR 100.21, "Using Non-Seismic Criteria," using the guidance in RG 1.78 (Revision 1), "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," RG 1.91 (Revision 1), "Evaluation of Explosion Postulated To Occur at Nearby Facilities and on Transportation Routes Near Nuclear Power Plants," RG 4.7 (Revision 2), "General Site Suitability for Nuclear Power Plant Sustainability," and RG 1.206 (Revision 0), "Combined License Applications for Nuclear Power Plants." The applicant performed an analysis of these accidents to determine whether any of them should be considered as design-basis events (DBEs). The DBEs are defined as those

accidents that have a probability of occurrence on the order of magnitude of 10^{-7} per year or greater with potential consequences serious enough to affect the safety of the plant to the extent that the guidelines specified in 10 CFR Part 100 could be exceeded. The following accident categories are considered in selecting DBEs: Explosions: flammable vapor clouds (delayed ignition); toxic chemicals; aircraft crashes; fires; collisions with intake structures; and liquid spills.

2.2.3.3 Regulatory Basis

The acceptance criteria associated with the relevant requirements of NRC regulations for the evaluation of potential accidents are given in NUREG-0800, Section 2.2.3, “Evaluation of Potential Accidents.”

The staff considered the following regulatory requirements in evaluating the potentiality and consequences of accident sequences:

- 10 CFR 52.17(a)(1)(vii), as it relates to the requirement that the application contain information on the location and description of any nearby industrial, military, or transportation facilities and routes and the requirements of 10 CFR 52.17(a)(1)(ix) as it applies to 10 CFR Part 100

- 10 CFR 100.20(b), as it relates to the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, and military and chemical facilities) that 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), as it relates to the requirement that the potential hazards associated with nearby transportation routes, industrial, and military facilities be evaluated and site parameters be 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 that site

2.2.3.4 Technical Evaluation

The staff reviewed the information presented in SSAR Section 2.2.3, pertaining to potential accidents as well as the applicant’s responses to several RAIs, as discussed below. The staff’s review confirmed that the information in the application addressed the required information relating to the evaluation of potential accidents.

The staff reviewed SSAR Sections 2.2.1 and 2.2.2 containing information related to industrial, military, and transportation facilities and routes to establish the presence and magnitude of potential external hazards that include accident categories, such as explosions, flammable vapor clouds (delayed ignition), toxic chemicals, fires, and airplane crashes addressed in SSAR Section 2.2.3.

2.2.3.4.1 Explosions and Flammable Vapor Clouds

<u>Explosions</u>: The applicant considered hazards involving potential explosions resulting in blast overpressure as a result of detonation of explosives, munitions, chemicals, liquid fuels, and gaseous fuels that are processed, stored, used, or transported near the PSEG Site. The allowable and actual distances of potential hazardous explosive chemicals transported or stored

are determined based on using 1 pound per square inch (psi) overpressure as a criterion for adversely affecting plant operation or preventing safe shutdown of the plant. In accordance with RG 1.91, peak positive incident overpressures below 1 psi are considered to cause no significant damage. The Salem and Hope Creek site chemicals, nearby facilities' chemicals, chemicals transported by vessel, and chemicals assumed to be transported by roadways near the PSEG Site are evaluated by the applicant. Hazardous materials potentially transported by a vessel on the Delaware River are identified in SSAR Table 2.2-16. Hazardous materials transported on nearby roads or located at nearby facilities, or at the Salem and Hope Creek Generating Stations are identified in SSAR Table 2.2-17. The effects of limiting explosion events along with determined minimum safe distances are summarized in SSAR Table 2.2-18. Four bounding chemicals at the Salem and Hope Creek Generating Stations site identified for explosion analysis include a 22,712 liters (L) (6,000 gallons (gal)) tank of gasoline, the 30,283 L (8,000 gal) truck that refills the tank of gasoline, 3,785,411 L (1,000,000 gal) capacity tank of diesel fuel, and a bank of 3,398 cu. m (120,000 cu. ft) hydrogen cylinders. The results indicate that the calculated safe distances are less than the actual distance from the source to the safety-related building at the new plant. The staff notes that the hydrogen that the applicant considered in the analyses is not listed either in SSAR Table 2.2-2a or Table 2.2-2b, and is indicated as "facility wide" in SSAR Table 2.2-3 without any amount. Therefore, in RAI 52, Question 02.02.03-5, the staff requested that the applicant provide clarification about the hydrogen storage and assumptions and methodology used to calculate minimum safe distance. In a March 23, 2012, response, the applicant provided details and a revision to SSAR Table 2.2-3. Based on its review of the applicant's response as well as the staff's independent assessment, the staff considers the response reasonable and acceptable as it satisfies the guidance in NUREG-0800. The staff also confirmed that the applicant included its committed revision in SSAR Revision 1. Accordingly, the staff considers RAI 52, Question 02.02.03-5, resolved.

The only offsite chemicals identified are a tank of gasoline and a tank of propane at the Lower Alloways Creek Township Buildings over 4.8 km (3 mi) away. The minimum safe distances calculated are much less than the actual distance of 4.8 km (3 mi).

Two types of explosions are analyzed for vessels on the Delaware River, which include liquid or vapor explosions and solid explosions. Based on the largest chemical explosion and sinking of the Bow Mariner in 2004, the applicant estimated 116 tons of methyl tertiary-butyl ether (MTBE) vapor from 22 emptied tanks that were ignited by spark and exploded. The standoff distance calculated is 0.8 km (0.5 mi), which is less than the actual distance of 1.45 km (0.9 mi). Since MTBE is not listed in SSAR Table 2.2-6, in RAI 53, Question 02.02.03-2, the staff requested that the applicant clarify the relevance of this chemical vapor compared to the chemicals that are documented to be shipped during 2003–2007 on the Delaware River. Additionally, the staff requested that the applicant also provide an evaluation of the potentially limiting chemical among those transported on the Delaware River with a maximum carried transport amount of 4,545,455 kg (10,000,000 lbs, as the bounding case) in accordance with the guidance provided in RG 1.91. In a March 23, 2012, response, the applicant provided adequate information. Based on its review of the applicant's response and an independent confirmatory calculation using RG 1.91 guidance, the staff concludes that the applicant's approach is reasonable and acceptable as the calculated safe distance is less than the actual distance and meets the RG 1.91 criterion. The staff considers RAI 53, Question 02.02.03-2 resolved.

The smallest solid explosive mass that can have a 1 psi overpressure at a distance of 1.45 km (0.9 mi) is 589 tons. Based on historical large vessel explosions, on the order of estimated

2,500 tons of solid explosive is considered for the analysis. The staff noted that details pertaining to incident rates, spill rates, and explosion rates are not provided in SSAR Section 2.2.3.2.2. Therefore, in RAI 54, Question 02.02.03-3, the staff requested that the applicant provide details that were used in the probabilistic analysis of solid explosive hazards. In a March 7, 2012, response, the applicant provided detailed assumptions and methodology in calculating estimated allowable trips per year not to exceed 1 x 10^{-6} explosions per year. The applicant also provided a revision to SSAR Section 2.2.3.2.2. The staff confirmed that the applicant's committed revision is included in SSAR Revision 1, Section 2.2.3.2.2. Based on its review of the applicant's response and further inclusion of the explosion probability of solid explosive materials in determining the total probability of all potential chemicals transported by vessel on the Delaware River, the staff finds the applicant's approach reasonable and acceptable as it satisfies the probability determination guidance specified in NUREG-0800, Section 2.2.3. Accordingly, the staff considers RAI 54, Question 02.02.03-3, resolved.

<u>Flammable Vapor Clouds</u>: <u>(Delayed Ignition)</u> Flammable gases in the liquid or gaseous state can form an unconfined vapor cloud that could drift toward the plant before ignition occurs, and then can burn or explode when the vapor concentration is within flammable range. For those chemicals with an identified flammability range, an air dispersion model based on the methods and equations in RG 1.78 and NUREG-0570, "Toxic Vapor Concentration in the Control Room Following a Postulated Accidental Release," is used to determine the distance that the vapor cloud can travel before the concentration is less than Lower Explosive Level (LEL). The analyzed effects of flammable vapor clouds and vapor cloud explosions from internal and external sources are summarized in SSAR Table 2.2-19.

Three bounding chemicals at the Salem and Hope Creek site that are analyzed include a 22,710 L (6,000 gal) tank of gasoline, the 30,280 L (8,000 gal) truck that refills the tank of gasoline, and a 3,396 cubic meter (cu. m.) (120,000 cubic feet (cu. ft.)) hydrogen tube farm. The applicant performed analysis of potential explosion impacts on the nearest safety-related building at the proposed plant, of gasoline storage tank at Hope Creek Generating Station, and also delivery of a gasoline truck to the storage tank. The results of the analysis indicate that the minimum safe distance from the gasoline storage tank and also the route of delivery tanker truck without exceeding an overpressure of 1 psi at the nearest safety-related building of the proposed plant is not met, specifically, the minimum allowable safe distance for the gasoline is greater than the actual distance from the tanks to the nearest postulated safety-related building at the proposed plant. The applicant stated that the Hope Creek Generating Station gasoline tank will be relocated for construction of the proposed plant, and the delivery truck route to the new tank will be analyzed for its effects on the proposed plant. Consistent with the applicant's stated commitment, the staff identified Permit Condition 2, described in Section 2.2.3.5 of this report, which addresses the safe distance to the nearest structures, systems, and components (SSCs) of the proposed plant, as it relates to compliance with an overpressure not to exceed 1 psi:

The safe distance for the hydrogen tanks is less than the actual distance. The safe distances determined for the offsite chemicals are much less than the nearby facilities distance of more than 4.8 km (3 mi) away.

Based on reports from the Maritime Exchange for the Delaware River and Bay (MEDRB), the USCG, and USACE, several chemicals are identified as the bounding chemicals that are transported along the Delaware River. These chemicals are propane, gasoline, benzene, alcohols (methanol, ethanol), carboxylic acids, ammonia, naphtha and solvents, methane,

acetone and vinyl chloride. The closest point from which vessel traffic approaches the proposed new plant is 1.45 km (0.9 mi). A vapor cloud of alcohols has a standoff distance of less than 1.45 km (0.9 mi). The vessels transporting chemicals on the Delaware River that include propane, gasoline, benzene, ammonia, naphtha, acetone and vinyl chloride are analyzed using probabilistic analysis. In SSAR Table 2.2-6, the applicant identified the list of chemical commodities transported on the Delaware River between 2003 and 2007. Some of the chemicals and total amounts are different from the chemicals listed in SSAR Table 2.2-15 for the probabilistic analyses of hazards due to chemicals transported on the Delaware River. Therefore, in RAI 51, Question 02.02.03-1, the staff requested that the applicant clarify the chemicals/data identified and evaluated in the hazard and probability evaluations. In a March 7, 2012, response, the applicant clarified how the chemicals and the amounts were accounted and considered in the probabilistic evaluations. The staff reviewed the response and finds that the applicant's assumptions are reasonable and acceptable as the applicant provided adequate clarifying information. Accordingly, the staff considers RAI 51, Question 02.02.03-1, resolved.

A probabilistic analysis, as discussed in SSAR Section 2.2.3.2.1, is used to determine the frequency of hazards due to chemicals transported on the Delaware River. The total allowable trips for the each of the chemical to have 1×10^{-6} hazards per year are identified in SSAR Table 2.2-14. The estimated trips of each chemical are shown in SSAR Table 2.2-15. The applicant concluded by stating, "For each chemical, the total number of allowable trips is greater than the estimated number of trips, and, therefore, none of these chemicals pose a threat greater than 1×10^{-6} per year." Based on the acceptance criteria of NUREG-0800, the staff considers that the aggregate probability of hazards should be determined, based on realistic data and assumptions, to be less than 1×10^{-6} per year, as opposed to the applicant's discrete individual chemical trips each having a probability of 1×10^{-6} or less per year. Therefore, in RAI 55, Question 02.02.03-4, the staff requested that the applicant revise the calculations to determine the total probability of explosive hazard from flammable vapor clouds due to all chemicals and solid explosives transported by vessels on the Delaware River. In an April 23, 2012, response, the applicant provided revised calculations for the total probability of 2.31×10^{-6} per year. Since the estimated total probability is greater than the NUREG-0800 acceptance criterion of 1×10^{-6} per year, the applicant determined the core damage frequency (CDF) of 7.35×10^{-9} per year using the highest estimated conditional core damage probability (CCDP) 3.18×10^{-3}, which is documented for the Advanced Boiling Water Reactor (ABWR) technology aircraft hazard event. The applicant also provided revisions to SSAR Section 2.2.3 as well as SSAR Tables 2.2-14 and 2.2-15, and committed to incorporate the same changes in the next revision of the SSAR. Based on its review of the response as well as independent assessment of total probability, the staff considers the applicant's assumptions and conclusion reasonable and acceptable as the analysis satisfies the NRC guidance in NUREG-0800. The staff confirmed that the applicant's committed revisions were included in the SSAR Revision 1. Accordingly, the staff considers RAI 55, Question 02.02.03-4, resolved.

In a July 17, 2012, response to RAI 50, Question 02.02.01-02.02.02-1, item (5), the applicant examined the potential threat posed by vessels occupying anchorages on the Delaware River near the PSEG Site. General Anchorage 2 and General Anchorage 3 are within 8 km (5 mi) of the PSEG Site. The applicant calculated the frequency of hazardous conditions at the PSEG Site due to vessels anchored in Anchorage 2 as 8.6×10^{-10} per year and due to vessels anchored in Anchorage 3 as 1.1×10^{-9} per year. Based on its review of the applicant's response containing assumptions and calculations, the staff considers the response reasonable and acceptable, as it satisfies the NUREG-0800 acceptance criteria associated with the regulatory requirements mentioned above. The applicant also provided revisions to SSAR

Sections 2.2.2.3.2, 2.2.3.2.2, and 2.2.3.2.3. The staff confirmed that in Revision 3 of the ESP application, dated March 31, 2014, the applicant correctly incorporated the changes in SSAR Sections 2.2.2.3.2, and 2.2.3.2.2, but not in 2.2.3.2.3. The staff informed the applicant about the inconsistency and identified this as Confirmatory Item 2.2-1. The staff verified that in Revision 4 to the PSEG Site ESP application (June 5, 2015), the applicant corrected this inconsistency. Therefore, the staff considers Confirmatory Item 2.2-1 closed.

2.2.3.4.2 Toxic Chemicals

Toxic chemicals hazards are considered for facilities and activities in the vicinity of the PSEG Site. These hazards include chemicals processed, stored, used, or transported near the PSEG Site. However, the control room habitability is not evaluated for this ESP application as PSEG has not selected a reactor design technology, and the control room characteristics are unknown. Therefore, chemicals that lead to concentration above the Immediately Dangerous to Life and Health (IDLH) at the power block boundary will be evaluated at the COL stage. The staff has identified this as COL Action Item 2.2-1, as described in Section 2.2.3.5 of this report.

Hazardous materials potentially on the Delaware River are identified in SSAR Table 2.2-16, and those transported on nearby roads or at nearby facilities are identified in SSAR Table 2.2-17. Only those chemicals at nearby facilities were evaluated by the applicant, and the applicant found this to not impact the PSEG Site. All other chemicals will be evaluated at the COL stage.

As described in SSAR Section 2.2.3.2, onsite chemical storage for the proposed new plant is not included in the PSEG ESP application, and will be evaluated at the COL stage, when the new plant reactor technology is selected. The staff has identified this as COL Action Item 2.2-2, as described in Section 2.2.3.5 of this report.

2.2.3.4.3 Fires

Hazards leading to high heat fluxes, smoke, nonflammable gases, or chemical bearing clouds from the release of materials as consequence of fires in the vicinity of the plant are considered. The chemical releases analyzed for potentially leading to high heat fluxes at safety-related buildings are as follows:

- a hydrogen tank jet fire from the tank farm on the Hope Creek site; a gasoline pool fire due to a spill of the Hope Creek delivery truck; a diesel pool fire due to a spill of the Hope Creek tank

- a boiling liquid expanding vapor explosion (BLEVE) fireball of the propane tank at the LAC Township Buildings; a pool fire from the spill of gasoline from a vessel on the Delaware River

- a BLEVE fireball of a propane vessel on the Delaware River

The results are summarized in SSAR Table 2.2-21. Based on the results of these analyses, the applicant concluded that none of the fires is hazardous to the new plant. The staff's confirmatory assessments confirm the applicant's conclusion that the potential heat rate from these fires would not adversely impact the closest SSC of the proposed plant.

2.2.3.4.4 Collisions with Intake Structure

The cooling water intake structure for the proposed new plant is located on the Delaware River, which is a navigable waterway. Therefore, a probability evaluation of an accident involving a runaway barge carrying flammable material that could cause a significant release resulting in fire or explosion upon striking the intake structure was performed. The probability was determined to be 5.9×10^{-8} per year, which is smaller by an order of magnitude than the NUREG-0800 acceptance criterion of 1×10^{-7} per year. The staff reviewed the applicant-considered factors in determining this probability and finds the applicant's approach and methodology reasonable and acceptable.

2.2.3.4.5 Liquid Spills

One of the reactor technologies being proposed by PSEG requires a safety-related structure on the Delaware River. The materials listed in SSAR Table 2.2-6 are those that are transported on the Delaware River and could potentially be spilled into the waterway. Other than coal, tar-like oil, and asphalt, having specific gravity less than 1, would float on the surface of the water, and would not dilute, and, therefore, are not likely to be drawn into the intake system. In the unlikely event of a spill of coal, tar-like oil, or asphalt into the Delaware River, these substances would be removed by the bar rack or traveling screen in the intake system. As a result, the unlikely event of a liquid spill would not impact the safe operation of the new plant.

2.2.3.4.6 Radiological Hazards

In SSAR Section 2.2.3.5, the applicant stated that the control-room shielding design and habitability systems for the new plant are capable of maintaining the main control room environment suitable for prolonged occupancy throughout the duration of the postulated accidents that require protection from external airborne radioactivity. Therefore, the applicant maintains that potential hazards due to the release of radioactive material from Hope Creek Generating Station or Salem Generating Station as a result of normal operations or an unanticipated event would not threaten the safety of the new plant.

2.2.3.5 Permit Condition and COL Action Items

- Permit Condition 2

    - An applicant for a COL or CP referencing this early site permit shall demonstrate that the nearest structures, systems, and components (SSCs) important to safety of the selected plant design can withstand the effects of potential explosions associated with the relocated gasoline storage tank and the gasoline delivery tanker truck. The applicant shall demonstrate this by using the methodologies provided in RG 1.91 and RG 1.78 for direct explosion and vapor cloud explosion, respectively, to confirm that a minimum safe distance exists between the nearest plant SSCs important to safety and the relocated gasoline storage tank and the gasoline delivery tanker truck such that the SSCs would not experience an overpressure in excess of 1.0 psi in the event of an explosion.

- COL Action Item 2.2-1

    - An applicant for a COL or a CP referencing this early site permit will, after selecting a reactor technology, evaluate the impact on the proposed plant at the PSEG Site of toxic chemicals processed, stored, used, or transported within the vicinity of the

PSEG Site, to identify chemicals that lead to concentration above the Immediately Dangerous to Life and Health (IDLH) at the power block boundary, and provide a detailed control room habitability assessment.

- COL Action Item 2.2-2

  - An applicant for a COL or a CP referencing this early site permit will, after selecting a reactor technology, identify potentially toxic, flammable, or explosive hazardous materials to be stored onsite, and evaluate their possible impact on the proposed plant at the PSEG Site.

2.2.3.6 Conclusion

Based on the aforementioned discussions, along with the inclusion of the COL Action Items 2.2-1 and 2.2-2, and subject to Permit Condition 2 and consistent with the resolution of Confirmatory Item 2.2-1, the staff finds that the PSEG ESP applicant has identified and evaluated potential accidents related to the presence of hazardous materials or activities in the PSEG Site vicinity that could affect a nuclear power plant or plants that might be constructed on the proposed site. The staff notes that from these potential accidents, the applicant has selected those that should be considered design-basis events at the COL stage. The staff reviewed the information provided and, for the reasons discussed above, along with the inclusion of the two COL action items mentioned above and subject to Permit Condition 2, concludes that the PSEG ESP applicant has established site characteristics and design parameters acceptable to meet the requirements of 10 CFR 52.17(a)(1)(vii), 10 CFR 52.17(a)(1)(ix), 10 CFR 100.20(b), and 10 CFR 100.21(e) for determining the acceptability of the PSEG Site.

2.3 Meteorology

To ensure that a nuclear power plant can be designed, constructed, and operated on an applicant's proposed ESP site in compliance with NRC regulations, the staff evaluates regional and local climatological information, including climate extremes and severe weather occurrences that may influence the design and affect the siting of a nuclear plant. The staff reviews information on the atmospheric dispersion characteristics of a nuclear power plant site to determine if the radioactive effluents from postulated accidental releases, as well as routine operational releases, comply with NRC regulations. The staff prepared Sections 2.3.1 through 2.3.5 of this report in accordance with the review procedures described in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)," using information presented in Section 2.3 of the PSEG Site ESP SSAR, responses to staff RAIs, and generally available reference materials, as described in applicable sections of NUREG-0800.

2.3.1 Regional Climatology

2.3.1.1 Introduction

In SSAR Section 2.3.1, "Regional Climatology," the applicant presented information on the climatic conditions and regional meteorological phenomena (both the averages and extremes thereof) that could influence the design and affect the operating bases of safety- and non-safety-related structures, systems, and components (SSCs) for the proposed nuclear power plant.

2.3.1.2 Summary of Application

In SSAR Section 2.3.1, 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 potential for restrictive air dispersion conditions and high air pollution levels at the proposed site

Based on the above information, the applicant provided in SSAR Table 2.0-1, "PSEG Site Characteristics," a representative list of characteristics that describe the PSEG Site. 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 applicant proposed these climatic site characteristics as minimum design and operating bases for the proposed PSEG 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, 1-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 (1-percent, and 0.4-percent annual exceedance; 100-year return period)

2.3.1.3 Regulatory Basis

The acceptance criteria for identifying regional climatological and meteorological information are based on meeting the relevant requirements of 10 CFR 52.17, "Contents of Applications;

Technical Information," and 10 CFR Part 100, "Reactor Site Criteria." The staff considered the following regulatory requirements in reviewing the applicant's identification of regional climatological and meteorological information.

- 10 CFR 52.17(a), as it relates to the requirement that the application contain a description of the seismic, meteorological, hydrological, and geological characteristics of the proposed site

- 10 CFR 100.20(c), as it relates to the requirement that those meteorological characteristics of the site that are necessary for safety analysis or that might have an impact on plant design be identified and characterized as part of the NRC's review of the acceptability of the site

- 10 CFR 100.21(d), as it relates to the requirement that the physical characteristics of the site- including meteorology, geology, seismology, and hydrology- be evaluated and site characteristics 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 at the ESP stage 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," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities":

- GDC 2, "Design Bases for Protection Against Natural Phenomena," as it relates to the requirement that SSCs 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," as it relates to the requirement 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, including loss-of-coolant accidents

The following are the related acceptance criteria from NUREG-0800, Section 2.3.1, "Regional Climatology."

- The description of the general climate of the region should be based on standard climatic summaries compiled by the National Oceanic and Atmospheric Administration (NOAA).

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

- The tornado parameters should be consistent with RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1. Alternatively, an applicant may specify any tornado parameters that are appropriately justified, provided that a technical evaluation of site-specific data is conducted.

- The basic (straight-line) 100-year return period, 3-second gust wind speed should be based on appropriate standards, with suitable corrections for local conditions.

- To be consistent with RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," Revision 2, the UHS meteorological data that would result in the maximum evaporation and drift loss of water and minimum water cooling should be based on long-period regional records that represent site conditions. (The guidance in this RG does not apply to passive reactor designs that utilize a passive containment cooling system at the UHS.)

- The weight of the 100-year return period snowpack should be based on data recorded at nearby representative climatic stations or obtained from appropriate standards with suitable corrections for local conditions. The weight of the 48-hour PMWP should be determined in accordance with reports published by NOAA's Hydrometeorological Design Studies Center.

- Ambient temperature and humidity statistics should be derived from data recorded at nearby representative climatic stations or obtained from appropriate standards with suitable corrections for local conditions.

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

- All other meteorological and air quality conditions identified by the applicant as design and operating bases should be documented and substantiated.

- Design Certification (DC)/COL Interim Staff Guidance (ISG)-007, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," which clarifies the staff's position on identifying winter precipitation events as site characteristics and site parameters to determine normal and extreme winter precipitation loads on the roofs of Seismic Category I structures.

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

- RG 1.23, Revision 1, "Meteorological Monitoring Programs for Nuclear Power Plants," which provides criteria for an acceptable onsite meteorological measurements program.

- RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," which describes the type of regional meteorological data that should be presented in SSAR Section 2.3.1.

- RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," which provides criteria for selecting the design-basis hurricane parameters

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

2.3.1.4 Technical Evaluation

The staff reviewed SSAR Section 2.3.1 to ensure that the ESP application represents the complete scope of information relating to "Regional Climatology." The staff's review confirmed that the information contained in the application addresses the required information relating to regional climatology.

2.3.1.4.1 Landforms and Ground Surface Character of the Site's Region

In SSAR Section 2.3.1.1, the applicant stated that the climate of the proposed site is the combined result of several geographic factors. These factors include the synoptic weather patterns that are typical of the area, the type of approaching air masses, and the character of the regional ground surface.

The PSEG Site is located on the eastern bank of the Delaware River, at the southwest corner of New Jersey (NJ). SSAR Figure 2.3-1, "New Jersey Landform Areas," (reproduced in Figure 2.3-1 of this report) depicts the major landform areas surrounding the site. The proposed PSEG Site is located near the edge of three of the landform areas: the Delaware River, the Inner Coastal Plain, and the Outer Coastal Plain. SSAR Figure 2.3-2, "Local Topographic Map," (reproduced in Figure 2.3-2 of this report) presents a regional topographic map for the area surrounding the PSEG Site.

In SSAR Section 2.3.1.1, the applicant stated that within a distance of approximately 8 km (5 mi) surrounding the PSEG site, the ground surface is primarily marsh. At distances greater than 8 km (5 mi), the ground surface is a combination of cleared area, coastal dune vegetation, forest (including oak, beach, and pine), and urban centers.

Figure 2.3-1 New Jersey Landform Areas (Reproduced from SSAR Figure 2.3-1)

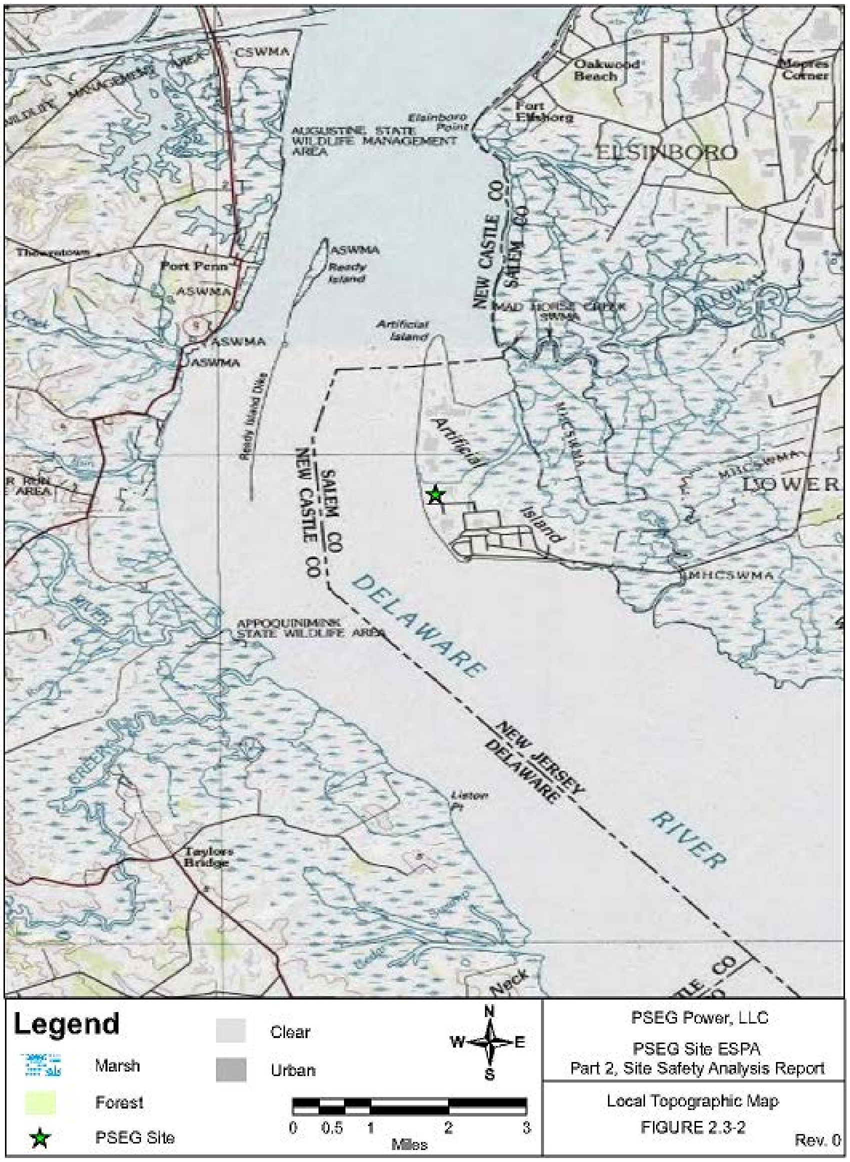

Figure 2.3-2 Local Topographic Map (Reproduced from SSAR Figure 2.3-2)

The staff finds this portion of the SSAR acceptable for information purposes only, as it does not result in any site characteristics.

2.3.1.4.2 General Climate of the Site's Region

The applicant described the proposed PSEG Site's general climate as a continental climate, with variations of that continental climate type on a regional basis. Elevations in the southwest portion of New Jersey are between sea level and 30.5 m (100 ft) above sea level. The proximity of Delaware Bay gives the PSEG Site a slightly maritime climate. The southwest region of New Jersey is shown to have the highest daytime temperatures and higher nighttime minimum temperatures in the state because it has a different soil type than the rest of New Jersey.

The prevailing winds in southwest NJ are from the southwest, except in winter when the west-to-northwest (rotating clockwise) winds dominate. High humidity is common in this portion of New Jersey, and moderate temperatures prevail when winds flow from the south or the east. The staff compared the applicant's general climate description to a similar National Climatic Data Center (NCDC) narrative description of the climate of New Jersey (NCDC, Climates of the States #60)[1] and confirms its accuracy and completeness; thus, the staff finds the applicant's description of the general climate acceptable.

2.3.1.4.3 Identification of Representative Regional Weather Monitoring Stations

The applicant explained the criteria that were used to determine the local weather reporting stations considered representative of the site area. The selection criteria that were presented included: (1) limiting the selected area to the inner and outer coastal plains, (2) excluding all stations within a distance of 16 km (10 mi) of the Atlantic Ocean, (3) excluding all stations located in the hills and mountains to the northwest in Delaware (DE), Maryland (MD), and Pennsylvania (PA), (4) excluding all stations in the vicinity of major water bodies other than the Delaware Bay, and (5) excluding all stations farther than 64 km (40 mi) from the PSEG Site.

The applicant provided the locations of all of the stations in the site's region, regardless of the selection criteria listed above, in SSAR Table 2.3-4, "Available NOAA Regional Meteorological Monitoring Stations," and SSAR Figure 2.3-11, "Locations and Categories of Regional Weather Monitoring Stations" (reproduced in Figure 2.3-3 of this report).

1 http://cdo.ncdc.noaa.gov/climatenormals/clim60/states/Clim_NJ_01.pdf, accessed December 13, 2010.

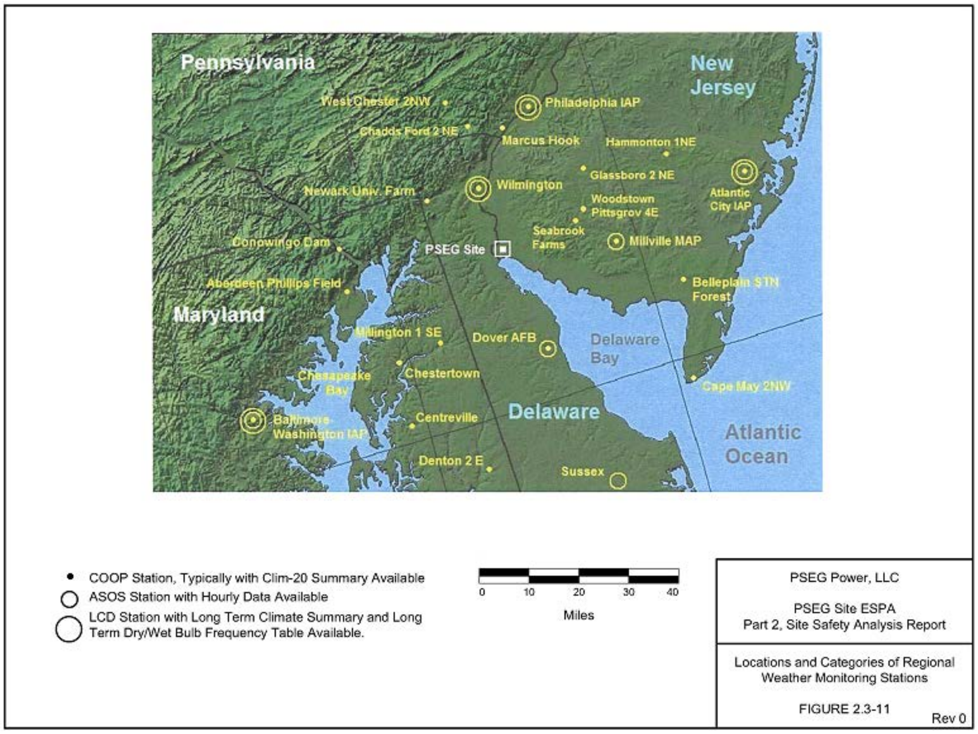

Figure 2.3-3 Locations and Categories of Regional Weather Monitoring Stations (Reproduced from SSAR Figure 2.3-11)

In a discussion about the selection criteria, the applicant demonstrated that the regional data is representative of the site's area along the Delaware Bay. The staff reviewed the selection criteria presented by the applicant and considers them appropriate and reasonable.

2.3.1.4.4 Data Sources

The applicant characterized the regional climatology of the proposed PSEG Site area using data from the NCDC, including data from first-order reporting stations in Philadelphia, PA, and Wilmington, DE, and from eight other nearby cooperative observer stations. The cooperative observer stations are located in Kent County in Delaware; Gloucester, Atlantic, Cumberland, and Salem Counties in New Jersey; Delaware County in Pennsylvania; and Kent County in Maryland. The regional climatic observation stations used by the applicant are included in the list presented in SSAR Table 2.3-4 and depicted in SSAR Figure 2.3-11 (reproduced in Figure 2.3-3 of this report).

The applicant also obtained information on mean and extreme regional climatological phenomena from a variety of sources, such as publications by the NCDC, 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 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). The staff reviewed these sources and finds them acceptable.

2.3.1.4.5 Severe Weather

2.3.1.4.5.1 Extreme Wind.

Estimating wind loading on plant structures involves identifying the site's "basic" wind speed, which is defined by American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) 7-05, "Minimum Design Loads for Buildings and Other Structures," as the "3-second gust speed at 33 ft (10 m) above the ground in Exposure Category C." Exposure Category C relies on the surface roughness categories as defined in Chapter 6, "Wind Loads," of ASCE/SEI 7-05. Exposure Category C is acceptable at the PSEG Site because of scattered obstructions of various sizes in the immediate site area. Exposure Category B specifies that there must be "urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger" prevailing "in the upwind direction for a distance of at least 2,600 ft (792 m) or 20 times the height of the building, whichever is greater." Exposure Category D specifies that there must be "flat, unobstructed areas and water surfaces" prevailing "in the upwind direction for a distance greater than 5,000 ft (1,525 m) or 20 times the building height, whichever is greater." Based on the site description in SSAR Section 2.3.3.3, neither Exposure Category B nor Exposure Category D accurately describes the conditions at the PSEG meteorological tower. ASCE/SEI 7-05 states that Exposure Category C shall apply for all cases for which neither Exposure Category B nor D applies. SSAR Figure 2.3-12, "Annual Mean Wind Rose at S/HC Primary Meteorological Tower 33 ft. Level During Three Year Period 2006-2008," shows that the PSEG Site has two prevailing wind directions, northwesterly and southeasterly.

Using a plot of basic wind speeds presented in ASCE/SEI 7-05 (reproduced in Figure 2.3-4 of this report) for the portion of the United States (U.S.) that includes the proposed PSEG Site, the applicant determined a 50-year return period wind speed of 40.2 m/s (90 mph). The applicant also used data from the AFCCC Engineering Weather Data (EWD) compact disc (CD) (Air Force Combat Climatology Center (AFCCC), National Climatic Data Center (NCDC), "Engineering Weather Data, 2000 Interactive Edition," developed by the AFCCC and published in the NCDC, Ashville, NC, 1999). The applicant noted that the highest 50-year recurrent wind speed at any of the first order reporting stations in the site area is 49 m/s (110 mph), as reported at Philadelphia International Airport. The staff confirmed this value using the EWD. This value is associated with a mean recurrence interval of 50 years[2]. Using a conversion factor listed in ASCE/SEI 7-05, the applicant derived a 100-year return period 3-second gust wind speed site characteristic value of 52.6 m/s (117.7 mph), as presented in SSAR Table 2.0-1.

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[2] The staff noted that the 50-year recurrence, 3-second gust basic wind speed reported by the EWD is based on data from ASCE 7-95. The 50-year recurrence basic wind speeds were updated 3 years later in ASCE 7-98 and were subsequently lowered to the basic wind speeds found in ASCE 7-05. The basic wind speeds presented in ASCE 7-05 were updated "based on a new and more complete analysis of hurricane wind speeds." A complete discussion of the reasons for this change can be found in ASCE/SEI 7-05, Section C6.5.4, "Basic Wind Speed."

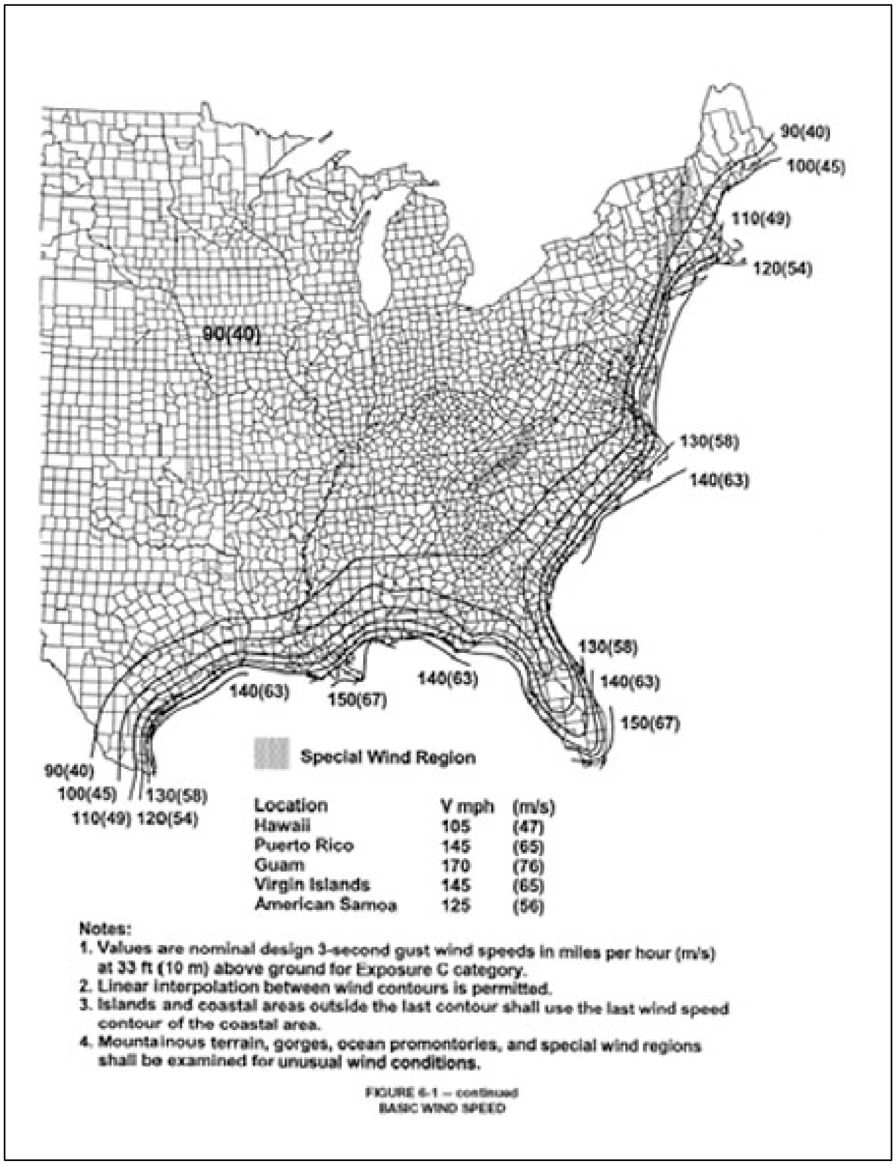

Figure 2.3-4 ASCE/SEI 7-05, Figure 6-1, "Basic Wind Speed"

In October 2011, the NRC issued RG 1.221, which provides the design-basis hurricane wind speeds that correspond to an exceedance frequency of 10^{-7} per year. Based on the data in RG 1.221, it is possible that the potential winds associated with hurricanes may exceed the wind speeds associated with tornadoes at sites near the coasts. In accordance with the requirements of 10 CFR Part 52 and 10 CFR Part 100, and with the guidance of RG 1.221, in RAI 56, Question 02.03.01-8, the staff requested that the applicant update the site characteristic values in the SSAR to include a new site characteristic called "Hurricane Wind Speed." In a March 23, 2012, response to RAI 56, Question 02.03.01-8, the applicant provided information on a new site characteristic titled, "Hurricane Wind Speed," and committed to update SSAR Table 2.0-1 with this information. Using the guidance in RG 1.221, the applicant assigned this site characteristic a wind speed of 71.1 m/s (159 mph). This wind speed represents the maximum nominal 3-second gust wind speed at 10 m (33 ft) above ground over open terrain having a probability of exceedance of 10^{-7} per year. In the response to RAI 56,

Question 02.03.01-8, the applicant added a new Table 2.3-38, "Hurricane Missile Site Characteristics for PSEG Site," which provides the Hurricane Missile Site Characteristics for the PSEG Site. Additionally, the applicant added a short description in SSAR Section 2.3.1.5.3, "Tropical Cyclones," of the development of the abovementioned site characteristic specific wind speed. The applicant committed to add the new table as well as the short description in the next revision of the application. The staff reviewed the response and the proposed changes, and finds them acceptable. In addition, the staff has verified that the applicant's committed changes have been incorporated into Revision 1 of the PSEG ESP application, dated May 21, 2012. Accordingly, the staff considers RAI 56, Question 02.03.01-8, resolved.

Since the applicant determined the site characteristic values in accordance with NUREG-0800, Section 2.3.1, and has chosen conservative values, the staff finds them adequate and acceptable.

2.3.1.4.5.2 Tornadoes.

The applicant chose the tornado site characteristics based on RG 1.76, Revision 1, which provides design-basis tornado characteristics for three tornado-intensity regions throughout the U.S., each with a 10^{-7} probability of occurrence. The proposed PSEG Site is located within tornado intensity region II. The applicant proposed the following tornado site characteristics, which are listed in SSAR Table 2.0-1:

maximum wind speed	89.4 m/s (200 mph)
translational speed	17.9 m/s (40 mph)
maximum rotational speed	71.5 m/s (160 mph)
radius of maximum rotational speed	45.7 m (150 ft)
pressure drop	6.2 kilopascals (kPa) (0.9 psi)
rate of pressure drop	2.76 kPa (0.4 psi/sec)

In SSAR Table 2.3-7, "Regional Tornadoes and Water Spouts," the applicant presented statistics on tornadoes that have occurred in the eight counties surrounding the PSEG Site. Using the NCDC Storm Events database, the staff was able to confirm (within a reasonable amount) the number of storms that have been recorded near the PSEG Site, as presented in SSAR Section 2.3.1.5.2, "Tornadoes."

SSAR Section 2.3.1.5.2, "Tornadoes," stated that the site design basis tornado (DBT) characteristics (SSAR Table 2.3-5) are from RG 1.76, Revision 1, March 2007. The staff maintained that the wind speeds provided in Revision 1 of RG 1.76 are not DBT wind speeds. In RAI 14, Question 02.03.01-1, the staff requested that the applicant update SSAR Section 2.3.1.5.2 to correct this error, or provide justification to substantiate the statement in the ESP application. In a May 13, 2011, response to RAI 14 Question 02.03.01-1, the applicant provided updates to the SSAR in which the applicant removed language stating that the values presented in the SSAR are the DBT wind speeds. The applicant corrected this language by clarifying that the wind speeds presented are site characteristic values. The applicant provided SSAR markups and committed to incorporate them in the next revision of the application. The staff reviewed the applicant's response to RAI 14, Question 02.03.01-1, as well as the

SSAR markups, and finds them acceptable. Subsequently, the staff verified that the applicant's committed changes have been incorporated in Revision 1 of the ESP application, dated May 21, 2012 and, therefore, the staff considers RAI 14, Question 02.03.01-1 resolved.

Since the applicant's tornado site characteristics are based on those presented in RG 1.76, Revision 1, the staff finds that the applicant has chosen acceptable tornado site characteristics.

2.3.1.4.5.3 Tropical Cyclones.

In SSAR Section 2.3.1.5.3, "Tropical Cyclones," and in SSAR Table 2.3-8, "Regional Tropical Cyclones by Storm Category," the applicant provided information on tropical cyclones. During the period of time between 1851 and 2008, 109 tropical cyclone centers passed within an 185-km (115-mi) radius of the proposed PSEG Site. The applicant used the NOAA-Coastal Services Center (CSC)[3] historical tropical storm database to determine that of the 109 tropical cyclone centers, 31 were extra-tropical depressions, 9 were tropical depressions, 60 were tropical storms, 6 were Category 1 hurricanes, and 3 were Category 2 hurricanes.

Using the same database, the staff was able to verify the statistics presented by the applicant. Therefore, the staff finds the applicant's description of the number of tropical cyclones in the vicinity of Salem County, NJ, acceptable.

2.3.1.4.5.4 Precipitation Extremes.

In SSAR Section 2.3.1.5.4, "Precipitation Extremes," the applicant stated that there is considerable variability of extreme rainfall and snowfall events across the site's climate region. The staff finds the applicant's statement consistent with the staff's understanding that extreme precipitation events are generally short-lived and confined to a small region. Due to this, one station may report extreme precipitation, whereas, a nearby station may report much less precipitation.

Table 2.3-1 Precipitation Extremes at the Salem/Hope Creek Site and at NOAA Regional Meteorological Monitoring Stations (Reproduced from SSAR Table 2.3-11)

Station Name	State	County	Maximum Recorded 24-Hour Rainfall (inches)	Maximum Recorded Monthly Rainfall (inches)	Maximum Recorded 24-Hour Snowfall (inches)	Maximum Recorded Monthly Snowfall (inches)
S/HC Site	NJ	Salem	10.03	13.51	not measured	not measured
Dover	DE	Kent	8.50	16.08	25.0	36.5
Glassboro 2 NE	NJ	Gloucester	6.67	15.37	14.0	27.0
Hammonton 1 NE	NJ	Atlantic	7.55	14.01	26.0	40.0
Marcus Hook	PA	Delaware	11.68	16.13	30.7	30.7
Millington 1 SE	MD	Kent	10.77	15.58	20.0	25.6

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3 http://www.csc.noaa.gov/ Accessed 12/15/2010

Station Name	State	County	Maximum Recorded 24-Hour Rainfall (inches)	Maximum Recorded Monthly Rainfall (inches)	Maximum Recorded 24-Hour Snowfall (inches)	Maximum Recorded Monthly Snowfall (inches)
Millville MAP	NJ	Cumberland	9.06	12.90	14.8	26.2
Philadelphia IAP	PA	Philadelphia	6.63	13.07	27.6	33.8
Seabrook Farms	NJ	Cumberland	6.57	12.99	11.0	23.6
Wilmington New Castle R	DE	New Castle	8.29	12.68	22.0	31.6
Woodstown Pittsgrove 4E	NJ	Salem	7.24	12.53	19.0	38.3
Overall Maximum			11.68	16.13	30.7	40.0

Based on observations from 10 nearby NOAA meteorological monitoring stations and from the Salem and Hope Creek Site, the applicant presented historical precipitation extremes for the region in SSAR Table 2.3-11, "Precipitation Extremes at the Salem/Hope Creek Site and at NOAA Regional Meteorological Monitoring Stations" (reproduced in Table 2.3-1 of this report) The applicant stated that the highest 24-hour rainfall total in the area was 297 mm (11.68 in.) on September 16, 1999, about 42 km (26 mi) to the north-northeast of the PSEG Site at the Marcus Hook monitoring station. The highest monthly rainfall total in the site area was 410 mm (16.13 in.) recorded during September 1999 at the same monitoring station. Site characteristic values corresponding to the site parameter precipitation (rain) rates for 1-hour and 5-minute time periods are addressed in SSAR Section 2.4.2.3, "Effects of Local Intense Precipitation," and are discussed in Section 2.4.2.2.3, "Effects of Local Intense Precipitation," of this report.

On July 1, 2009, the staff issued Design Certification (DC)/COL Interim Staff Guidance (ISG)-007, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," which clarifies the staff's position on identifying winter precipitation events as site characteristics and site parameters to determine normal and extreme winter precipitation loads on the roofs of Seismic Category I structures. The ISG updates and revises the previously issued staff guidance provided in NUREG-0800, Section 2.3.1.

DC/COL-ISG-007 states that normal and extreme winter precipitation events should be identified in NUREG-0800, Section 2.3.1, as COL site characteristics for use with NUREG-0800, Section 3.8.4, "Other Seismic Category I Structures," in determining the normal and extreme winter precipitation loads on the roofs of seismic Category I structures. The normal winter precipitation roof load is a function of the normal winter precipitation event, whereas the extreme winter precipitation roof loads are based on the weight of the antecedent snowpack resulting from the normal winter precipitation event plus the larger resultant weight from either: (1) An extreme frozen winter precipitation event or (2) an extreme liquid winter precipitation event. The snow and/or ice from the extreme frozen winter precipitation event is assumed to accumulate on the roof on top of the snow and/or ice from the earlier normal winter precipitation event.

Whereas the water from the extreme liquid winter precipitation event may or may not accumulate on the roof, depending on the geometry of the roof and the type of drainage provided. The ISG further states:

- The normal winter precipitation event should be the highest ground-level weight (in pounds per square foot (lb/ft^2)) among: (1) The 100-year return period snowpack; (2) the historical maximum snowpack; (3) the 100-year return period two-day snowfall event; or (4) the historical maximum two-day snowfall event in the site region.

- The extreme frozen winter precipitation event should be the higher ground-level weight (in lb/ft^2) of: (1) The 100-year return period two-day snowfall event; and (2) the historical maximum two-day snowfall event in the site region.

- The extreme liquid winter precipitation event is defined as the theoretically greatest depth of precipitation (in inches of water) for a 48-hour period that is physically possible over a 25.9-km^2 (10-mi^2) area at a particular geographical location during those months with the historically highest snowpacks.

In a May 13, 2011, response to RAI 14, Question 02.03.01-2, the applicant committed to updating the SSAR to include a discussion in accordance with DC/COL-ISG-07. The staff reviewed the response and determined that the applicant's response and associated SSAR markups did not include the normal and extreme winter precipitation load specified in the ISG. Therefore, in RAI 48, Question 02.03.01-7, the staff requested that the applicant expand the list of site characteristics in SSAR Table 2.0-1 to include site characteristic values that correspond to the normal and extreme winter precipitation site parameter values contained in the Design Control Documents (DCDs) for the reactor designs referenced in SSAR Section 1.2.2, "Site Development." These winter precipitation loads should be determined in accordance with the guidance provided in DC/COL-ISG-07. In a February 16, 2012, response to RAI 48, Question 02.03.01-7, the applicant provided information consistent with the guidance in the ISG, and committed to update SSAR Table 2.0-1 to include two additional winter precipitation site characteristics (Normal Winter Precipitation Event and Extreme Frozen Winter Precipitation Event). The applicant also committed to update the text in SSAR Section 2.3.1.5.4, "Precipitation Extremes," to include a discussion on how the additional site characteristics were determined. The applicant committed to including in SSAR Section 2.3.1.5.4, a description of the historical maximum snowpack and the normal winter precipitation load as defined by the ISG. The staff reviewed the applicant's response with the proposed changes and confirmed the values presented by using verified NCDC sources. Since the applicant followed the methodology suggested DC/COL-ISG-07, the staff finds the applicant's proposed revisions acceptable.

Subsequently, the staff verified that the applicant's committed changes have been incorporated in Revision 1 of the ESP application, dated May 21, 2012. Accordingly, the staff considers RAI 48, Question 02.03.01-7 resolved.

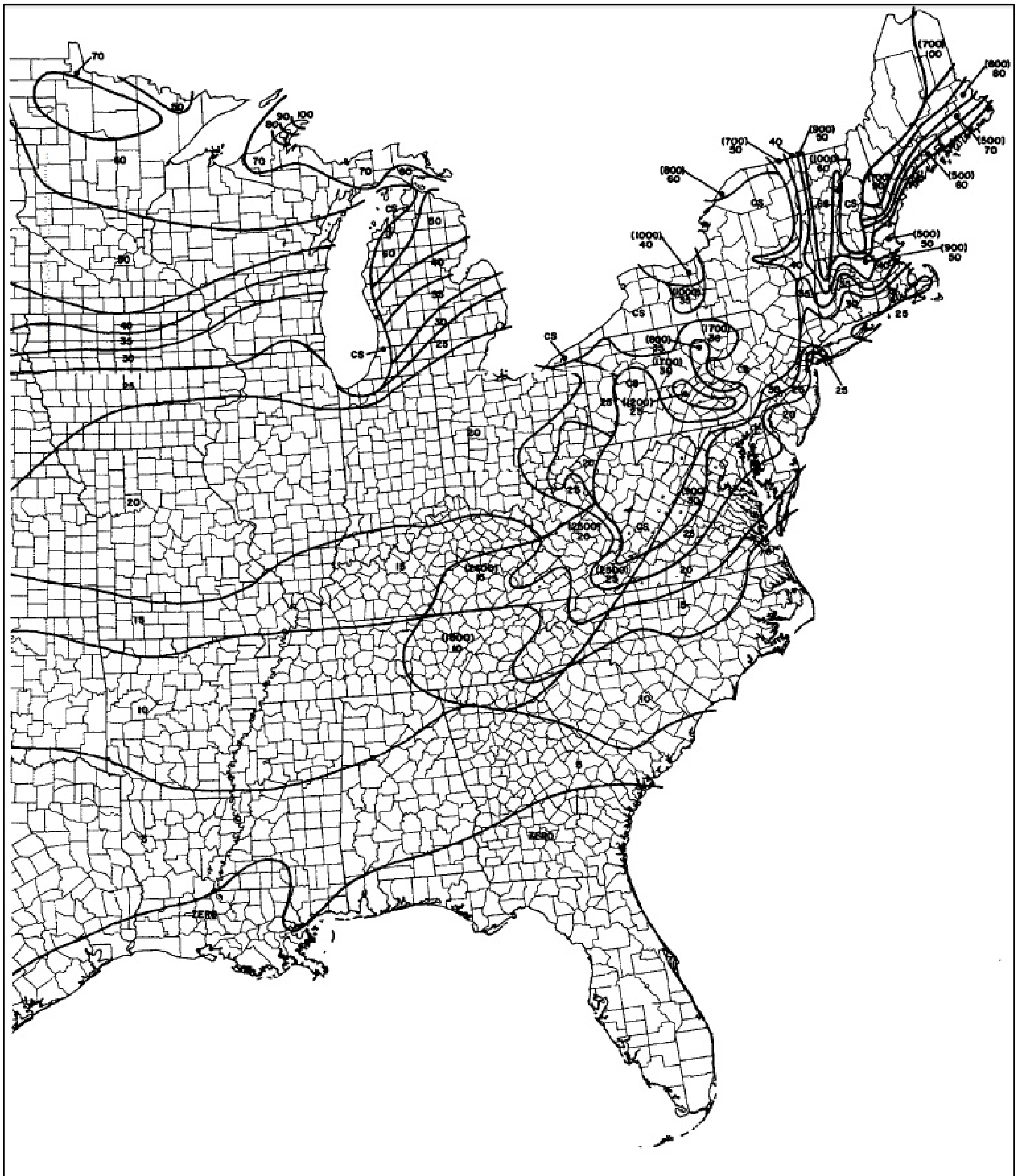

Figure 2.3-5 ASCE 7-05, "Figure 7-1: Ground Snow Loads, p_g, for the United States (lb/ft^2)"

In SSAR Section 2.3.1.5.4, "Precipitation Extremes," the applicant identified the maximum 24-hour snowfall for the area surrounding the PSEG Site to be 780 mm (30.7 in.) on January 8, 1996. This snowfall was measured at the Marcus Hook observation station located approximately 42 km (26 mi) north-northeast of the PSEG Site. The applicant identified its extreme frozen winter precipitation event as 100.1 kg/m^2 (20.51 lb/ft^2), based on the 100-year return period two-day snowfall event. This snowfall measurement is consistent with the staff's understanding that it is the highest recorded snowfall event in the region. The 50-year return

period ground-level snowpack, as given in ASCE/SEI 7-05, Figure 7-1, “Ground Snow Loads, p_g for the United States (lb/ft^2),” (reproduced in Figure 2.3-5 of this report) is equal to 117.2 kg/m^2 (24 lb/ft^2) when converted to a 100-year weight. The applicant also presented its extreme liquid winter precipitation event as 533 mm (21.0 in.) liquid depth, which was identified as the 48-hour PMWP. Using ASCE/SEI 7-05 and NCDC Snow Climatology[4] the staff independently confirmed the winter precipitation data presented by the applicant and finds it complete and acceptable.

2.3.1.4.5.5 Hail, Snowstorms and Ice Storms.

This section’s discussion on hail, freezing rain, and sleet is intended to provide a general climatic understanding of the severe weather phenomena in the site’s region but does not result in the generation of site characteristics for use as design or operational bases.

Hail can accompany severe thunderstorms and can be a major weather hazard, causing significant damage to crops and property. In SSAR Section 2.3.1.5.5, “Hail, Snowstorms, and Ice Storms,” the applicant stated that the NOAA “Climate Atlas of the United States” (NCDC, “The Climate Atlas of the United States,” Version 2.0 CD, published by NCDC Ashville, NC, September 2002) was used to estimate that the annual mean number of days with hail 2.54 cm (1.0 in.) or greater in diameter is approximately 0.5 per year at the PSEG Site. The applicant also stated that large hail events (i.e., those with hail having a diameter greater than 4.45 cm (1.75 in.)) have been observed only six times within the two counties surrounding the PSEG Site during the 60-year period covered in the NOAA reference.

The staff confirmed the applicant’s statement that query results from the NCDC Storm Events Database for hail event(s) reported in Salem County, NJ, and New Castle County, DE, between January 1, 1950, and August 31, 2010, show that a total of six hail events with hail 4.45 cm (1.75 in.) or greater in diameter occurred in the PSEG Site area.

The staff notes that the number of reported hail events has increased significantly over time, primarily as a result of increased reporting efficiency and confirmation skill. This increase in hail reports is also likely caused by the increased number of targets because of urbanization. This is because there are more targets damaged by hail in urban areas than in a rural area. Estimates of hail size can range widely based on the surrounding area’s population density and the years considered. The applicant stated that Salem and New Castle Counties can expect, on average, hail with a diameter of 2.54 cm (1.0 in.) or greater approximately 0.5 days per year. The staff verified the hail frequencies presented by the applicant from “The Climate Atlas of the United States.” Based on the National Severe Storms Laboratory (NSSL) “Severe Thunderstorm Climatology, Total Threat,”[5] the staff finds that, when considering data from 1980 through 1999, the total number of days per year with hail greater than 1.91 cm (0.75 in.) in diameter ranges from 1 to 2.

In SSAR Section 2.3.1.5.5, “Hail, Snowstorms, and Ice Storms,” the applicant stated that the annual snowfall is highly variable across the region and ranges from 2.54 centimeters (cm) to 127 cm (1 in. to 50 in.). Occasionally, these snow events are accompanied by, or alternate with, sleet and freezing rain as the weather system moves over the area. The Climate Atlas of the

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4 http://www.ncdc.noaa.gov/ussc/index.jsp, accessed June 2, 2011.

5 Severe Thunderstorm Climatology. Accessed 10/26/2010. https://www.nssl.noaa.gov/hazard/

United States indicates that the occurrence of snowfall 2.54 cm (1.0 in.) or greater in the site area averages 2.5 to 5.4 days per year. Using the NCDC Climate Maps of the United States (CLIMAPS)[6] and Local Climatological Data (LCDs) from the nearby NWS reporting stations, the staff independently confirmed the hail and ice storm frequencies provided by the applicant.

2.3.1.4.5.6 Thunderstorms.

This section's discussion on thunderstorms and lightning is intended to provide a general climatic understanding of the severe weather phenomena in the site's region but does not result in the generation of site characteristics for use as design or operational bases.

In SSAR Section 2.3.1.5.6, "Thunderstorms," the applicant stated that, on average, approximately 27 days with thunderstorm occurrences happen per year in the site area. This frequency was obtained from the 2010 NCDC LCD Annual Summary with Comparative Data for Wilmington, DE[7]. The majority of the storms recorded (73 percent) occurred between May and August.

In SSAR Section 2.3.1.5.6, the applicant estimated, based on a method attributed to the Electric Power Research Institute (EPRI) and the U.S. Department of Agriculture (USDA, "Rural Utilities Service Summary of Items of Engineering Interest," August 1988), that approximately 3.3 flashes to earth per km^2 per year (8.6 flashes/mi^2-yr) occur at the PSEG Site. The staff independently evaluated this estimate based on NCDC LCDs from the same weather reporting station, the EPRI method (3.3 flashes/km^2-yr (8.6 flashes/mi^2-yr)), a 10-year flash-density map from Vaisala[8] (3 to 4 flashes/km^2-yr (7.7 to 10.4 flashes/mi^2-yr)), and a 1999 study by G. Huffines and R.E. Orville titled, "Lightning Ground Flash Density and Thunderstorm Duration in the Continental United States: 1989–96" (Journal of Applied Meteorology 38(7): 1013-1019, July 1999) (1 to 3 flashes/km^2–yr (2.6 to 7.7 flashes/mi^2-yr)). Based on these accepted sources, the staff finds that the applicant has provided a reasonable estimate of the frequency of lightning flashes.

2.3.1.4.6 Meteorological Data for Evaluating the Ultimate Heat Sink

RG 1.27, Revision 2, states that the UHS should be designed to provide sufficient cooling water to permit safe shutdown and cooling down of each unit and to keep each unit in a safe shutdown condition. In the event of an accident, the UHS is designed to provide sufficient cooling water to safely dissipate the heat for the accident. The UHS is sized so that makeup water is not required for at least 30 days following an accident and design-basis temperature and chemistry limits for safety-related equipment are not exceeded. The UHS is designed to perform its safety function during periods of adverse site conditions, resulting in maximum water consumption and minimum cooling capability.

RG 1.27 specifies that applicants should ensure that design-basis temperatures of safety-related equipment are not exceeded and that a 30-day cooling supply is available. Consequently, applicants should identify the meteorological conditions that result in minimum water cooling and maximum 30-day evaporation and drift loss.

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6 NCDC Climate Maps of the United States. http://cdo.ncdc.noaa.gov/cgi-bin/climaps/climaps.pl

7 Quality Controlled Local Climatological Data. http://cdo.ncdc.noaa.gov/qclcd/QCLCD?prior=N

8 http://www.lightningsafety.noaa.gov/stats/08_Vaisala_NLDN_Poster.pdf, accessed October 26, 2010

To verify the applicant's site characteristic design conditions for the UHS, the staff examined hourly temperature and humidity observations from the same stations as the applicant (Wilmington, Dover, and Millville). The staff calculated 1-day, 5-day, and 30-day average wet-bulb and coincident dry bulb temperatures from the hourly data and selected the periods with the highest average wet-bulb temperatures as the worst periods. The resulting maximum 1-day, 5-day, and 30-day average wet-bulb temperature values were similar to the values presented by the applicant. Based on the results of this analysis, the staff finds the design-basis UHS meteorological site characteristics proposed by the applicant in SSAR Table 2.0-1 acceptable.

2.3.1.4.7 Design Basis Dry Bulb and Wet Bulb Temperatures

In SSAR Section 2.3.1.7, "Design Basis Dry Bulb and Wet Bulb Temperatures," the applicant based its ambient air temperature and humidity site characteristics on hourly databases recorded at first-order stations located in Wilmington and Dover, DE, and Millville, NJ. The applicant presented the site characteristic temperature and humidity values in SSAR Table 2.0-1 and in SSAR Section 2.3.1.5. The staff performed an independent analysis using hourly NCDC data from the same stations. The staff calculated dry-bulb and wet-bulb temperatures that are similar to those presented by the applicant. As a result of this confirmatory analysis, the staff finds the proposed site characteristics for ambient air temperature and humidity appropriate.

SSAR Section 2.3.1.7 describes the method used to calculate the 100-year return period maximum and minimum dry-bulb temperatures. The applicant used a linear regression technique from Chapter 14 of the 2009 ASHRAE Handbook (ASHRAE, "The Handbook CD 2009 Fundamentals," CDR, published by ASHRAE Atlanta, GA, 2009). The staff used data from the 2009 ASHRAE Weather Data Viewer, Version 4.0, to determine the 100-year return maximum and minimum dry-bulb temperature values for the PSEG Site. Through this method, the staff finds that the applicant's proposed 100-year return period maximum and minimum dry-bulb temperature site characteristic values of 41.1 °C (105.9 °F) and -28.2 °C (-18.7 °F) are correct and acceptable.

The applicant also presented the maximum and minimum (zero percent exceedance) site characteristic temperatures for the PSEG Site area. The applicant presented a zero percent exceedance maximum dry bulb temperature of 42.2 °C (108 °F). This maximum dry bulb temperature was recorded at the Marcus Hook reporting station. Using NCDC hourly data from reporting stations in Dover and Wilmington, DE, Millville, NJ, and Philadelphia, PA, the staff performed an independent confirmatory analysis to determine the 0-percent-exceedance dry bulb temperature. Using these NCDC observation station data, the staff confirmed the applicant's 0-percent-exceedance site characteristics dry bulb temperature value. The staff affirms that the 0 percent annual exceedance dry bulb temperature bounds the PSEG Site characteristic 100-year return period dry bulb temperature. The staff finds this acceptable because the observation of 42.2 °C (108 °F) bounds the staff's independent calculations for 100-year return period and maximum 0 percent exceedance dry bulb temperatures. Therefore, the staff considers the proposed site characteristic temperatures conservative.

The applicant also presented a 100% exceedance minimum dry bulb temperature of -26.1 °C (-15 °F) and a zero-percent-exceedance non-coincident wet bulb temperature of 30.1 °C (86.2 °F). Using hourly observation data from NCDC reporting stations in Dover and Wilmington, DE, Millville, NJ, and Philadelphia, PA, the staff performed an independent

confirmatory analysis and determined that the applicant's site characteristic temperatures are correct and conservative. Therefore, the staff accepts the PSEG Site characteristic temperatures as provided in SSAR Table 2.0-1.

2.3.1.4.8 Restrictive Dispersion Conditions

This section's discussion on restrictive dispersion conditions is intended to provide a general understanding of the phenomena in the site's region but does not result in the generation of site characteristics for use as design or operational bases.

In SSAR Section 2.3.1.8, "Restrictive Dispersion Conditions," the applicant used estimates of air stagnation provided in Air Stagnation Climatology for the United States (Wang, J.X.L. and J.K. Angell, "Air Stagnation Climatology for the United States (1948-1998)," NOAA/Air Resources Laboratory Atlas No. 1, National Oceanic and Atmospheric Administration, Silver Spring, MD, April 1999). The applicant stated that, on average, the PSEG Site experiences 11 days per year with stagnation conditions, or 2 cases per year with the mean duration of each case lasting 5 days. Using a reference (Holzworth, G.C., "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United Stated," AP-101, U.S. Environmental Protection Agency, January 1972) consistent with NUREG-0800, Section 2.3.1, the staff verified that the information provided by the applicant is correct and adequate.

2.3.1.4.9 Air Quality

The following discussion on air quality is intended to provide a general understanding of the phenomena in the PSEG Site's region, but does not result in the generation of site characteristics for use as design or operational bases.

The EPA establishes national ambient air quality standards (NAAQS)[9] for ground-level ozone and other criteria pollutants (pollutants that can injure health, harm the environment and cause property damage). The EPA works with partners at State, local, and Tribal levels to meet these standards. Under the Clean Air Act (CAA), as amended in 1990, each State must develop a plan describing how it will attain and maintain the NAAQS. Ozone and particulate matter (PM) (a complex mixture of extremely small particles and liquid droplets that can affect the heart and lungs and cause serious health effects) are criteria pollutants. These standards apply to the concentration of a pollutant in outdoor air. If the air quality in a geographic area meets or exceeds the national standard, it is called an attainment area; areas that do not meet the national standard are called non-attainment areas.

In SSAR Section 2.3.1.9, "Air Quality," the applicant explained that the proposed PSEG Site is located in the Metropolitan Philadelphia Interstate Air Quality Control Region (40 CFR 81.15, "Metropolitan Philadelphia Interstate Air Quality Control Region (Pennsylvania-New Jersey-Delaware)"). The counties within this region include Salem County, NJ and New Castle County, DE. Salem County, NJ is a non-attainment area for ozone under the 8-hour standard. New Castle County, DE is a non-attainment area for ozone under the 8-hour standard and for PM under the $PM_{2.5}$ standard. According to the EPA, $PM_{2.5}$ are fine particles such as those

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9 U.S. Environmental Protection Agency, "Ozone (O_3) Standards," **http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_index.html**, particularly "Ozone Implementation - Programs and Requirements for Reducing Ground Level Ozone," **http://www.epa.gov/airquality/ozonepollution/implement.html**.

found in smoke and haze and are 2.5 micrometers in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air. Using data provided by the EPA, the staff has verified that the information provided by the applicant is correct and adequate.

2.3.1.4.10 Climate Changes

To be compliant with NRC regulations, nuclear power plants (NPPs) must be built in consideration of the most severe 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. NPPs are designed with these stipulations on the environmental conditions that are considered at the site. Climate change is a concern because of the potential for unforeseen changes in extreme conditions in the local and regional environment. In SSAR Section 2.3.1.10, "Climate Changes," the applicant provided a discussion on the climatology of the PSEG Site region with regards to the trends in meteorological phenomena.

NUREG-0800, Section 2.3.1, states that historical data used to characterize a site should extend over a significant time interval to capture cyclical extremes. The staff obtained datasets considered to be of sufficient duration to determine the adequacy of the applicant's proposed site characteristics. For example, snow load was based on a 100-year return period and ambient design temperatures were based on a minimum of 30 years of hourly data and an estimated 100-year return period value. Tornado statistics were based on a 35-year period and tornado wind speeds were based on a 10^{-7} per year return interval as stated in DG-1143. Extreme winds were based on a 100-year return period, including 158 years of historical hurricane data (1851–2008).

The U.S. Global Change Research Program (USGCRP) released a report to the President and Members of Congress in June 2009 titled, "Global Climate Change Impacts in the United States." (Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.) This report, produced by an advisory committee chartered under the Federal Advisory Committee Act, summarizes the science of climate change and the impacts of climate change on the United States.

The USGCRP report found that the average annual temperature of the Northeast (which includes southwest New Jersey where the proposed PSEG Site is located) did not change significantly over the past century as a whole, but the annual average temperature has risen approximately 1.1 °C (2 °F) since 1970 with the greatest seasonal increase in temperature occurring during the winter months. Climate models predict continued warming in all seasons across the Northeast and an increase in the rate of warming through the end of the 21st century. Average temperatures in the Northeast are projected to rise by 1.7 to 2.8 °C (3 to 5 °F) by the end of the 2050s, depending on assumptions regarding global greenhouse-gas emissions.

The USGCRP report also states that there has been a 10- to 15-percent increase in observed annual average precipitation from 1958 to 2008 in the region where the proposed PSEG Site is located. Future changes in total precipitation are more difficult to project than changes in temperature. Model projections of future precipitation generally indicated that northern areas of the U.S. will have more precipitation in the winter months and less in the summer months. Except for indications that the amount of rainfall from individual hurricanes will increase, climatic models provide divergent results for future precipitation for most of the northeast.

The USGCRP reports that the power and frequency of Atlantic hurricanes has increased substantially in recent decades, but the number of North American mainland land-falling hurricanes does not appear to have increased over the past century. The USGCRP reports that likely future changes for the United States and surrounding coastal waters include more intense hurricanes with related increases in wind and rain, but not necessarily an increase in the number of these storms that make landfall.

In SSAR Section 2.3.1.10, the applicant analyzed trends in temperature and rainfall normals over a 70-year period for successive 30-year intervals by decade beginning in 1931 (e.g., 1931 through 1960, 1941 through 1970, etc.) for the climate divisions NJ-02 and DE-01. The applicant stated that the normal (i.e., 30-year average) temperature showed no discernible trend over the 70-year period, with a slight increase of about 0.28 °C (0.5 °F) during the most recent normal period. The applicant also stated that the normal rainfall had increased by about 25 mm (1 in.) during the most recent normal period.

The USGCRP further states that there is no clear trend in the frequency or strength of tornadoes since the 1950s for the United States as a whole. In SSAR Section 2.3.1.10, the applicant stated that the number of recorded tornado events has generally increased since detailed records were routinely kept beginning around 1950. However, much of this increase is attributable to a growing population, greater public awareness and interest, and technological advances in detection. The USGCRP report reaches the same conclusion.

The USGCRP reports that the distribution by intensity for the strongest 10 percent of hail and wind reports is little changed, providing no evidence of an observed increase in the severity of such events. Climate models project future increases in the frequency of environmental conditions favorable to severe thunderstorms. But the inability to adequately model the small-scale conditions involved in thunderstorm development remains a limiting factor in projecting the future character of severe thunderstorms and other small-scale weather phenomena.

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 PSEG Site. However, no conclusive evidence or consensus of opinion is available on the rapidity or nature of such changes. There is a level of uncertainty in projecting future conditions because the assumptions regarding the future level of emissions of heat trapping gases depend on projections of population, economic activity, and choice of energy technologies. If it becomes evident that long-term climatic change is influencing the most severe natural phenomena reported at the site, the COL holders have a continuing obligation to ensure that their plants stay within the licensing basis.

2.3.1.5 Conclusion

As discussed above, the applicant presented and substantiated information to establish the regional meteorological characteristics. The staff reviewed the information provided and, for the reasons given above, concludes that the applicant has established site characteristics and design parameters acceptable to meet the requirements of 10 CFR 100.20(c)(2) and 10 CFR 100.21(d).

The staff finds that the applicant has considered the most severe phenomena historically reported for the site and surrounding area in establishing the above site characteristics.
The staff, following the guidance provided in NUREG-0800, Section 2.3.1, has accepted the

methodologies used to determine the severity of the phenomena reflected in these site characteristics. Accordingly, the 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 staff finds the site characteristics previously identified by the applicant and reviewed by the staff 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 staff concludes that the identification and consideration of the climatic site characteristics discussed 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).

ESP applicants need not demonstrate compliance with the GDC listed in Section 2.3.1.3 of this report, "Regulatory Basis," however, the applicant chose to provide all necessary information with respect to regional climatology.

In view of the above, the staff finds the applicant's proposed site characteristics related to climatology for the proposed PSEG Site acceptable.

2.3.2 Local Meteorology

2.3.2.1 Introduction

In SSAR Section 2.3.2, "Local Meteorology," the applicant presented information on local (site) meteorological parameters, an assessment of the potential influence of the proposed plant and its facilities on local meteorological conditions and the impact of these modifications on plant design and operation, and a topographical description of the site and its environs.

2.3.2.2 Summary of Application

In SSAR Section 2.3.2, 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 how the construction and operation of the nuclear power plant and associated facilities that are planned to be built on the proposed site will influence the local meteorology, 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

In Section 2.3.2 of this report, the staff verifies that the applicant has identified and considered the meteorological and topographical characteristics of the site and the surrounding area, as well as changes to those characteristics that might be caused by the construction and operation of the proposed facility.

2.3.2.3 Regulatory Basis

The acceptance criteria, as identified in NUREG-0800, Section 2.3.2, "Local Meteorology," 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), as it relates to the requirement that the application contain a description of the seismic, meteorological, hydrological, and geological characteristics of the proposed site

- 10 CFR 100.20(c), as it relates to the requirement that that the meteorological characteristics of the site that might be necessary for safety analysis or that might have an impact on plant design be identified and characterized as part of the staff's review of the acceptability of a site

- 10 CFR 100.21(c), as it relates to the requirement that site atmospheric dispersion characteristics be evaluated and dispersion parameters established to ensure 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), as it relates to the requirement that the physical characteristics of the site, including meteorology, geology, seismology, and hydrology be evaluated and site characteristics established to ensure 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, at the ESP stage, in compliance with the above regulatory requirements would be necessary to determine, at the COL stage, a proposed facility's compliance with the requirement in 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants":

> 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.

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

- RG 1.23, Revision 1, which provides criteria for an acceptable onsite meteorological measurements program to be used to monitor site characteristics related to local (onsite) meteorology

- RG 1.206, 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 Section 2.3.2, the staff applied the same above-cited methodologies and techniques.

2.3.2.4 Technical Evaluation

The staff reviewed SSAR Section 2.3.2 to ensure that the ESP application represents the complete scope of information relating to this review topic. The staff's review confirmed that the applicant addresses the required information relating to local meteorology.

2.3.2.4.1 Local Meteorology

2.3.2.4.1.1 Data Sources.

To describe the local meteorology, the applicant used data from the onsite meteorological monitoring system, first-order NWS stations, and other nearby cooperative network observing stations listed in SSAR Table 2.3-4, "Available NOAA Regional Meteorological Monitoring Stations," and presented in SSAR Figure 2.3-11 (reproduced in Figure 2.3-3 of this report). 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 also presented mean values for, and historical extremes of, temperature, rainfall, and snowfall data from the offsite observation stations listed in SSAR Tables 2.3-1, "NOAA Climate Summary for Wilmington, Delaware," 2.3-2, "NOAA Climate Summary for Atlantic City, New Jersey," and 2.3-3, "NOAA Climate Summary for Philadelphia, Pennsylvania."

The staff evaluated the information regarding local meteorological conditions submitted by the applicant using data from the PSEG onsite meteorological monitoring system, as well as climatic data reported from the NCDC sources "Monthly Station Climate Summaries," "U.S. Monthly Climate Normals," and "Daily Surface Data."

2.3.2.4.2 Normal, Mean, and Extreme Values of Meteorological Parameters

2.3.2.4.2.1 Wind.

In this Section of this report, the staff discusses information provided by the applicant in SSAR Sections 2.3.2.2.1.1, "Scales of Air Motion," 2.3.2.2.1.2, "On-Site Wind Roses during Three Year Period," and 2.3.2.2.1.3, "On-Site Wind Roses during 32 Year Period."

In SSAR Section 2.3.2.2.1.1, "Scales of Air Motion," the applicant provided a brief description of the scales of air motion. The macroscale, mesoscale, and microscale airflow patterns are commonly used in meteorological literature when discussing air movement patterns of varying spatial and temporal scales. The staff accepts this portion of the SSAR for informational purposes only because it does not result in the generation of site characteristics for use as design or operational bases.

In SSAR Section 2.3.2.2.1.2, "On-Site Wind Roses during Three Year Period," the applicant presented hourly wind data from the PSEG onsite meteorological monitoring program, as described in SSAR Section 2.3.3, "On-Site Meteorological Measurements Program," from January 1, 2006, through December 31, 2008. The applicant also provided annual and seasonal wind roses measured at the 10-m (33-ft) observation height of the onsite

meteorological measurement system. The 10-m (33-ft) observation height is the only height used for the atmospheric-dispersion modeling described in Sections 2.3.4 and 2.3.5 of this report. The prevailing annual wind direction for the site is generally from the north and northwest quadrants. There is also a secondary maximum from the southeast. Winds from the northwest predominate during the autumn and winter months; southeasterly winds predominate during the spring months and account for approximately nine percent of the total winds during the summer and autumn.

The applicant stated that no calm winds were recorded at the site because of the sensitivity of the on-site sonic wind sensor and the open exposure of the flat terrain and Delaware Bay. The staff confirmed this statement and accepts it as correct and adequate.

In SSAR Section 2.3.2.2.1.3, "On-Site Wind Roses during 32 Year Period," the applicant provided wind roses (SSAR Figure 2.3-29, "Annual Mean Wind Rose at S/HC Primary Meteorological Tower 33-ft Level During 32 Year Period 1977-2008") compiled from a 32-year period of record (1977–2008) at the proposed PSEG Site (reproduced in Figure 2.3-6). The staff agrees that the longer period of record shows similar wind speed and direction characteristics when compared with the 3-year period of record (2006–2008). The staff accepts the comparison between the two datasets as informational and has not verified its accuracy because the 32-year period of record is not used in the generation of site characteristics for use as design or operational bases.

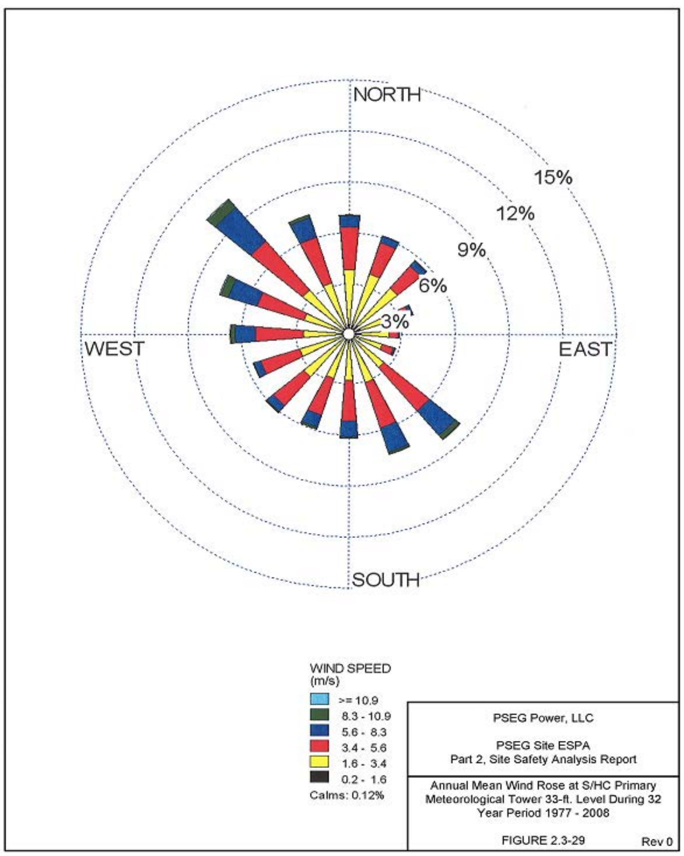

Figure 2.3-6 Annual Mean Wind Rose at S/HC Primary Meteorological Tower 33-ft Level During 32 Year Period 1977-2008 (Reproduced from SSAR Figure 2.3-29)

Using data from the onsite meteorological measurements program recorded between January 1, 2006, and December 31, 2008, the staff verified wind roses and joint frequency distributions (JFDs) provided by the applicant and accepts them as correct and adequate.

2.3.2.4.2.1.1 *Comparison of Annual and Seasonal Three Year On-Site Wind Roses with Annual and Seasonal Station Wind Roses*.

The applicant compared the onsite wind summaries against wind speed and direction from the Wilmington, Millville, and Dover reporting stations in the following SSAR Figures:

- Figure 2.3-36, "Annual Mean Wind Roses at S/HC Primary Meteorological Tower 33 ft. Level During Three Year Period 2006–2008 and Long-Term at Wilmington, Millville, and Dover."

- Figure 2.3-37, "Winter Mean Wind Roses at S/HC Primary Meteorological Tower 33 ft. Level During Three Year Period 2006–2008 and Long-Term at Wilmington, Millville, and Dover."

- Figure 2.3-38, "Spring Mean Wind Roses at S/HC Primary Meteorological Tower 33 ft. Level During Three Year Period 2006–2008 and Long-Term at Wilmington, Millville, and Dover."

- Figure 2.3-39, "Summer Mean Wind Roses at S/HC Primary Meteorological Tower 33 ft. Level During Three Year Period 2006-2008 and Long-Term at Wilmington, Millville, and Dover."

- Figure 2.3-40, "Autumn Mean Wind Roses at S/HC Primary Meteorological Tower 33 ft. Level During Three Year Period 2006–2008 and Long-Term at Wilmington, Millville, and Dover."

The annual PSEG Site 3-year wind rose shows two primary wind directions, northwest and southeast. The three stations in comparison all show an annual primary wind direction from the west through northwest directions (clockwise). Wilmington and Dover also show that winds blow from the south and surrounding sectors. The applicant states that the higher frequency of winds from the southeast at the PSEG Site, when compared with the surrounding stations, is because of the proximity and direction of the Delaware Bay coastline.

2.3.2.4.2.1.2 *Wind Direction Persistence*.

The applicant presented wind persistence data from the PSEG onsite meteorological monitoring program, as described in SSAR Section 2.3.3, "On Site Meteorological Measurements Program," from January 1, 2006, through December 31, 2008. The applicant stated that wind persistence is an indicator of the duration of atmospheric transport from a specific sector to a corresponding downwind sector that is 180 degrees opposite. The applicant provided detailed information on the wind persistence that was observed by the onsite meteorological measurements in the following SSAR Tables:

- Table 2.3-21, "Wind Direction Persistence/Wind Speed Distributions at the Salem/Hope Creek Primary Meteorological Tower 33 ft. Level 2006-2008 Period Wind Speed Greater than or Equal to 2.24 m/sec"

- Table 2.3-22, "Wind Direction Persistence/Wind Speed Distributions at the Salem/Hope Creek Primary Meteorological Tower 33 ft. Level 2006-2008 Period Wind Speed Greater than or Equal to 4.47 m/sec"

- Table 2.3-23, "Wind Direction Persistence/Wind Speed Distributions at the Salem/Hope Creek Primary Meteorological Tower 33 ft. Level 2006-2008 Period Wind Speed Greater than or Equal to 6.71 m/sec"

- Table 2.3-24, "Wind Direction Persistence/Wind Speed Distributions at the Salem/Hope Creek Primary Meteorological Tower 33 ft. Level 2006-2008 Period Speed Greater than or Equal to 8.94 m/sec"

- Table 2.3-25, "Wind Direction Persistence/Wind Speed Distributions at the Salem/Hope Creek Primary Meteorological Tower 33 ft. Level 2006-2008 Period Speed Greater than or Equal to 11.18 m/sec"

Through analysis of data from the onsite meteorological measurements program, collected between January 1, 2006, and December 31, 2008, the staff independently confirmed the wind persistence measurements at the PSEG Site, and thus accepts the applicant's data and discussion.

2.3.2.4.2.2 Atmospheric Stability.

The applicant classified atmospheric stability in accordance with the guidance provided in RG 1.23, Revision 1. Atmospheric stability is a critical parameter for estimating dispersion characteristics as applicable for SSAR Sections 2.3.4, "Short-Term (Accident) Diffusion Estimates," and 2.3.5, "Long-Term (Routine) Diffusion Estimates." Dispersion of effluents is greatest for extremely unstable conditions (i.e., Pasquill stability class A) and decreases progressively through extremely stable conditions (i.e., Pasquill stability class G) as discussed in RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants." The applicant primarily based its stability classification on temperature change with height (i.e., delta-temperature or $\Delta T/\Delta Z$) between the 45-m (150-ft) and 10-m (33-ft) heights, as measured by the PSEG onsite meteorological monitoring program between January 1, 2006 and December 31, 2008. In SSAR Section 2.3.2.2.2, "Atmospheric Stability," the applicant explained that the use of the delta-temperature between the 45-m (150-ft) and 10-m (33-ft) heights is more appropriate than the use of the delta-temperature between the 91-m (300-ft) and 10-m (33-ft) levels. This is because short-term and long-term releases from each of the reactor technologies used to develop the plant parameter envelope (PPE) are considered to occur at ground level. Using this lower layer to determine the stability class is more representative of conditions that would affect a ground-level release.

In SSAR Tables 2.3-26 and 2.3-27, the applicant provided annual frequencies of atmospheric stability classes for the 3-year period of record from January 1, 2006, through December 31, 2008. The applicant stated that there is a predominance of slightly stable (Pasquill stability class E) and neutral (Pasquill stability class D) conditions at the proposed PSEG Site. Extremely unstable conditions (Pasquill stability class A) occur about 11 percent of the time and would be expected to occur most frequently during the spring and summer. Extremely stable conditions (Pasquill stability class G) occur about seven percent of the time and would be expected to occur most frequently during the autumn. 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 PSEG Site is generally consistent with expected meteorological conditions.

Through analysis of data from the onsite meteorological measurements program, collected from January 1, 2006, through December 31, 2008, the staff independently confirmed the

atmospheric stability measurements at the proposed PSEG Site, and thus accepts the applicant's data and discussion. The staff notes that these data are appropriate to use as input to the dispersion models discussed in Sections 2.3.4 and 2.3.5 of this report.

2.3.2.4.2.3 Temperature.

In SSAR Section 2.3.2.2.3, "Temperature," the applicant characterized normal and extreme temperatures for the site based on the ten representative surrounding observation stations listed in SSAR Section 2.3.1.3, "Identification of Representative Regional Weather Monitoring Stations." The extreme maximum temperature recorded in the vicinity of the site is 42.2 °C (108 °F) at the Marcus Hook, PA cooperative recording station 42 km (26 mi) to the NNE of the proposed PSEG Site. The extreme minimum temperature recorded in the vicinity of the site is -26.1 °C (-15 °F) at the Millington 1 SE, MD station located 37 km (23 mi) to the SW of the proposed PSEG Site. Due to its location near the Delaware Bay, the proposed PSEG Site typically experiences temperatures that are more moderate than the cooperative reporting stations that are farther inland. Through the use of data from the surrounding NCDC recording stations, the staff confirmed the temperature discussion provided by the applicant.

2.3.2.4.2.4 Water Vapor.

In SSAR Section 2.3.2.2.4, "Water Vapor," the applicant provided wet-bulb temperature, dew point temperature, and relative humidity data summaries from the Wilmington, DE NWS observation station to characterize the typical atmospheric moisture conditions near the proposed PSEG Site.

In SSAR Table 2.3-1, "NOAA Climate Summary for Wilmington, Delaware," the applicant showed that for a 25-year period of record, the mean annual wet-bulb temperature is 9.4 °C (48.9 °F) at the Wilmington, DE NWS site. The highest monthly mean wet-bulb temperature is 20.6 °C (69.0 °F) during July, and the lowest monthly mean wet-bulb temperature is -1.7 °C (29.0 °F) during January. The applicant stated that the mean annual dew point temperature at Wilmington is 7.0 °C (44.6 °F), which also reaches its maximum during summer and minimum during winter. The applicant gives the highest monthly mean dew point temperature as 18.9 °C (66.1 °F) during July, and the lowest monthly mean dew point temperature as -4.3 °C (24.1 °F) during January.

Based on a 30-year period of record from the data recorded at the Wilmington, DE NWS site, the applicant stated that relative humidity averages 68 percent on an annual basis. The average early morning relative humidity levels exceed 80 percent from June through October. Typically, the relative humidity values reach their diurnal maximum in the early morning and diurnal minimum during the early afternoon.

The staff verified and finds acceptable 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 "Wilmington, DE, 2009 Local Climatological Data, Annual Summary with Comparative Data." Due to the proximity of Wilmington, DE, to the proposed PSEG Site and because of the similarity of topographic features at both locations (e.g., distance from the Delaware Bay), the PSEG atmospheric moisture data should be typical of the atmospheric moisture conditions in the proposed site's region.

2.3.2.4.2.5 Precipitation.

Based on data from the surrounding observation stations listed in SSAR Table 2.3-18 and presented in SSAR Figure 2.3-11 (Section 2.3.1.4.3 of this report), the applicant stated that the average annual precipitation (water equivalent) totals generally range from 915 mm (36.04 in.) to 1176 mm (46.28 in.) The highest average annual precipitation is 1176 mm (46.28 in.), which occurs at the Dover, DE station (approximately 37 km (23 mi) to the south of the proposed PSEG site).

The applicant also stated that the mean annual snowfall recorded at the surrounding stations ranges from 19.1 cm (7.5 in.) to 49.0 cm (19.3 in.), as presented in SSAR Table 2.3-19, "Mean Monthly and Annual Snowfall (in.) at the NOAA Regional COOP Meteorological Monitoring Stations." The highest annual average snowfall total of 49.0 cm (19.3 in.) is at the Philadelphia International Airport (IAP) located 48.3 km (30 mi) to the north-northeast of the proposed PSEG site, based on the 2009 LCD for Philadelphia, PA.

Using daily snowfall and rainfall data from NCDC, the staff independently verified the precipitation statistics presented in SSAR Section 2.3.2 and finds them acceptable and accurate.

2.3.2.4.2.6 Fog.

Wilmington, DE is the closest station to the proposed PSEG Site that makes fog observations. In SSAR Section 2.3.2.2.6, "Fog," the applicant stated that, based on a 45-year period of record, Wilmington averages about 26 days per year of heavy fog conditions (i.e., conditions in which visibility is reduced to one-quarter of a mile or less).

The applicant stated that the frequency of typical fog conditions at Wilmington, DE is expected to be similar to that at the proposed PSEG Site because of the proximity and similarity of topographic features between the two locations. Both sites are located in relatively flat terrain and are nearly equidistant from the Delaware River.

Using the 2009 NCDC LCD from Wilmington, DE, the staff confirmed the applicant's assertion that the Wilmington, DE station reports approximately 26 days per year with heavy fog observations. The staff agrees that the frequency of fog conditions at Wilmington, DE is expected to be similar to that at the proposed PSEG Site because of the similarity of topographic features at both locations.

2.3.2.4.3 Potential Influence of the Plant and its Facilities on Local Meteorology

In SSAR Section 2.3.2.3, "Potential Influence of the Plant and Related Facilities 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 on 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. In Section 2.3.3 of this report, the staff discusses the effects of these larger structures on wind flow.

Although temperature may increase above altered surfaces at the proposed PSEG Site, the effects will be too limited in their vertical profile and horizontal extent to alter local- or regional-scale ambient temperature changes. Due to the limited and localized nature of the

expected modifications associated with the proposed plant structures and the associated improved surfaces, the staff agrees that the proposed facility will not have significant impacts on local meteorological conditions.

2.3.2.4.4 Current and Projected Air Quality

As discussed in Section 2.3.1 of this report, the proposed PSEG Site is located in the Metropolitan Philadelphia Interstate Air Quality Control Region (40 CFR 81.15, "Metropolitan Philadelphia Interstate Air Quality Control Region (Pennsylvania-New Jersey-Delaware)"). The counties within this region include Salem County, NJ and New Castle County, DE. Salem County, NJ is a non-attainment area for ozone under the 8-hour standard. New Castle County, DE is a non-attainment area for ozone under the 8-hour standard and for PM under the $PM_{2.5}$ standard. The closest Federal Class I area in the surrounding area is the Brigantine Wilderness at the Edwin D. Forsythe National Wildlife Refuge, an area of 2672 hectares (6603 acres) on the Atlantic Ocean shoreline located 113 km (70 mi) from the proposed PSEG Site.

In SSAR Section 2.3.2.4, "Current and Proposed Site Air Quality," the applicant stated that the proposed nuclear steam supply system (NSSS) and other radiological systems related to the proposed facility will not be sources of criteria pollutants (as discussed in Section 2.3.1.4.9 of this report) 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.

In SSAR Section 2.3.2.4, the applicant stated that once a reactor technology is selected and detail design is completed for the cooling towers and combustion sources, PSEG will consult and work with the New Jersey Department of Environmental Protection to demonstrate compliance with the applicable air quality regulations. At the COL or CP stage, if the applicant chooses a plant design that requires the use of an UHS cooling tower, the applicant will need to identify the appropriate meteorological characteristics (i.e., maximum evaporation and drift loss and minimum water cooling conditions) used to evaluate the design of the chosen UHS cooling tower. In accordance with 10 CFR 52.17(a)(1)(iii), "Contents of applications; general information," at the time of the COL or CP application, the applicant will provide the design type and characteristics of the UHS.

2.3.2.4.5 Topographic Description

The proposed PSEG Site is located in Salem County, NJ, adjacent to the Delaware Bay. SSAR Figure 2.3-41, "PSEG Site Directional Elevation Profiles within 50 Miles of PSEG Site," displayed the elevation of the land within 80 km (50 mi) of the site. SSAR Figure 2.3-41 is reproduced in Figure 2.3-7.

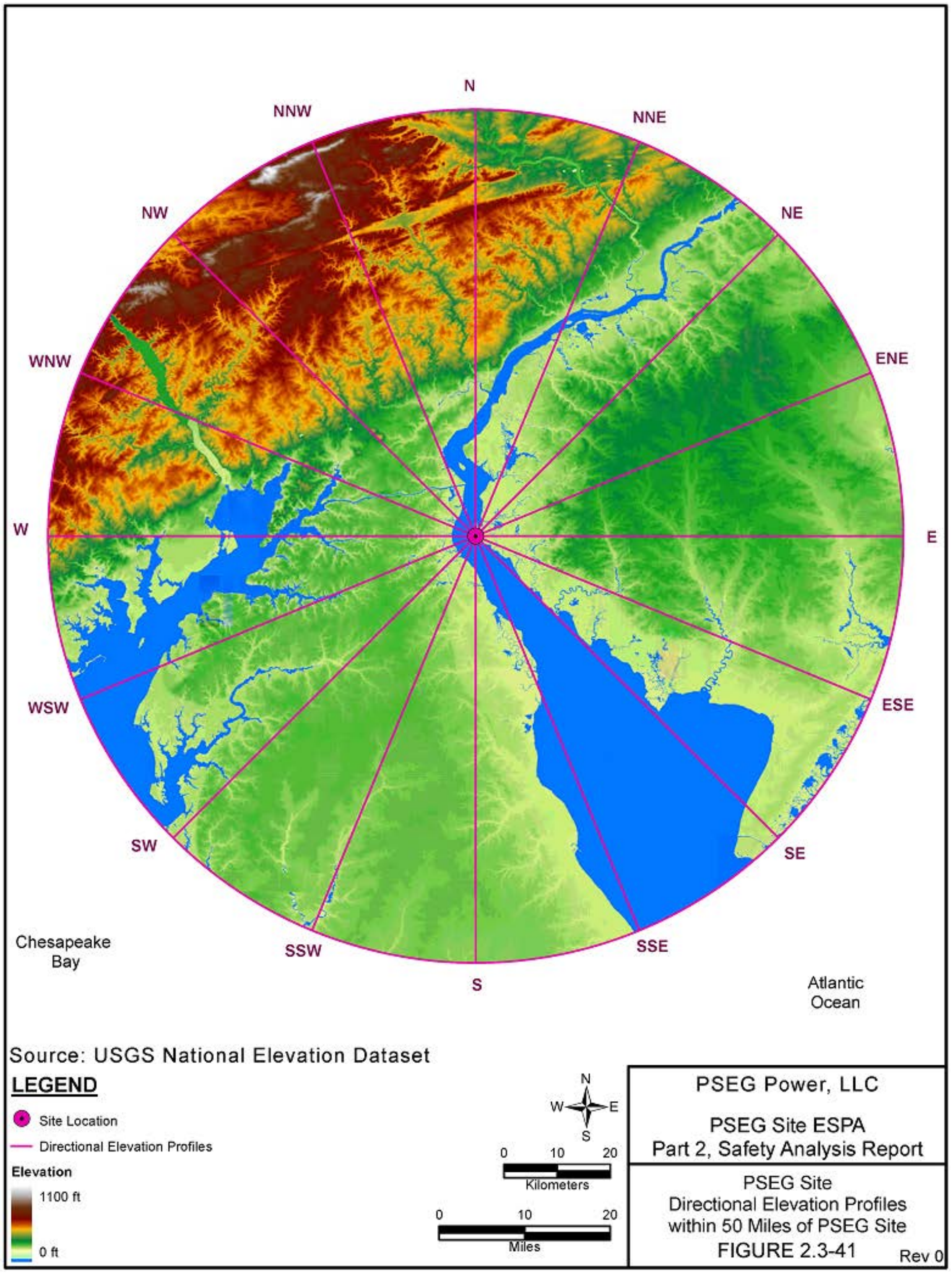

Figure 2.3-7 PSEG Site Directional Elevation Profiles within 50 Miles of the PSEG Site (Reproduced from SSAR Figure 2.3-41)

The applicant also provided terrain elevation profiles along each of the 16 standard 22.5-degree compass radials out to a distance of 80 km (50 mi) in the following SSAR figures:

- Figure 2.3-42, "Elevation Profiles to a 50-Mile Radius for N and NNE Direction Sectors"
- Figure 2.3-43, "Elevation Profiles to a 50-Mile Radius for NE and ENE Direction Sectors"
- Figure 2.3-44, "Elevation Profiles to a 50-Mile Radius for E and ESE Direction Sectors"
- Figure 2.3-45, "Elevation Profiles to a 50-Mile Radius for SE and SSE Direction Sectors"
- Figure 2.3-46, "Elevation Profiles to a 50-Mile Radius for S and SSW Direction Sectors"

- Figure 2.3-47, “Elevation Profiles to a 50-Mile Radius for SW and WSW Direction Sectors”
- Figure 2.3-48, “Elevation Profiles to a 50-Mile Radius for W and WNW Direction Sectors”
- Figure 2.3-49, “Elevation Profiles to a 50-Mile Radius for NW and NNW Direction Sectors”

Based on these profiles, the applicant characterized the site terrain as gently rolling with elevations increasing to the northwest clockwise through the north-northeast. The staff agrees with this terrain characterization based on topography data from the USGS. The staff finds that the applicant provided necessary and adequate topographic information.

2.3.2.5 Conclusion

As discussed above, the applicant presented and substantiated information on local meteorological, air quality, and topographic characteristics of importance to the safe design and operation of a nuclear power plant or plants, falling within the applicant’s PPE, that might be constructed on the proposed PSEG Site. The staff reviewed the information provided and, for the reasons given, concludes that the applicant’s identification and consideration of the meteorological, air quality, and topographical characteristics of the site and the surrounding area meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d), and are sufficient to determine the acceptability of the site.

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

Early Site Permit applicants need not demonstrate the compliance with the GDC listed in Section 2.3.2.3, “Regulatory Basis,” of this report; however, the applicant chose to provide all necessary information with respect to local meteorology that can be provided for an ESP.

2.3.3 Onsite Meteorological Measurement Program

2.3.3.1 Introduction

The PSEG onsite meteorological measurements program addresses the need for onsite meteorological monitoring and the resulting data.

2.3.3.2 Summary of Application

In SSAR Section 2.3.3, 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

In Section 2.3.3 of this report, the staff 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 design-basis accidents (DBAs) and routine releases from a nuclear power plant of the type specified by the applicant.

2.3.3.3 Regulatory Basis

The acceptance criteria, as identified in NUREG-0800, Section 2.3.3, "Onsite Meteorological Measurements Programs," 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 100.20(c), as it relates to the requirement that the meteorological characteristics of the site that are necessary for safety analysis or that might have an impact on plant design be identified and characterized as part of the staff's review of the acceptability of a site

- 10 CFR 100.21(c), as it relates the requirements that the meteorological data used to evaluate site atmospheric dispersion characteristics and establish dispersion parameters such that: (1) radiological effluent release limits associated with normal operation can be met for any individual located off site; and (2) radiological dose consequences of postulated accidents meet prescribed dose limits at the EAB and the outer boundary of the LPZ

- 10 CFR 100.21(d), as it relates to the requirement that the physical characteristics of the site, including meteorology, geology, seismology, and hydrology, be evaluated and site characteristics established to ensure 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 Section 13.3 of this report, "Emergency Planning") 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 Part 50, Appendix E, as it relates to the requirement for emergency plans to have adequate provisions for equipment that will be used to determine the magnitude of, and continuously assess the impact of, the release of radioactive materials to the environment

- 10 CFR 50.47(b), as it relates to the requirement 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

The development and implementation of an onsite meteorological program is necessary for the collection of onsite meteorological information at the ESP stage, in order 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."

The following Regulatory Guide applies to this section:

- RG 1.23, Revision 1, which provides criteria for an acceptable onsite meteorological measurements program that can be used to monitor local meteorology site characteristics.

The related acceptance criteria from NUREG-0800, Section 2.3.3 of are as follows:

- The preoperational and operational monitoring programs should be described, including: (1) A site map (drawn to scale) that shows the tower location and true north with respect to man-made structures, topographic features, and other features that may influence site meteorological measurements; (2) distances to nearby obstructions of flow in each downwind sector; (3) measurements made; (4) elevations of measurements; (5) exposure of instruments; (6) instrument descriptions; (7) instrument performance specifications; (8) calibration and maintenance procedures and frequencies; (9) data output and recording systems; and (10) data processing, archiving, and analysis procedures.

- Meteorological data should be presented in the form of Joint Frequency Distributions (JFD) of wind speed and wind direction by atmospheric stability class in the format described in RG 1.23, Revision 1. An hour-by-hour listing of the hourly averaged parameters should be provided in the format described in RG 1.23, Revision 1. If possible, evidence of how well these data represent long-term conditions at the site should also be presented, possibly through comparison with offsite data.

- At least two consecutive annual cycles (and preferably three or more whole years), including the most recent 1-year period, should be provided with the application. These data should be used by the applicant to calculate (1) the short-term atmospheric-dispersion estimates for accident releases discussed in Section 2.3.4 of this report and (2) the long-term atmospheric dispersion estimates for the routine releases discussed in Section 2.3.5 of this report.

- The applicant should identify and justify any deviations from the guidance provided in RG 1.23, Revision 1.

2.3.3.4 Technical Evaluation

The staff reviewed the applicant's information concerning the onsite meteorological measurements program. The applicant used the pre-application onsite meteorological measurements program at the PSEG Site to collect data 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 operational onsite meteorological measurements program at the time of the COL application in accordance with the guidance provided in Section C.III.2.2.3.3 of RG 1.206, "Combined License Applications for Nuclear Power Plants."

2.3.3.4.1 Onsite Meteorological Measurements Program

2.3.3.4.1.1 General Program Description.

The applicant provided a narrative of the onsite meteorological monitoring system in SSAR Section 2.3.3.2, "General Program Description." The onsite meteorological monitoring program at the PSEG Site is a continuation of the current program that supports the operating Salem and Hope Creek (S/HC) power plants. Instruments for measuring pertinent meteorological parameters are mounted on a 90-m (300-ft) guyed, open-lattice tower. The meteorology tower is located about 1667 m (5470 ft) southeast of the proposed power block area.

The applicant provided a summary of the instrumentation on the primary and backup towers in SSAR Table 2.3-28, "Meteorological Instrumentation Descriptions and Accuracies for the On-Site Meteorological Monitoring System." The meteorological monitoring tower has observation equipment mounted at heights of 10, 45, and 90 m (33, 150, and 300 ft) above ground level. Measured data include wind speed and direction at 10, 45 and 90 m (33, 150, and 300 ft), temperature at 10, 45 and 90 m, (33, 150, and 300 ft) differential temperature between 90 and 10 m (300 and 33 ft) and 45 and 10 m (150 and 33 ft), dew point temperature (calculated based on the coincident ambient temperature and relative humidity measurements) at 10 m (33 ft), precipitation, barometric pressure, and solar radiation at the tower base, and sigma theta (standard deviation of the wind direction) at 90, 45, and 10 m (300, 150, and 33 ft). In SSAR Section 2.3.3.2, the applicant described the backup meteorological tower as being a 10-m (33-ft) utility pole located 118 m (386 ft) south of the primary tower. The backup tower is used only in the event that the instrumentation on the primary tower is unavailable. The measurements taken at the backup tower include wind speed, wind direction, and sigma-theta at the 10-m (33-ft) level only.

2.3.3.4.1.2 Location, Elevation, and Exposure of Instruments.

In SSAR Section 2.3.3.3, "Location, Elevation, and Exposure of Instruments," the applicant explained that the base of the meteorological 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 low native vegetation. The applicant stated that it had evaluated minor structures in the vicinity of the primary meteorological tower. These structures were determined to have no adverse effect on the measurements taken at the meteorological measurement tower. The applicant stated that the closest major structures to the meteorological measurement tower will be the existing S/HC reactor buildings and proposed natural draft cooling towers for the PSEG Site. 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 S/HC cooling tower is located 1432 m (4700 ft) northwest of the meteorological tower and has a height of 156 m (512 ft). The new reactor cooling towers are to be located 2072 m (6800 ft) northwest of the meteorological tower and have a maximum potential height of 180 m (590 ft), based on the PPE.

RG 1.23, Revision 1 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. However, 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. The current S/HC cooling tower does not meet the 10-building-height distance criterion, but because of its conical shape, it is not expected to have any adverse aerodynamic effects on the meteorological tower wind measurements. The staff agrees with the applicant's discussion in SSAR Section 2.3.3.3 regarding the 10-building-height distance criterion and, therefore, concludes that building wake from the existing S/HC reactors and cooling towers and the proposed PSEG structures will not cause any adverse aerodynamic effects. For the proposed cooling tower with its potential height of 180 m (590 ft), being 2072 m (6800 ft) away thus clearly satisfies the above rule.

The primary meteorological equipment is mounted on a 90-m (300-ft) guyed, triangular open-lattice tower with solid legs and a 0.45-m (18-in.) face. Wind sensors are mounted on the northwest side of the tower (upwind when the wind is blowing from its most prevalent direction)

to reduce the turbulent effects of the tower on the measurements. In SSAR Section 2.3.3.2, the applicant stated that the sensors are mounted on booms at distances that are equal to more than twice the horizontal width of the tower to further minimize the turbulent effects of the tower on the measurements.

2.3.3.4.1.3 Instrument Maintenance.

In SSAR Section 2.3.3.4, "Instrument Maintenance," the applicant provided a description of how often the meteorological equipment is inspected and serviced. The meteorological data is reviewed daily by a meteorologist and sensor and system repairs are performed as needed. The applicant stated that full system calibrations are done on a quarterly basis. Also, the wind sensors are swapped out and returned to the manufacturer for wind tunnel calibrations on an annual basis, or every fourth calibration. The guyed wires are inspected annually and anchors are inspected every 3 years. The staff concludes that the instrument maintenance practices, as described in SSAR Section 2.3.3.4 conform to the guidance provided in RG 1.23, Revision 1. Accordingly, the staff finds these descriptions acceptable.

2.3.3.4.1.4 Data Collection and Analysis.

In SSAR Section 2.3.3.5, "Data Collection and Analysis," the applicant explained that data from the meteorological tower is collected, processed, displayed, and transmitted by equipment in the meteorological building at the base of the primary meteorological tower. The measurements are recorded once per second and are then stored in separate 15-minute and hourly average files. Real-time measurements are available for display in the meteorological building at the tower base. Fifteen minute averages are available to the operators in the S/HC Control Rooms and the Technical Support Centers (TSCs) over fiber optic cable or modem. Meteorological data are downloaded and reviewed daily using software and manual checks for reasonableness.

For the 2006–2008 data set, the average data recovery rates were well above the 90-percent threshold established in Revision 1 of RG 1.23 for all variables except the 10-m (33-ft) dew point temperature during 2006 and 2008. The applicant stated that the 10-m (33-ft) dew point temperature failed to meet the 90-percent recovery rate threshold because of recurring instrument failure. The applicant also stated that they have installed redundant instruments so that the 90-percent threshold will now be met. The applicant presented a table summary of the meteorological monitoring systems' recovery rates in SSAR Table 2.3-29, "Annual Data Recovery Statistics for the On-Site Meteorological Monitoring System."

2.3.3.5 COL Action Items Related to the On-Site Meteorological Measurements Program

PSEG ESP application, Part 5 describes the proposed Emergency Plan, including inspection, tests, analyses, and acceptance criteria (ITAAC). Attachment 10, "Emergency Planning – Inspections, Tests, Analyses, and Acceptance Criteria (EP-ITAAC)" in Part 5 of the ESP application includes the emergency planning (EP) ITAAC. The following EP-ITAAC involve demonstrating that the operational onsite meteorological monitoring program appropriately supports the PSEG emergency plan.

- EP Program Element 6.3: Demonstrated through training or drills that EPIPs provide direction to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitor readings, and on-site and off-site exposures and contamination for various meteorological conditions (Acceptance Criteria 6.3).

- EP Program Element 6.4: Demonstrated that meteorological data necessary to implement the EPIPs is retrievable in the Control Room, TSC and EOF (Acceptance Criteria 6.4).

These items will be addressed by the COL applicant at the COL stage, and the requirements will be met by way of fulfilling EP-ITAAC 6.3 and 6.4 and Acceptance Criteria 6.3 and 6.4. EP, including EP ITAAC, is addressed in Section 13.3, "Emergency Planning," of this report.

2.3.3.6 Conclusion

As discussed above, the applicant presented and substantiated information to establish the onsite meteorological monitoring program and the resulting database. The staff reviewed the information provided and, for the reasons given above, concludes that the onsite meteorological monitoring system provides adequate data to represent onsite meteorological conditions as required by 10 CFR 100.20 and 10 CFR 100.21. The onsite data also provide an acceptable basis for (1) making estimates of atmospheric dispersion for design-basis accident releases and routine releases from a nuclear power plant or plants that might be constructed on the proposed site and (2) meeting the requirements of 10 CFR Part 20, 10 CFR Part 100, and 10 CFR Part 50, Appendix I.

2.3.4 Short-Term Diffusion (Accident) Estimates

2.3.4.1 Introduction

The short-term diffusion estimates are used to determine the amount of airborne radioactive materials expected to reach a specific location during an accident situation. The diffusion estimates address the requirement for conservative atmospheric dispersion (relative concentration) factor (χ/Q value) estimates at the exclusion-area boundary (EAB), at the outer boundary of the low-population zone (LPZ), and at the control room for postulated design-basis accidental radioactive airborne releases.

2.3.4.2 Summary of Application

In SSAR Section 2.3.4, the applicant presented this specific information on atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and the outer boundary of the LPZ:

- 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

In Section 2.3.4 of this report, the staff verified that the applicant 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.

2.3.4.3 Regulatory Basis

The acceptance criteria (as identified in NUREG-0800, Section 2.3.4, "Short-Term Dispersion Estimates for Accident Releases") 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), as it relates to the requirement that the meteorological characteristics of the site that are necessary for safety analysis or that might 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), as it relates to the requirement that site atmospheric-dispersion characteristics be evaluated and dispersion parameters established to ensure 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 related acceptance criteria from NUREG-0800, Section 2.3.4 are as follows:

- a description of the atmospheric dispersion models used to calculate χ/Q values for accidental releases of radioactive and hazardous materials to the atmosphere

- 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

- a discussion of atmospheric diffusion parameters, such as lateral and vertical plume spread (σ_y and σ_z) as a function of distance, topography, and atmospheric conditions, should be related to measured meteorological data

- hourly cumulative frequency distributions of χ/Q values from the effluent release point(s) to the EAB and LPZ should be constructed to describe the probabilities of these χ/Q values being exceeded

The following Regulatory Guide applies to this section:

- RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Revision 1, as it relates to the use of dispersion models.

2.3.4.4 Technical Evaluation

The staff reviewed SSAR Section 2.3.4, "Short-Term (Accident) Diffusion Estimates," to ensure that the ESP application represents the complete scope of information relating to this review topic. The staff's review confirmed that the application addresses the required information relating to the short-term diffusion estimates.

To evaluate atmospheric dispersion characteristics with respect to radiological releases to the control room, detailed design information (e.g., vent heights, intake heights, and distance and direction from release vents to the room) is necessary. Since the ESP application uses a plant

parameter envelope, and therefore little detailed and specific design information is available at this stage for the nuclear power plant or plants that might be constructed on the proposed site, a COL or CP applicant citing this ESP will need to assess the dispersion of airborne radioactive materials to the control room at the COL or CP stage.

2.3.4.4.1 Atmospheric Dispersion Model

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, Revision 1, as described in SSAR Section 2.3.4.1, "Basis."

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 of hourly values of wind speed and wind direction by atmospheric stability class. 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 (e.g., 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-to-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-to-2-hour "5-percent overall site χ/Q value."

The larger of the two χ/Q values, either the 0.5-percent maximum sector-dependent value or the 5-percent overall site value, is selected to represent the χ/Q value for the 0-to-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 to 8 hours, 8 to 24 hours, 1 to 4 days, and 4 to 30 days), PAVAN performs a logarithmic interpolation between the 0-to-2-hour χ/Q values and the annual average (8760-hour) χ/Q values for each of the 16 sectors and the overall site. For each time period, the highest χ/Q value from among the 16 sectors and the overall site is identified and becomes the short-term site characteristic χ/Q value for that time period.

2.3.4.4.2 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 1, 2006, through December 31, 2008, as described in SSAR Section 2.3.4.1. The wind data were obtained from the 10-m (33-ft) level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken at the 45-m (150-ft) and 10-m (33-ft) levels of the onsite meteorological tower.

In RAI 34, Question 02.03.04-2, the staff requested that the applicant justify why the SSAR did not include χ/Q values that accounted for the potential effects of land-water boundaries on the airflow of the site area. In a September 8, 2011, response to RAI 34, Question 02.03.04-2, the applicant provided the requested information, with a commitment to update SSAR Sections 2.3.2.2.1.2 and 2.3.4.1 to include an expanded discussion on the airflow patterns at the PSEG Site. The applicant stated that closed sea-breeze mesoscale circulations do not occur at the PSEG Site, and recirculation of airflow during periods of prolonged atmospheric stagnation seldom occurs. The staff reviewed the applicant's September 8, 2011, response to RAI 34, Question 02.03.04-2; verified that the committed changes have been made in the ESP application, Revision 1 dated May 21, 2012; and finds the response acceptable. Accordingly, the staff considers RAI 34, Question 02.03.04-2 resolved.

The staff developed an annual wind rose for each level of the meteorological tower. The wind roses developed by the staff and provided by the applicant in SSAR Figures 2.3-12 through 2.3-28 show higher frequencies of winds from the southeast and northwest. As stated in Sections 2.3.2 of this report, this is generally consistent with the wind patterns recorded in the site's region. As discussed in Sections 2.3.2 and 2.3.3 of this report, the staff considers the 2006–2008 onsite meteorological database suitable for input to the PAVAN model.

2.3.4.4.3 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, as described in SSAR Section 2.3.4.1. 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 PSEG Site. Therefore, the staff finds the applicant's use of diffusion parameter assumptions, as outlined in RG 1.145, acceptable.

2.3.4.4.4 Conservative Short-Term Atmospheric Dispersion Estimates for EAB and LPZ

The applicant modeled one ground-level release point and did not take credit for building wake effects, as described in SSAR Section 2.3.4.1. 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 the EAB to be a circular region that surrounds the expected power block area, as described in SSAR Section 2.3.4.1. The power block area is used to conservatively enclose all possible release points for the selected reactor technologies. The shortest distance from the outer edge of the power block area to the EAB is 600 m (1968 ft), as shown in SSAR Table 2.3-31, "PAVAN 0-2 Hour 0.5% Exclusion Area Boundary χ/Q Values," and SSAR

Figure 1.2-3, “Site Utilization Plan.” SSAR Figure 1.2-3 is reproduced in Figure 2.3-8. This distance was used as the distance in each direction and is considered a conservative assumption. The outer boundary of the LPZ for the PSEG Site is a circle surrounding the power block area with a radius of 8045 m (5 mi). The distance from the power block area to the LPZ is shown in SSAR Table 2.3-32, “PAVAN 0-30 Day Low Population Zone χ/Q Values,” and SSAR Figure 2.1-21, “PSEG Site 2010 Resident Population Within the Low Population Zone.”

SSAR Tables 2.3-31 and 2.3-32 list the short-term atmospheric-dispersion estimates for the 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 2.0-1. The staff finds these χ/Q values acceptable for use as site characteristics because they are a conservative estimate of the atmospheric dispersion at the proposed PSEG Site. These atmospheric dispersion site characteristics are used by the applicant to demonstrate compliance with the requirements of 10 CFR 100.21(c)(2) for the radiological dose consequences of postulated accidents.

Figure 2.3-8 Site Utilization Plan (Reproduced from SSAR Figure 1.2-3)

Using the information presented by the applicant in SSAR Table 2.3-27, including the JFD of wind speed, wind direction, and atmospheric stability measured at the 10-m (33-ft) level, the staff confirmed the applicant’s χ/Q values by running the PAVAN computer code and obtaining consistent results (within 1 percent). The applicant’s JFD used eleven wind speed categories based on RG 1.23, Revision 1. The staff accepts the short-term χ/Q values presented by the applicant.

2.3.4.5 *Conclusion*

As discussed above, the applicant presented and substantiated information to establish short-term (post-accident) atmospheric dispersion site characteristics. The staff reviewed the information provided and, for the reasons given above, concludes that the applicant has established site characteristics and design parameters acceptable to meet the requirements of 10 CFR 52.17(a)(1)(ix), 10 CFR 100.21(c)(2), and 10 CFR 100.20(c).

2.3.5 Long-Term Atmospheric Dispersion Estimates for Routine Releases

2.3.5.1 *Introduction*

The long-term dispersion estimates are used to determine the amount of airborne radioactive materials expected to reach a specific location during normal operations. The diffusion estimates address the requirement concerning atmospheric dispersion and dry deposition estimates for routine releases of radiological effluents to the atmosphere.

2.3.5.2 *Summary of Application*

In SSAR Section 2.3.5, the applicant provides details on the following specific areas:

- atmospheric dispersion and deposition 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
- meteorological data and other assumptions used as input to the atmospheric dispersion models
- derivation of diffusion parameters (e.g., σ_z)
- atmospheric-dispersion (relative concentration) factors (χ/Q values) and deposition factors (D/Q values) used for assessment of consequences of routine airborne radioactive releases
- the characteristics of each release mode
- the location of potential receptors for dose computations
- any additional information requirements prescribed in the "Contents of Application" sections of the applicable chapters of 10 CFR Part 52, Subpart A, "Early Site Permits"

2.3.5.3 *Regulatory Basis*

The acceptance criteria (as identified in NUREG-0800, Section 2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases") 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), as it relates to the requirement that the meteorological characteristics of the site that are necessary for safety analysis or that might 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), as it relates to the requirement that site atmospheric-dispersion characteristics be evaluated and dispersion parameters established to ensure 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 in order 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 following Regulatory Guides apply to this section:

- RG 1.23, Revision 1, as it relates to an acceptable onsite meteorological measurements program, which can be used to monitor site characteristics related to local meteorology

- 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," Revision 1, as it relates to calculating offsite doses

- RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, as it relates to calculating offsite doses

The related acceptance criteria from NUREG-0800, Section 2.3.5 are as follows:

- a detailed description of the atmospheric dispersion and deposition models used by the applicant to calculate annual average concentrations in the air and the amount of material deposited as a result of routine releases of radioactive materials to the atmosphere

- a discussion of atmospheric diffusion parameters, such as vertical plume spread (σ_z) as a function of distance, topography, and atmospheric conditions

- meteorological data summaries (onsite and regional) used as input to the dispersion and deposition models

- points of routine release of radioactive material to the atmosphere, including the characteristics (e.g., location and release mode) of each release point

- the specific location of potential receptors of interest (e.g., the nearest vegetable garden, nearest resident, nearest milk animal, and nearest meat cow in each 22½-degree direction sector within a 5-mi (8-km) radius of the site)

- the χ/Q and D/Q values to be used for assessment of the consequences of routine airborne radiological releases as described in RG 1.206, Section 2.3.5.2: (1) Maximum annual average χ/Q values and D/Q values at or beyond the site boundary and at specified

locations of potential receptors of interest using appropriate meteorological data for each routine venting location, and (2) estimates of annual average χ/Q values and D/Q values for 16 radial sectors to a distance of 50 mi (80 km) from the plant using appropriate meteorological data

2.3.5.4 Technical Evaluation

The staff reviewed SSAR Section 2.3.5, "Long-Term (Routine) Diffusion Estimates," to ensure that the ESP application represents the complete scope of information relating to this review topic. The staff's review confirmed that the application addresses the required information relating to long-term atmospheric dispersion estimates.

2.3.5.4.1 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 Releases at Nuclear Power Stations") to estimate χ/Q and D/Q values resulting from routine releases, as described in SSAR Section 2.3.5.1, "Basis." The XOQDOQ model implements the constant mean wind direction methodology outlined in RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1.

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 (e.g., annual averages), the plume's horizontal distribution is assumed to be evenly distributed within the downwind direction sector (i.e., "sector averaging"). A straight-line trajectory is assumed between the release point and all receptors.

2.3.5.4.2 Release Characteristics and Receptors

The applicant modeled one ground-level release point, setting the minimum building cross-sectional area and building height to zero, as described in SSAR Section 2.3.5.1. The applicant assumed a ground-level release to model routine releases. A ground-level release is a conservative assumption at a relatively flat terrain site, such as the PSEG Site, resulting in higher χ/Q and D/Q values when compared to a mixed-mode (i.e., part-time ground, part-time elevated) release or a 100-percent elevated release, as discussed in RG 1.111, Revision 1. Therefore, the staff finds a ground-level release assumption acceptable.

The distance to the receptors of interest (i.e., the nearest meat animal, residence, and vegetable garden) were presented in SSAR Table 2.3-34, "XOQDOQ Predicted Maximum χ/Q and D/Q Values at Receptors of Interest for Routine Releases." The distances to each of these receptors have been derived from a land use census table provided by the applicant in SSAR Reference 2.3.5-1, "2008 Annual Radioactive Effluent Release Report for the Salem and Hope Creek Generating Stations." The distances were adjusted to reflect the source originating at Unit 2, because the original land use evaluation was centered on Unit 1. The staff finds these assumptions acceptable.

NUREG-0800, Section 2.3.5 states that the ESP site characteristics should include the maximum χ/Q and D/Q values calculated at the specific locations of potential receptors of interest. SSAR Section 2.3.5.2, "XOQDOQ Modeling Results," stated that the site boundary's

χ/Q values were disregarded for sectors SE to NW (in the clockwise direction) because the site boundary is bordered by the Delaware River. In RAI 35, Question 02.03.05-4, the staff requested that the applicant update the SSAR to include the χ/Q and D/Q values at the site boundary for all 16 radial directions. In a September 9, 2011, response to RAI 35, Question 02.03.05-04, the applicant provided the requested information, including a draft revision of SSAR Section 2.3.5.2 and a new SSAR Table 2.3-37, "XOQDOQ Predicted Annual Average χ /Q and D/Q Values at the Site Boundary for Routine Releases." The staff evaluated the χ/Q and D/Q values provided in the RAI response and finds the response acceptable. However, the applicant also explained that the χ/Q and D/Q values at the portion of the site boundary adjacent to the Delaware River (sectors SE to NW in the clockwise direction) are not considered in the analyses for radiological exposure because of routine gaseous effluents in that area. The applicant states in the RAI response that this is acceptable "because of the negligible time any individual is expected to spend in this area during any one year period." The directions that are being excluded contain 7 of the 10 highest site boundary χ/Q and D/Q values. The staff agrees that at the time this ESP is issued, it is unlikely that there is a limiting exposure pathway for routine releases for these site boundary sectors adjacent to the Delaware River. The staff finds this conclusion acceptable for this ESP application based on the assumption presented by the applicant that the time any individual is expected to spend in the excluded areas is negligible. Therefore, the staff considers RAI 35, Question 02.03.05-4 resolved.

The staff's conclusion of acceptability regarding RAI 35, Question 02.03.05-4, and SSAR Section 2.3.5 is based on assumptions presented by the applicant as to the types of exposure pathways and locations of dose receptors described in the ESP application. However, the COL applicant should consider whether different exposure pathways and dose receptors exist that would not fall within the ESP long-term release atmospheric dispersion site characteristic values, including for those sectors adjacent to the Delaware River that the applicant screened from its analysis, and confirm that associated doses are in compliance with applicable NRC requirements. 10 CFR 20.1302(b)(1) states that a licensee shall show compliance with the annual dose limit in 10 CFR 20.1301 by (1) demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit. A COL applicant referencing this ESP can comply with 10 CFR 20.1302, in part, by ensuring that the decision made in the ESP application to disregard the sectors adjacent to the Delaware River is still valid.

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> An applicant for a COL or a CP referencing this early site permit should verify specific release point characteristics and specific locations of receptors of interest used to generate the long-term (routine release) atmospheric dispersion site characteristics. Any different exposure pathways and dose receptor locations, including those in sectors adjacent to the Delaware River, should be identified and discussed in order to demonstrate that long-term release atmospheric dispersion estimates fall within the site characteristic values in the ESP and to provide assurance of compliance with NRC dose requirements.

2.3.5.4.3 Meteorological Data Input

The meteorological input to XOQDOQ used by the applicant consisted of a JFD of wind speed, wind direction, and atmospheric stability based on hourly onsite data from a 3-year period from

January 1, 2006, through December 31, 2008, as stated in SSAR Section 2.3.5.1. The wind data were obtained from the 10-m (33-ft) level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 45-m (150-ft) and 10-m (33-ft) levels on the onsite meteorological tower. Following the discussion provided in Section 2.3.2 of this report, the staff considers the 2006–2008 onsite meteorological database suitable for input to the XOQDOQ model.

RG 1.111, Revision 1, states that spatial and temporal variations of airflow should be considered at sites along and near coasts with significant land-water boundary layer effects on airflow and sea-land breeze circulations. SSAR Section 2.3.2.2.1.2 describes the complex wind patterns at the PSEG Site that are caused in part by Delaware Bay breezes and local shoreline breezes. The staff noted that in the XOQDOQ input/output files that were provided to the staff in an April 6, 2011, response to RAI 16, Question 02.03.05-1, adjustments for the potential effects of land-water boundaries on airflow had not been addressed. In RAI 35, Question 02.03.05-03, the staff requested that the applicant update SSAR Section 2.3.5 to include the χ/Q and D/Q values that consider and account for the potential effects of land-water boundaries, or provide justification as to why this is not necessary for the PSEG Site. In a September 9, 2011, response to RAI 35, Question 02.03.05-03, the applicant provided the requested information along with a commitment to update SSAR Sections 2.3.2.2.1.2 and 2.3.5.1 to include an expanded discussion on the airflow patterns at the PSEG Site. For ease of review, the revisions to SSAR Subsection 2.3.2.2.1.2 were applied from PSEG's response to RAI 34, Question 02.03.04-2. The applicant stated that closed sea-breeze mesoscale circulations do not occur at the PSEG Site, and recirculation of airflow during periods of prolonged atmospheric stagnation seldom occurs.

The staff developed an annual wind rose for each level of the meteorological tower. The wind roses developed by the staff and those provided by the applicant in SSAR Figures 2.3-12 through 2.3-28 show increased winds from the southeast and northwest. As stated in Section 2.3.2 of this report, this is generally consistent with the wind patterns recorded in the site region.

10 CFR 100.21(c)(1) requires that site atmospheric dispersion characteristics must be evaluated and dispersion parameters established such that radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site can be met for any individual located offsite. SSAR Section 2.3.5.1 stated that the downwind distances used to determine the χ/Q and D/Q values at each of the receptors of interest were calculated from the center of the power block area. In RAI 35, Question 02.03.05-5, the staff requested that the applicant justify why the SSAR used the center point of the power block, rather than the outer edge, to determine the distances to the receptors. In a September 9, 2011, response to RAI 35, Question 02.03.05-05, the applicant stated that the reactor technologies that are being considered typically have vent stacks near the center of the power block. The applicant also stated that the building wake effects are conservatively not credited in the χ/Q and D/Q calculations. The staff reviewed the applicant's response to RAI 35, Question 02.03.05-5 and finds it acceptable as correct and adequate. Accordingly, the staff considers RAI 35, Question 02.03.05-5 resolved.

2.3.5.4.4 Diffusion Parameters

The applicant chose to implement the diffusion parameter assumptions outlined in RG 1.111, Revision 1, as a function of atmospheric stability, for its XOQDOQ model runs as stated in SSAR Section 2.3.5.1. The staff evaluated the applicability of the XOQDOQ diffusion parameters and concluded that no unique topographic features preclude the use of the XOQDOQ model for the PSEG Site. Therefore, the staff finds the applicant's use of diffusion parameter assumptions (as outlined in RG 1.111, Revision 1) acceptable. As discussed in Section 2.3.5.4.3 of this report, the applicant determined that it was not necessary to model and include the effects of land-water boundaries on the χ/Q and D/Q values. Since the site is not subject to the frequent sea-breeze circulations commonly observed at coastal locations, the staff agrees with this assessment.

2.3.5.4.5 Resulting Relative Concentration and Relative Deposition Factors

SSAR Table 2.3-34 lists the maximum long-term atmospheric dispersion and deposition estimates for the receptors of interest that the applicant derived from their XOQDOQ modeling results. SSAR Tables 2.3-35, "XOQDOQ Predicted Annual Average χ/Q Values at the Standard Radial Distances and Distance-Segment Boundaries for Routine Releases," and 2.3-36, "XOQDOQ Predicted Annual Average D/Q Values at the Standard Radial Distances and Distance-Segment Boundaries for Routine Releases," also contain the applicant's long-term atmospheric dispersion and deposition estimates for the 16 radial sectors from the site boundary to a distance of 80 km (50 mi) from the proposed PSEG Site.

The χ/Q values presented in SSAR Tables 2.3-34 and 2.3-35 reflect several plume radioactive decay and deposition scenarios. RG 1.111, Revision 1, Section C.3 states that radioactive decay and dry deposition should be considered in radiological impact evaluations of potential annual radiation doses to the public that result from routine releases of radioactive materials in gaseous effluents. RG 1.111, Revision 1, Section C.3.a 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 are as follows:

- Undepleted/No Decay χ/Q values are χ/Q values 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 of radioactive decay.

- Undepleted/2.26-Day Decay χ/Q values are χ/Q values 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-133.

- Depleted/8.00-Day Decay χ/Q values are χ/Q values 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.

Using the information provided by the applicant, including the 10-m (33-ft) level JFDs of wind speed, wind direction, and atmospheric stability, in SSAR Tables 2.3-34 through 2.3-36, the staff confirmed the applicant's χ/Q and D/Q values by running the XOQDOQ computer code and obtaining similar results (i.e., values on average within about 1-percent). The applicant's JFDs

used 11 wind speed categories based on RG 1.23, Revision 1. Based on the discussion above, the staff finds the long-term χ/Q and D/Q values provided by the applicant acceptable.

2.3.5.5 Conclusion

As discussed above, the applicant provided meteorological data and an atmospheric dispersion model that is appropriate for the characteristics of the PSEG Site and release points. The staff's review confirmed that the applicant addressed the required information relating to long-term diffusion estimates, and there is no outstanding information to be addressed in the SSAR related to this section. Therefore, the staff concludes that representative atmospheric dispersion and deposition conditions have been calculated for specific locations of potential receptors of interest. The characterization of atmospheric dispersion and deposition conditions satisfies the criteria described in RG 1.111 and 10 CFR Part 100 and are appropriate for the evaluation to demonstrate compliance with the numerical guides for doses for any individual located offsite contained in 10 CFR Part 50, Appendix I.

2.4 Hydrologic Engineering

To ensure that a nuclear power plant or plants can be designed, constructed, and safely operated on the applicant's (PSEG) proposed site (i.e., PSEG Site) and in compliance with U.S. Nuclear Regulatory Commission (NRC) regulations, the staff evaluated the hydrologic characteristics of the site and surrounding vicinity that may affect the safety of a potential nuclear power plant at the site. These site characteristics describe the potential for flooding due to precipitation, riverine processes (runoff, dam breach discharge, channel blockage or diversion), coastal effects (storm surges and tsunamis), and combined events (e.g., from coincident wind waves). In addition, the staff reviewed the maximum elevation of surface water during floods and combined events, associated static and dynamic characteristics, minimum water-surface elevation during low-water events, maximum elevation of groundwater, and the characteristic ability of the site to attenuate a postulated accidental release of radiological material into surface water and groundwater. The surface water hydrologic site characteristics determine the design-basis flood for the proposed PSEG Site, and provide the basis for determining whether flood protection will be required. The groundwater hydrologic site characteristics determine the design-basis groundwater loadings and provide the basis for radiological dose analysis for a potential receptor from the postulated accidental release of radioactive liquid effluents in surface and ground waters.

The staff prepared Sections 2.4.1 through 2.4.14 herein in accordance with the review procedures described in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Sections 2.4.1 through 2.4.14, using information presented in the applicant's Site Safety Analysis Report (SSAR), Revision 3, Section 2.4, "Hydrologic Engineering," which references responses to staff requests for additional information (RAIs), and generally available reference materials (e.g., those cited in applicable sections of NUREG-0800).

2.4.1 Hydrologic Description

The applicant provided information on the radioactive liquid effluents that would be generated as a normal byproduct of nuclear power operations. These radioactive materials will be collected, processed, stored, and discharged in a controlled manner to the local environment. The proposed facility will have the ability to handle these radiological effluents in a manner that

minimizes radioactive releases to the environment and maintains exposure to the public during normal plant operation, anticipated operational occurrences (AOO), and maintenance at levels that are as low as is reasonably achievable (ALARA).

2.4.1.1 Introduction

The PSEG Site is located on a tidally influenced reach of the Delaware River 83.7 km (52 mi) north of the mouth of Delaware Bay (Figure 2.4.1-1). SSAR Section 2.4.1 provides an overview of the hydrologic characteristics and phenomena that have the potential to affect the plant design basis of a reactor technology to be determined within the plant parameter envelope (PPE) at the combined license (COL) application stage. Designs under consideration within the PPE are discussed in Section 2.4.1.4.1 of this report.

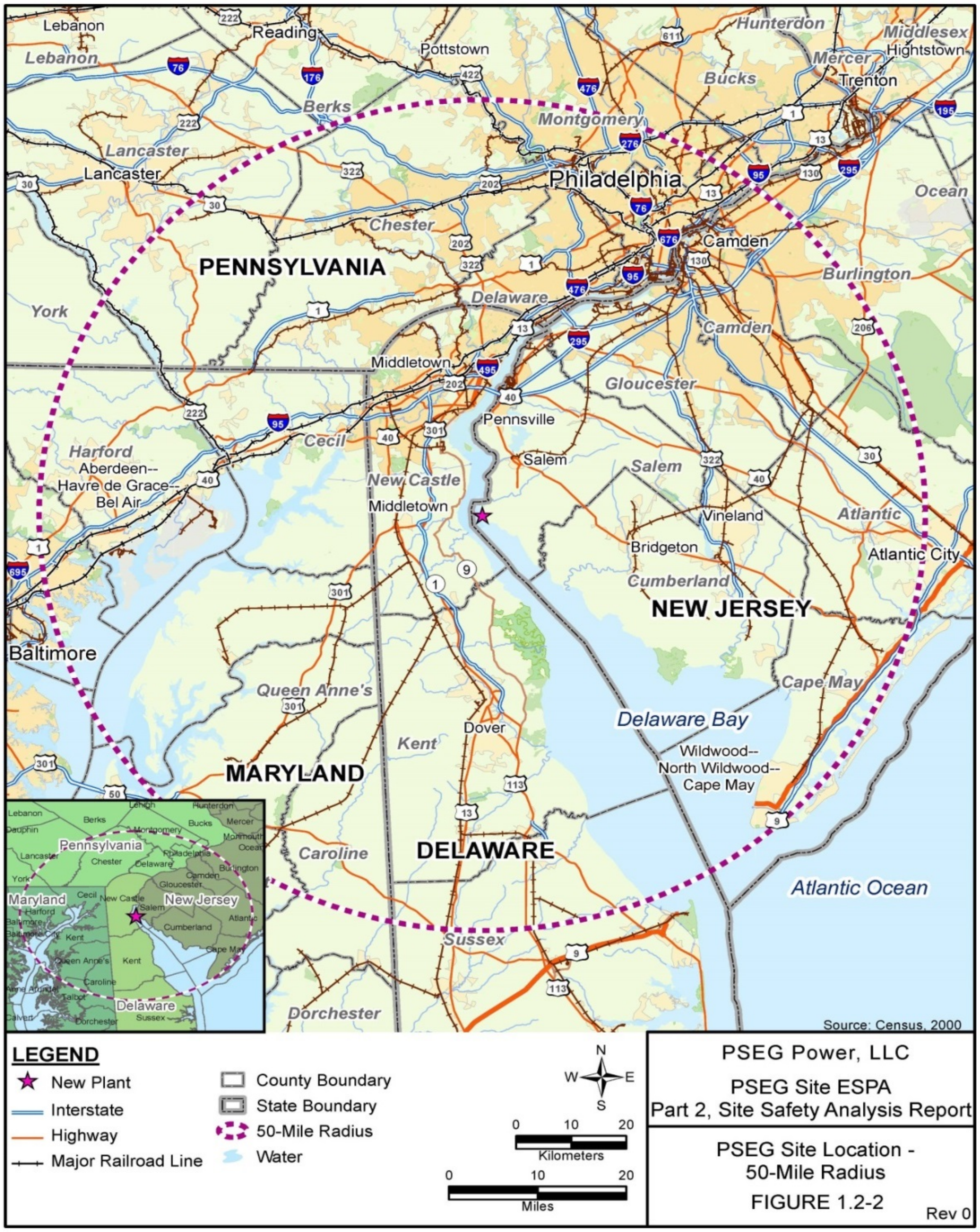

Figure 2.4.1-1 PSEG Site Region (from SSAR Revision 3, Figure 1.2-2)

The hydrologic description of the PSEG Site includes the interface of the plant with the hydrosphere, hydrological causal mechanisms, surface and groundwater uses, hydrologic data, and alternate conceptual models. The staff review discusses the following specific areas: (1) interface of the plant with the hydrosphere, including descriptions of site location, major hydrologic features in the site vicinity, surface water and groundwater-related characteristics, and the proposed water supply to the plant; (2) hydrological causal mechanisms that may require special plant design bases or operating limitations with regard to floods and water

supply requirements; (3) current and likely future surface and groundwater uses by the plant and water users in the vicinity of the site that may impact safety of the plant; (4) available spatial and temporal data relevant for the site review; (5) alternate conceptual models of the hydrology of the site that reasonably bound hydrological conditions at the site; (6) potential effects of seismic and nonseismic data on the postulated design bases and how they relate to the hydrology in the vicinity of the site and the site region; and (7) any additional information requirements prescribed within the "Contents of Application" sections of the applicable subparts to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

2.4.1.2 Summary of Application

In SSAR Section 2.4.1, the applicant described the site and all safety-related elevations, structures, and systems from the standpoint of hydrologic considerations and provided a discussion of proposed changes to natural drainage features. Since a technology has not been selected proposed changes to existing grade, a site grading plan and a drainage design will be evaluated at the COL stage.

2.4.1.3 Regulatory Basis

The relevant requirements of NRC regulations for the hydrologic description, and the associated acceptance criteria, are specified in NUREG–0800, Section 2.4.1.

The applicable regulatory requirements for identifying the site location and describing the site hydrosphere are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), "Contents of applications," as it relates to the hydrologic characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, "Reactor Site Criteria," as it relates to identifying and evaluating hydrologic features of the site. The requirements to consider physical site characteristics in site evaluations are specified in 10 CFR 100.20(c).

The staff also used the appropriate sections of the following regulatory guides (RGs) for the acceptance criteria identified in NUREG–0800, Section 2.4.1:

- RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, "Seismic Design Classification," as it relates to those structures, systems, and components (SSCs) intended to protect against the effects of flooding.

- RG 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, “Flood Protection for Nuclear Power Plants,” as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.1.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.1 and confirmed that the information in the application adequately and acceptably addresses the required information and components related to the site’s hydrologic description. On the basis of its review, the staff confirmed that the information contained in the application addresses the required information related to this section under Docket 52-043. The staff’s technical evaluation of the information including the applicant’s responses to RAIs will be documented in the staff’s Final Safety Evaluation Report (FSER) for the ESP.

The staff conducted a site audit on February 15 - 16, 2011, in accordance with the guidance provided in NUREG-0800, Section 2.4.1 to review information provided by the applicant. The staff used information from this site visit, United States Geological Survey (USGS) topographic maps, topographic maps of the site provided by the applicant, available studies and references, and independent reviews to verify the hydrologic description provided by the applicant. The following sections describe the staff’s evaluation of the technical information submitted by the applicant.

2.4.1.4.1 Site and Facilities

Information Submitted by the Applicant

The applicant’s proposed plant location is north of the Hope Creek Generating Station (HCGS) lying mostly within the current property boundary. The applicant developed an agreement in principle with the U.S. Army Corps of Engineers (USACE) to acquire an additional 85 acres immediately to the north of the HCGS for the proposed facility. Although a specific reactor technology has not been selected for construction at the PSEG Site, designs under consideration inclusive of the PPE are as follows:

- Single Unit U.S. Evolutionary Power Reactor (U.S. EPR)
- Single Unit Advanced Boiling Water Reactor (ABWR)
- Single Unit U.S. Advanced Pressurized-Water Reactor (US-APWR)
- Dual Unit Advanced Passive 1000 (AP1000)

The applicant described the site hydrology and the principal plant structures with the constraints of the PPE for the associated design elevations, and presented maps showing drainage patterns for existing conditions. The Delaware River will be used for circulating water system makeup water and plant turbine cooling systems. The minimum surface water elevation for the ultimate heat sink (UHS) makeup water intake is -4.85 meters (m) (-15.9 feet (ft)) North American Vertical Datum (NAVD) 1988 (SSAR Section 2.4.11).

The design basis flood (DBF) level is 9.78 m (32.1 feet (ft)) NAVD88 as described in SSAR Section 2.4.5, while the proposed site grade is 11.25 m (36.9 ft) NAVD88. The intake structure will be designed at the COL stage with flood protection features to withstand the DBF and associated effects as required by the selected technology. At the COL stage, a site grading plan and drainage system will be designed to route runoff from probable maximum precipitation (PMP) into swales and pipes draining toward the Delaware River. The staff is tracking the

applicant's evaluation of PMP and associated site drainage at the COL stage via COL Action Item 2.4-1 and flood protection at the COL stage via COL Action Item 2.4-2 (See Sections 2.4.2.4.3 and 2.4.10.4, respectively, of this report).

The Staff's Technical Evaluation

Initially, the staff determined that reference elevations in the SSAR, Revision 0, referred to multiple elevation datum and temporal information**.** In RAI 25, Question 02.04.01-2, the staff requested that the applicant provide consistent elevation information and datum conversion procedures, temporal information and gaging station identification. In a June 23, 2011, response to RAI 25, Question 02.04.01-2, the applicant committed to modify and correct text and tables in SSAR Section 2.4. The staff confirmed that the corrections were incorporated into Revision 1 of the ESP application (May 21, 2012). Elevations reported in SSAR Section 2.4, Revision 1, were converted into NAVD88 datum consistently. Some components of hydrologic events such as storm surge and wave height are customarily expressed in feet, which need not be referenced to a geographic datum. The staff considers RAI 25, Question 02.04.01-2 resolved.

Based on a review of the material presented by the applicant in SSAR Section 2.4.1, the staff's observations of the PSEG Site during the February 2011 site audit, and the applicant's response to the RAIs discussed above, the staff finds that the applicant has adequately considered the hydrologic characteristics of the ESP site within this section.

2.4.1.4.2 Hydrosphere

This section describes the hydrology in the vicinity of the proposed site, including rivers and streams, lakes and reservoirs, coastal regions, and surface water and groundwater uses.

Information Submitted by the Applicant

The applicant described the local and regional hydrology surrounding the PSEG Site. As stated in SSAR Section 2.4.1.1, the applicant's descriptions of hydrologic characteristics were taken from publicly available maps and data published by the USGS, National Oceanic and Atmospheric Administration (NOAA), Natural Resources Conservation Service (NRCS), USACE, and/or appropriate State agencies and the Delaware River Basin Commission (DRBC).

The proposed PSEG Site is located on Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey (NJ). The Delaware River has a drainage area of approximately 35,224 square kilometers (km^2) (13,600 square miles (mi^2)) and is the largest undammed river east of the Mississippi River. The river basin includes portions of Delaware, Maryland, New Jersey, New York, and Pennsylvania and crosses five physiographic provinces: the Coastal Plain, Piedmont, New England, Valley and Ridge, and the Appalachian Plateau. The total drainage area upstream of the PSEG Site is 29,785 km^2 (11,500 mi^2).

The site is located 52 river miles (RM) upstream (i.e., at RM 52), from the mouth of Delaware Bay. The proposed finished new plant grade is 11.25 m (36.9 ft) NAVD88, which is 1.47 m (4.8 ft) above the DBF (9.78 m (32.1 ft) NAVD88) based on storm surge as described in SSAR Section 2.4.5. As discussed in Section 2.4.2 herein, tidal action and storm surge is the primary influence on the DBF. Under normal conditions, the tidal flow ranges from 11,327 cubic meters (m^3) (400,000 cubic feet (ft^3)) per second to 13,366 m^3 (472,000 ft^3) per second while freshwater flow at the PSEG Site is approximately 425 m^3 (15,000 ft^3) per second (USACE, 1992).

Average annual precipitation in the Delaware River basin ranges from 127 centimeters (cm) (50 inches (in.)) in the upper basin to 107 cm (42 in.) in the lower basins near the PSEG Site and is generally evenly distributed over the basin throughout the year (USGS, http://nj.usgs.gov/nawqa/delr/su.descrpt.html).

As the Delaware River is the primary source of water for operation for the PSEG plant, the applicant stated that the safety-related intake structure for the selected reactor technology will be designed to operate during the lowest water conditions, which is assumed coincident with a 20-year low flow in the Delaware River at Trenton and 90 percent exceedance low tide, which would result in an extreme and temporary low water level of -4.85 m (-15.9 ft) NAVD88.

The Staff's Technical Evaluation

The staff reviewed the completeness of the hydrologic data and watershed characteristics, and made several spot checks to confirm the accuracy of specific data, such as basin physiography, precipitation, tidal surges, peak flood flows and historical water surface elevations in the Delaware River. As noted in studies of the Delaware River (USACE, 1992), tidal flow is approximately 30 times greater than fresh water flow at the PSEG Site under average conditions increasing to approximately 290 times greater near the Delaware Bay entrance (Pape et al., 1982). During the site visit and audit in 2011, the staff identified and confirmed various site characteristics that were considered in flood analyses at the site and finds the applicant's evaluation adequate.

Based on a review of the material presented by the applicant in SSAR Section 2.4.1, the staff's observations of the PSEG Site during the February 15-16, 2011, site visit and audit, and the staff's independent review of published data and reports, the staff finds that the applicant has adequately considered the hydrosphere near the PSEG Site.

2.4.1.4.3 Hydrologic Casual Mechanisms

Information Submitted by the Applicant

The Delaware River is the only surface water body of any significance that could affect the site. The Delaware River has a drainage area of 35,224 km^2 (13,600 mi^2) and is undammed along the entire course of its main stem. The transition between the head of the Delaware Bay and the mouth of the river occurs at RM 48, 6.48 km (4 mi) downstream from the PSEG Site. At the PSEG Site, the Delaware River is subject to tidal influence from the mouth of the Delaware River to the upstream limit of the estuary, which is defined by RM 134 in Trenton, NJ. Historical records indicate that the highest flood events recorded near the mouth of the Delaware River and within Delaware Bay are caused by storm surge associated with hurricanes. Wave run up due to tsunamis is far less likely to affect the PSEG Site as there have been few recorded Atlantic coast incidents of significant run up due to tsunamis.

Tides enter Delaware Bay from the Atlantic Ocean and propagate upstream. The tide of the Delaware Estuary is semidiurnal in character. There are two high waters and two low waters in a tidal day, with comparatively little diurnal inequality. The Reedy Point station (RM 58.6) is the tidal gauge station nearest the PSEG Site. The mean tide range at this location is 1.63 m (5.34 ft), indicating a significant influence of tide on river flow. NOAA tidal gauge stations are used to calibrate hydraulic models for the tidally influenced sections of the Delaware River and Delaware Bay.

There are 24 reservoirs on Delaware River tributaries in the Delaware River Basin (Figure 2.4.1-2 of this report). Of these, nine reservoirs are dedicated for water supply, two generate hydropower, three are dedicated for flood loss reduction, and one is solely for flow augmentation. The remaining nine reservoirs are multipurpose, providing water for a combination of water supply, flow augmentation, and flood loss reduction. Dedicated water supply reservoirs fill during the winter and spring months to ensure water supply during dry months. Multipurpose reservoirs and those dedicated to flood reduction maintain year-round flood storage voids to mitigate flooding. Flow management of the Delaware River is accomplished through coordinated releases from major reservoirs on its tributaries as overseen by the DRBC.

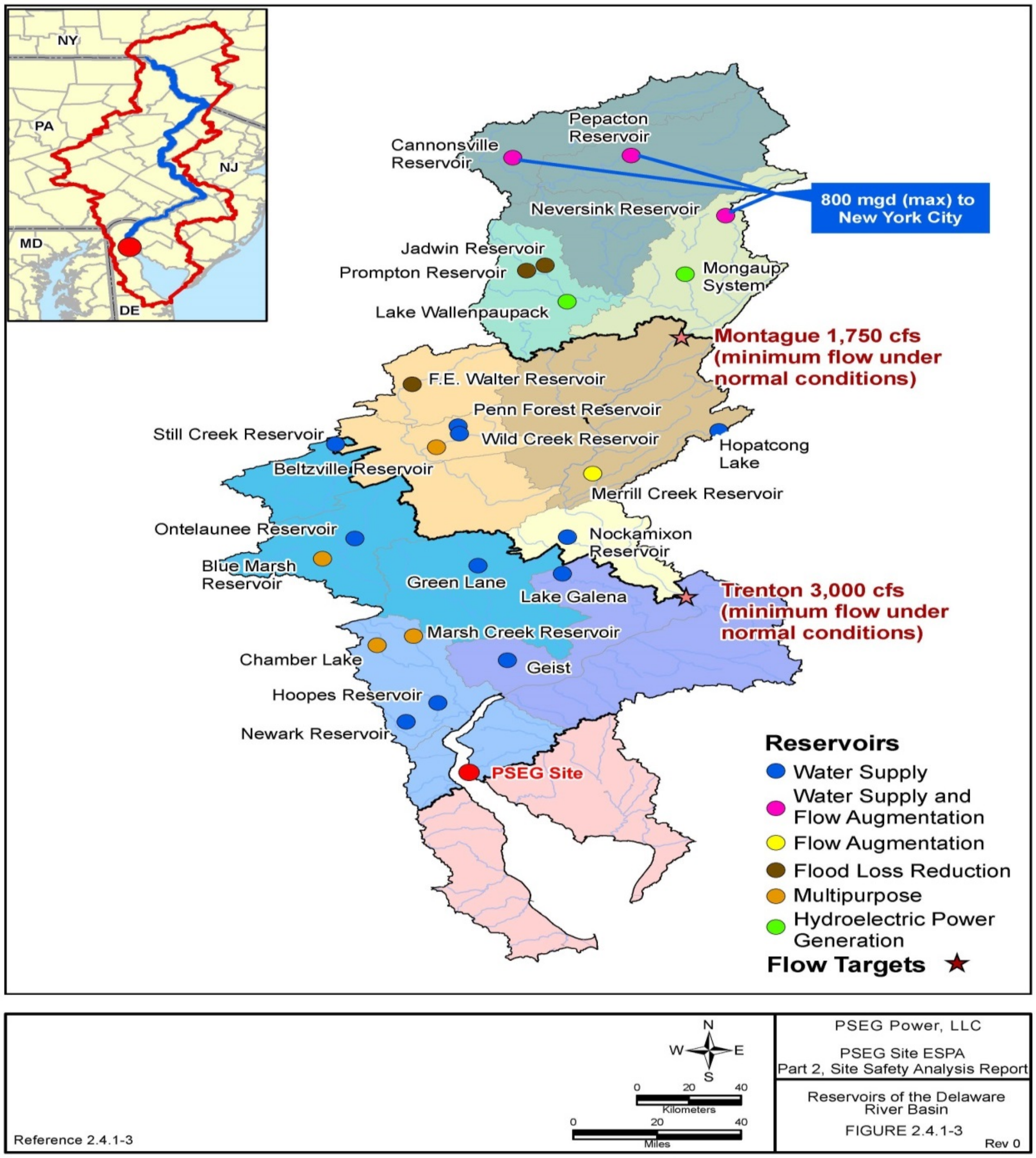

Figure 2.4.1-2 Reservoirs in the Delaware River Basin (from SSAR Revision 3, Figure 2.4.1-3)

The Staff's Technical Evaluation

The staff reviewed the information provided by the applicant and performed an independent review of the applicant's information. The staff also visited the site and verified the disposition and elevation of the Delaware River, surrounding creeks, and hydrologic features. The staff supplemented this information with other publicly available sources of data. Based on this review, the staff concludes that the information and data provided are adequate.

Specific discussions of the effects of various hydrologic phenomena such as storm surge, tsunamis, floods, dam failures, ice effects, and groundwater levels are included in Sections 2.4.2 through 2.4.14 herein.

2.4.1.4.4 Surface and Groundwater Uses

Information Submitted by the Applicant

The Delaware River is a primary source of water for industry and municipalities, a receiving body for effluent, a resource for power generation, and a location for recreational activities. The DRBC authorizes Delaware River surface-water withdrawals for industrial and public water supply purposes in Delaware, Pennsylvania and New Jersey. The majority of surface-water users are located upstream of the PSEG Site. The primary surface-water users of the Delaware River are industrial, power, commercial, and water supply. Instream use of the Delaware River includes port traffic, barge traffic, fishing, boating, and other recreational activities.

The applicant addressed groundwater in SSAR Section 2.4.12 and summarized groundwater users in the SSAR. The staff's reviews of the information submitted by the applicant are located in Section 2.4.12 herein.

The applicant described the current and past surface-water use of the Delaware River. This information about water use was presented and summarized in the SSAR.

The Staff's Technical Evaluation

The staff reviewed the information provided by the applicant and performed an independent review of the applicant's information. The staff also visited the site and verified the location of important water users. The staff supplemented this information with other publicly available sources of data. Based on this review, the staff concludes that the information and data provided are adequate.

2.4.1.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.1.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the PPE, and that there is no outstanding information required to be addressed in the SSAR related to this section.

As set forth above, the applicant has presented and substantiated information to establish the site description. The staff has reviewed the information provided and, for the reasons given above, concludes that the applicant has provided sufficient details about the site description to allow the staff to evaluate, as documented in Section 2.4.1 above, whether the applicant has met the relevant requirements of 10 CFR 52.17(a)(1) and 10 CFR Part 100 with respect to determining the acceptability of the site. The staff finds that the applicant has provided sufficient information to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100.

2.4.2 Floods

2.4.2.1 Introduction

SSAR Section 2.4.2 discusses historical flooding at the proposed site and in the region of the site. The information summarizes and identifies the individual types of flood-producing phenomena, and combinations of flood-producing phenomena, considered in establishing the flood design basis for safety-related plant features.

Section 2.4.2 herein provides a review of the specific areas as follows: (1) local flooding on the site and drainage design; (2) stream flooding; (3) surges; (4) seiches; (5) tsunami; (6) dam failures; (7) flooding caused by landslides; (8) effects of ice formation on water bodies; (9) combined event criteria; (10) other site-related evaluation criteria; and (11) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.2.2 Summary of Application

In SSAR Section 2.4.2, the applicant addresses the information related to site-specific and regional flood causal mechanisms.

2.4.2.3 Regulatory Basis

The relevant requirements of NRC regulations for the identification of floods and flood design considerations, and the associated acceptance criteria, are specified in NUREG–0800, Section 2.4.2.

The applicable regulatory requirements for identifying probable maximum flooding on streams and rivers are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to the hydrologic characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10CFR 100.20(c).

The staff also used the appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG–0800, Section 2.4.1:

- RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, "Seismic Design Classification," as it relates to those SSCs intended to protect against the effects of flooding.

- RG 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, "Flood Protection for Nuclear Power Plants," as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.2.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.2 and confirmed that the information in the application addresses the required information related to site floods. The staff's technical review of this application included an independent review of the applicant's information in the SSAR and in the applicant's responses to staff RAIs. The staff supplemented this information with other publicly available sources of data. The review areas included:

- Stream flooding
- Surges and seiches
- Tsunamis
- Dam failures
- Effects of ice formation in water bodies
- Channel diversions
- Combined events criteria
- Consideration of other site-related evaluation criteria

In addition to the systematic review of information provided by the applicant, the staff visited the site and verified the location and elevation of important streams and hydrologic features. The staff reviewed the available information in SSAR, Revision 0, and concluded that the SSAR did not provide sufficient detail describing the techniques and methodology used for surface water modeling and resulting flood levels at the site. Therefore, in RAI 25, Question 02.04.01-1, the staff requested that the applicant provide detailed descriptions of the methods used, the simulation input files, and a description of the simulation scenarios so the staff could verify that the parameters were reasonable given the resulting runoff flow paths and flood levels. The staff's review of the information contained in the SSAR is discussed below.

2.4.2.4.1 Flood History

<u>*Information Submitted by the Applicant*</u>

The applicant provided extensive analyses and computations to determine maximum flow rates and flood levels. Detailed information was provided regarding input parameters and flood computations associated with the following:

- Stream and river flooding
- Dam failures (on Delaware River Tributaries)
- Surge and seiche flooding
- Tsunamis
- Effects of ice formation in water bodies
- Channel diversions
- Combined events criteria

Flooding due to underwater landslides was evaluated within the tsunami scenarios by the applicant. Due to a lack of a technology-specific grading plan and site drainage system design, less detailed information was provided for local flooding on the site and drainage based on the PMP. Once a final technology is selected with an associated grading plan and drainage design, PMP peak flows and water levels will be re-analyzed to establish the maximum water surface elevation near plant safety-related SSCs.

The Staff's Technical Evaluation

In a June 23, 2011, response to RAI 25, Questions 02.04.01-1 and 02.04.01-2 (See Section 2.4.1.4.1 of this report), the applicant provided detailed maps, surface water input and output files, and a user information guide clearly describing the information and methods used for surface water modeling including river flooding, dam failures on tributaries to the Delaware River, tidal induced flooding and low water, and channel diversions with combined event scenarios. The staff finds the information submitted adequate for the staff's evaluation and considers RAI 25, Questions 02.04.01-1 and 02.04.01-2 resolved.

The staff reviewed the flood history information provided by the applicant in SSAR Section 2.4.2 and finds that the information provided is sufficient to establish the history of flooding at and near the PSEG Site.

2.4.2.4.2 Flood Design Considerations

Information Submitted by the Applicant

The applicant noted that the highest recorded flood events near the mouth of the Delaware River and in the vicinity of the site are produced by storm surge with southeast to northwest moving hurricanes producing the more severe surge levels.

The Trenton, NJ gauge is the last downstream gauge at which discharge values for the Delaware River are determined based solely on freshwater discharge. In selecting the initial base flow for flood event scenarios, the applicant used discharge measurements from the Trenton gauge for a June 2006 flood event. The applicant selected this discharge measurement of greater than 6,372 m^3 (225,000 ft^3) per second over two earlier (1905 and 1955), discharge measurements of greater than 9,314 m^3 (329,000 ft^3) per second, for the following reasons: (a) the 2006 event had more recent and accurate records; (b) a substantial reservoir capacity was added, including flood control reservoirs, since the earlier events; (c) it best represented the current configuration of the basin; and (d) the relatively uniform rainfall totals over the basin during the 2006 event were conducive to subbasin calibration. Major river flood events have little impact on gauge levels at the PSEG Site due to the wide and open marine connection of the Delaware River adjacent to the site.

Tsunamis (SSAR Section 2.4.6) along the Atlantic Coast are rare in the historical record; the most recent tsunami was recorded in 1929 at Atlantic City with amplitude of 0.67 m (2.2 ft). In SSAR Section 2.4.7, the applicant reviewed the USACE Cold Regions Research and Engineering Laboratory (CRREL) Ice Jam Database and noted no ice jams causing flooding downstream of the PSEG Site, and evaluated the ice jam flooding potential. Combinatory dam break flooding potential is evaluated by the applicant in SSAR Section 2.4.4. The flooding scenarios investigated for the site include the following:

- Flooding due to PMP on the site (SSAR Section 2.4.2)

- Probable maximum flood (PMF) on rivers and streams (SSAR Section 2.4.3)
- Potential dam failures (SSAR Section 2.4.4)
- Maximum surge and seiche flooding (SSAR Section 2.4.5)
- Probable maximum tsunami (PMT) (SSAR Section 2.4.6)
- Ice effect flooding (SSAR Section 2.4.7)
- Channel diversions (SSAR Section 2.4.9)

The applicant's evaluation of the above flooding scenarios confirmed that the DBF for the new plant of 9.78 m (32.1 ft) NAVD88 is associated with storm surge. As applicable to the design at the COL stage, the applicant will design a safety-related intake structure to withstand the DBF and associated effects (See Section 2.4.10 of this report). All safety-related SSCs at a site grade elevation or higher will have adequate safety margins relative to the DBF for the given PPE.

The Staff's Technical Evaluation

The applicant's assertion that the strong tidal nature of the Delaware River adjacent to the site precludes significant impacts to safety-related SSCs from rainfall/runoff scenarios in the river basin is reasonable given the physiography of the area and the wide and open marine connection of the Delaware River at the PSEG Site. The applicant's choice of a flood flow magnitude slightly less than two earlier, larger events in the interest of a more complete and accurate record results in an appropriately conservative representation of the physical system for surface water modeling. The staff reviewed the historical record for flooding and the CRREL Ice Jam Database and verified that no ice jams downstream of the PSEG Site have caused flooding. The staff finds that the applicant's conclusion of the DBF due to storm surge as the bounding event is consistent with the historical record and physiography of the Delaware River basin. The staff finds the applicant's evaluation of flood design considerations adequate.

Based on a review of the applicant's information contained in the SSAR, the staff finds that the applicant appropriately considered flood-causing phenomena and their combinations that are relevant for the PSEG Site.

2.4.2.4.3 Local Intense Precipitation

Information Submitted by the Applicant

To determine the potential effects of flooding, it is very important to select an appropriately conservative rainfall event on which to base the hydrologic designs. Further, the staff considers that the selection of a design flood event should not be based on the extrapolation of limited historical flood data, due to the unknown level of accuracy associated with such an extrapolation. The applicant utilized the PMP event, computed by deterministic methods (rather than statistical methods) and based on site-specific hydrometeorological characteristics. The PMP has been defined as the most severe reasonably possible rainfall event that could occur as a result of a combination of the most severe meteorological conditions occurring over a watershed. No recurrence interval is normally assigned to the PMP; however, the staff has concluded that the probability of such an event being equaled or exceeded during the plant lifetime is very low. Accordingly, the PMP is considered by the staff to provide an acceptable design basis. The staff considers that use of the PMP meets requirements of 10 CFR 52.17, "Contents of Applications; Technical Information in Final Safety Analysis Report," and provides

sufficient margins to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Prior to determining the runoff, the flooding analysis requires the determination of PMP amounts for the specific site location. Techniques for determining the PMP have been developed for the United States by Federal agencies in the form of hydrometeorological reports for specific regions. These techniques are widely used and provide straightforward procedures with minimal variability.

For the PSEG Site, PMP values and rainfall distributions were estimated by the applicant using reports prepared by NOAA, including Hydrometeorological Report No. 51 (HMR-51) (National Oceanic and Atmospheric Administration/National Weather Service (NOAA/NWS), 1978) and Hydrometeorological Report No. 52 (HMR-52) (NOAA/NWS, 1982). Using these reports, a 1-hour PMP of 46.73 cm (18.4 in.) was used by the applicant as a basis for estimating the PMF for each of the subbasins affected. (The PMF is a hypothetical flood that is considered to be the most severe reasonably possible flood, based on comprehensive hydrometeorological application of the PMP and other hydrologic factors favorable for peak runoff.) The staff reviewed HMR-51, HMR-52, and the procedures for estimating PMP values for several different durations, and concluded that the PMP amounts are acceptable for the subbasin drainage areas.

Due to the lack of a specific technology, a site grading plan and storm water management system necessary to establish the maximum site water surface elevation due to the PMP have not been determined. The applicant has stated that the local PMP event will not affect new plant safety features; however, a detailed PMP analysis to determine the maximum site water level cannot be performed until a specific technology is selected.

<u>*The Staff's Technical Evaluation*</u>

The staff reviewed NOAA HMR-51 (NOAA/NWS, 1978) and HMR-52 (NOAA/NWS, 1982) to verify the applicant's determination of the PSEG Site PMP event. The staff finds that the applicant's deterministic method of defining the PMP event for the site reasonable and the associated analysis adequate; however, the site grading plan and storm water management system will be specific to the reactor technology to be selected by the COL applicant. Accordingly, the staff identified COL Action Item 2.4-1 to address this item.

COL Action Item 2.4 1

> An applicant for a COL or CP referencing this early site permit should design the site grading to provide flooding protection to safety related structures at the ESP site based on a comprehensive flood water routing analysis for a local PMP event without relying on any active surface drainage systems that may be blocked during this event.

Based on a review of the applicant's information in the SSAR, the staff finds that the applicant has appropriately considered flood-causing phenomena related to local intense precipitation for the PSEG Site.

2.4.2.4.4 Infiltration Losses

Information Submitted by the Applicant

The applicant used the NRCS curve number method (USDA, 2004) commonly used to estimate runoff. This method incorporates the effects of soil, surface vegetation and land management into a representative value for each of the subbasins. To maximize runoff, initial soil moisture was saturated by using the highest antecedent moisture condition (AMC) III, for the respective curve number prior to the PMP event. The applicant used these subbasin curve numbers as initial conditions to estimate peak discharge resulting from the PMP event. Weighted by subbasin areas, curve numbers were calculated for each of the subbasins to derive initial soil moisture conditions.

The Staff's Technical Evaluation

Using AMC III is an acceptable and reasonable method of initializing soil saturation to limit infiltration losses prior to a PMP event. Curve number values are between 0 and 100 with values near 100 characteristic of impervious basins (i.e., maximum runoff). Weighted by subbasin areas, curve numbers were calculated for each of the subbasins and resulted in a relatively high overall average value of 90.5 to provide conservative estimates of peak discharge relative to the PMP event. The staff finds the applicant's analysis adequate.

The staff agreed that the flood causing phenomena associated with infiltration losses considered by the applicant are appropriate for the PSEG Site. Based on a review of the applicant's information in the SSAR, the staff finds that the applicant has appropriately considered flood-causing phenomena related to infiltration losses for the PSEG Site.

2.4.2.4.5 Time of Concentration

Information Submitted by the Applicant

The time of concentration is the amount of time required for runoff to reach the outlet of a drainage basin from the most remote point in that basin. The peak runoff for a given drainage basin is inversely proportional to the time of concentration. If the time of concentration is assumed to be smaller, the peak discharge will be larger. Times of concentration and/or lag times are typically computed using empirical relationships such as those developed by Federal agencies.

The applicant estimated times of concentration and lag times for the various subbasins using methods recommended by NRCS and presented in the USDA, "Urban Hydrology for Small Watersheds," Technical Release (TR) 55 Manual (USDA, 1986).

The Staff's Technical Evaluation

These methods are generally accepted in hydrologic engineering practice and are considered by the staff to be appropriate and adequate for estimating times of concentration at the PSEG Site. The staff finds the applicant's analysis adequate.

The staff agreed that the flood causing phenomena associated with time of concentration considered by the applicant are appropriate for the PSEG Site. Based on a review of the

applicant's information in the SSAR, the staff finds that the applicant has appropriately considered flood-causing phenomena related to time of concentration for the PSEG Site.

2.4.2.4.6 Rainfall Distributions

Information Submitted by the Applicant

A typical PMP value is derived for periods of about 1 hour. If the time of concentration is less than 1 hour, it is necessary to extrapolate the data presented in the various hydrometeorological reports to shorter time periods. For example, the applicant used distributions recommended in NOAA, Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian, Hydrometeorological Report (HMR)-52 (NOAA/NWS, 1986) and determined the 5-minute PMP to be about 15.5 cm (6.1 in.), with a resulting rainfall intensity of 1.85 m (72.8 in.) per hour.

The Staff's Technical Evaluation

Based on a review of the applicant's assumptions, input parameters, and calculations, the staff finds that the computed peak rainfall amounts (and resulting intensities) for various short time periods are reasonable and conservative and, are therefore adequate.

The staff agreed that the flood causing phenomena associated with rainfall distributions considered by the applicant are appropriate for the PSEG Site. Based on a review of the applicant's information in the SSAR, the staff finds that the applicant has appropriately considered flood-causing phenomena related to rainfall distributions for the PSEG Site.

2.4.2.4.7 Computation of Peak Flood Discharges and PMF Water Levels

Information Submitted by the Applicant

Various methods can be used to determine peak PMF flows and water levels, depending on the location of the feature, the drainage area, and other factors. Peak flows and water levels generated by the PMP/PMF within the PSEG Site were determined by the applicant using the Hydrologic Engineering Centers-Hydrologic Modeling System (HEC-HMS) (USACE, http://www.hec.usace.army.mil/software/hec-hms/) model developed by the USACE. The software is widely used by many Federal agencies (and others) for various hydrologic analyses and is considered by the staff to be an adequate model.

Due to the lack of a specific technology, a site grading plan and storm water management system necessary to establish the maximum site water surface elevation due to the PMP have not been developed. A detailed PMP analysis to determine the maximum site water level given a site-specific drainage system will be performed by the applicant and reviewed by staff at the COL stage after a reactor technology is selected.

The Staff's Technical Evaluation

Although the staff concluded that the models and procedures outlined above are acceptable, the staff needed additional information and the applicant's calculations to determine the acceptability of the computed peak flood flows and water levels. The applicant addressed the staff's needs in a June 23, 2011, response to RAI 25, Questions 02.04.02-1 and 02.04.02-2 (See Section 2.4.1.4.1 of this report). The staff reviewed digital modeling files, explanations and

calculations submitted by the applicant concerning the flooding caused by the probable maximum precipitation at the site. The approach to the modeling appears to be appropriate but a final evaluation of the PMP impacts to site-specific flooding cannot be made until the detailed modeling is conducted based on an actual site design and storm water management system. The staff finds the applicant's analysis adequate. The staff considers RAI 25, Questions 02.04.02-1 and 02.04.02-2, resolved, noting that PMP impacts will be developed by the applicant at the COL stage after a specific reactor technology is selected. The staff is tracking the applicant's evaluation of PMP and flood protection at the COL stage via COL Action Item 2.4-1 (See Section 2.4.2.4.3 of this report).

2.4.2.5 Post Early Site Permit Activities

The staff will review the applicant's modeling incorporating site-specific grading plans and storm water management system design features to determine site-specific PMP flooding, identified as COL Action Item 2.4-1.

2.4.2.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the PPE, and that there is no outstanding information required to be addressed in the SSAR related to this section as related to the application.

As set forth above, the applicant presented and substantiated information to establish the site description. The staff reviewed the information provided and, for the reasons given above, concludes that the applicant has provided sufficient details about the site description to allow the staff to evaluate, as documented in Section 2.4.2 herein, whether the applicant has met the relevant requirements of 10 CFR 52.17(a)(1) and 10 CFR Part 100 with respect to determining the acceptability of the site. In conclusion, the applicant has provided sufficient information for satisfying the requirements of 10 CFR Part 52 and 10 CFR Part 100. The COL applicant will address COL Action Item 2.4-1.

2.4.3 Probable Maximum Flood on Streams and Rivers

2.4.3.1 Introduction

SSAR Section 2.4.3 describes the hydrological site characteristics affecting any potential hazard to the plant's safety-related facilities as a result of the effect of the PMF on streams and rivers, and combinations of flood-producing phenomena.

Section 2.4.3 herein provides a review of the following specific areas: (1) design basis for flooding in streams and rivers; (2) design basis for site drainage; (3) consideration of other site-related evaluation criteria; and (4) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts of 10 CFR Part 52.

2.4.3.2 Summary of Application

In SSAR Section 2.4.3, the applicant addresses the information about site-specific PMFs on streams and rivers.

2.4.3.3 Regulatory Basis

The relevant requirements of NRC regulations for identifying the PMF on streams and rivers, and the associated acceptance criteria, are specified in NUREG–0800, Section 2.4.3.

The applicable regulatory requirements for identifying the PMF on streams and rivers are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirements to consider physical site characteristics in site evaluations are specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The staff also used the appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG-0800, Section 2.4.3:

- RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants,” as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, “Seismic Design Classification,” as it relates to those SSCs intended to protect against the effects of flooding.

- RG 1.59, “Design Basis Floods for Nuclear Power Plants,” as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, “Flood Protection for Nuclear Power Plants,” as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.3.4 Technical Evaluation

The staff reviewed SSAR Section 2.4.3 and confirmed that the information contained in the application addresses the relevant information related to this section. In addition to the systematic review of information provided by the applicant, the staff also visited the site, verified the location and elevation of important streams and hydrologic features, and supplemented this information with other publicly available sources of data. The review topics included the following:

- Design basis for flooding in streams and rivers
- Combined events criteria
- Design basis for site drainage
- Effects of sediment erosion and deposition

- Consideration of other site-related evaluation criteria

In the initial review of the information provided in SSAR Section 2.4.3 and the information gathered during the site visit, the staff determined that the information in SSAR, Revision 0, for the methods of analysis related to identification of the effects of probable maximum flooding on streams and rivers was not sufficiently detailed and substantiated for the staff to assess drainage patterns and independently confirm maximum water levels associated with the PMF. As discussed below, the applicant subsequently provided sufficient and substantiated information regarding the effects of probable maximum flooding on streams and rivers.

Due to the wide and open marine connection of the Delaware River at the PSEG Site, tidal influences and storm surge are the primary drivers in determining the design-basis flood rather than PMF due to precipitation-induced riverine flooding. As discussed previously in Section 2.4.2.5 of this report, potential PMP impacts to site surface-water drainage systems will be evaluated at the COL stage after a reactor technology is selected.

2.4.3.4.1 Design Bases for Flooding in Streams and Rivers

Information Submitted by the Applicant

The applicant used three methods to determine the PMF: two methods simulate flood levels from two different PMP events, and the third method determines the flood level from the Approximate Method from RG 1.59, "Design Basis Floods for Nuclear Power Plants." Two PMP events were developed using HMR-51 and HMR-52 (NOAA/NWS, 1978 and NOAA/NWS, 1982, respectively): the first was designed to yield maximum rainfall over the Delaware Basin and the second was designed to yield more intense rainfall close to, and upstream of the PSEG Site. Of these two PMP events, the one resulting in the highest simulated water level at the PSEG Site was selected. Alternatively, the Approximate Method from RG 1.59, Appendix B, was used to determine a PMF. The analysis producing the highest water level at the plant was selected as the PMF.

After establishing the PMF, the applicant selected the following two combined events (Alternative I and Alternative II) based on American National Standards Institute/American Nuclear Society, "Determining Design Basis Flooding at Power Reactor Sites" (ANSI/ANS-2.8-1992) to arrive at a design-basis flood:

Alternative I

- One-half PMF or 500-year flood (whichever is less)
- Surge and seiche from the worst regional hurricane or windstorm including wind-waves
- 10 percent exceedance high tide

Alternative II

- PMF
- 25-year surge and seiche with wind-waves
- 10 percent exceedance high tide

HEC-HMS (USACE, http://www.hec.usace.army.mil/software/hec-hms/) and HEC-RAS (USACE, http://www.hec.usace.army.mil/software/hec-ras/) were used to simulate the PMF. Based on PMP results, HEC-HMS was used to calculate the PMF discharge to the Delaware

River from the watershed that was then applied to the HEC-RAS model, which simulates Delaware River processes and routes the subbasin runoff to ultimately determine the maximum water level at the PSEG Site. Inputs to the HEC-RAS model included the 10 percent exceedance high tide, and surge and seiche. Wind-waves were calculated based on the USACE Coastal Engineering Manual (USACE, 2002).

The Staff's Technical Evaluation

The staff reviewed the applicant's design basis methodology for determination of flooding on streams and rivers. The applicant utilized the PMP event computed by deterministic methods (rather than statistical methods), and based on site-specific hydrometeorological characteristics. The staff reviewed HMR-51, HMR-52, and the procedures for estimating PMP. No recurrence interval is normally assigned to the PMP; however, the staff finds that such an event being equaled or exceeded during the plant lifetime is unlikely. The staff considers that use of the PMP meets the requirements to provide a sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, and provides an acceptable design basis.

For conservatism, the applicant applied two PMP events as a basis for surface-water modeling to determine the maximum water level at the site from each event. An alternative analysis to determine discharge was performed consistent with the Approximate Method of RG 1.59. For additional conservatism, additional flooding mechanisms for two scenarios were added to the PMF calculated from the surface-water simulations including surge and seiche from the worst regional hurricane or windstorm, and wind-wave activity. The staff considers the bases methodology developed by the applicant adequate. Components of the methodology are described in further detail below.

2.4.3.4.2 Basin Discharge

Information Submitted by the Applicant

The applicant-derived PMP estimates were from HMR-51 isohyetal maps (NOAA/NWS, 1978) and applied in a temporal and spatial pattern over the Delaware River basin based on procedures in HMR-52 (NOAA/NWS, 1982) to yield maximum runoff. The applicant modeled two PMP events to maximize rainfall throughout the Delaware River Basin, and to yield more intense rainfall close to and upstream of the PSEG Site. The basin wide event that produced the greatest PMP event was determined as a 38,850 km^2 (15,000 mi^2) storm centered over Doylestown, PA and oriented at 222 degrees azimuthal (deg) to produce maximum total rainfall. The upper basin storm close to and upstream of the PSEG Site that produced the greatest PMP was determined to be a 5,568 km^2 (2,150 mi^2) storm in the upper basin centered over Philadelphia, PA with an orientation of 263 deg. The upper basin storm was found to produce the highest flood level at the site through modeling with HEC-HMS and HEC-RAS as described below. A 1-hour PMP of 24.1 cm (9.5 in.) for the upper basin storm was used by the applicant as a basis for estimating the PMF for each of the drainage areas affected.

The applicant then used HEC-HMS based on the results of the two PMP events to determine the runoff hydrograph for the Delaware River Basin. To calculate discharge hydrographs, the applicant used the NRCS curve number method in HEC-HMS to determine precipitation losses. NRCS soil survey information and USGS land use codes determined the curve numbers. The applicant used Antecedent Moisture Curves (AMC) III curve numbers (USDA, 2004) to represent ground that is nearly saturated with more than 5 cm (2 in.) of rainfall prior to and

within 5 days of the PMP events. Routing of the drainage reaches was conservatively assumed to have no attenuation or diffusion. Prior to the PMP event, tributaries were assumed to flow at an average monthly base flow value based on USGS gauge values. These values were multiplied by the USGS base flow index and used as initial base flows for the HEC-HMS simulations. The USGS base flow index is the ratio of base flow to total flow, expressed as a percentage.

The method resulting in the highest water elevation of 0.79 m (2.6 ft) and discharge (41,852 m^3 (1,478,000 ft^3) per second) adjacent to the PSEG Site was associated with the PMP above for the upper basin. Once this PMF was established, the applicant used ANSI/ANS-2.8-1992 to determine combinations of tide and storm surge to establish an overall flood level associated with the PMF event.

The Staff's Technical Evaluation

The applicant utilized the PMP event computed by deterministic methods (rather than statistical methods), and based on site-specific hydrometeorological characteristics. The PMP has been defined as the most severe reasonably possible rainfall event that could occur as a result of a combination of the most severe meteorological conditions occurring over a watershed. No recurrence interval is normally assigned to the PMP; however, the staff finds that such an event being equaled or exceeded during the plant lifetime is unlikely.

Prior to determining the runoff, the flooding analysis requires the determination of PMP amounts for the site location. The procedures for estimating PMP values for several different durations were reviewed by the staff, and it was concluded that the PMP amounts determined by the applicant are acceptable for the various subbasins in the watershed and are considered by the staff to provide an acceptable design basis. Using these reports, a 1-hour PMP of 24.1 cm (9.5 in.) was used by the applicant as a basis for estimating the PMF for each of the various small drainage areas affected. A typical PMP value is derived for periods of about 1 hour. If the time of concentration is less than 1 hour, it is necessary to extrapolate the data presented in the various hydrometeorological reports to shorter time periods. For example, the applicant used distributions recommended in HMR-52 and determined the 5-minute PMP to be about 15.5 cm (6.1 in.).

Infiltration losses were conservatively determined using the runoff methodology developed by the NCRS (USDA, 2004). In this AMC III method, a runoff curve number (CN) is estimated for the various subbasins to assume nearly saturated soil conditions prior to the design storm to maximize runoff. Curve numbers incorporate the drainage basin's soils, vegetation, and vegetation density, in addition to the assumed antecedent moisture conditions.

The time of concentration is the amount of time required for runoff to reach the outlet of a drainage basin from the most remote point in that basin. The peak runoff for a given drainage basin is inversely proportional to the time of concentration. The applicant used the lag method, which conservatively assumes no attenuation (lag) or diffusion for the hydrographs used for routing.

Based on a review of the applicant's assumptions and calculations, the staff concludes that the parameters incorporated into the basin discharge model are adequate.

Initially in SSAR, Revision 0, it was unclear to the staff if these rainfall distributions had been appropriately incorporated into the runoff models. Therefore, in RAI 25, Questions 02.4.02-1

and 02.04.02-2, the staff requested that the applicant provide additional information regarding USACE HEC-HMS (USACE, http://www.hec.usace.army.mil/software/hec-hms/) and HEC-RAS (USACE, http://www.hec.usace.army.mil/software/hec-ras/) input data, and basin-specific drainage details to address these information needs. In a June 23, 2011, response, the applicant submitted the requested information. The staff finds that the applicant appropriately and satisfactorily incorporated the rainfall distributions into the runoff model. Accordingly, the staff considers RAI 25, Questions 02.04.02-1 and 02.04.02-2 resolved.

2.4.3.4.3 Computation of Peak Water Levels

Information Submitted by the Applicant

The applicant used peak discharges computed by HEC-HMS (USACE, http://www.hec.usace.army.mil/software/hec-hms/) as input to the HEC-RAS (USACE, http://www.hec.usace.army.mil/software/hec-ras/) model, which was then used for simulating Delaware River hydraulic processes and flood water routing downstream through the basin system and for the computation of the peak water levels at the PSEG Site. In the HEC-RAS model, Manning's *n* value for the lower Delaware River was calibrated to range from 0.013 to 0.027 to tide and Trenton stage-discharge data. For the combinatory events including the PMF, the applicant used ANSI/ANS-2.8-1992 alternatives which included 10 percent exceedance high tide and, surge and seiche. Wind wave activity as prescribed in the USACE Coastal Engineering Manual (USACE, 2002) was included in the resulting peak water level estimate.

The combinatory events as prescribed by ANSI/ANS-2.8-1992 Alternative I produced a maximum peak water level at the plant of 6.40 m (21.0 ft) NAVD88 based on a one-half PMF contribution with 10 percent exceedance high tide (2.01 m (6.6 ft)), surge and seiche from Hurricane Hazel, the most severe regional hurricane on record (3.44 m (11.3 ft)), and coincident wave runup (0.94 m (3.1 ft)).

At the COL stage, the applicant will ensure that site grading adequately routes runoff to swales and pipes away from SSCs to the Delaware River (COL Action Item 2.4-1). Once a reactor technology is selected, the design of the intake structure will be determined and, protection from the design basis flood and associated effects will be evaluated at the COL stage (COL Action Item 2.4-2). Safety related site grade (11.25 m (36.9 ft) NAVD88) SSCs are at a sufficient elevation above the design basis flood (9.78 m (32.1 ft) NAVD88) to provide for flood protection based on the PPE.

The Staff's Technical Evaluation

The staff reviewed the methods and procedures above and determined them consistent with the suggested criteria in RG 1.59 and current best practices. However, the staff required further information including the applicant's HEC-HMS and HEC-RAS surface-water modeling files and drainage basin details to evaluate and confirm calculations of peak flood flows and surface water levels. In addition, the vertical datum used by the applicant for the surface water elevation data and the identification of gaging stations was unclear. Therefore, in RAI 25, Questions 02.04.02-1 and 02.04.02-2, the staff requested that the applicant provide additional information regarding the surface-water modeling files for staff review. In a June 23, 2011, response, the applicant provided information to clarify water surface datum and elevations, and gaging station locations. The staff reviewed the applicant's HEC-HMS and HEC-RAS input and output files and, associated information and finds the results and information presented in the SSAR adequate. In this response, the applicant provided SSAR revisions that were

subsequently incorporated into SSAR, Revision 1 (May 21, 2012). Accordingly, the staff considers RAI 25, Questions 02.04.02-1 and 02.04.02-2, resolved.

The staff reviewed the description of methods used to determine the PMF as described in the SSAR, and summarized above to ensure that the methods and procedures used were reasonable and adequate. Although the staff noted that some of the model versions used had been superseded by newer versions, these changes were not significant in the ESP analysis based on the staff's independent analysis using the current model versions. Additionally, although the overall resolution of the applicant's basin model was somewhat coarse (e.g., using daily mean discharges rather than 15-minute intervals, daily mean precipitation rather than 15-minute intervals, and large time step intervals compared to the lag times for a majority of the subbasins), the staff recognizes that these assumptions are needed given the large area the model encompasses and associated computational limitations. The staff finds that the modeling conducted by the applicant was adequate for obtaining an appropriately conservative representation of flows resulting from postulated events.

The staff agreed that PMF associated with combinatory events considered by the applicant is appropriate for the PSEG Site. Based on a review of the applicant's information in the SSAR, the staff finds that the applicant has appropriately considered flood-causing phenomena related to the PMF on streams and rivers for the PSEG Site.

2.4.3.4.4 Effects of Sedimentation Erosion and Deposition

Information Submitted by the Applicant

Based on extensive HCGS operating experience at the adjacent HCGS intake structure, and HEC-RAS simulations performed by the applicant, sediment deposition in the vicinity of the intake structure will not result in significant accumulations nor impact SSCs. The applicant will monitor and maintain the intake structure to mitigate any sedimentation effects.

The Staff's Technical Evaluation

The information provided by the applicant is considered to be sufficient to demonstrate that the effect of sediment deposition is negligible. Considering the extensive HGS operating experience and staff's review of the HEC-RAS modeling simulations, the staff considers the applicant's evaluation of sediment deposition adequate.

2.4.3.5 Post Early Site Permit Activities

There are no post ESP activities for this section.

2.4.3.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the plant parameter envelope, and that there is no outstanding information required to be addressed in the SSAR related to this section.

As set forth above, the applicant has presented and substantiated information to establish the site description. The staff has reviewed the information provided and, for the reasons given above, concludes that the applicant has provided sufficient details about the site description to

allow the staff to evaluate, as documented in Section 2.4.3 herein, whether the applicant has met the relevant requirements of 10 CFR 52.17(a)(1) and 10 CFR Part 100 with respect to determining the acceptability of the site. In conclusion, the applicant has provided sufficient information for satisfying the requirements of 10 CFR Part 52 and 10 CFR Part 100.

2.4.4 Potential Dam Failures

2.4.4.1 Introduction

SSAR Section 2.4.4 addresses potential dam failures to ensure that any potential hazard to safety-related structures due to failure of onsite, upstream, and downstream water control structures is considered in the plant design.

Section 2.4.4 herein presents a review of the specific areas related to dam failures. The specific areas of review are as follows: (1) flood waves resulting from severe dam breaching or failure, including those due to hydrologic failure, routed to the site and the resulting highest water surface elevation that may result in the flooding of SSCs important to safety; (2) failures of dams in the path to the plant site caused by the failure of upstream dams due to earthquakes and the effect of the highest water surface elevation at the site under the failure conditions; (3) dynamic effects of dam failure-induced flood waves on SSCs important to safety; (4) effects of sediment deposition or erosion during dam failure-induced flood waves that may result in blockage or loss of function of SSCs important to safety; and (5) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.4.2 Summary of Application

In SSAR Section 2.4.4, the applicant addresses the site-specific information on potential dam failures. There are no dams downstream of the PSEG Site nor are there any dams on the main stem of the Delaware River. Therefore, downstream dam failures and cascading dam failures were not considered in the applicant's analyses. No safety-related water control structures will be constructed on the site; therefore, failure-induced flooding of onsite water control or storage structures is not considered. In summary, the areas for review consideration include flood waves from severe breaching of upstream dams, simultaneous dam failures, and effects of sediment deposition.

2.4.4.3 Regulatory Basis

The relevant requirements of NRC regulations for the identification of floods, flood design considerations, and potential dam failures, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.4.4.

The applicable regulatory requirements for identifying the effects of dam failures are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirements to consider physical site characteristics in site evaluations are specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The staff also used the appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG-0800, Section 2.4.4:

- RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, "Seismic Design Classification," as it relates to those SSCs intended to protect against the effects of flooding.

- RG 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, "Flood Protection for Nuclear Power Plants," as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.4.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.4. The staff confirmed that the applicant addressed the relevant information related to the flood elevation site characteristics associated with the most severe plausible dam failure event. The staff's technical review of this application included an independent review of the applicant's information in the SSAR. The staff supplemented this information with other publicly available sources of data.

2.4.4.4.1 Dam Failure Permutations

Information Submitted by the Applicant

The applicant observed that there are no dams on the main stem of the Delaware River either up- or down- stream of the PSEG Site. Therefore, the site or water supplies will not be affected by Delaware River dam failures. The applicant identified 24 reservoirs used for water supply, flood control, flow augmentation, and hydropower on Delaware River tributaries (DRBC, 2008). The USACE National Inventory of Dams (NID) database was used to obtain information on dam and reservoir characteristics. Selected groupings of these reservoirs based on storage volume and distance from the PSEG Site were used for the dam breach modeling combinations.

To calculate maximum water level, peak flows and velocities due to postulated dam failure, the applicant used dam breach flows calculated by HEC-HMS (USACE, http://www.hec.usace.army.mil/software/hec-hms/) coupled with NOAA bathymetry data and USGS topography information for the Delaware River, tributaries and associated flood plains as input to HEC-RAS to calculate water levels and flow velocities. The resulting high water level at the PSEG Site was the basis for calculating wave runup for the 2-year wind speed in the critical direction. The flow velocities were used in the calculation of sediment deposition to evaluate the

potential effects on the safety-related intake structure. The applicant applied the dam breach analysis based on the approach described in Section 9.2.1.2 of ANSI/ANS-2.8-1992, "Seismic Dam Failures," and RG 1.59 for combined events criteria associated with dam failure modeling.

To incorporate tidal influences of the Delaware River at the PSEG Site, a 10 percent high tide exceedance was included in the analyses. In summary, the applicant's analyses were developed considering the following:

- A downstream boundary condition of 10 percent high tide exceedance
- Multiple dam failure peak flows reaching the site simultaneously at high tide
- Full reservoirs at the time of dam breach
- Instantaneous dam failure due to a seismic event

Due to the large areal extent of the Delaware River basin and the spatially variable distributions of dams on its tributaries, the applicant developed permutations of dam failures to evaluate estimated flooding at the PSEG Site. The permutations were based on the largest volumes of water stored and the distance from the PSEG Site. The permutations included the four scenarios in Table 2.4.4-1 below.

Table 2.4.4-1 Summary of Tributary Dam Failure Output Data Excluding Tidal Effects

Name of Dam/ Reservoir	Failure Scenario	Maximum Discharge at Breach (per second)	Discharge at PSEG Site (per second)	Maximum Water Surface at PSEG Site (NAVD88)	Time from Failure to Peak Discharge (days:hours:min)
Pepacton Reservoir	1	7,590,000 ft3 214,925 m3	839,000 ft3 23,758 m3	0.80 ft 0.24 m	09:22:00
Cannonsville Reservoir		6,530,000 ft3 184,909 m3			
Lake Wallenpaupack	2	1,080,000 ft3 30,582 m3	721,000 ft3 20,416 m3	0.60 ft 0.18 m	09:21:00
Neversink Reservoir		1,790,000 ft3 50,687 m3			
F.E. Walter Reservoir	3	2,210,000 ft3 62,580 m3	686,000 ft3 19,425 m3	0.6 ft 0.18 m	09:22:00
Beltzville Reservoir		1,120,000 ft3 31,715 m3			
Nockamixon Reservoir		455,000 ft3 12,884 m3			
Blue Marsh Reservoir	4	1,070,000 ft3 30,299 m3	634,000 ft3 17,953 m3	0.50 ft 0.15 m	09:18:00
Marsh Creek Reservoir		214,000 ft3 6,060 m3			
Springton Reservoir (Geist Dam)		113,000 ft3 3,200 m3			
Edgar Hoopes Reservoir		51,600 ft3 1,461 m3			

Excluding tidal effects, the maximum change in water level of the dam failure scenarios results in an increase in surface-water levels of less than .31 m (1 ft) at the PSEG Site inclusive of the

500-year flood. When tidal effects and wind waves are added, the maximum flood elevation does not exceed 2.87 m (9.4 ft) NAVD88. This scenario includes 10 percent high tide exceedance (1.37 m (4.5 ft) NAVD88) coincident with the 500-year flood (0.61 m (2.0 ft)), the combined dam failures of Pepacton and Cannonsville reservoirs (0.09 m (0.3 ft)), and the 2-year wind speed in the critical direction (0.79 m (2.6 ft)).

The applicant evaluated suspended sediment accumulation that could affect the operation of the intake structure for the new plant. For the evaluation, the closest reservoirs to the PSEG Site, (Hoopes and Marsh Creek Reservoirs at RM 37 and 53, respectively), were chosen representing 125 years of sediment build-up even though the reservoirs are less than 78 years old. Sediment characteristics were based on soil types with settling velocities determined by Stoke's Law (Lamb, 1994). Based on the simulations, an average of 12.7 cm (5 in.) of sediment build-up results with less occurring at the area of the intake structure at the PSEG Site.

The Staff's Technical Evaluation

In SSAR Section 2.4.4 and as summarized above, the staff reviewed the description of methods used to determine the effects of dam breach to assure that the methods and procedures used were adequate and reflect current and acceptable methods.

In RAI 26, Question 02.04.04-1, the staff requested that the applicant provide more information on sediment deposition conclusions reached in the SSAR. In a June 9, 2011, response, the applicant detailed the description of the analysis, which the staff found adequate. The staff ran confirmatory modeling of the four dam breach scenarios using the input and output file information from the applicant's June 23, 2011, response to RAI 25, Question 02.04.01-1. The staff finds that the modeling conducted by the applicant was adequate for obtaining an appropriately reasonable characterization of the effects of the dam breach scenarios. Accordingly, the staff considers RAI 26, Question 02.04.04-1 resolved.

In RAI 26, Question 02.04.04-2, the staff requested that the applicant provide additional information concerning the timing of potential coincident flood waves arriving at the site and the corresponding conceptualization of the flood wave characterization. In a June 9, 2011, response, the applicant provided the requested information and committed to update SSAR Section 2.4.4.1 to note the conservatism used in the analysis. The staff finds the applicant's response adequate, and confirmed that the committed updates were included in SSAR Revision 1 (May 21, 2012). Accordingly, the staff considers RAI 26, Question 02.04.04-2 resolved.

2.4.4.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.4.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the PPE, and that there is no outstanding information required to be addressed in the SSAR related to this section.

As set forth above, the applicant has provided sufficient information pertaining to dam failures. Therefore, the staff concludes that the applicant has met the requirements 10 CFR 52.17(a), 10 CFR 100.20(c), and 10 CFR 100.23(c) relating to dam failures. Further, the applicant has considered the most severe 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.

2.4.5 Probable Maximum Surge and Seiche Flooding

2.4.5.1 Introduction

This section of the SSAR addresses the probable maximum surge and seiche flooding to ensure that any potential hazard to the safety-related SSCs at the proposed site has been considered in compliance with NRC regulations.

This section presents the evaluation of the following topics based on data provided by the applicant in the SSAR and information available from other sources: (1) probable maximum hurricane (PMH) that causes the probable maximum surge as it approaches the site along a critical path at an optimum rate of movement; (2) probable maximum wind storm (PMWS) from a hypothetical extratropical cyclone or a moving squall line that approaches the site along a critical path at an optimum rate of movement; (3) a seiche near the site and the potential for seiche wave oscillations at the natural periodicity of a water body that may affect the elevations of the floodwater surface near the site or cause a low water-surface elevation affecting safety-related water supplies; (4) wind-induced wave runup under PMH or PMWS winds; (5) effects of sediment erosion and deposition during a storm surge and seiche-induced waves that may result in blockage or loss of function of SSCs important to safety; (6) the potential effects of seismic and non-seismic information on the postulated design bases and how they relate to a surge and seiche in the vicinity of the site and the site region; and (7) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts of 10 CFR Part 52.

2.4.5.2 Summary of Application

This section addresses the information related to probable maximum surge and seiche flooding in terms of impacts on structures and water supply.

2.4.5.3 Regulatory Basis

The relevant requirements of NRC regulations for the effects of probable maximum storm surge (PMSS), and the associated acceptance criteria, are specified in NUREG-0800, Section 2.4.5.

The applicable regulatory requirements for identifying surge and seiche hazards, design considerations, and the associated acceptance criteria, are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d)(3), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The staff also used appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG-0800, Section 2.4.5:

- RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to those SSCs intended to protect against the effects of flooding or those associated with the Makeup Water Intake Structure (MWIS).

- RG 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, "Flood Protection for Nuclear Power Plants," as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.5.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.5. The staff's review confirmed that the information in the application addresses the probable maximum surge and seiche flooding. The staff's technical review of this section includes an independent review of the applicant's information in the SSAR and in the responses to the RAIs.

This section describes the staff's evaluation of the technical information presented in the SSAR Section 2.4.5.

2.4.5.4.1 Methodology

<u>Information Submitted by the Applicant</u>

In SSAR Section 2.4.5, the applicant determined the PMH storm surge still water level by combining the effects of surge at the open Atlantic coast coincident with the 10 percent exceedance high tide. That surge plus tide is propagated through Delaware Bay to the new plant location; and the effects of wind setup resulting from wind stress over Delaware Bay are superimposed, by addition, on the propagated storm surge. The applicant's overall approach uses the following methods and analysis.

- One-dimensional (1D) Bodine method to determine storm surge at the open coast using PMH parameters from NOAA's Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Windfields National Weather Service Technical Report NWS-23 (NWS-23) coincident with the 10 percent exceedance high tide.

- HEC-RAS analysis to propagate that surge through Delaware Bay to the site. The approach uses Bodine surge hydrograph as the stage boundary condition at RM 0 and discharge hydrographs generated by HEC-HMS for the Delaware River at Trenton and its major downstream tributaries. The approach includes effects of hurricane-associated precipitation.

- Kamphuis method to determine wind setup at the site caused by winds blowing over the Delaware Bay using PMH parameters from NWS-23.

- NOAA two-dimensional (2D) SLOSH (Sea, Lake, and Overland Surges from Hurricanes) Display Program (Version. 1.61g) data for comparison with Bodine model results at the open coast. The approach uses a Category 4 hurricane. The approach does not model effects from river flow, sea-level rise and 10 percent exceedance high tide included in the still water level (SWL) calculation.
- 2D ADCIRC+SWAN Models to determine final design basis flood PMSS.

The Staff's Technical Evaluation

The staff determined through independent confirmatory analysis that PSEG's application of PMH storm parameters as input in the SLOSH model produces water surface elevations that exceed the publicly available SLOSH Display Program (V. 1. 61 g) data for Category 4 storms in the PSEG Site area. In RAI 67, Question 02.04.05-12, the staff requested that the applicant provide an analysis of the PMH events using a conservative, current practice approach such as those predicted by a 2D storm surge model (e.g., ADCIRC, FVCOM, SLOSH, other) with input from appropriate PMH scenarios and with resolution that captures the nuances of the bathymetry and topography near the project site. In a November 27, 2013, response to RAI 67, Question 02.04.05-12, the applicant submitted a 2D probabilistic storm surge analysis (PSSA) using the ADCIRC (ADvanced CIRCulation) storm surge model driven by hurricanes determined by the Joint Probability Method with Optimal Sampling (JPM-OS). The staff conducted a public telephone conference with the applicant on January 8, 2014, to clarify an apparent inconsistency in the low water level description in SSAR Sections 2.4.5 and 2.4.11, which the applicant committed to address by modifying these two SSAR Sections. During this teleconference, the staff also asked a series of questions regarding the applicant's use of the PSSA for a revised storm surge analysis, which is the first application of the methodology for evaluating flood hazard at a U.S. nuclear power plant site. The staff asked questions regarding models and parameters as well as interpretation of the applicant's results in light of the use of both deterministic and probabilistic models, treatment of epistemic and aleatory uncertainty in the probabilistic models, and the basis and implication of the selected discretization scheme for the JPM-OS integration. Lastly, the staff discussed the need for a regulatory audit in order to gain an in-depth understanding of the overall approach used, modeling assumptions, and results of the storm surge analysis before making safety conclusions concerning the characteristics and assessment of storm surge flooding at the PSEG Site.

From February 4 to 6, 2014, the staff conducted a regulatory audit involving SSAR Section 2.4, "Hydrology," of the application. On March 5, 2014, the staff informed the applicant of significant issues involving the PSSA and corresponding documentation. On April 30, 2014, the applicant requested an exemption from completing the storm surge flood analysis until the COL stage. On June 10, 2014, the staff held a public meeting at the applicant's request, to discuss the bases and rational of the exemption request. During the meeting, the staff suggested that the applicant perform additional 2D deterministic calculations to compare with the original one dimensional (1D) storm analysis to reach a conclusion on the conservatism of the flooding height determination. On June 17, 2014, the staff issued a letter to the applicant denying the exemption request based on the staff's determination that its bases in support of describing special circumstances, as required by regulations, were insufficient to grant the exemption.

On July 10, 2014, the staff held a public meeting at the applicant's request to discuss its approach to a revised response to RAI 67, Questions 02.04.05-12 through 02.04.05-17. The applicant provided an overview of the 2D deterministic ADCIRC storm surge calculations and

comparison with the original 1D Bodine calculations in order to establish that the latter produced a more conservative flooding height. During the meeting, the staff provided detailed feedback regarding potential or actual gaps in the applicant's approach. On July 17, 2014, the applicant submitted a response to the staff's June 17, 2014, exemption denial letter. In this letter, the applicant included a schedule for the revised response to RAI 67, Questions 02.04.05-12 through 02.04.05-17.

On August 14, 2014, the staff held a public meeting at the applicant's request to discuss its completed storm surge revised analysis results and the SSAR markups in conjunction with the application review. In an August 21, 2014, letter, the applicant provided a revised response to RAI 67, Questions 02.04.5-12 through 02.04.5-17, which are discussed in the following sections. The applicant's response to RAI 67, Questions 02.04.05-12 and 02.04.05-15 included a regulatory commitment which will result in revisions to the SSAR and Environmental Report (ER). The staff has identified these revisions to the SSAR as Confirmatory Item 2.4-1. The applicant provided the following revised methodology:

- The replacement of the November 2013 PSSA analysis with original storm surge analysis based on the PMH storm (NWS23) model with the 1D Bodine storm surge model, coupled with HEC-RAS and wind setup model of Kamphuis.

- The use of a deterministic 2D storm surge analysis using ADCIRC+SWAN (Simulating WAves Nearshore) to provide data for comparison with 1D Bodine model results.

On April 06, 2015, the staff held a public meeting to discuss the staff's evaluation of the applicant's August 21, 2014, revised response to RAI 67. During the meeting, the staff pointed out that the applicant's statement in the RAI response regarding flood protection to safety-related SSCs did not provide a sufficient level of detail for the staff to develop a permit condition to require such flood protection. The applicant stated that they used the PPE approach and until a reactor technology is selected, details on flood protection cannot be available. Instead, the applicant discussed their approach to the completed storm surge revised analysis as well as the results, in particular the 2D deterministic results, the associated SSAR markups submitted with the August 21, 2014, RAI response, and their plan to submit a supplement to the RAI response by April 15, 2015. The applicant stated that SSAR Section 2.4.5 will be revised to describe the use of a 2D model to define the design basis water surface elevation level (WSEL), and the narratives in Subsections 2.4.5.5 and 2.4.5.6 will be revised to emphasize the use of the already applied ADCIRC+SWAN model as a refined modeling approach. The applicant further stated that their PMH Simulation #2 with antecedent WSEL set to projected sea level rise of 0.41 m (1.35 ft) is used to produce the design basis total WSEL of 32.1 ft. NAVD88, and appropriate areas of SSAR Section 2.4 will be updated to show a design basis total WSEL of 9.78 m (32.1 ft) NAVD88. In addition, the applicant stated that the site grade elevation (11.25 m (36.9 ft)) NAVD88) will be established at a level providing for adequate clearance above the design basis flood based on the PPE. The applicant also stated that in the supplement, they will highlight that their Bodine/HEC-RAS/Kamphuis screening process based on NWS 23 is maintained, the description of the Bodine/HEC-RAS/Kamphuis/ CEM model is retained, and a high resolution ADCIRC+SWAN model has been used to perform a refined analysis of the selected PMH storm, establishing design basis flood level of 9.78 m (32.1 ft) NAVD88.

Subsequently, on April 15, 2015, the applicant supplemented their revised August 21, 2014, response to RAI 67. The applicant stated that the design basis Water Surface Elevation

(WSEL), as provided in their August 21, 2014, revised response to RAI 67, was established using a 1D model, and that the results from the use of this model are considered unrealistically conservative. In addition, the applicant stated that their deterministic analysis using a 2D, high-resolution storm surge model, submitted on August 21, 2014, provides a conservative, yet more realistic, design basis WSEL. The applicant affirmed that the supplemental response revises the SSAR to credit the results from the high-resolution storm surge model to establish the design basis flood level for the PSEG Site. The applicant provided the following revised hierarchical hazard approach (HHA) methodology:

- 1D Bodine storm surge model, coupled with HEC-RAS and wind setup model of Kamphuis used as a sensitivity analysis and screening method to determine the PMH parameters for the development of the PMSS.

- 2D ADCIRC+SWAN model simulations of the screened PMH parameters in conjunction with Coastal Engineering Manual (CEM) wave runup equations used to determine PMSS design basis flood level.

In the supplemental response, the applicant also provided changes to the SSAR. The staff reviewed the applicant's supplemental information including changes to the SSAR. The staff's evaluation of the applicant's supplemental information involving the 1D and the 2D deterministic analyses, comparison of the results from these analyses, and the applicant's selection of one of their 2D storm surge values as the DBF, is described in the following sections, including the staff's conclusion in Section 2.4.5.6 of this report. The applicant included a regulatory commitment to incorporate the SSAR changes in the next revision of the ESP application. The staff has identified this commitment as Confirmatory Item 2.4-2. The staff verified that in Revision 4 to the PSEG Site ESP application (June 5, 2015), the applicant incorporated the committed changes indetified in Confirmatory Item 2.4-1 and Confirmatory Item 2.4-2. Therefore, the staff considers these Confirmatory Items closed.

2.4.5.4.2 Probable Maximum Winds and Associated Meteorological Parameters

Information Submitted by the Applicant

In SSAR Section 2.4.5.1, the applicant described the PMWS and associated meteorological parameters. The development process for the PMWS applies guidance and data from the NOAA NWS 23 report (1979). The applicant presents the development of the PMWS and associated meteorological parameters in SSAR Section 2.4.5.1.1. The development of the PMWS applies guidance and data from the Dover, DE, weather station. A summary of the applicant's PMH parameters is provided in the table below:

Table 2.4.5-1 ESP Applicant's Probable Maximum Hurricane Parameter Values

Parameter, units	Symbol	Range/Value
Peripheral Pressure, cm (in. of Hg) (mb)	P_w	76.50 (30.12) (1019.98)
Central Pressure, cm (in. of Hg) (mb)	P_o	67.69 (26.65) (902.47)
Radius of Maximum Winds, km (nautical miles, NM)	R	20.4 to 51.9 (11,20 and 28)
Forward Speed, km/hr (knots, kt)	T	48.1 to 77.8 (26, 34 and 42)
Hg = mercury; in. of Hg = one-thirtieth of atmospheric pressure (e.g., 0.49 psia).		

Pressure Drop, ΔP = 3.5 in. of Hg (118.5 mb)

SSAR Section 2.4.5.1 documents that the PMH, as defined by NOAA's, "Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Windfields," National Weather Service Technical Report NWS 23, represents the PMWS at the PSEG Site. As defined by NOAA, the applicant states that the PMH may exhibit a range of meteorological characteristics, so preliminary screening level calculations are performed that identify the PMH bounding characteristics that produce the PMSS at the new plant location. A PMH with R = 51.9 km (28 NM (nautical miles)), T = 29.9 mph (26 kt (knots)), and track direction, from 138 degrees (moving northwest) is used by the applicant to specify the PMWS at the site location. The maximum sustained winds over the ocean are calculated by the applicant to be 145 mph (126 kt); while the maximum winds over Delaware Bay are 145 mph (126 kt), and maximum winds at the new plant location are 133.5 mph (116 kt). Thus, the applicant's PMH is a relatively strong Category 4 hurricane by the Saffir-Simpson hurricane scale.

To verify that the PMH is the PMWS for the PSEG Site, the applicant averaged the winds at Dover to over 4 hours, a sufficient duration to cause wind setup of Delaware Bay, based on the observations summarized in SSAR Section 2.4.5.1.1. The applicant's analysis shows that 4-hour average winds parallel to the long axis of Delaware Bay did not exceed 35 mph (30 kt) at Dover. The applicant states that the overwater winds are expected to be 57.5 mph (50 kt) when overland winds are 34.5 mph (30 kt) (NOAA/NWS, 1979). Therefore, winds of sufficient duration to cause wind setup or seiche did not exceed 57.5 mph (50 kt) over Delaware Bay during the period of 1978 through 2008 (e.g., climatological period use by NWS-23). By comparison, the wind speeds associated with the PMH are 145 mph (126 kt) over Delaware Bay. Therefore, the applicant states that the PMH represents the PMWS for the PSEG Site.

The applicant concluded SSAR Section 2.4.5.1 with a discussion of the appropriateness of using NWS 23. The applicant stated that the PMH parameters in NWS 23 are based on historical data for hurricanes making landfall on the U.S. coasts between 1851 and 1975, and that comparisons of hurricane climatology during the period evaluated in NWS 23 indicate that the NWS 23 parameters for the PMH are still applicable. NOAA published a technical memorandum (NOAA/NWS, 2007) analyzing the number and strength of hurricane strikes by decade and location in the United States. The applicant stated that, according to this publication, on average, a Category 4 or stronger hurricane hits the United States once every 7 years. However, in the 35 years from 1970 to 2005, only three Category 4 or larger hurricanes have reached the U.S., which is less than the expected number of 5 in 35 years. Based on this information, the applicant stated that it is reasonable to conclude that the number and strength of hurricanes since NWS 23 was published are not greater than those of hurricanes prior to 1975. The NWS 23 climatological data set includes the relatively active period of 1945 through 1970. Therefore, the applicant concluded that the meteorological criteria for hurricanes affecting the gulf and east coasts of the United States, described in NWS 23, are conservative, even considering potential future climatic variability.

The Staff's Technical Evaluation

The staff evaluated the applicant's PMWS calculations as presented in SSAR Section 2.4.5.1. The applicant's development of the PMWS follows the relevant regulatory criteria. The staff verified the project location and meteorological parameters — central pressure, pressure drop, radius to maximum winds, forward speed, coefficient related to the density of air, and track direction — with the tables and figures provided in NOAA NWS 23. The staff confirmed the track orientation relative to the near shore bathymetric contours through a review of bathymetric contour figures presented during the site audit. However, the SSAR Section 2.4.5.1 did not

contain enough information to ensure proper development and evaluation of wind speeds from the PMH storm parameters.

SSAR Section 2.4.5.1 contains statements about maximum storm surge resulting from selected PMH storm parameters; however, evaluation of the influence of different parameters is not possible without a table of results. Therefore, in RAI 39, Question 02.04.05-1, the staff requested that the applicant provide a table of wind speeds developed from the PMH meteorological parameters given in SSAR Section 2.4.5. In a November 22, 2011, response, the applicant provided an acceptable table of speeds based on the PMH meteorological parameters. Accordingly, the staff considers RAI 39, Question 02.04.05-1 resolved.

The staff reviewed the applicant's wind stress coefficient values specified in the Bodine (1971) model and report (Equation 9a). Based on the staff's review of values applied by other recent coastal storm surge studies for the Federal Emergency Management Agency (FEMA), the applicant's value of 3.3×10^{-6} seems reasonable. However, SSAR Section 2.4.5.1 contains no sensitivity results to demonstrate how the applicant's capping the maximum wind drag coefficient influences the final surge values from the Bodine model. Therefore, in RAI 39, Question 02.04.05-3, the staff requested that the applicant provide results of sensitivity testing undertaken to evaluate the effect of modifying the default wind drag coefficient in the Bodine storm surge model. In a December 9, 2011, response, the applicant provided a sensitivity study of wind drag coefficients in the Bodine model, which the staff finds adequate. Accordingly, the staff considers RAI 39, Question 02.04.05-3 resolved.

The staff evaluated the applicant's analyses completed for the PMWS calculations as presented in SSAR Section 2.4.5.1.1. The staff verified the relevant proximity of Dover to the proposed project site. The staff questioned the appropriateness of applying a 31-year measured wind speed record to develop the PMWS condition. The 31-year record may prove sufficient to extrapolate wind speeds at higher return periods. However, with an undefined return period for the PMH, extrapolation of measured wind speeds and comparison to PMH values has challenges. The staff reviewed the applicant's procedure used to develop the overwater wind speed and agrees that the PMH represents the PMWS for the proposed project site.

2.4.5.4.3 Antecedent Water Level

<u>Information Submitted by the Applicant</u>

The applicant used the maximum monthly high tide values from 1987 through 2008 to analyze the NOAA tidal gauge stations upstream and downstream from the PSEG Site to determine the 10 percent exceedance high tide at the site (NOAA, http://tidesandcurrents.noaa.gov/station_retrieve.shtml?type=Historic%20Tide%20Data&state=Delaware&id1=855). The applicant stated that this approach for estimating 10 percent exceedance high tide, based on recorded tides, intrinsically includes the effects of sea level anomaly (also known as initial rise). In addition, ANSI/ANS-2.8-1992, Section 7.3.1.1.2, concludes sea level anomaly need not be included when 10 percent exceedance high tide is based on recorded tides. Therefore, sea level anomaly is not included in the applicant's analysis because recorded tide data is used to calculate the 10 percent exceedance high tide.

The applicant's analysis calculates a 10 percent exceedance high tide of 1.3 m (4.3 ft) NAVD88 at the Lewes, DE, NOAA tidal gauge (8557380) at RM 0, and 1.4 m (4.6 ft) NAVD88 for the Reedy Point, DE, NOAA tidal gauge (8551910) at RM 59. Based on these values, the applicant

calculated a 10 percent exceedance high tide at the new plant location at RM 52 is determined by linear interpolation to be 1.37 m (4.5 ft) NAVD88.

The applicant briefly discusses the methodology to determine sea level trends near the proposed project site in SSAR Section 2.4.5.4. The applicant used the trend of sea level at the tide gauge with the nearer location to the PSEG Site—the NOAA Reedy Point tidal gauge station. The applicant stated that measurements at any given tide station include both global sea level rise and vertical land motion, such as subsidence, glacial rebound, or large-scale tectonic motion. The applicant's analysis of the NOAA Reedy Point tidal gauge station determined that a monthly sea level trend based on monthly mean sea level data from 1956 through 2006 is 0.35 m (1.14 ft)/century, with an upper 95 percent confidence limit of 0.41 m (1.35 ft)/century (NOAA, http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8551910). Thus, the maximum flood level determined by the applicant at the new plant location includes 0.41 m (1.35 ft) to conservatively account for sea level rise over the projected 60-year lifespan of the new plant.

The Staff's Technical Evaluation

The staff reviewed the applicant's work outlined in SSAR Section 2.4.5.2.2.1 that details the estimation of the 10 percent exceedance high tide required as part of the maximum storm surge evaluation. The 10 percent exceedance high tide value of 1.37 m (4.5 ft) NAVD88 at the proposed project site provides a reasonable value. The USACE Shore Protection Manual (SPM) (1984) contains an analysis of the tide record at Lewes, DE. The SPM analysis indicates that the SSAR Section 2.4.5.2.2.1 value for the 10 percent exceedance high tide of 1.37 m (4.5 ft) NAVD88 provides a conservative estimate. The staff also reviewed the Reedy Point tidal gauge station data and analysis developed by NOAA, and located at: http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8551910. The staff verified that the tide data and analysis match the values contained in SSAR Section 2.4.5.4.

The staff reviewed the Intergovernmental Panel on Climate Change (IPCC) (2007) sea level rise estimates. IPCC (2007) Synthesis Report Table 3.1 provides estimates for sea level change by 2100 for different scenarios with a minimum low-end value near 0.2 m (0.66 ft) and a maximum high-end value near 0.6 m (1.97 ft). Given that IPCC values apply for a 93-year period (2007 to 2100), a 60-year horizon and a linear increase in sea level rise would produce low-end and high-end changes of 0.13 m (0.43 ft) and 0.40 m (1.3 ft). Given the review of the NOAA tidal station data and the IPCC report plots, the sea level change value applied by the applicant (0.41 m (1.35 ft) over 60 years) provides a reasonable estimate.

2.4.5.4.4 Surge Water Levels at the Open Coast

Information Submitted by the Applicant

The applicant's review of historical surges near the PSEG Site determined that Hurricane Hazel and the Chesapeake-Potomac hurricane produced the maximum historical storm surges recorded in Delaware Bay. Of these, the Chesapeake-Potomac hurricane storm center passed closer to the PSEG Site, exhibiting a northwesterly track most similar to the hypothetical storm track of the PMH (NOAA/NWS, 1979 and NOAA, 1987). Based on the storm track and adequate available data related to this storm, the applicant selected the Chesapeake-Potomac hurricane of August 1933 to validate the storm surge model used to determine the PMSS.

The storm surge water levels determined by the Bodine method are used by the applicant as a stage boundary (at the open coast) condition at the mouth of Delaware Bay for the HEC-RAS simulation within the Delaware River estuary. The applicant inputs the PMH identified in SSAR Section 2.4.5.1 into the Bodine calculations which results in a maximum surge elevation of 6.37 m (20.9 ft) NAVD88 at the mouth of Delaware Bay. The applicant value included a fluctuating tide at the mouth of the bay that generates the 10 percent exceedance high tide at the PSEG Site coincident with the peak storm surge.

The applicant validated the Bodine model methodology by reproducing the surge observed during the Chesapeake-Potomac hurricane of 1933. The applicant's pressure distribution and winds associated with this storm are specified as described by Bretschneider (Bretschneider, 1959) and NOAA (NOAA, 1992). The Bretschneider method reports maximum sustained winds over the ocean of 50 kt (58 mph), and maximum sustained winds over Delaware Bay of 43 kt (50 mph). The simulated storm exhibits maximum winds of 56 kt (64 mph) over the ocean, and 41 kt (47 mph) over Delaware Bay, similar to the wind speeds reported for the Chesapeake-Potomac hurricane.

The applicant's comparison of the Bodine model results with the actual response to the Chesapeake-Potomac hurricane is expressed as storm surge, the difference between actual water levels and the predicted astronomical tide level. The applicant stated that the storm surge calculated at the mouth of Delaware Bay, using the Bodine method, reproduces the observed surge as described by Bretschneider (Bretschneider, 1959). For example, the applicant's peak storm surge result at Reedy Point, DE, is calculated to be 2.4 m (7.9 ft), while the observed surge at Reedy Point was 2.35 m (7.71 ft). The applicant stated that this margin of error is consistent with comparable models, such as NOAA's SLOSH model which has a stated margin of error of plus or minus 20 percent (NOAA, 1992).

The Staff's Technical Evaluation

Historical Surges

The staff reviewed the applicant's information on the significant historical surge events near the proposed plant site. The Bretschneider (1959) report provides a thorough historical account of the Chesapeake-Potomac hurricane characteristics and surge levels. Without another significant storm to provide an extensive and accurate measured surge data set, the Chesapeake-Potomac hurricane provides the best available validation storm. Notably, the Chesapeake-Potomac hurricane surge at the project site equals approximately 30 percent of the PMH surge at the project site, specifically 2.44 m versus 8.14 m (8 ft versus 26.7 ft). The large difference between the applicant's validation storm and the PMH model surge values introduces some concern that processes that occur during a PMH-level surge event may not occur during lower surge events (such as the validation storm). Examples of different processes that may occur with very large surge levels include more flow over inundated inland areas and changes in the effects of bottom friction given the greater water depths of a PMH-level surge.

Bodine One-dimensional Surge Model

A staff evaluation of the influence of different applicant storm surge parameters is not possible without a table of storm surge parameters and surge level results. Therefore, in RAI 39, Question 02.04.05-2, the staff requested that the applicant provide a table of storm surge levels developed with the Bodine model for the different PMH meteorological parameter combinations given in SSAR Section 2.4.5. In addition, the staff requested that the applicant provide any

analyses that demonstrate the influence of varying track direction on surge levels at the open coast and project site. In a November 22, 2011, response to RAI 39, Question 02.04.05-2, the applicant provided an acceptable table of storm surge levels developed on the Bodine model and justification that varying track direction from that used in the analysis would produce the maximum surge at the site. Therefore, the staff considers RAI 39, Question 02.04.05-2 resolved.

The applicant applied a method to satisfy the combined events criteria specified in ANSI/ANS-2.8-1992, Section 9.2.2. The method combines the surge derived from the PMH storm with wind wave activity. The method specifies that the surge coincide with the 10 percent exceedance high tide level. Given the models applied for the study and their range of application and assumptions, the method requires combining results from several models. Specifically, the method requires combining results from models that (1) estimate the surge at the open ocean, (2) propagate the surge through the bay, and (3) determine the wind setup that occurs within the bay. The timing of the model simulation ensures that the 10 percent exceedance high tide coincides with the time of maximum surge at the proposed project site.

The staff reviewed the Bodine (1971) model report and the applicant's model development and application sections in the SSAR. ANSI/ANS-2.8-1992 cites the Bodine model as an acceptable methodology to develop storm surge estimates at the open coast. However, SSAR Section 2.4.5 did not provide enough detail to completely understand and evaluate the model application. Therefore, in RAI 39, Question 02.04.05-4, the staff requested that the applicant provide the Bodine model input files and information on boundary conditions applied in the modeling. In a December 9, 2011, response to RAI 39, Question 02.04.05-4, the applicant provided the Bodine model input files and information on boundary conditions applied in the modeling. Therefore, the staff considers RAI 39, Question 02.04.05-4 resolved.

2.4.5.4.5 Propagation of Surge through Delaware Bay

Information Submitted by the Applicant

The propagation of surge through Delaware Bay is calculated by the applicant using the HEC-RAS computer program. The HEC-RAS model is developed by the applicant using channel geometry and floodplain elevations for the Delaware River between Trenton, NJ, and the head of Delaware Bay determined from the Triangular Irregular Network (TIN) terrain model developed from the USGS National Elevation Dataset (NED) (USGS, http://seamless.usgs.gov/index.php) digital elevation model (DEM), and the NOAA Estuarine Bathymetry DEM (NOAA, http://egisws01.nos.noaa.gov/servlet/BuildPage?template=bathy.txt&parm1=M090&B1=Submit) The applicant calibrated the HEC-RAS model using observed tidal data. The calibrated model is then used by the applicant to simulate the propagation of the open coast surge from the mouth of Delaware Bay to the PSEG Site.

The upstream boundary conditions used as inputs to the applicant's HEC-RAS model, consisting of discharge of the Delaware River at Trenton, and discharge of tributaries downstream of Trenton, are based on a 2006 event to account for hurricane-related precipitation. The water levels determined by HEC-RAS, and winds defined by NOAA (NOAA/NWS, 1979) for the PMH, are then used by the applicant to determine wind setup at the PSEG Site. The applicant's combination of HEC-RAS surge, which includes the 10 percent exceedance high tide, and Kamphuis wind setup determines the PMH surge still water level at the PSEG Site.

The applicant stated that the effect of winds blowing over Delaware Bay, referred to as wind setup, is calculated using a standard method presented by Kamphuis (Kamphuis, 2000), and is added to the HEC-RAS simulated water levels. Wind setup depends on wind speed and direction over the center of Delaware Bay; a coefficient accounting for wind and bottom stress; and water depth. The applicant's winds over the center of Delaware Bay at model time step 20.5 hours are 120 kt (138 mph) from the south-southeast, and are determined in accordance with NWS 23 (NOAA/NWS, 1979). The applicant's stress coefficient is 3.3×10^{-6} (Bretschneider, 1959). The applicant stated that the cross-section average depth of water varies with the radius of maximum winds (RM) and time, and is determined from the HEC-RAS water levels and channel geometry. The calculated wind setup at time 20.5 hours is 4.27 m (14.0 ft) at the PSEG Site. The wind setup is added by the applicant to the HEC-RAS water level to determine the still water level: 8.19 m (26.86 ft) at 20.5 hours.

The applicant stated that Bretschneider (Bretschneider, 1959) determined that cross-wind effects on storm surge are virtually negligible (less than 3 percent) upstream of the head of Delaware Bay (upstream of RM 48), and reduces surge on the east side of the estuary at the new plant location (Bretschneider, 1959); therefore, neglecting cross-wind effects is conservative at the new plant location. The applicant stated that the wind setup algorithm of Kamphuis is a steady-state analytical solution of the fundamental equations governing hydrodynamics, which can be found in reference texts (USACE, 2002 and Bretschneider, 1966). Its primary assumption, that water levels exhibit a steady state response to varying winds, is considered conservative by the applicant because the bay does not respond to the winds instantaneously.

The Staff's Technical Evaluation

The staff reviewed the HEC-RAS model development and discussion sections in SSAR Section 2.4.5.2.2. HEC-RAS is a one-dimensional model and does not account for flow perpendicular to the primary longitudinal axis of Delaware Bay and estuary. The applicant stated that this limitation should not have a significant effect on the HEC-RAS model's ability to simulate either tide or storm surge at the proposed plant site.

HEC-RAS Model Upgrades

The applicant's November 22, 2011, response to RAI 39, Question 02.04.05-7 lists HEC-RAS model upgrades in Version 4.1 (V4.1) that are not found in Version 4.0 (V4.0) (applied in the SSAR analysis). The applicant's response also states that only two model corrections in V4.1 could affect results for analysis (related to bridge crossings). The staff's comparison of output for bridge crossing data developed with V4.1 and V4.0 of code indicate identical curves. However, the applicant did not conduct a model results comparison between more recent HEC-RAS versions and the model used for the SSAR. Instead, the applicant relied on the development of bridge curves with each model version and on documented differences between the versions. Therefore, in RAI 67, Question 02.04.05-17, the staff requested that the applicant provide a discussion of its V4.0 HEC-RAS model compared to the latest HEC-RAS model version to confirm that there is no effect to any of the HEC-RAS model results from recent software updates. In an August 21, 2014, response to RAI 67, Question 02.04.05-17, the applicant provided details of testing completed to understand differences in model results near the PSEG Site for HEC-RAS V4.0 and V4.1. The staff notes that the results presented in the RAI response demonstrate minimal differences in the river flow and WSEL at the PSEG Site when comparing HEC-RAS V4.0 and V4.1 results.

The staff review of the RAI response indicates the additional testing sufficiently answers the RAI request to confirm that there is no effect to any of the HEC-RAS model results from recent software updates. The comparison of HEC-RAS V4.0 and V4.1 demonstrates that recent software upgrades do not influence model results near the PSEG site. Therefore, the staff considers RAI 39, Question 02.04.05-17 resolved.

HEC-RAS Model Setup

The applicant's HEC-RAS modeling discussion did not provide sufficient detail to analyze the modeling approach and results. Therefore, in RAI 25, Question 02.04.01-1, the staff requested that the applicant provide the HEC-RAS model input files, model control files, calibration procedure, model version, and HEC-RAS modeling report. In a June 23, 2011, response to RAI 25, Question 02.04.01-1, the applicant provided the HEC-RAS model input files, model control files, calibration procedure, model version, and HEC-RAS modeling report. The staff finds that the information submitted by the applicant provided sufficient detail to analyze the modeling approach and results. Therefore, the staff considers RAI 39, Question 02.04.05-5 resolved. However, the staff had the following comments and observations.

- A staff review of the HEC-RAS geometry file and model setup (i.e., MASTER.g01) showed the roadways leading to the two bridges are not included in the model. The surge flow could have been partially blocked by the roadways. The applicant possibly used an ineffective flow scheme (HEC-RAS model ineffective flow area method).

- During a staff review of the unsteady HEC-RAS model (Delaware River Hydraulic Model) surge calibration run (Plan: Surge calibration 1933), the applicant's animation of the longitudinal water surface profile appeared to indicate model numerical instability during the simulation. The numerical instability occurred to a degree that could affect calibration and model prediction values.

- During a staff review of the unsteady HEC-RAS model (Delaware River Hydraulic Model) PMH surge run (Plan: PMH_R28_T26_25YR_FLD_DYNAMIC), the applicant's animation of the longitudinal water surface profile appears to indicate model numerical instability during the simulation. The instability, which occurs approximately 51.5 km (32 mi) from the PSEG Site, appears very pronounced just before the passing of the peak surge wave for the PMH surge run.

In RAI 67, Question 02.04.05-16, the staff requested that the applicant provide a discussion and justification for the applied HEC-RAS model setup. The staff also requested that the applicant describe any steps taken to minimize the model instabilities, and if steps were taken to reduce model instabilities, to describe how these steps affected the model calibration. In an August 21, 2014, response to RAI 67, Question 02.04.05-16, the applicant provided information related to questions concerning HEC-RAS model bridge approach embankments and model instabilities.

The response related to HEC-RAS model bridge approach embankments provided details of additional model simulations designed to evaluate different approaches to handle the bridge approach embankments within the model. The applicant modified the HEC-RAS model geometry file, which included the approximate bridge roadway approaches using estimates based on available information. The applicant then re-executed the PMH simulation in HEC-RAS and computed the resultant WSELs at the PSEG Site. The results indicated minimal changes in the flow rate and WSEL at three locations near the PSEG Site.

The response related to model instabilities provided a general discussion of the features within the model results and details of additional simulations performed to better understand the model features. The response stated that stability issues are not uncommon in unsteady flow analyses. The oscillating water level pointed out in the RAI is described as a perceived numerical instability. To better understand the significance of the water level oscillations, the applicant completed four additional model tests with each designed to evaluate the sensitivity of the model results to various parameters or model settings changed for the specific test.

The applicant made the following four sensitivity runs:

1. Adjust computational time step from 30 seconds to 5 seconds.

2. Set Theta coefficient = 1.0, (changed from 0.6 in PMH run). The Theta coefficient is a weighting factor applied in the model finite difference calculations.

3. Adjust Options and Tolerances, including keeping Theta = 1.0, increasing maximum number of warm up time steps from 20 to 40, and adjusting Theta during the warm up period from 0.6 to 1.0.

4. Add interpolated cross sections every 610 m (2,000 ft) from RM 56.8 to the most upstream cross section.

The model results indicate, as shown in Table RAI 67-16-2 of the August 21, 2014, response to RAI 67, Question 02.04.05-16, that the current PMH run in the unchanged HEC-RAS model generally produces the most conservative estimate, with the exception that the sensitivity run using a 5-second time step, which has the effect of increasing oscillations rather than decreasing, is 0.01 foot higher at RMs 50.36 and 52 (near the PSEG Site). Given the results, the applicant stated that the results show the current HEC-RAS model is appropriate for the PMH storm surge event and no changes to the HEC-RAS model or resultant water surface elevations are required.

Concerning the bridge geometry portion in RAI 67, Question 02.04.05 16, the staff requested that the applicant provide a discussion and justification for the model setup applied. The August 21, 2014, RAI response provided additional detail to justify the method applied and demonstrated how model results change, given an alternative model setup.

Concerning the model instability portion in RAI 67, Question 02.04.05-16, the staff requested that the applicant describe any steps taken to minimize the model instabilities and, if steps were taken to reduce model instabilities, describe how these steps affected the model results. The August 21, 2014, RAI response detailed four different analyses conducted to understand the instabilities, which occur approximately 51.5 km (32 mi) from the PSEG Site, and the influence of the instabilities on the water levels at the PSEG Site. The RAI response described the rationale and procedure of implementing the four different tests. The results indicated that the different parameter values in the four test cases induce only minimal changes in water level at the PSEG Site. The staff notes that this shows a lack of sensitivity of the WSEL at the PSEG Site to the parameter settings tested. The model results do not significantly alter the model instability signal that led to the RAI. Therefore, it remains unknown to the staff if, and by how much, the model instability affects the downstream water levels near the PSEG Site. However, given the explanations provided in the RAI response and the model results within the RAI response that indicate minimal WSEL changes at the PSEG Site for the four parameter

cases tested, the staff finds that the RAI response has sufficiently addressed the concern. Therefore, the staff considers RAI 67, Question 02.04.05-16 resolved.

HEC-RAS Water Levels

The staff reviewed the Bretschneider (1959) report and confirmed the report's statement that crosswind effects result in a water level change equal to about 3 percent of the total water level change caused by longitudinal (long-axis) effects. Notably, the counter-clockwise rotation of hurricane winds near the project site would cause a lowering of the water level on the east side of Delaware Bay and estuary (proposed plant location) as the PMH storm approaches from the sea. After the storm passes, easterly-directed winds could cause an increase in water levels at the proposed project site; however, the surge and wind vector timing must be analyzed to determine if maximum water level conditions would occur.

The staff reviewed the applicant's comparison of model results with observed water levels and surge for the Chesapeake-Potomac (1933) hurricane. SSAR Figure 2.4.5-3, "Comparison of Bodine Method and Observed WSEL in Delaware Bay for the Chesapeake-Potomac Hurricane," presents water level comparisons for the modeled and observed conditions at the mouth of Delaware Bay. SSAR Figure 2.4.5-4, "Comparison of Calculated and Observed Surge at Reedy Point, DE," presents water level comparisons for the modeled and observed conditions at Reedy Point, DE, and includes the tidal record.

In the discussion, the applicant stated that SSAR Figure 2.4.5-3 presents surge (i.e., excluding astronomical tide) comparisons; however, the figure labels designate water level comparisons. The applicant's discussion for the Reedy Point data presents surge level magnitudes of 2.41 m (7.9 ft) modeled, versus 2.34 m (7.7 ft) observed; however, the figure presents water level records and determination of the surge values that are unclear to the staff. The measured water level record at Reedy Point, DE indicates a higher water level than the simulated value for almost the entire storm. The applicant's statement that the simulated storm surge provides a conservative estimate is valid for only a short time period. The model is not conservative when applied to the total water level at the project site, as the observed peak water levels exceed those modeled (2.5 m (8.2 ft) versus 2.44 m (8.0 ft) NAVD88 at time 27 hours in SSAR Figure 2.4.5-4) at peak conditions. Therefore, in RAI 39, Question 02.04.05-6, the staff requested that the applicant provide additional discussion and verification of the development of water level records, including datum conversions, from the Bretschneider (1959) report. In addition, the staff requested that the applicant clarify the calculation of the storm surge from the observed water levels and tidal record at the Reedy Point, Delaware Station, in SSAR Figure 2.5.4-4, and to ensure that its model predictions are conservative. In a December 9, 2011, response to RAI 39, Question 02.04.05-6, the applicant provided the additional discussion and verification of the development of water level records, including datum conversions, from the Bretschneider (1959) report and clarified the calculation of the storm surge from the observed water levels and tidal record at the Reedy Point, DE Station in SSAR Figure 2.5.4-4. Therefore, the staff considers RAI 39, Question 02.04.05-6 resolved.

The staff evaluated the SSAR Section 2.4.5.2.2.3 discussion of the method to propagate the surge from the mouth of Delaware Bay to the proposed project site. The discussion explains that the applicant used observed tidal data to calibrate the HEC-RAS model. In RAI 39, Question 02.04.05-7, the staff requested that the applicant provide additional information on the testing done to confirm that execution of more recent HEC-RAS model versions (V4.1 released in early 2010) than applied in the SSAR did not result in significant changes to the HEC-RAS

model results. In a November 22, 2011, response to RAI 39, Question 02.04.05-7, the applicant provided the additional information on the testing done to confirm that execution of more recent HEC-RAS model versions (V4.1 released in early 2010) did not result in significant changes to the HEC-RAS model results. Therefore, the staff considers RAI 39, Question 02.04.05-7 resolved.

The staff discussed the rainfall event the applicant applied during the HEC-RAS modeling of the PMH surge. The applicant applied a historical rainfall event (June 2006) that produced a basin average rainfall of 15.24 cm (6.0 in.) in the Delaware River Basin. During the site audit, the applicant provided additional discussion of the selection criteria for the rainfall event and stated that the selected rainfall event exceeded the National Hurricane Center guidance for inland flooding related to hurricanes in the project area (approximately 8.38 cm (3.3 in.)). During the site audit, the applicant stated that the rainfall event applied in HEC-RAS represents a 25-yr rainfall event for the study area (http://www.srh.noaa.gov/lub/?n=climate-pcpn-freq-atlas). The staff concludes that the rainfall condition applied during the HEC-RAS simulation of the PMH surge provides a reasonably conservative estimate of precipitation during the PMH event.

The staff reviewed SSAR Section 2.4.5.2.2.3 describing the applicant's inclusion of wind setup in the total surge estimates with a standard method detailed in Kamphuis (2000). The applicant's discussion provided limited details on the development and application of the wind setup model within Delaware Bay. Discussions with the applicant during the site audit provided some additional details, but questions remained concerning the methods applied. For example, it was unclear if the method applied by the applicant considered the shape of the bay in the wind setup analysis.

To better understand the applicant's wind setup method and develop a staff confirmatory analysis that considers the shape of Delaware Bay and estuary, in RAI 39, Question 02.04.05-8, the staff requested that the applicant provide the model setup and input conditions applied to develop the wind-induced water level changes from the mouth of Delaware Bay to the project site. The staff also requested that the applicant provide information related to any additional analysis completed to understand how the shape of Delaware Bay would influence wind-induced water level changes in the Delaware Bay. Therefore, in RAI 67 (follow-up to RAI 39, Question 02.04.05-8), Question 02.04.05-13, the staff requested that the applicant provide the following:

(1) a discussion of depth values applied by the wind setup method. The PSEG response to RAI 39, Question 02.04.05-8 stated that bathymetry along the fetch line is applied in the wind setup model, but the bathymetry values necessary to calculate the total water depth were not clearly provided in the RAI 39 response. The wind setup calculation depends on the total water depth and the bathymetric location applied in the wind setup calculation is important (but not clearly demonstrated). The bathymetry across Delaware Bay varies significantly so the depth value can vary widely depending on where the value is chosen.

(2) a discussion of what wind speed averaging was applied to develop the wind speeds applied in the wind setup calculations. The PSEG response to RAI 39, Question 02.04.05-8 did not clearly describe the wind field averaging method applied in the application of the wind speeds within the wind setup calculation.

In RAI 67, Question 02.04.05-13, the staff also noted that using a conservative, current practice approach, such as those predicted by an execution of a 2D storm surge model (e.g., SLOSH) with input from appropriate PMH scenarios, the applicant will account for the shape of the bay

when developing wind-induced water level changes from the mouth of Delaware Bay to the project site approximately 80 km (50 mi) inland. This methodology will negate the need for combining multiple models and methods.

In a December 9, 2011, response to RAI 39, Question 02.04.05-8, the applicant provided the additional information on the model setup and input conditions applied to develop the wind-induced water level changes from the mouth of Delaware Bay to the project site as well as how the shape of Delaware Bay would influence wind-induced water level changes in the bay. In an August 21, 2014, response to RAI 67, Question 02.04.05-12, the applicant provided results from a deterministic storm surge analysis using the ADCIRC storm surge model. In response to RAI 67, Question 02.04.05-13, the applicant provided details of the depth values applied in the wind setup methodology — NOAA's National Ocean Service Estuarine Bathymetry Data Set. A bathymetric profile along the wind setup fetch is generated from the NOAA data to provide the elevation of the bottom of the bay at 10-m (32.8-ft) intervals along the 85.5 kilometer (km) (53.1 mi) fetch. Wind setup is calculated in a step-wise manner at every 10 m (32.8 ft) along the fetch, starting at the midpoint of the fetch and stepping toward the PSEG Site.

The December 9, 2011, response to RAI 39, Question 02.04.05-8 provided additional details of the depth values applied in the wind setup methodology. The details indicate that the depth values come from a reasonable data source with values applied at 10-m (32.8-ft) intervals along the fetch.

The December 9, 2011, response to RAI 39, Question 02.04.05-8 also provided additional details of the wind speed averaging within the wind setup calculation and states that no temporal or spatial wind speed averaging was applied. The method applies the winds from NWS 23. NWS 23 applies 10-min averaged winds and this averaging period is appropriate for these calculations.

In a December 9, 2011, response to RAI 39, Question 02.04.05-8, the applicant stated that the wind setup is calculated in a step-wise manner at every 10 m along the fetch, starting at the midpoint of the fetch and stepping toward the site. The staff required additional information to understand the rationale for starting the wind setup calculation at the midpoint of the fetch (listed as 85.5 km (53.1 mi)) for winds blowing from the south-southeast in the response to RAI 39, Question 02.04.05-8). Enclosure 3 to the December 9, 2011, response to RAI 39, Question 02.04.05-8 provided a portable document format (PDF) document with wind setup model files. However, the tables in the PDF document do not clearly demonstrate the fetch value applied in the wind setup calculations. Given the size of the opening of Delaware Bay to the Atlantic Ocean, the fetch value should equal entire fetch length and not half of the fetch length (the procedure for calculating wind setup in a lake or enclosed water body). Allowing wind setup to only occur over half of the fetch length will cause an underestimate of the wind setup in a bay. Independent calculations suggest that including the complete fetch (85.5 km (53.1 mi)), could approximately double the wind setup value near the PSEG Site (depending on the wind speeds and water depths applied) and potentially increase the surge by 1.2 m (3.9 ft). However, the 2D ADCIRC results presented in the applicant's response to RAI 67, Question 02.04.05-12 demonstrates the conservatism of the current 1D model results (12.92 m (42.4 ft)). Accordingly, the staff considers RAI 39, Question 02.04.05-8 and RAI 67, Question 02.04.05-13 resolved.

In RAI 67, Question 02.04.05-14, the staff requested that the applicant provide the following:

(1) clarification on the time of maximum still water level provided in the response to RAI 39, Question 02.04.05-9. In the PSEG response to RAI 39, Question 02.04.05-9, the simulation time of maximum still water level (21.0 hours) does not match the maximum still water level in SSAR, Revision 1, Table 2.4.5.1 and "Table RAI 39-9-2" (20.5 hours). The applicant also stated the design flooding condition occurs at simulation time 21.5 hours when SSAR Table 2.4.5-1 and Table RAI 39-9-2 indicate 21.0 hours.

(2) the relationship between the two wind speeds listed in the applicant's response to RAI 39, Question 02.04.05-9, "Table 39-9-1" (Column 2 and Column 4).

In a November 27, 2013, response to RAI 67, Question 02.04.05-14, the applicant provided additional information on the simulation timing of the maximum still water level and the simulation timing of maximum flooding. The response stated that due to the reanalysis of the design basis storm surge using different methodology as discussed in the response to RAI 67, Question 02.04.05-14, this question is no longer applicable to the PSEG Site Early Site Permit Application (ESPA). In an August 21, 2014, revised response to RAI 67, Question 02.04.05-14, the applicant stated that a typographical error was identified in the response text of RAI 39, Question 02.04.05-9 regarding the reported simulation time for maximum SWL and the time of the design flooding condition when SWL plus wave runup reaches its maximum elevation. The correct simulation time of maximum SWL is 20.5 hours. Similarly, the correct simulation time of the design flooding condition when SWL plus wave runup reaches its maximum elevation is 21.0 hours. These values are consistent with SSAR Table 2.4.5-1 and Table RAI 39-9-2. The staff's review of the August 21, 2014, revised RAI 67, Question 02.04.05-14 response confirmed that the additional detail and clarification removes the uncertainty concerning the timing of the maximum still water level.

Concerning the wind speed averaging procedure, Table RAI 67-14-1 provides additional detail on the applicant's application of wind speed within the wave runup calculations. It remained unclear to the staff why different wind averaging time periods — shown in column 7 and ranging from 1 to 5 hours — are applied for analysis periods that feature constant 30 minute increments. Review of the resultant wind speeds in column 10 revealed only modest reduction — approximately 10 percent — in the wind speeds from the base wind speed in column 2. Given the magnitude of the reduced wind speeds in column 10, the wave runup estimates should provide reasonable values at the PSEG Site. In an August 21, 2014, revised response to RAI 67, Question 02.04.05-14, the applicant stated that the wind speed in Column 4 of Table 39-9-1 in applicant's response to RAI 39, Question 02.0.4.05-9, is the average of the wind speeds in Column 2 for the averaging period shown in Column 6, Table RAI 67-14-1, which includes additional columns with notes describing the procedure used to average the wind speed values and directions is provided to clarify the relationship between the two wind speeds in Table RAI 39-9-1. Therefore, the staff considers RAI 67, Question 02.04.05-14 and RAI 39, Question 02.04.05-9 resolved.

2.4.5.4.6 Coincident Wave Runup

Information Submitted by the Applicant

The applicant presents the methodology to determine wave runup coincident with the PMH surge in SSAR Section 2.4.5.3 and subsections. The section provides estimates of wave runup at the proposed project site.

The applicant determined that the maximum wave runup at the PSEG Site does not occur simultaneously with maximum still water level (SSAR Table 2.4.5-1). The analysis demonstrates that when the still water level reaches its maximum at 8.20 m (26.9 ft) NAVD88 wave runup is 2.1 m (6.9 ft) NAVD88, which combines to an elevation of 10.3 m (33.8 ft) NAVD88. Thirty minutes later, the still water level drops to 8.1 m (26.6 ft) NAVD88 and wave runup increases to 2.4 m (7.9 ft) NAVD88, which combine to 10.5 m (34.6 ft) NAVD88, 0.2 m (0.7 ft) higher than the previous time step.

The Staff's Technical Evaluation

The staff reviewed the wave runup calculation methodology presented in the CEM and applied by the applicant. The wind field surrounding the proposed plant site near the time of maximum surge proves critical to understanding the wave runup. However, SSAR Section 2.4.5.3 did not present enough information for the staff to completely understand and evaluate the methods applied by the applicant to calculate the wave runup at the proposed project site. During the PSEG Site audit, the applicant provided preliminary design drawings to demonstrate the preliminary design of the riprap protection (slope 3H:1V or flatter).

SSAR Section 2.4.5.3 did not adequately describe the wind field surrounding the project site near the time of maximum PMH surge. Therefore, in RAI 39, Question 02.04.05-10, the staff requested that the applicant provide plots that illustrate the wind vector directions and magnitudes at the time of, and at several times before and after, maximum PMH surge. In addition, the staff requested that the applicant provide wave runup estimates at the proposed project site for these times. In a December 9, 2011, response to RAI 39, Question 02.04.05-10, the applicant provided the wind vector plots and associated wave runup estimates for a riprap embankment at the proposed site. Therefore, the staff considers RAI 39, Question 02.04.05-10 resolved.

In RAI 67, Question 02.04.05-15, the staff requested that the applicant provide additional justification for the equation applied to develop the runup (i.e., justification for the use of a roughness coefficient with the CEM section II-4-4-a(1) equation). In addition, the staff requested that the applicant provide a discussion on the exceedance level of the runup estimate developed and the appropriateness of that exceedance level. In an August 21, 2014, response to RAI 67, Question 02.04.05-15, the applicant provided an explanation of the wave runup methodology described in SSAR Section 2.4.5.3 that has been revised to use the methodology presented in USACE Coastal Engineering Manual (CEM), Chapter VI-5. Enclosure 2 to the response provided a revised SSAR Section 2.4.5.3 that details the methodology used, input parameters at critical time steps, and resulting wave runup values. The revised methodology increases the WSEL due to the PMH event to 12.92 m (42.4 ft) NAVD88.

The staff's review of the wave runup methodology indicated that the analysis applies the method of USACE CEM, Chapter VI-5. Accordingly, the staff considers RAI 67, Question 02.04.05-15 resolved.

After reviewing SSAR Section 2.4.5.3.2, "Wave Runup at the New Plant Location," the staff determined that additional information was needed relative to the details of the analysis to estimate the wind-induced wave runup at the project site. Therefore, in RAI 39, Question 02.04.05-10, the staff requested that the applicant provide details of the equations and parameters applied to estimate the wind-induced wave runup at the project site. Specifically, the staff requested that the applicant provide information on the equations applied, the wind speed averaging calculations, and the breaking ratio applied. In addition, the staff requested

that the applicant clearly define the wave heights (maximum versus significant) applied in the equations. In a December 9, 2011, response to RAI 39, Question 02.04.05-10, the applicant provided the details of the equations and parameters applied to estimate the wind-induced wave runup at the project site. Based on its review of the response to RAI 39, Question 02.04.05-10, the staff concluded that applicant demonstrated an adequate understanding of the application of the CEM equations to develop the wave runup at the project site. Accordingly, the staff considers RAI 39, Question 02.04.05-10 resolved.

2.4.5.4.7 Maximum Water Level Associated with the PMH

Information Submitted by the Applicant

The applicant discusses the methodology to determine the maximum water level associated with the PMH at the proposed project site in SSAR Section 2.4.5.5.

The PMH, defined in SSAR Section 2.4.5.1, is determined by the applicant to produce the PMH surge, as defined in RG 1.59. The storm used by the applicant to determine maximum water elevation is the PMH that causes the PMSS as it approaches the PSEG Site along a critical path at an optimum rate of movement. The applicant determined that the maximum water elevation occurs at the time when water levels, including wave runup, peak. At the time of the maximum water level, the still water level at the new plant location is calculated to be 8.1 m (26.7 ft) NAVD88.

The applicant's addition of wave runup, 2.4 m (7.9 ft), creates a water surface elevation of 10.5 m (34.6 ft) NAVD88. A future sea level rise of 0.41 m (1.35 ft) per century is added to the effects of storm surge and wave runup for a PMSS during the projected life of the new plant of 10.9 m (35.9 ft) NAVD88 at the PSEG Site. In an August 21, 2014, response to RAI 67, Question 02.04.05-15, Enclosure 2 to the response provided a revised SSAR Section 2.4.5.3, which details the USACE CEM, methodology used, input parameters at critical time steps, and resulting wave runup values. The revised wave runup methodology increases the WSEL due to the PMH event to 12.92 m (42.4 ft) NAVD88.

The Staff's Technical Evaluation

The staff evaluated the data and discussion presented in SSAR Section 2.4.5.5. The staff agrees that the timing of the surge components proves critical to the development of the maximum water level at the project site. The applicant's response to the information requested in RAI 67, Question 02.04.05-12, allowed the staff to more completely evaluate the time and magnitude of the wind fields and water levels near the project site before and after the storm passes the proposed project site. In addition, the staff's evaluation of the 2D ADCIRC+SWAN coupled model results shows the timing and magnitude of the storm surge — including wave effects — and wave heights near the PSEG Site. The staff's analysis of the water levels indicates the applicant's ADCIRC+SWAN model simulations produce lower total water levels than the combined Bodine/HEC-RAS/Kamphuis model.

2.4.5.4.8 Sediment Erosion and Deposition Associated with the PMH Surge

Information Submitted by the Applicant

The applicant discussed the evaluation of sediment erosion and deposition patterns associated with the PMH surge at the proposed project site in SSAR Section 2.4.5.6, "Sediment Erosion and Deposition Associated with the PMH Surge."

The applicant stated that the tidal current velocities normally range from 0.61 to 0.91 m/s (2 to 3 ft/sec). The applicant's analysis of velocities determined by the HEC-RAS model's simulation of the PMH surge show that velocities throughout Delaware Bay exceed 1.49 m/s (4.9 ft/sec), while velocities in the river channel near the new plant exceed 2.44 m/s (8 ft/sec). Therefore, the applicant concludes that these calculated current velocities are sufficient to cause re-suspension of natural sediments and cause erosion (Cook, et al., 2007).

The applicant determined gross deposition by conservatively assuming that all total suspended solids in the water column are deposited within a few days after passage of the hurricane. The applicant stated that observations of total suspended solids (TSS) concentrations in other bays and estuaries shortly after passage of hurricanes indicate that TSS increase approximately tenfold more than normal pre-storm levels (Jones, 1992, Walker, 2001, and Wilber, et al., 2006). TSS levels near the bottom of the Delaware Bay normally range between 450 and 525 milligrams/liter (mg/L) (0.033 lb/ft^3) during the flood and ebb periods in the tidal cycle (Cook, et al., 2007). Therefore, the applicant concludes that TSS levels immediately after the storm could reach 5,000 mg/L, which is 10 times greater than the normal level of approximately 500 mg/L. The applicant stated that since current velocities are higher in the river channel near the new plant than would generally occur throughout Delaware Bay, net erosion is more likely to occur than net deposition.

The applicant stated that an intake structure would be protected from erosion because net deposition would occur immediately around it. The applicant calculations based on the assumption that 5,000 mg/L of total suspended solids deposit shortly after the passage of a hurricane indicate that deposition is not expected to exceed 5.1 cm (2 in.) of sediment. Thus, the applicant concludes that the effect of the PMSS on sediment deposition and erosion is not expected to adversely affect operation of safety-related SSCs.

The Staff's Technical Evaluation

The information presented in SSAR Section 2.4.5.6 did not adequately explain the possible sediment dynamics near the proposed site during the PMH surge. To understand and evaluate local areas of sediment erosion and deposition requires estimation of the 2D current velocity field (application of a 2D hydrodynamic model). The SSAR analysis assumes uniform sediment deposition in Delaware Bay and estuary. Known 2D flow effects do not support the assumption of uniform deposition and erosion. Details of local sediment erosion and deposition patterns may prove unnecessary should safety-related SSCs not depend on erosion and deposition near the proposed project site. In RAI 39, Question 02.04.05-11, the staff requested that the applicant provide additional information concerning the sediment dynamics near the proposed project site under hurricane-induced current velocities. Analysis of the 2D (horizontal) distribution of sediment erosion and deposition requires estimation of the 2D current velocity field (application of a 2D hydrodynamic model). The applicant provided study results from Celebioglu (2006) that demonstrate relatively minor deposition and erosion depths for a 100-yr flood event based on a coupled hydrodynamic and sediment transport model. While the PMH

storm forcing would produce greater current and wave forcing, the amount of erosion and deposition should not greatly exceed the estimate of 5.1 cm (2 in.) provided by the applicant. In addition, the SSAR documentation states that safety-related SSCs will be protected against sedimentation (erosion or deposition) that could affect the integrity of those facilities. This protection provides additional assurance that sedimentation won't affect critical infrastructure.

2.4.5.4.9 Comparative Storm Surge Analyses and Design Basis Flood Level

Information Submitted by the Applicant

Table 2.4.5-2 below provides a comparison of the applicant's and the staff's storm surge analyses. The applicant used two other methodologies available from NOAA and NRC to determine storm surge at the open coast: NOAA's SLOSH program and RG 1.59, Appendix C. In an August 21, 2014, response to RAI 67, Question 02.04.05-12, the applicant developed a deterministic 2D storm surge analysis using ADCIRC+SWAN (Simulating WAves Nearshore) to provide data for comparison with 1D Bodine model results. The 2D ADCIRC+SWAN model results produced lower water levels for the storm simulation that matches the NWS-23 PMH forcing. In an April 15, 2015, supplement to the revised response to RAI 67, the applicant described their basis and justification for their selection of 2D ADCIRC+SWAN maximum WSEL of 9.78 m (32.1 ft) as the design basis flood for the new plant location.

RG 1.59 for Storm Surge Analysis

The applicant stated that RG 1.59 is applicable to determine PMH surge levels on open coast sites on the Atlantic Ocean and Gulf of Mexico. Therefore, the applicant concluded that it is appropriate to use this methodology for estimating storm surge up to the mouth of Delaware Bay, but it was not appropriate to use it beyond the area where a hurricane makes initial landfall. As such, the applicant stated that it is not an acceptable method for estimating surge at the PSEG Site. The applicant's RG 1.59, Appendix C, results for the mouth of Delaware Bay were based on interpolating results from Atlantic City, NJ, and Ocean City, MD, and then adjusting to NAVD88. Including the 10 percent exceedance high tide, RG 1.59 estimated a maximum storm surge of 6.61 m (21.7 ft), NAVD88 at the mouth of the Delaware Bay.

2D SLOSH Display Program V. 1.61g

The applicant's SLOSH results were accessed using the SLOSH Display Program v. 1.61g (NOAA, 2009) and adjusted to account for the 10 percent exceedance high tide and NAVD88 datum. The applicant stated that storms presented in the Display Program include a Category 4 storm on the Saffir-Simpson scale, but the Delaware Basin v3 SLOSH dataset does not include a storm with the same parameters as the applicant's PMH determined for the PSEG Site. Using the SLOSH Display Program, the applicant shows the highest surge elevation at the mouth of Delaware Bay is 5.36 m (17.6 ft) NAVD88. Accounting for the 10 percent exceedance high tide indicates a Category 4 storm elevation of 6.04 m (19.8 ft) NAVD88.

The Staff's Technical Evaluation

The Applicant's 2D SLOSH Display Program V. 1.61g

The staff reviewed the applicant's comparison of the Bodine model results at the open coast with the SLOSH Display Program V. 1.61g data. The applicant discussion indicated that the SLOSH data represent a Category 4 (Saffir-Simpson scale) storm, but the discussion did not

provide sufficient detail to compare the storm characteristics simulated by the Bodine and SLOSH models. During the site audit, the applicant stated that it was not able to obtain the SLOSH source code from NOAA. Having the source code could have allowed the applicant to execute SLOSH model simulations with the PMH parameters. In RAI 39, Question 02.04.05-7, the staff requested that the applicant provide additional information on the storm parameters for the SLOSH model that developed the SLOSH Display Program V. 1.61g data applied in the study.

The data above allows a more direct comparison of the storm parameters applied to develop the SLOSH (visualization program) and the Bodine model storm surge estimates at the mouth of Delaware Bay and at the proposed project site. SSAR Sections 2.4.5.2.2.2 and 2.4.5.2.2.3 discuss and compare the model results; however, the storm characteristics for each method were not completely explained. In RAI 67, Question 02.04.05-12, the staff requested that the applicant provide an analysis of the PMH events using a conservative, current practice approach such as those predicted by a 2D storm surge model (e.g., ADCIRC, FVCOM, SLOSH, other) with input from appropriate PMH scenarios and with resolution that captures the nuances of the bathymetry and topography near the project site.

Discussions with the applicant during the site audit suggested that the applicant may obtain the SLOSH executable files and conduct SLOSH model simulations. The staff requested results from any SLOSH simulations conducted by the applicant for storms with the PMH parameters. In a November 22, 2011, response to RAI 39, Question 02.04.05-7, the applicant provided the additional information on the storm parameters for the SLOSH model that developed the SLOSH Display Program. This information allowed the staff a more direct comparison of the SLOSH storm parameters and Bodine model storm surge estimates at the mouth of the Delaware Bay and site. In an August 21, 2014, response to RAI 67, Question 02.04.05-12, the applicant provided results from a deterministic storm surge analysis using the ADCIRC storm surge model. Accordingly, the staff considers RAI 39, Question 02.04.05-7 and RAI 67, Question 02.04.05-12 resolved.

Staff SLOSH Analysis

The applicant applied the SLOSH model with publically available storm results from the SLOSH Display Program (V. 1.61g) with intensities comparable to Saffir-Simpson scale Category 4 forcing. However, the applicant did not provide SLOSH model results for storm forcing created to match the PMH storm parameters as provided in NWS 23. Through independent confirmatory analysis, the staff determined that application of PMH storm parameters as input in the SLOSH model produces water surface elevations that exceed the publically available SLOSH Display Program (V. 1.61g) data for Category 4 storms in the PSEG project area. The staff applied the Delaware Basin V3 (DE3) SLOSH grid with storm files developed to simulate various combinations of PMH storm parameters. The staff's SLOSH analysis added 10 percent exceedance tide levels to the final results for comparison to the applicant values. Note that the SLOSH results do not account for wave-induced water level effects (wave setup).

Staff ADCIRC+SWAN

As compared to the Bodine/HEC-RAS/Kamphuis model results, the applicant demonstrated that the ADCIRC+SWAN model results show (refer to Table 2.4.5-2 below) the coupled 2D modeling system produces lower water levels for the PMH storm forcing (developed from the NWS 23 guidance). The applicant's analysis applied the ADCIRC+SWAN model mesh developed during the FEMA Region III coastal storm surge study with enhanced resolution near the project site.

Revised SSAR Figure 2.4.5-10 compares the original and modified resolution near the project site. The increased resolution inserted for the applicant's analysis seems reasonable to the staff given the topography and bathymetry features near the project site and the need to study water levels and waves in the immediate vicinity of the PSEG Site.

As stated above and shown in Table 2.4.5-2 below, the ADCIRC+SWAN model results show the coupled 2D modeling system produces lower water levels for the PMH storm forcing developed from the NWS 23 guidance (as compared to the Bodine/HEC-RAS/Kamphuis model). However, the PMH storm forcing applied represents a single event determined to result in the highest WSEL at the PSEG Site based on results from the Bodine/HEC-RAS/Kamphuis modeling approach. The Bodine/HEC-RAS/Kamphuis modeling approach has limitations developing water levels up a complex inland bay/estuary, so application of this approach as a screening tool could miss storm forcing that produces the highest WSEL at the PSEG Site (located well up the bay). Therefore, application of only the characteristics from the single PMH storm that produced the highest water levels in the Bodine/HEC-RAS/Kamphuis modeling approach required review. To confirm if other NWS 23-derived storm parameter sets produce higher water levels at the project site, the staff conducted independent ADCIRC+SWAN simulations.

The staff's independent ADCIRC+SWAN simulations applied the study model mesh provided by PSEG (originally developed for the FEMA Region III coastal storm surge study with increased resolution near the project site). As a first step, the staff reviewed the model mesh resolution and features and found reasonable resolution to resolve important surge-altering features near the project site and within Delaware Bay.

As a second step in the independent analysis, the staff confirmed the ability to reproduce the PSEG study model results near the project site for similar model settings and storm forcing. The staff executed the PSEG study Hurricane Isabel validation simulation and the PMH storm simulation. The results from the independent Hurricane Isabel and PMH storm simulations, presented in Table 2.4.5-2 below, showed nearly identical values near the project site with differences in maximum water levels on the order of 0.01 m (0.03 ft). The independent simulation with the PMH forcing applied a slightly modified mesh with a small channel near Cape May, NJ, removed. The initial independent PMH simulation developed water level instability in the small channel located over 64.4 km (40.0 mi) from the project site. Execution of the PMH simulation with the slightly modified mesh showed successful model completion with results almost identical to the PSEG PMH simulation. Given the size of the channel, the feature should cause a very localized influence on surge and no influence on surge at the PSEG Site. The near-identical model results in the completed independent PMH simulation with the channel removed in the modified mesh demonstrate the lack of influence near the project site.

With confidence in the ability to reproduce the ADCIRC+SWAN results near the project site, the staff next developed and executed simulations for storms with variations in the PMH forcing. The PSEG PMH storm forcing was developed based on the maximum WSEL at the project site from the Bodine/HEC-RAS/Kamphuis modeling results. However, limitations in the Bodine/HEC-RAS/Kamphuis modeling approach may have led to the selection of PMH storm parameter values that do not truly reflect maximum water levels at the project site given possible NWS 23 storm parameter ranges. As listed in the SSAR Revision 3 (March 31, 2014), the NWS 23 meteorological parameters are the following:

- Central pressure, P_0 = 26.65 in. of mercury (Hg) (902.5 millibars (mb))

- Pressure drop, ΔP = 3.5 in. of Hg (118.52 mb)
- Radius of maximum winds, R = from 11 to 28 NM (20.4 to 51.9 km)
- Forward speed, T = from 26 to 42 kt (48.2 to 77.8 km/hr)
- Coefficient related to density of air, K = 68 (when parameters are in units of in. of Hg and kt)
- Track direction, from 138 degrees (moving northwest)

The PSEG PMH storm applies NWS 23 value for P_0, ΔP, K, and track direction along with the largest R value (28 NM (51.9 km)), slowest forward speed (26 kt (48.2 km/hr)) — also shown in SSAR Table 2.4.5-4. The staff notes that the selection of these values, as defined in NWS 23, seems reasonable. Importantly, the PSEG PMH simulations applied a landfall location offset 28 NM (51.9 km) southwest from the center of the Delaware Bay mouth (SSAR Figure 2.4.5-1). Given the complexity of the bay shape, selection of the landfall location could significantly influence the storm surge values at the PSEG Site. The Bodine/HEC-RAS/Kamphuis modeling approach does not adequately resolve the bay features or some of the physical processes necessary to accurately develop the storm surge near the PSEG Site. The ADCIRC+SWAN model contains a detailed representation of the bay features and the important physical processes necessary to simulate the influence of the landfall location on the storm surge levels at the PSEG Site. In addition, given the bay geometry, various forward velocities for the storm could induce site-specific changes to the timing and magnitude of the maximum WSEL at the PSEG Site. Given the bay geometry and the NWS 23 parameter ranges, the staff investigated the sensitivity of the landfall location and forward speed on the WSEL near the PSEG Site.

To investigate the sensitivity of the storm surge results to the landfall location, the staff executed several additional simulations with the PMH track offset from the original value. The first set of additional simulations features the following storm tracks:

1. PMH storm track shifted 14 NM (25.9 km) to the southwest (SW_14_NM)
2. PMH storm track shifted 14 NM (25.9 km) to the northeast (NE_14_NM)

Near the PSEG Site, the SW_14_NM simulation showed increased maximum water levels as compared to the PSEG PMH simulation with differences near 0.75 ft (0.23 m). The NE_14_NM simulation showed decreased maximum water levels near the PSEG site as compared to the PSEG PMH simulation with differences near 1.52 m (5 ft). Based on this information, the staff executed additional shifted track simulations with the storm track shifted 7 NM to the southwest (SW_7_NM) and 21 NM to the southwest (SW_21_NM). The SW_7_NM and SW_21_NM simulations produced maximum WSEL values between 0 meters and .31 meters (0 and 1 ft) higher than the PSEG PMH simulation; however, the maximum WSEL increase was less than that of the SW_14_NM simulation. These simulations show that modifying the track landfall location can produce higher WSEL at the PSEG Site, but the increase in maximum WSEL is less than 0.31 m (1 ft).

To investigate the sensitivity of the storm surge results to the storm forward velocity, the staff executed two additional simulations with the PMH storm velocity increased to 55.6 km/hr (30 kt) and 63.0 km/hr (34 kt). The staff developed the modified forward velocity storms by altering the wind forcing time step applied in the ADCIRC model control file. Given the goal to evaluate the sensitivity of the WSEL to storm forward velocity, this approach allowed the staff to leverage the existing 2D wind and pressure fields developed for the PMH (with a 48.2 km/hr (26 kt) forward velocity). As compared to the PMH storm forcing results, the model results for the 55.6 km/hr (30 kt) and 63.0 km/hr (34 kt) forward velocities indicate reduced maximum WSEL values near the PSEG site. The maximum WSEL values are reduced by about 0.61 m (2.0 ft) for the

55.6 km/hr (30 kt) simulation and by about 1.22 m (4 ft) for the 63.0 km/hr (34 kt) simulation. These results indicate the 48.2 km/hr (26 kt) forward velocity — the slowest forward velocity in the range provided by NWS 23 — produces the largest WSEL at the PSEG Site.

Detailed review of the ADCIRC+SWAN model PMH simulation results in the immediate vicinity of the PSEG Site revealed some notable maximum water level features that the staff considered needed further investigation. The features presented as undulations in the maximum WSEL with the undulation magnitude on the order of a few feet. Review of the model mesh input file revealed a line of 92 land boundary nodes shaped in an arc that surrounded the north, east, and south side of the PSEG Site and extended into Delaware Bay. The staff did not find documentation for the rationale of including this feature in the model mesh. To evaluate the sensitivity of the maximum WSEL results near the PSEG Site to the node string, the staff removed the node string and executed an ADCIRC+SWAN simulation with the PMH storm forcing. The ADCIRC+SWAN model results for the simulation with the land boundary nodes removed shows similar water level features as compared to the original PMH simulation. Detailed review of the WSEL in contour plots shows no WSEL undulations in the vicinity of where the land boundary nodes were located in the original simulation. The differences in maximum WSEL near the PSEG Site range from approximately +/- 0.03 m (0.1 ft) with the land boundary versus without land boundary simulations. At times other than at maximum WSEL, differences can exceed 0.91 m (3.0 ft). These results indicate that the land boundary nodes, while not having a documented purpose, cause only a minor effect on the water level values near the project.

The staff also compared wave height results for the PSEG PMH simulation and the sensitivity ADCIRC+SWAN simulations. Comparison of significant wave height (Hs) time series at locations near the PSEG Site show similar wave heights and mean periods for the PSEG PMH and staff PMH simulations for most comparisons. The staff's PMH simulation with unexplained land boundary nodes removed produces slightly larger wave heights at some locations near the PSEG Site (locations adjacent the land boundary). The Hs results for the simulation with the land boundary nodes removed reach approximately 0.15 m (0.5 ft) to 0.31 m (1.0 ft) higher than the PSEG PMH simulation results (refer to Table 2.4.5-2 below). For locations closer, the PSEG Site in areas that feature depth limited waves, the difference in Hs is negligible. Since the larger differences in Hs do not exceed 0.31 m (1.0 ft) and locations nearer the PSEG Site show negligible difference, the effect of the land boundary should not cause significant effects on water levels or wave runup.

The staff also executed additional simulations designed to understand the influence of changing the maximum number of SWAN iterations (MXITNS = 2) on wave height within the spectral wave model solution. Recent coastal surge studies have applied different values for the MXITNS parameter, with a value of two representing the low end of the range. The staff executed ADCIRC+SWAN simulations with MXITNS = 8 and MXITNS = 12 to evaluate the sensitivity of the ADCIRC+SWAN model result to the parameter selection. The results of the MXITNS = 8 and MXITNS = 12 simulations show similar wave height and period values near the PSEG Site with values that exceed those of the MXITNS = 2 simulation (original PMH simulation). At the west side of the PSEG Site (location with largest SWAN waves), the higher MXITNS simulations have maximum significant wave heights equal to 2.53 m (8.3 ft) versus 2.04 m (6.7 ft) for the MXITNS = 2 simulation. For locations further from the site, but still in close proximity — labeled "perimeter" locations in the PSEG input files — the higher MXITNS simulations have maximum significant wave heights from 0.31 m (1.0 ft) to 1.37 m (4.5 ft) larger than for similar locations in the PSEG MXITNS = 2 simulation. Review of mean wave periods

near the site shows the higher iteration threshold generally reduces the simulation mean wave periods on the order of 1 to 2 seconds. The resulting storm parameters and maximum total water surface elevation, as discussed above, are summarized in Table 2.4.5-2 below.

Table 2.4.5-2 Storm Parameters and Maximum Total Water Surface Elevation

Parameter	PSEG ESP Bodine/ HEC-RAS	PSEG ESP ADCIRC Run #1	PSEG ESP ADCIRC Run #2 (DBF)	PSEG ESP ADCIRC Run #3	Staff ADCIRC Confirmatory Run #1 [3]	Staff ADCIRC Confirmatory Run #2 [4]
Peripheral Pressure (in. of Hg (mb))	30.12 (1020)	30.15 (1021)	30.15 (1021)	30.15 (1021)	30.15 (1021)	30.15 (1021)
Central Pressure (in. of Hg (mb))	26.64 (902)	26.64 (902)	26.64 (902)	26.64 (902)	26.64 (902)	26.64 (902)
Radius of Maximum Winds (NM (km))	28 (51.86)	28 (51.86)	28 (51.86)	28 (51.86)	28 (51.86)	28 (51.86)
Forward Speed (kt (km/hr))	26 (48.15)	26 (48.15)	26 (48.15)	26 (48.15)	26 (48.15)	26 (48.15)
Max Wind Speed (kt (km/hr))	116 (214.83)	116 (214.83)	116 (214.83)	116 (214.83)	116 (214.83)	116 (214.83)
10% Astronomical High Tide (ft (m))	4.5 (1.37)	4.5 (1.37) [1]	4.5 (1.37) [1]	4.5 (1.37) [2]	4.5 (1.37) [1]	4.5 (1.37) [1]
100-yr Sea Level Rise (ft (m))	1.35 (0.41)	1.35 (0.41) [1]	1.35 (0.41) [2]	1.35 (0.41) [2]	1.35 (0.41) [1]	1.35 (0.41) [1]
Maximum Still Water Level (ft-NAVD88 (m-NAVD88))	26.7 (8.14)	18.63 (5.68)	20.16 (6.14)	25.27 (7.70)	18.63 (5.68)	19.54 (5.96)
Wave Runup (ft (m))	14.3 (4.36) [1]	7.51 (2.29) [1]	7.43 (2.26) [1]	7.74 (2.36) [1]	10.97 (3.34) [1]	9.99 (3.04) [1]
Maximum Total Water Surface Elevation (ft. NAVD88 (m-NAVD88))	**42.4 (12.92)**	**31.99 (9.75)**	**32.09 (9.78)**	**33.01 (10.06)**	**35.46 (10.81)**	**35.38 (10.78)**

1) Added after model simulation to maximum still water level at site

2) Added prior to model simulation for initial sea level

3) Apply PSEG PMH parameters applied in ADCIRC+SWAN model

4) Shift PMH storm track 14 nmi to the southwest in SWAN+ADCIRC model

2.4.5.4.10 Seiche and Resonance

Information Submitted by the Applicant

The applicant discussed the evaluation of seiche and resonance effects at the proposed project site in SSAR Section 2.4.5.7, “Seiche and Resonance.”

The applicant stated that the seiche motion in an estuary like Delaware Bay causes the largest water level fluctuations at the head of tide (near Trenton, NJ), while water levels are relatively constant at the mouth of the bay. This type of seiche is called the fundamental mode (USACE, 2002). The free oscillation period of the fundamental mode seiche propagating along the length of the Delaware Estuary from its mouth at RM 0 to the head of tide at Trenton (RM 134) is 31 hrs.

The applicant stated that shorter length seiche waves (with shorter oscillation periods) are possible. This situation may occur when the effect of winds blowing along the axis of Delaware Bay (northwest-southeast) may excite a seiche within Delaware Bay, but with little effect on the upper estuary, due to the change in orientation of the river in the upper estuary (more nearly northeast-southwest) and less surface area for the wind to act on. Therefore, the applicant concludes that winds from the northwest tend to excite a shorter length wave with greater effect in Delaware Bay and less effect in the upper estuary. Fluctuations in the strength of northwest winds could generate seiche waves of the second mode, which have a period of 10 hrs (USACE, 2002).

The applicant stated that there are observed water level fluctuations in Delaware Bay that have lower frequency than tides (subtidal), which are semidiurnal (indicating 12-hr periods). The magnitude of these subtidal oscillations at the PSEG Site is less than 0.6 m (2.0 ft). The applicant also stated that these observed water level fluctuations are associated with wind forces of two types. The first type is direct wind stress on the surface of Delaware Bay, while the second is an indirect forcing associated with wind stress fluctuations over the Atlantic Ocean. The applicant’s analysis indicated that the fluctuations in wind stress are associated with fluctuations in water levels in the Delaware Bay at periods of more than 3 days. Together, these direct and indirect wind stress fluctuations are associated with nearly all subtidal fluctuations of water surface elevations observed at Reedy Point, DE, 7 mi (11.3 km) from the new plant location (Wong and Moses-Hall, 1998 and Wong and Garvine, 1984).

The applicant’s analysis of reported observations show that the atmospheric forcing, associated with seiche motion in Delaware Bay, occurs with longer periods (more than 3 days) than the natural period of oscillation of the Delaware Estuary (30 hours or less). Therefore, the applicant concludes that Delaware Bay does not resonate with the meteorologically-induced wave periods.

The applicant stated that Delaware Bay would not resonate with seismic activity. The applicant’s analysis showed that seismic waves have a period of 1 hr or less (Oliver, 1962). SSAR Section 2.4.6 documents the effect of tsunami-induced seiche motion in Delaware Bay, showing that the magnitudes of water level fluctuations are too small to affect safety-related SSCs. Therefore, the applicant concludes that due to the lack of resonance with identified forcing functions, as well as observational evidence of the relatively small magnitude of seiche motions, potential seiche waves produce much smaller flood levels than the PMSS.

The Staff's Technical Evaluation

The staff applied the seiche equations presented in the CEM and confirmed the primary and secondary mode periods with representative length and depth values for the Delaware Bay system. Application of an open basin with a length of 215 km (134 mi) and an average depth of 6 m (20 ft) results in a primary seiche mode equal to 31.1 hrs. With the same bay configuration, the first fundamental seiche mode (first harmonic) equals 10.4 hrs. These seiche periods confirm the values stated by the applicant in SSAR Section 2.4.5.7.

The staff reviewed the two studies of subtidal (lower frequency than the tide) water level fluctuations in Delaware Bay (Wong and Hall, 1998; and Wong and Garvine, 1984) referenced in SSAR Section 2.4.5.7. The staff review of the articles confirms the applicant's statements in SSAR Section 2.4.5.7 related to wind effects on subtidal water level fluctuations and the periods of the fluctuations.

The information provided by the applicant and the review conducted by the staff indicate that seiche motion in Delaware Bay should produce water level changes much lower than the PMSS.

2.4.5.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.5.6 Conclusion

The staff accepted the final 1D Bodine and 2D ADCIRC+SWAN methodologies used by the applicant to determine the severity of the surge and seiche phenomena reflected in this analysis, as documented in this section of the report. In the context of the above discussion, the staff finds the applicant's analysis acceptable for use in establishing the design bases for SSCs important to safety. Accordingly, the staff concludes that the use of these methodologies results in an analysis containing a sufficient margin for the limited accuracy, quantity, and period of time in which the data were accumulated.

In order to verify that the applicant's screening 1D storm surge model results of a PMSS with wave runup of 12.9 m (42.4 ft) NAVD88 was very conservative, the applicant conducted several separate, industry-standard 2D analyses of storm surge, resulting in DBF values between 9.75 to 10.06 m (31.99 to 33.01 ft) NAVD88 which is well below the one-dimensional analysis as well as the proposed site grade, and in agreement with the staff's confirmatory analysis. As the 2D ADCIRC+SWAN modeling system represents the current state-of-the-art practice in storm surge hazard assessment, the applicant's PMH maximum WSEL of 9.78 m (32.1 ft) is the DBF. The staff accepted the applicant's PMSS of 9.78 m (32.1 ft) as the DBF noting that it was a very conservative analysis and most realistic of the simulations with the post-addition of the 10 percent exceedance high tide. For example, the highest storm surge of record (8.85 m (29.0 ft) NAVD88) in the U.S. was a result of Hurricane Katrina in New Orleans in 2005. Further, during 2012, when Hurricane Sandy made landfall approximately 120.7 km (75 mi) northwest of the PSEG Site, it resulted in a maximum storm surge of 2.1 m (7.0 ft) NAVD88 near the Oyster Creek Nuclear Generating Station (an operating nuclear facility on the New Jersey coast). Finally, the staff notes that the applicant has established the site grade 1.47 m (4.8 ft) above the maximum flood elevation.

Consistent with the resolution of Confirmatory Items 2.4-1 and 2.4-2 identified in Section 2.4.5.4.1 of this report, the staff concludes that the applicant's identification and consideration of the surge and seiche hazards set forth above is acceptable and meets the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.23(d).

2.4.6 Probable Maximum Tsunami Hazards

2.4.6.1 Introduction

This section of the SSAR addresses the hydrological design basis developed to ensure that any potential tsunami hazards to the SSCs important to safety are considered in plant design.

This section presents the staff's review of the flood levels caused by postulated tsunami wave-forming scenarios. The specific areas of the review include the description of the PMT, historical tsunami records, source generator characteristics, tsunami analyses, tsunami water levels, hydrograph and harbor or breakwater influences of a tsunami-like wave, and its effects on safety-related facilities.

2.4.6.2 Summary of Application

In SSAR Section 2.4.6, the applicant provides site-specific information about potential tsunami effects on the site.

2.4.6.3 Regulatory Basis

The relevant requirements of NRC regulations for the consideration of probable maximum tsunami hazards, design considerations, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.4.6.

The applicable regulatory requirements for identifying PMT hazards are as follows:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The related acceptance criteria are as follows:

- RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, "Seismic Design Classification," as it relates to those SSCs intended to protect against the effects of flooding or those associated with the MWIS.

- RG 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, "Flood Protection for Nuclear Power Plants," as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.6.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.6. The staff confirmed that the information in the application addresses the relevant information related to the PMT. The staff's technical review of this section includes an independent review of the applicant's information in the SSAR and the responses to the RAIs.

This section describes the staff's evaluation of the technical information in SSAR Section 2.4.6.

2.4.6.4.1 Probable Maximum Tsunami

Information Submitted by the Applicant

The applicant evaluated potential tsunamigenic sources that could affect the PSEG Site in southern New Jersey (ten Brink, et al., 2008). The applicant indicates that the Method of Splitting Tsunami (MOST) model is used to propagate the tsunamis from their sources to the PSEG Site.

In SSAR Section 2.4.6.2, the applicant indicates that tsunami events that could affect the PSEG Site could be generated by a range of near- and far-field geoseismic sources. The near-field sources include submarine mass-failure events associated with slope failures on the continental shelf margin, or large sediment movements in the form of turbidity currents. The applicant suggested that because Delaware Bay is a low-lying coastal-plain estuary bounded by nearly flat terrain, the occurrence of locally generated waves due to subaerial or submarine landslides is unlikely. The far-field sources include coseismic activity in Caribbean subduction zones, including the Hispaniola and Puerto Rico Trenches, and faulting zones in the regions west and south of Portugal that the applicant interprets to be inactive. The applicant indicated that large-scale submarine mass-failure events have also been identified along the Mid-Atlantic Ridge and British Isles, and that catastrophic failure of volcanic cones associated with the island of La Palma in the Canary Islands could generate a tsunami of concern.

The applicant stated that based on previous studies and historical tsunami records, three potential tsunamigenic sources were chosen for further study. These include: a submarine landslide off the coast of North Carolina or Virginia, a volcanic flank failure on La Palma, and submarine fault displacement from an earthquake along the Hispaniola Trench. Analysis of the geology along the Mid-Atlantic continental margin of the United States suggests the presence of historical landslide deposits, and indicates that larger events are commonly associated with low sea levels. The applicant indicated that large submarine landslides along the North Carolina and Virginia coasts could result in large tsunami amplitudes along the United States east coast, where the Currituck landslide is of particular interest among previous events.

The applicant indicated that a volcanic flank failure could result in large tsunami waves along the western Atlantic Ocean boundary (Ward and Day, 2001), but that more recent studies have

suggested smaller amplitudes of 3 m (10 ft) along the United States east coast (Mader, 2001and Pararas-Carayannis, 2002).

The applicant indicated that although the Puerto Rico Trench is commonly suggested as a possible source of tsunamigenic activity, the Hispaniola Trench has a greater tsunamigenic potential. For example, a series of events with M_w between 6.8 and 7.6 occurred between 1946 and 1953 in the Hispaniola Trench. The applicant noted that a set of sources along the Hispaniola Trench that combine to produce a 9.0 M_w event is used here.

The applicant indicated that the amplitudes of the PMT positive runup and negative drawdown at the PSEG Site are computed for each source using the MOST model and that none of the simulations predict tsunami-induced water elevations that result in the design-basis flood at the site.

The Staff's Technical Evaluation

The staff conducted an independent confirmatory analysis to determine the PMT at the PSEG Site; it is described in the sections that follow. The staff considered both far-field seismogenic (Puerto Rico subduction zone (see Figure 2.4.6-1 of this report)) and far-field (Canary Islands (see Figure 2.4.6-2 of this report)) and near-field (Currituck (see Figure 2.4.6-3 of this report)) landslide sources as potential generators for the PMT. Initial analysis indicates that the near-field submarine landslide is the likely source that determines the PMT maximum water level. The PMT minimum water level is determined by a far-field earthquake source along the Puerto Rico subduction zone.

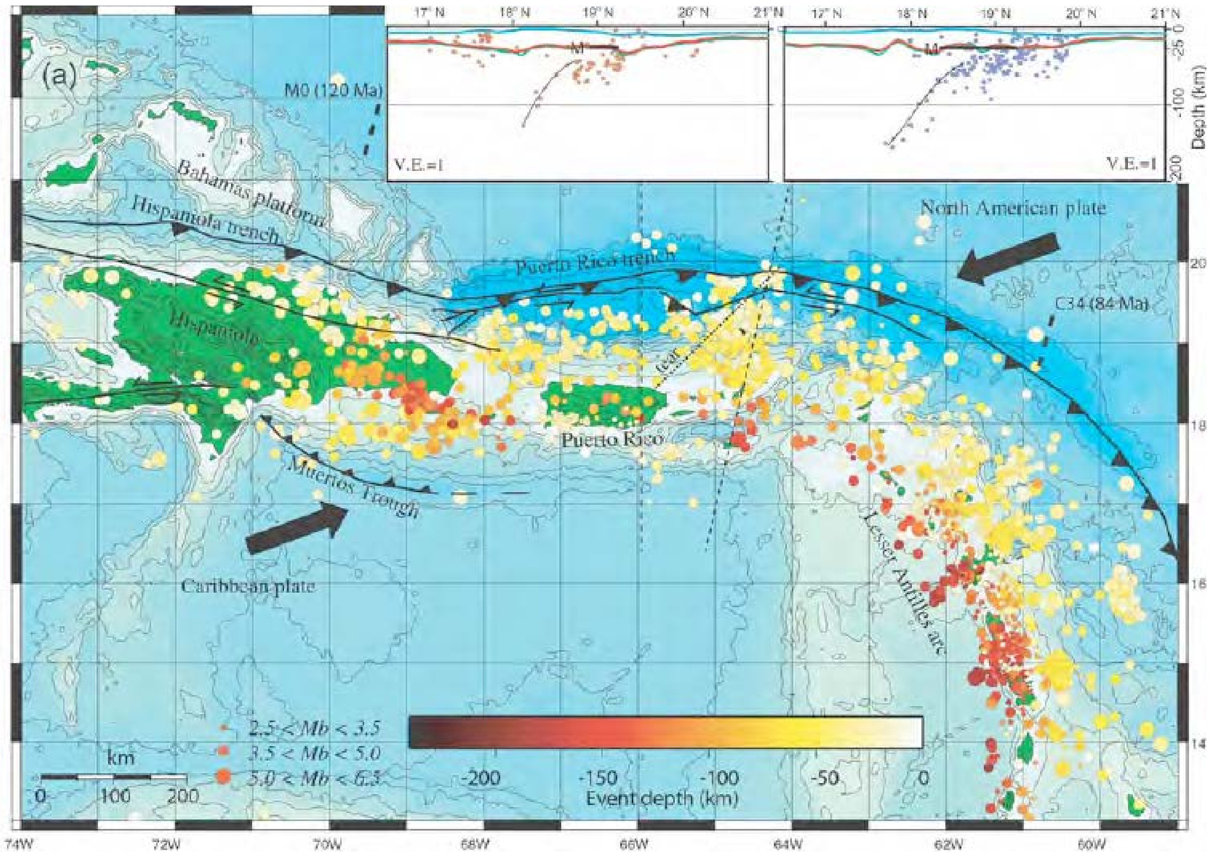

Figure 2.4.6-1 Major faults in the Greater Antilles region

Subduction zone fault represented by line with barbed pattern. Insets show the subduction of the North American plate beneath the Caribbean plate along two different transects. Large arrows show the direction of relative convergence between the two plates. North latitudes are shown (ten Brink, 2005).

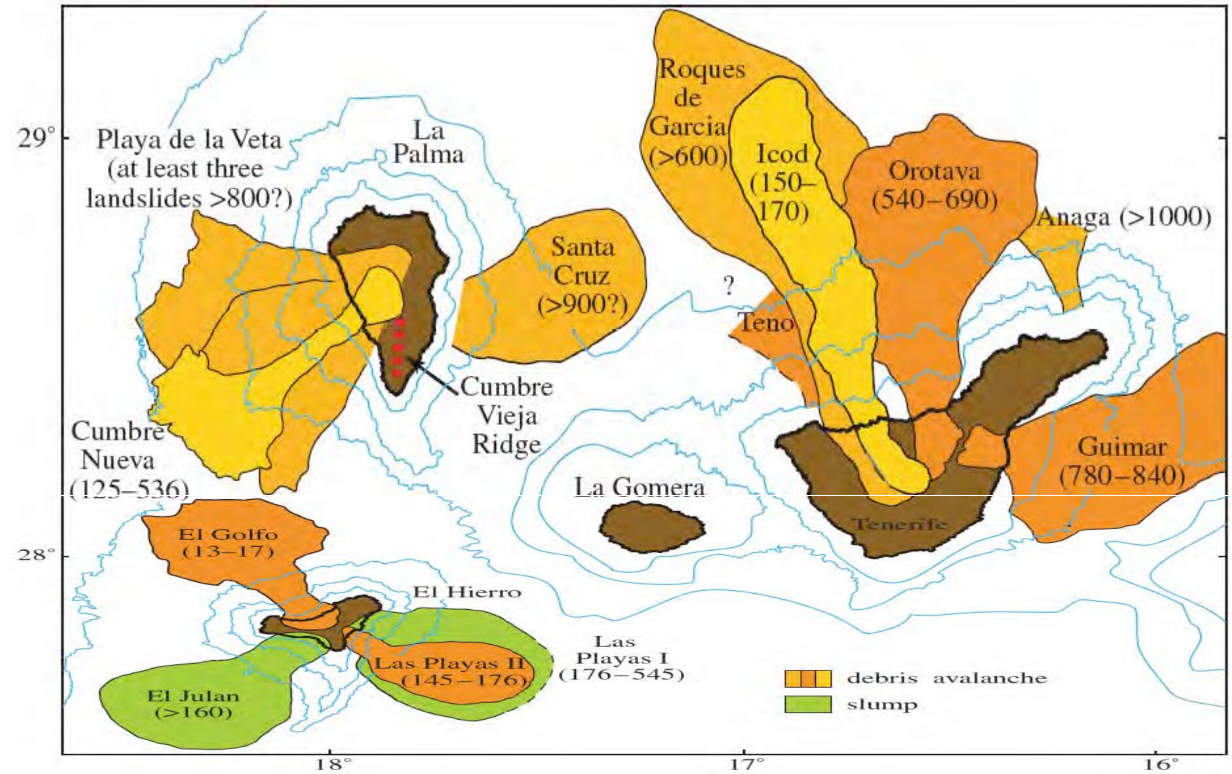

Figure 2.4.6-2 Location and ages (in thousands of years before present) of landslides in the Canary Islands (Masson, et al., 2006). North latitudes and west longitudes are shown. Bathymetric contour interval is 1 km.

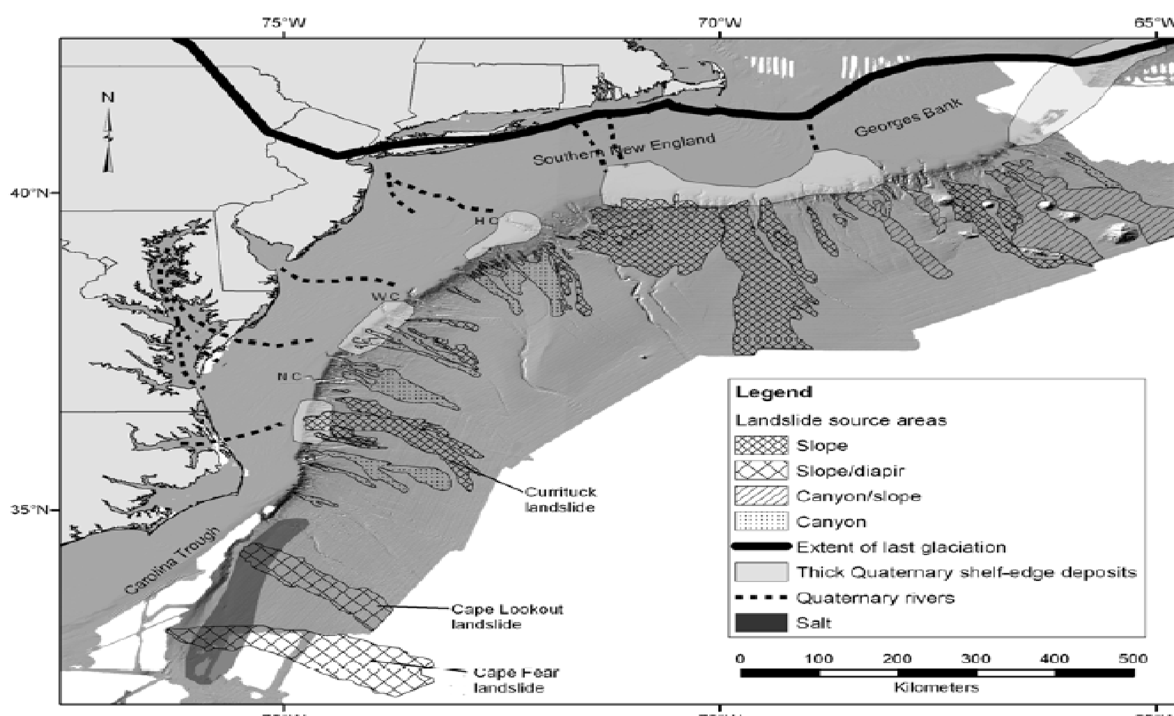

Figure 2.4.6-3 Observed landslides offshore NE Atlantic coast (Twichell, et al., 2009)

In RAI 20, Question 02.04.06-1, the staff requested that the applicant provide additional information, an evaluation, and a discussion in the SSAR of the following items:

a. 1918 Puerto Rico Tsunami (SSAR 2.4.6.3). PSEG stated that the 1918 earthquake occurred within the Puerto Rico Trench and that it was responsible for the tsunami. It is believed that the earthquake actually occurred in the Mona Passage or just north of it and that the landslide likely contributed to the tsunami. Provide a clarification of the 1918 earthquake source location.

b. Paleotsunami deposits (Missing from SSAR). Related information is presented in SSAR Section 2.5.1. PSEG stated that for the site no references to paleotsunamis have been found in existing literature, and no evidence of tsunami has been found in site borings.

In the May 11, 2011, response to RAI 20, Question 02.04.06-1, the applicant provided the following:

1. 1918 Puerto Rico Tsunami

Current research into the 1918 Puerto Rico Tsunami indicates that the October 11, 1918, Mona Passage earthquake triggered a tsunami that affected the western coast of Puerto Rico. The cause of the tsunami was previously suggested to be seafloor displacement by a normal fault on the eastern wall of the Mona Rift. Using newly available multibeam bathymetry and multichannel seismic reflection profiles, research has identified a submarine landslide with steep headwall and sidewall scarps 15 km (9 mi) off the northwestern coast of Puerto Rico. Based on this new data it has been postulated that the landslide, which was induced by the earthquake, was responsible for the generation of the tsunami.

The staff verified that in Revision 1 of the ESP application (May 12, 2012), the applicant revised SSAR Section 2.4.6.1.3 to reflect this change in source location.

2. Paleotsunami Deposits

A tsunami deposit is usually identified by sedimentary context such as larger grain size than surrounding sediments, spatial distribution of the deposit, and by ruling out other higher-energy depositional modes (Jaffe and Gelfenbaum, 2002).

Samples obtained from site borings were consistent with the fluvial and marine depositional conditions described in published literature and discussed in SSAR Section 2.5.1.2.3.2. The geologic strata at the PSEG Site consist of Lower Cretaceous, Upper Cretaceous, Lower Tertiary (Paleocene), Upper Tertiary (Neogene), and Quaternary formations above the basement rock. The dominant depositional processes for these strata were marine and fluvial over a series of regressive and transgressive events. The Cretaceous/Tertiary boundary was penetrated by the 16 borings performed for the PSEG Site exploration. Review of samples from the borings indicated strata or features that are consistent with the depositional environments described in SSAR Section 2.5.1.2.3.2, and the site samples were not interpreted to represent a paleotsunami occurrence.

Representatives of the New Jersey Geological Survey (NJGS) were contacted to determine if they have any knowledge of geologic evidence for paleotsunamis in the New Jersey area. As a result of the conversations with NJGS, Miller, et al. (2003) was identified as reporting evidence of tsunami deposits in the New Jersey area. Review of Miller, et al. (2003) determined that

boreholes drilled at Bass River, NJ (approximately 95 km (59 mi) east of the PSEG Site) and at Ancora, NJ (approximately 64 km (40 mi) northeast of the PSEG Site), as part of the Ocean Drilling Program, found a thin (less than 10 cm (4 in.) thick) clast unit above the Cretaceous/Tertiary boundary that appears to be related to a tsunami. The tsunami was not considered related to earthquakes, but is attributed, possibly, to a massive slumping on the Atlantic slope related to the bolide impact near Chicxulub, Mexico, that marked the end of the Cretaceous (Miller, et al., 2003).

The applicant committed to revise SSAR Sections 2.4.6, 2.5.1 and 2.5.4 to expand on the discussion of paleotsunamis. The staff confirmed that Revision 1 of the ESP application (May 21, 2012) reflects the revised SSAR text and figure. Accordingly, the staff considers RAI 20, Question 02.04.06-1 resolved.

In RAI 20, Question 02.04.06-2, the staff requested that the applicant provide an updated figure showing a maximum slope angle of 0.3 degrees and an updated figure/reference to related work in SSAR Section 2.5.5 in a revision of the SSAR. In a May 11, 2011, response to RAI 20, Question 02.04.06-2, the applicant stated that SSAR Figure 2.4.6-1 has a scale of slope (i.e., dimensionless rise over run) ranging from 0 to 0.002. At the maximum scale value, the angle of the slope would equal 0.115 degrees. To minimize any further confusion over this figure, the applicant revised the figure to have a dimensioned scale in angular degrees. The staff verified that Revision 1 of the ESP application (May 21, 2012) contains the applicant's committed change.

In SSAR Section 2.5.5, the applicant stated that the analysis of slopes will be conducted at the COL stage. SSAR Section 2.5.5.1 discusses the general site slope characteristics and states that analyses will consider potential failure surfaces extending into the Delaware River. The applicant's text also states that portions of the site outside the new plant power block are relatively flat, and that there are no existing slopes on the site, either natural or manmade, that could affect the stability of the site. The applicant committed to revise SSAR Section 2.4.6.2 to reflect the following:

> Figure 2.4.6-1 shows the naturally occurring angular topography slopes on a grid in the vicinity of the PSEG Site, and shows a maximum slope value of 0.3^{o} occurring inland of the site. Stability analysis will be conducted during the COLA phase of the project, and will include consideration of failure surfaces that extend into the Delaware River adjacent to the site as discussed in SSAR Subsection 2.5.5.1.

SSAR Figure 2.4.6-1, provided in Enclosure 3 of the applicant's May 11, 2011, response to RAI 20, Question 02.04.06-2, was revised by the applicant and submitted in a May 31, 2011, supplement to the May 11, 2011, response. The applicant committed to revise the SSAR to provide a scale in angular degrees. The staff confirmed that Revision 1 of the ESP application (May 21, 2012) contains the applicant's committed changes. Accordingly, the staff considers RAI 20, Question 02.04.06-2 resolved.

2.4.6.4.2 Historical Tsunami Record

<u>Information Submitted by the Applicant</u>

SSAR Section 2.4.6.1 provides a list of 10 historical tsunamis that have affected the eastern United States and Canada since 1755. From these, the applicant identified four potential tsunamigenic sources that could affect the PSEG Site: a submarine landslide on the continental

shelf along the U.S. east coast; seismic or volcanic sources along the Atlantic Ocean's eastern boundary; coseismic activity in the subduction zones of several Caribbean trenches; and earthquake zones in the North Atlantic Ocean. The applicant indicated that historical records suggest the largest tsunami in the mid-Atlantic region of the U.S. east coast would originate from the first three of these sources.

The applicant suggested a large submarine mass-failure event, known as the Currituck landslide, occurred off the coast of North Carolina in the late Pleistocene era. Simulations of the event (ten Brink, et al., 2008) suggest that coastlines immediately facing the slide experienced tsunami amplitudes of about 6 m (20 ft), but that the upcoast and downcoast effects were on the order of 2.01 m (6.6 ft).

The applicant indicated that a significant Atlantic Ocean tsunami generated off the coast of Portugal in 1755 affected the U.S. east coast. However, although runup in Portugal may have been more than 30 m (98 ft), numerical simulations indicate the maximum tsunami amplitudes along the U.S. east coast reached 3 m (9.8 ft) (Mader, 2001).

The applicant indicated that a tsunamigenic $M_w = 7.3$ earthquake occurred within the Puerto Rico Trench in 1918. The resulting tsunami caused runup in Puerto Rico of almost 6 m (20 ft), but only 0.06 m (0.2 ft) at a tide gauge in Atlantic City, NJ, 64.37 km (40 mi) northeast of the mouth of the Delaware Bay.

The 1929 $M_w = 7.2$ earthquake and associated landslide in the Grand Banks caused the largest recorded tsunami in the northern part of the North American east coast. The applicant indicates that the runup height at the Burin Peninsula (Newfoundland) was 27 m (89 ft), but that the effects were mostly confined to the Newfoundland coast. The applicant noted that the water-level records at Atlantic City suggest a maximum tsunami amplitude of 0.68 m (2.2 ft).

The Staff's Technical Evaluation

The applicant summarized the essential historical record of tsunamis in the region. The staff performed an independent review of the tsunami historical record with respect to the source characteristics needed to determine the PMT. These characteristics include detailed geo-seismic descriptions of the controlling local tsunami generators, including location, source dimensions, and maximum displacement. Based on this review, the staff determined that the applicant needed to provide additional information regarding the historical record to assist in the characterization of potential tsunami sources that might impact the site, and on April 11, 2011, issued RAI 20, Question 02.04.06-3, requesting that the applicant address the following:

(1) Other Regional Landslide Sources (Missing from SSAR). Provide description, parameters, and tsunami estimates of other mapped landslide sources that might impact the site, as well as a discussion of how the Currituck was chosen as the primary landslide tsunami source on the continental shelf.

(2) Activity of Offshore Portugal Seismic Zone (SSAR 2.4.6.2 2nd Paragraph). Discuss what the applicant means by "inactive" as applied to the seismic zone offshore Portugal. This is an important consideration with regard to the historical tsunami record and tsunami generating potential from that region.

In a May 11, 2011, response to RAI 20, Question 02.04.06-3, the applicant provided the following:

(1) Other Regional Landslide Sources

The applicant stated that the Currituck slide is one of several apparent Paleolithic slide events occurring on the outer slope of the U.S. East Coast continental shelf. Landslide-generated tsunamis typically cause the greatest levels of inundation on shorelines immediately landward of the slide event. Therefore, the applicant stated that it is most relevant to consider additional historical or potential slides in the Mid-Atlantic Bight region, spanning from the Hudson Canyon to Cape Hatteras. The applicant's review of morphological studies (Twichell, et al., 2009) of slide deposits in this region concluded that the most prominent slides are fluvial in origin, being linked to river delta deposits formed during the late Quaternary low stand of sea level, when the major rivers of the regions reached across the present shelf. In particular, the Currituck slide is associated with the delta of the Susquehanna River. Additional deltas of the Delaware and Hudson Rivers also have associated slide deposits. Information on the distribution of slide volumes (Chaytor, et al., 2009) showed that the Currituck slide is the largest slide occurring in the region, making it the most logical candidate for study. SSAR Section 2.4.6 was revised to include this discussion.

(2) Activity of Offshore Portugal Seismic Zone

That applicant stated that the word "inactive" was not intended to minimize the tsunami generating potential from the offshore Portugal region. The applicant revised SSAR Section 2.4.6 to delete the term.

The applicant committed to add references Canals, et al., (2004) and Locat, et al., (2009a) to SSAR Section 2.4.6.

The staff confirmed that Revision 1 of the ESP application (May 21, 2012), reflects the revised SSAR text and references. The staff considers RAI 20, Question 02.04.06-3 resolved.

2.4.6.4.3 Source Generator Characteristics

Information Submitted by the Applicant

The applicant stated that the values used in this study for the source generator characteristics are from available literature sources. For the Currituck landslide, the applicant followed ten Brink et al. (2008) in using a total slide volume of 165 cubic kilometers (216 billion cubic yards), and a vertical slide displacement of 1,750 m (5,742 ft). The applicant indicated that although the source location was initially taken as the location of the actual landslide, three additional locations to the north were also tested.

The applicant also considered the collapse of the flank of the Cumbre Vieja volcano on the island of La Palma in the Canary Islands. The applicant indicated that this hypothetical event has been extensively studied and that the main source input is based on the scientific literature. The applicant indicated that a previous study (Løvholt, et al., 2008) using a Boussinesq-type model, predicted that the maximum runup in the Canary Islands was 188 m (617 ft) based on a landslide depth of 1,635 m (5,363 ft). The applicant noted that model predictions of Løvholt, et al., (2008) are smaller than those of Ward and Day (2001), but larger than those of Mader (2001).

For a Hispaniola Trench earthquake, the applicant assumed that the subduction zone slip event occurs along the full length of the trench. The applicant indicated that this event is modeled by dividing the trench into seven segments and that the vertical displacement of each segment is determined using the half-plane solution of Okada (1985) to obtain a M_w = 9.0 earthquake.

The Staff's Technical Evaluation

Potential tsunami sources that are likely to determine the PMT at the PSEG Site include subaerial and submarine landslides, near-field intra-plate earthquakes, volcanic eruption and sector collapse, and inter-plate earthquakes. Based on the analysis of currently available data, the staff concludes that the causative tsunami generator for the PMT at the PSEG Site is local submarine landslides. Details are provided below.

Subaerial Landslides

With regard to subaerial landslides, there are no significant coastal cliffs near the PSEG Site that would produce tsunami-like waves that exceed the amplitude of those generated by other sources. The lower Delaware Estuary-Bay region is characterized by gently sloping topography inland, transitioning to a relatively flat coastal plain along the coast, dominated by salt marshes, sandy beaches and dunes, and coastal forests. Coastal elevations do not exceed 3 m (10 ft), except in the Wilmington, DE area where gently sloping hills reach the Delaware Bay, resulting in elevations of approximately 7 m (23 ft) at the coastline (USGS Marcus Hook Quadrangle PA-DE-NJ).

Volcanogenic Sources

According to the Global Volcanism Program of the Smithsonian Institution (http://www.volcano.si.edu/), there are two general regions of volcanic activity that have the potential to generate localized wave activity along the east coast of the United States: (1) Lesser Antilles; and (2) Canary Islands/Azores/Cape Verdes Islands. Subaerial and submarine eruptive and debris avalanche processes on the volcanic islands of the Lesser Antilles have generated a number of tsunamis over the last 150 years (Pararas-Carayannis, G., 2002, Pelinovsky, et al., 2003, and Poisson and Pedreros, 2010). While observations and modeling indicate significant local effects, wave heights attenuate rapidly before reaching other islands within the Lesser Antilles chain (Poisson and Pedreros, 2010 and Heinrich, et al., 1998). Due to the rapid attenuation of wave heights and complicated propagation path created by the islands of the Lesser Antilles themselves, tsunami amplitudes from these volcanoes are unlikely to be significant along the east coast of the United States (Smith and Shepherd, 1995).

Canary Islands Region: The maximum credible landslide event is a catastrophic volcanic flank failure along the SW flank of La Palma Island. The maximum estimated landslide volume is 500 km^3 (120 mi^3) (Ward and Day, 2001), though Masson, et al., 2006 notes that this volume is 2 to 3 times bigger than a typical Canary island landslide and that such landslides often fail as separate (in terms of tsunami generation) sub-events. The geologic age of these landslides range from 13,000-17,000 ybp (Years Before Present (geology)) for the El Golfo landslide on El Hierro Island to over a 1 million ybp (Masson, et al., 2006). From these studies, the age of the Cumbre Nueva landslide for which the maximum credible landslide event is based is 125,000-536,000 ybp. The initial research on the La Palma flank failure (Ward and Day, 2001) predicts wave heights of 10-25 m (33 ft to 82 ft) on the eastern shore of North America from the 500 km^3 (120 mi^3) landslide volume. The hydrodynamic model used by Ward and Day (Ward and Day, 2001), however, does not include the effects of non-linear advection or wave breaking.

More recent research that incorporates these effects suggests wave heights along the eastern U.S. coast from this failure would be less than 3 m (9.8 ft) (Mader, 2001) or less than 1 m (3 ft) (Gisler and Weaver, 2006).

Based on existing evidence, volcanoes along the Lesser Antilles or in the eastern Atlantic Ocean are too far away, unfavorably situated, and/or have modeling to show reduced wave heights along the U.S. east coast.

Intra-Plate Earthquakes

The primary sources of intra-plate earthquakes suitably located to generate tsunamis are the mid-Atlantic Ridge and associated transform faults. Mid-ocean ridge faults are unlikely to generate transoceanic tsunamis because of a low corner magnitude (M_{cm} = 5.82±0.07) (Bird, et al., 2002). Oceanic transform faults have a higher corner magnitude because there is little vertical displacement associated with strike-slip earthquakes; only small tsunamis can be expected from these fault zones.

Inter-Plate Earthquakes

The Azores-Gibraltar Oceanic Convergence Boundary: The offshore boundary between the African and Eurasian tectonic plates is classified as an oceanic convergence boundary (Bird, 2003). An M=8.4-8.7 earthquake along this plate boundary offshore of Lisbon in 1755, generated a transoceanic tsunami that was observed in the Caribbean and Canada. The specific faults that make up this plate boundary in the Azores Gibraltar region are highly complex.

Using the statistical analysis of Bird and Kagan (2004), we can estimate the magnitude distribution of earthquakes along the world's oceanic convergence zones. Due to a much smaller sample size in comparison to subduction zones, however, there is much greater uncertainty in the distribution curves for the earthquakes (Geist and Parsons, 2009). The maximum tsunami amplitude offshore of the Delaware Bay entrance from a M=8.4-8.7 Azores-Gibraltar earthquake is approximately 0.5 m (Barkan, et al., 2009). The annual probability for this size earthquake is $1.0 \times 10^{-6} – 2.5 \times 10^{-4}$ (high degree of uncertainty).

The Greater Antilles Subduction Zone: This fault represents the boundary between the North American and Caribbean tectonic plates, in which the North American plate is being subducted (pulled beneath) the Caribbean plate. The types of earthquakes that are generated along subduction zones involve thrust motion with large amounts of vertical seafloor motion and are relatively efficient at generating tsunamis. In comparison, transform plate boundaries involve strike-slip motion and are much less efficient at generating tsunamis. Since the relative convergence direction between the two plates at the Greater Antilles subduction zone is highly oblique to the orientation of the fault, it is possible that there may be a mixed mode of thrust and strike-slip motion for earthquakes at this subduction zone.

Due to the large surface area of these faults, the world's largest earthquakes occur on subduction zone thrusts. As explained in Geist and Parsons (2009), there are several methods to determine the maximum magnitude that can occur on subduction zones. The most conservative method is a statistical fit to the frequency-magnitude distribution of earthquakes (known as the Gutenberg-Richter distribution) that occur on all of the world's subduction zones (Bird and Kagan, 2004). Since the length of the Greater Antilles subduction zone may limit the

maximum earthquake magnitude possible, parametric and empirical methods are also considered.

The maximum tsunami amplitude offshore of the Delaware Bay entrance from a M=9.1 Greater Antilles subduction earthquake is approximately 1-3 m (3 ft to 10 ft) (ten Brink, et al., 2007).

Far-Field Submarine Landslides

Puerto Rico trench: Numerous landslide scarps of various sizes are present along the southern margin of the Puerto Rico trench, primarily within the Arecibo and Loiza amphitheaters, but also elsewhere along the edge of the Puerto Rico-Virgin Island (PR-VI) carbonate platform and within Mona Canyon. While the Aricebo and Loiza amphitheaters were initially considered to each be the result of large, potentially catastrophic slope failures (volume estimates of up to 1,500 km^3; (360 mi^3) (Schwab, et al., 1991 and Mercado, et al., 2002)), recent analysis of high-resolution geophysical data and sediment cores suggests that the amphitheaters were created by numerous, smaller failure events (Figure -11; ten Brink, et al., 2006). The largest of the landslides identified in ten Brink, et al., (2006) has a volume of 22 km^3 (5.3 mi^3). Lopez-Venegas, et al., (2008) identified a submarine landslide at the head of Mona Canyon northwest of Puerto Rico (volume of 10 km^3 (2.4 mi^3) that may have been initiated by the 1918 Mona Passage earthquake and been the principle source of the tsunami that impacted Puerto Rico and nearby coasts.

East Atlantic Ocean Margins: Numerous submarine landslide scars and mass transport deposits have been identified along the European and African coasts of the Atlantic Ocean (Canals, et al., 2004). The Storegga (Norway) and Sahara (Africa) landslides are two of the largest and most well studied from these margins. Modeling of the tsunami generated by the Storegga landslide shows significant local wave heights that diminish with distance that correspond to coastal inundations identified by onshore tsunami deposits in Norway, Scotland, etc. The U.S. east coast will likely experience limited or no effect from this tsunami with wave heights lower than that from a local submarine landslide source. No numerical modeling has yet been performed on the 60,000-year-old Sahara Slide, but given its similarity to submarine landslides along the west North Atlantic margin, it is expected that any transoceanic tsunami will not exceed the effects of a local submarine landslide source.

For the remainder of this section, the staff focuses on submarine landslide sources as the principal generator for the PMT at the PSEG Site.

Local Submarine Landslides

Much, if not all, of the continental slope offshore of the U.S. mid-Atlantic coast has been shaped by geologically recent (Late Pleistocene-Holocene) submarine mass failures (Twichell, et al., 2009). The most recent mapping of this region highlights the prevalence of composite landslides/debris flows, rather than discrete failures, across this region, complicating the determination of tsunami source characteristics. Since it is the best expressed and most well studied of the submarine landslides in the mid-Atlantic region, the maximum credible landslide event in this region is based on the past occurrence of the Currituck landslide (approximately 60 km (37 mi) south of Norfolk Canyon), one of the four largest submarine landslides (in volume) identified along the U.S. east coast.

The Currituck landslide occurred as two subevents that appear to have occurred contemporaneously (Locat, et al., 2009a). The total volume of the landslide is estimated to be

128 km^3 (30 mi^3) in Locat, et al., 2009a and 165 km^3 (40 mi^3) in Locat, et al., 2009b. As the latter estimate is most conservative, it is used as the maximum credible volume.

Quaternary shelf edge delta deposits derived from the ancestral Delaware, Susquehanna, and Roanoke Rivers likely make up the bulk of the failed material along the mid-Atlantic continental shelf and slope, but some Pliocene strata may have been removed as well (Locat, et al., 2009b) and Bunn and McGregor, 1980). Approximately 4-9 m (13 ft to 30 ft) of sediment has accumulated since the Currituck landslide (Locat, et al., 2009b) leading to an estimated age of the failure of between 25,000-50,000 ybp, based on average sedimentation rates of 5 cm/year (2 in./year) for sediment burying the scar and deposits (Locat, et al., 2009b and Lee, 2009).

Seismic Seiches

Seismic seiches are fundamentally a different type of wave than tsunamis. Rather than being impulsively generated by displacement of the sea floor, seismic seiches occur from resonance of seismic surface waves (continental Rayleigh and Love waves) within enclosed or semi-enclosed bodies of water. The harmonic periods of the oscillation are dependent on the dimensions and geometry of the body of water. Seismic seiches have not been recorded along the U.S. east coast.

Evaluation of PSEG Site Geotechnical Boring Logs

An independent analysis of the geotechnical and observation well boring logs collected on behalf of the applicant by MACTEC Engineering and Consulting, Inc. (SSAR Appendix 2AA) primarily within the footprints of the proposed new power block and east of the existing operating station, was conducted to identify any intervals with characteristics commonly associated with tsunami deposits. Logs from 26 borings were reviewed. It should be noted that the borings are not continuously sampled and are primarily a geotechnical tool and, therefore, do not contain detailed stratigraphic, lithologic, or textural descriptions. The PSEG Site sits on an artificial island over what once was a peripheral margin of Delaware Bay/River. Filling of the island began in the early 1900s and was essentially complete by the early 1940s. Sedimentary deposits (‘alluvium’) below the artificial fill is consistent with an environment that has switched between estuarine/salt-marsh and higher energy fluvial settings. Due to the limited geologic information and the complicated estuarine/fluvial and artificial fill architecture of the PSEG Site, the evaluation of the boring logs in a paleotsunami deposit sense is inconclusive.

Stratigraphy Encountered in Logs

The PSEG Site lies within the mid-Atlantic coastal plain, which consists of Mesozoic to Recent eastward thickening wedges of unconsolidated fluvio-deltaic and marine sediments that progress seaward across the continental shelf (Olsson, et al., 1988). In the Salem, NJ area, the coastal plain deposits consist of (from oldest to youngest): the Cretaceous Potomac Group; Upper Cretaceous Magothy; Merchantville; Englishtown; Marshalltown; Mt. Laurel; Navesink; and New Egypt formations, Paleocene Hornerstown and Vincentown formations, and the Miocene Kirkwood Formation (Olsson, et al., 1988). Based on the geotechnical logs (SSAR Appendix 2AA), the deepest of the borings (EB-3) encountered is the full Cretaceous to Miocene sequence as well as the overlying alluvium and fill deposits, while the remainder of the borings bottomed in the Mt. Laurel or Marshalltown formations.

2.4.6.4.4 Tsunami Analysis

Information Submitted by the Applicant

In SSAR Section 2.4.6.4, the applicant indicated that the Method of Splitting Tsunami (MOST) model (Titov and Gonzalez, 1997) is used to simulate the three case studies. The MOST model has also been extensively validated and verified by comparing numerical results with results from the operational version of the code at the University of Southern California. In addition, the MOST model provides a hierarchical environment that can describe tsunami generation, propagation, and inundation using a system of three nested grids. The grids used in the tsunami hazard analysis include a large-scale grid A, an intermediate-resolution grid B, and a high-resolution grid C that includes the PSEG Site.

The applicant stated that the MOST model is based on the nonlinear shallow-water equations and incorporates bottom friction by using Manning's formula. All three case studies are simulated using a Manning's coefficient (n = 0.01), which is assumed to represent smooth bed conditions and correspond to a conservative, worst-case PMT. Two sets of simulations are performed for each scenario. The first set uses a still water level corresponding to the 10 percent exceedance high tide to determine the maximum runup. The second set uses a still water level corresponding to the 90 percent exceedance low tide to determine the maximum drawdown.

The applicant noted that a water level in Delaware Bay corresponding to the 10 percent exceedance high tide at the PSEG Site represents a static water elevation of 1.4 m (4.5 ft) NAVD88. The applicant indicated that the topographic and bathymetric data used to construct the model domains were obtained from the NOAA National Geophysical Data Center (NGDC) Coastal Relief Model (CRM), the NOAA National Ocean Service (NOS) Arc Global Relief Model (ETOPO 1), and the New Jersey and Delaware Digital Elevation Grids.

The applicant indicated that the large-scale grids differ for each case study, and that these grids were generated based on ETOPO 1 for the La Palma and Hispaniola tsunamis, and include the continental shelf and offshore areas in the Atlantic Ocean for the Currituck landslide. The intermediate-resolution grids are based on CRM, and the same grid is used for the La Palma and Hispaniola case studies. A different grid is used for the Currituck landslide. The high-resolution grids are the same for all three case studies and are based on the CRM and NJ and DE digital elevation grids. To account for the different datums of the different datasets, the applicant indicated that NOAA's vertical datum transformation tool was used.

The Staff's Technical Evaluation

Numerical Grid Development

The bathymetry/topography grid required by the hydrodynamic model is created via two main sources: (1) the GEBCO 1-minute global elevation database, and (2) 3-arcsec (approximately 90-m) resolution elevation data taken from the NOAA Coastal Relief Model for Delaware Bay. The bathymetry and topography are shifted vertically to account for high tide and sea level rise. Mean high water in the area of the site is 1.63 m (5.35 ft) above mean low water and 0.77 m (2.53 ft) above the NAVD88 datum (data taken from the Reedy Point, DE tidal station). To account for sea level rise, 0.75 m (2.46 ft) is added to the still water level; this value exceeds the upper limit of the sea level rise as given in the IPCC 2007 report. Therefore, the staff's sea level

rise estimate is considered more conservative than the applicant's. Thus, the total vertical shift leads to a still water level of +1.52 m (4.99 ft) NAVD88.

In the Atlantic Ocean Basin, there are known significant potential tsunami source locations. Following the source discussion given in the previous section, most of these can be eliminated as being clearly less energetic than others. For example, for distance earthquake sources, a very large event along the Puerto Rico Subduction Zone will produce a larger wave at the site due to proximity and directionality. Distant landslide generated waves will be controlled by the Canary Island source, which will utilize information from the largest (in volume) published hypothetical event, even if this large volume is debatably implausible. The nearfield landslide source to be examined is the Currituck landslide, which occurred just offshore of the site.

Numerical Simulations – Physical Limits

The purpose of these simulations is to provide an absolute upper limit on the tsunami wave height that could be generated by the three potential sources. Note that these limiting simulations use physical assumptions that are implausible for landslide sources; the results of these simulations will be used to filter out tsunami sources that are incapable of adversely impacting the PSEG Site under even the most conservative assumptions. Specifically, these assumptions are as follows:

1. Time scale of the seafloor motion is very small compared to the period of the generated water wave (tsunami).

2. Bottom roughness, and the associated energy dissipation, is negligible in locations that are initially wet (i.e., locations with negative bottom elevation, offshore).

Assumption 1 simplifies the numerical analysis considerably. With this assumption, the sea surface response matches the change in the seafloor profile exactly. This type of approximation is used commonly for subduction-earthquake-generated tsunamis, but is known to be very conservative for landslide tsunamis (Lynett and Liu, 2002). The incorporation of this modeling simplification is driven by the desire to remove specification of the landslide time history, and its large associated imprecision and uncertainty. The initial pre-landslide bathymetry profile, as estimated by examination of neighboring depth contours, is subtracted by the post (existing) landslide bathymetry profile. This "difference surface" is smoothed and then used directly as a "hot-start" initial free surface condition in the hydrodynamic model.

Assumption 2 does not simplify the analysis significantly; however, it does prevent the use of an overly high bottom roughness coefficient, which could artificially reduce the tsunami energy reaching the shoreline. Note that while the offshore regions are assumed to be without bottom friction, such an assumption is too physically unrealistic to accept for the inland regions where the roughness height may be the same order as the flow depth. For tsunami inundation, particularly for regions such as this project location where the wave might inundate long reaches of densely vegetated land, inclusion of some measure of bottom roughness is necessary.

<u>Currituck Landslide Source</u>

As provided in the landslide characterization section, the excavation depth of this slide is approximately 300 m (984 ft). This length provides the trough elevation (i.e., -300 m (984 ft)) of the hot-start initial water surface condition. The horizontal dimensions of the slide source region are ~20 km (12 mi) in width and 50 km (31 mi) in length.

For this tsunami hazard investigation, the simulation domain was divided into two separate, but coupled, components – an offshore domain and a nearshore domain. First, a simulation was performed to look at the waves near the offshore source and their evolution in shallow water approaching the Delaware Bay. These simulations provided a time series of water surface elevation and fluid velocity near the Delaware Bay entrance. These time series were then used to force the nearshore domain, which encompasses the entire Delaware Bay. The two domains, offshore and nearshore, were both too large in memory and computational requirements to be run simultaneously.

The Currituck landslide is the largest estimated submarine landslide in the region, thus the staff performed one-horizontal-dimension (1D) and two-horizontal-dimension (2D) simulations to examine the offshore source. The 1D simulations do not include the radial spreading and refraction effects. Physically, a 1D simulation is approximating a simultaneous slope failure of the entire continental shelf along the eastern seaboard.

First, results from the 1D offshore domain are discussed. The depth transect is taken from the source location directly to the Delaware Bay entrance. A constant spatial grid size of 25 m (82 ft) is used across the transect for the 1D cases. The simulation is based on the fully nonlinear Boussinesq equations, with wave breaking included. Note that the entire bottom profile is submerged, and thus there is no bottom friction dissipation in any form in this simulation. Although the generated wave is initially characterized as a leading depression wave, this depression is quickly overrun by the following and faster-moving positive elevation wave. The wide shallow shelf leads to a depth-limiting effect on the wave height. This height decreases from approximately 200 m (656 ft) at the shelf break to approximately 40 m (131 ft) near the Delaware Bay entrance. By this time, the incident wave has transformed into a long period pulse of positive elevation energy.

While there is little in the literature to evaluate these results in any context, these records can be compared with the numerical simulations presented in Geist, et al., (2009). In Geis, et al., (2009), attempts were made to simulate the waves directly from an assumed landslide motion (i.e., to generate the waves physically from the bottom boundary condition rather than use an initial hot start condition). In addition, the wave on the shelf was simulated in 1HD, similar to this NRC study. In Geist, et al., (2009), the tsunami elevation near the shoreline was approximately 6 m (20 ft), while at the shelf break it was approximately 15 m (49 ft). The difference in reduction factors, 6/15=0.4 from Geist, et al., (2009) and 40/200=0.20 from this NRC study, is attributed to the depth-limiting effect. With long lengths of shallow depth propagation, large amplitude waves will be dissipated – here meaning reduced in amplitude -- much faster than relatively smaller waves.

Next, with a time series from the 1HD offshore simulation taken near the Delaware Bay entrance, the nearshore domain simulation can proceed. The nearshore domain uses a constant spatial grid size of 100 m (328 ft). The simulation is based on the fully nonlinear Boussinesq equations, with wave breaking included. On initially dry land, bottom friction due to a roughness characteristic of a smooth, even surface (Manning's n=0.02) is employed; elsewhere again there is no friction. Note that the elevations given in these figures are relative to the simulation datum of 1.52 m (+4.99 ft) NAVD88; 1.52 m (4.99 ft) should be added to the presented values in order to convert them to a NAVD88 elevation. Of immediate note is the rapid attenuation of wave height through the entrance of the Delaware Bay. The tsunami elevation immediately offshore of the Delaware Bay is greater than 20 m (65.6 ft), yet 20 km (12.5 mi) up channel, the maximum elevation is close to 12 m (39.4 ft). The wave height

continues to diminish as the wave propagates further up channel due to directional interference. Near the PSEG Site, the maximum 1HD water elevation reaches 8.6 m (+28.2 ft) NAVD88.

The maximum 1HD values of water surface elevation show a rapid decrease in wave height near the entrance. Similarly, the largest recorded fluid speed values are isolated to the area near the entrance, and quickly reduce inside the Delaware Bay. Note, however, that fluid speeds near the entrance are extreme, with a large area experiencing speeds greater than 10 m/s (32.8 ft/s). As expected, the channel just offshore of the PSEG Site shows a local maximum in speeds. Here the water velocity reaches 5.9 m/s (19.4 ft/s). This large velocity is largely isolated to the Delaware Bay channel, and maximum speeds at the PSEG site are 3.3 m/s (10.8 ft/s).

For the 2D investigation, two simulations, each using a different bottom friction coefficient, show the range of possible tsunami elevations near the site. Each 2D simulation setup is identical, except for bottom friction coefficient. In one simulation, the bottom friction is set to zero at all initially submerged grid points. The other simulation imposes a Manning's *n* value of 0.025, corresponding to a smooth, natural bed, at all initially submerged grid points. This friction coefficient is a realistic, if not conservative, estimate for the continental shelf seafloor. Inside the Delaware River estuary, a Manning's *n* of 0.025 would be considered conservative, as published studies have found values of 0.03-0.04 more realistic (e.g., Ambrose and Roesch, 1982). For both 2D simulations, all initially dry locations use a Manning's *n* value of 0.025.

The 2D simulations predict a maximum tsunami elevation of 6.0 m (19.7 ft) with the no-friction simulation and 1.0 m (3.3 ft) from the with-friction simulation. The PMT is taken from the with-friction simulation, which still employs a conservative friction coefficient.

Canary Islands Source

The Canary Islands landslide source has initiated significant debate within the tsunami research community. The initial tsunami assessment by Ward and Day (Ward and Day, 2001), due to a coherent failure of an entire island into the ocean, led to runup predictions of 10 to 25 m (32 ft to 82 ft) along nearly the entire east coast of the United States. Subsequent studies (Mader, 2001) have attempted to downplay the hazard, with reductions in runup by a factor of 10 for the most extreme case. In this study, the staff applies the most conservative published source values. Similar to the previous examinations, if this conservative setup has a damaging effect on the PSEG Site, the source parameters will be given additional scrutiny and unreasonable conservatism will be relaxed under the Hierarchical Hazards Approach (HHA) methodology.

The simulation approach for the Canary Island scenario utilizes three different simulation domains. The first will be the Atlantic Ocean domain (ocean domain), which is used to simulate the tsunami from its source to the continental shelf of the eastern United States. The output from the ocean domain is used to force a domain focused on the effects of the continental shelf break and the shallow shelf waters (shelf domain). The reason for this separation of offshore domains is due to the fact that important physical spatial scales in the open ocean are 1-10 km (0.62 – 6.2 mi), while on the shelf, where front steeping and breaking play a role, the relevant length scales are 10-100 m (32.8 – 328 ft). To accommodate this variability across two orders of magnitude, it is computationally most reasonable to tackle the problem with separated domains, executed independently. The third domain used for this tsunami scenario is the same nearshore domain as used with the Currituck scenario, which is forced with output from the shelf domain.

Following Reference Mader (2001), a coherent La Palma collapse will generate an initial wave with amplitude approaching 1,000 m (3,281 ft). For the simulations here, a hot start condition is placed just offshore of La Palma, with a crest elevation of 1,000 m (+3,281 ft) and a trough elevation of -1,000 m (-3,281 ft). The disturbance has a length of 50 km (31.1 mi) and a width of 25 km (15.5 mi), again taken approximately from the information in Mader (2001). The wave propagation is modeled in the entire northern Atlantic Ocean in the ocean domain, using a grid length of 2 km (1.2 mi). The simulation is based on the fully nonlinear Boussinesq equations, with wave breaking included. Snapshots of the wave field 30 minutes after generation show the wave field spreading radially, almost as a point source, with the wave spreading rapidly both through radial spreading and frequency dispersion. In time, the tsunami has transformed into a long train with the longest frequencies at the lead; note that the largest crest does not in fact occur with the first wave. When reaching the continental shelf break along the eastern United States, the maximum crest elevation is less than 10 m (32.8 ft). The leading wave has a period of approximately 750 seconds which decreases to approximately 350 seconds near the back end of the train. The largest wave heights are located within this period range.

The 2-km (1.2-mi) grid used in the Atlantic Ocean simulation described above is not fine enough to resolve the shoaling and dissipation processes on the shallow continental shelf. Thus, to estimate the wave height at the entrance of the Delaware Bay from the Canary Islands tsunami, a second offshore simulation must be run, described above as the shelf domain. The wave disturbance as it approaches the shelf has little along-coast variability, and it is deemed that a 1HD, cross-sectional simulation will very reasonably capture the transformation of this wave train over the shelf break and across the shallow shelf. Snapshots of this 1HD offshore simulation at the shelf break show the largest of the waves shoaling to a great height, with crest elevations close 40 m (131.2 ft), and break immediately thereafter. These waves then form individual bore fronts which quickly travel across the shallow water shelf, decreasing in crest elevation as they approach the shoreline. The resulting disturbance has the form of a large number of 5-10 m (~16 – 33 ft) high bore fronts, one after the next, spaced 2-8 minutes apart. These bore fronts can become stacked on top of one another. This process, driven by amplitude dispersion, can lead to an amplified bore front if a trailing large bore overtakes and combines with a leading smaller, and slower traveling, bore.

The offshore forcing for the nearshore domain uses the identical numerical setup described in the Currituck scenario section. Due to the relatively short period of the individual pulses, compared to the Currituck wave, as well as the smaller incident crest elevations, less wave energy is able to travel far up the Delaware Bay. Similar to Currituck, the scattering of the wave at the entrance is the primary wave height reducer. The maximum recorded water surface elevation and fluid speed at the PSEG Site for the Canary Islands tsunami is also smaller than that due to the Currituck event. For the Canary Islands tsunami, the maximum sea surface elevation is 6.1 m (+20 ft) NAVD88 (including high tide and sea level rise) and the maximum fluid speed is 2.3 m/s (7.5 ft/s) at the PSEG Site. Thus, despite the tremendous wave heights at the source region, by the time the wave has spread radially in the Atlantic, spread energy through frequency dispersion, dissipated due to breaking along the continental shelf, and traversed the geometrically irregular Bay, the tsunami elevation is reduced by orders of magnitude.

Puerto Rico Subduction Zone Source

The last source to be investigated for the PSEG Site is the subduction zone that borders much of the northeastern and eastern extent of the Caribbean Islands. Here, the staff assumes that

the entire fault zone ruptures during a single earthquake event. Seafloor displacements are taken as the expected maximum values that this fault might generate. The initial sea surface condition is a direct mapping of the vertical seafloor displacement to the ocean surface. It is clear to the staff that the total rupture is composed of five individual regions; a simplification used to reasonably characterize the entire length. It is also evident to the staff that the largest waves will be directed toward the northeast Atlantic basin.

With a subduction zone earthquake, the generated waves are long in wavelength. The staff notes that this implies that the physics of the waves are simpler, relative to the dispersive waves created by the two landslide sources examined previously. To numerically model this source, the open-source tsunami model COMCOT (Cornell Multi-grid Coupled Tsunami Model) is used. A grid covering the entire western Atlantic is generated with a spatial grid size of 1 minute (1/60 of a degree latitude or longitude). A single grid layer is used; there is no nesting of domains for refinement. The time step used by the model is 1 second. The linear version of the model is used, and there is no bottom friction applied anywhere in the domain. The linear version of the model is deemed acceptable because, as will be shown, the wave height to water depth ratio is less than 0.1 at all areas of interest, and usually no greater than 0.01.

Once the wave exits the source area, the crest elevation of the main wave is about 2 m (6.6 ft) in the open ocean; Bermuda would experience an extreme and damaging wave. It is clear that the east coast of the United States, while certainty feeling effects from this source, would see relatively minor wave impact. By the time the wave has reached the continental shelf offshore of the Delaware Bay, the maximum crest elevation of the wave is approximately 1 m (3.3 ft). When the wave hits the shallow shelf, the wavelength shortens quickly, and the wave height increases.

Due to the small offshore height of the wave, compared to the two previously examined sources, it would not be expected that this wave would break and steepen into bore fronts near the shelf break. In this location, at the shelf break, the water depth is roughly 50 m (164 ft), while the wave height is approximately 3 m (9.8 ft), and the transformation processes will still be largely governed by linear shallow water physics. As the wave approaches the Delaware Bay entrance, shoaling amplification and refractive spreading approximately cancel, and the wave crest elevation entering the Delaware Bay is 1.5 m (4.9 ft). Compared to the near-Bay maximum crest elevation of 40 m (131.2 ft) for the Currituck source and 10 m (33 ft) for the Canary Islands source, the Puerto Rico subduction zone source is not likely to produce larger impacts at the PSEG Site. Thus, the water surface elevation at the PSEG Site is quite low, well below 0.25 m (0.82 ft).

2.4.6.4.5 Tsunami Water Levels

Information Submitted by the Applicant

In SSAR Sections 2.4.6.4.5 – 2.4.6.4.8, the applicant summarized the water-level predictions for each case study. For the Currituck landslide, the numerical predictions suggest the wave heights in Delaware Bay are not sensitive to the landslide location or width among the cases tested as long as the total landslide volume is the same. The applicant suggested that the former is owing to the fact that the offshore shelf bathymetry, rather than the source location, controls the wave height distribution and focusing patterns. The applicant indicated that the remaining numerical simulations use the historical landslide location.

The applicant indicated that the model predictions suggest that Delaware Bay filters out the high frequency components of the tsunami and that there is a region of high waves in the Delaware Bay entrance, but that this high wave energy does not extend into the bay itself. The applicant indicated that including bottom friction in the model reduces the magnitude of the predicted runup and drawdown. The water levels (Currituck landslide) associated with maximum runup and drawdown at the site are 1.72 m (+5.64 ft) NAVD88 and -1.88 m (-6.17 ft) NAVD88, respectively.

The applicant indicated that the La Palma event is simulated using an initial N-wave source input as a static initial condition. The applicant indicated that the wave has a dominant wave period of approximately 25 minutes and that the wave is filtered by the lower Delaware Bay. The applicant indicated that the water levels (La Palma event) associated with maximum runup and drawdown at the site are 1.45 m (+4.76 ft) NAVD88 and -1.62 m (-5.32 ft) NAVD88, respectively.

The applicant indicated that for the Hispaniola Trench subduction zone coseismic event, the tsunami source is based on a composite source consisting of seven fault segments with a total M_w of 9.0 and that the vertical displacement of each segment is calculated following Okada (1985). The applicant indicated that, similar to the other two case studies, the model predicts that refraction directs waves away from the Delaware Bay entrance, and that the bay effectively filters the high-frequency components of the tsunami. The applicant indicated that the water levels (Hispaniola Trench subduction zone coseismic event) associated with maximum runup and drawdown at the site are 1.59 m (+5.22 ft) and -1.69 m (-5.55 ft) NAVD88, respectively.

The applicant indicated that the PMT at the PSEG Site is generated by the Currituck landslide.

The Staff's Technical Evaluation

In RAI 20, Question 02.04.06-4, the staff requested that the applicant provide additional information, evaluation, and a discussion in the SSAR of the following items:

- Appropriateness of Shallow-Water Wave Models (SSAR Section 2.4.6.4.1). Reference to NUREG/CR-6966 and physics-based discussion on possible limitations of the MOST model for this application.

- Water Levels for Bottom Friction Experiment (SSAR Sections 2.4.6.4.1 and 2.4.6.4.5). Resolve the discrepancy between water levels shown in SSAR Figure 2.4.6-2 with the water levels stated in the last paragraph of SSAR Section 2.4.6.4.5. Reference to section presenting 10 percent exceedance tidal levels, and repeat tidal values when presenting runup/rundown in SSAR Section 2.4.6.4.5.

- Input Parameters and Results for All Water Level Models (SSAR Section 2.4.6.2). Provide images of initial conditions and snapshots of the wave field in time in a revised version of the SSAR.

- Determination of Simulation Time (SSAR Section 2.4.6.4.4). Provide information in the updated SSAR that shows that the results of a long-time Currituck landslide simulation, out to 40 hours of real elapsed time, show no evidence of a seiche.

- Sensitivity Experiments for Atlantic Margin Landslides (SSAR Section 2.4.6.4.5, 2nd Paragraph). Provide information regarding whether the other locations of the landslides

used in the sensitivity experiments are in a geologically similar environment compared to the actual Currituck landslide.

- Landslide Initial Conditions (SSAR 2.4.6.4.5 and 2.4.6.4.6). Provide a discussion of conservativeness of the TOPICS method of determining initial conditions for the Currituck landslide and the N-wave for the Canary Islands. Provide all input parameters.

- Effective Filtering of Delaware Bay (SSAR Section 2.4.6.4.5, 3rd Paragraph, SSAR Section 2.4.6.4.6, 1st Paragraph, and SSAR Section 2.4.6.4.7, 3rd Paragraph). Provide additional simulation results for a case or cases with a finer resolution, to test the numerical effect of high frequency filtering and to ensure that the model is not unrealistically damping these components.

- Hispaniola Earthquake Source Parameters (SSAR Section 2.4.6.4.7, 2nd Paragraph). Provide a discussion on how the source parameters are derived.

In a May 11, 2011, response to RAI 20, Question 02.04.06-4, the applicant provided the requested information and committed to provide the following revisions:

- SSAR Section 2.4.6.4.8: line 6, first paragraph will be revised to add the negative sign in front of -5.08 ft NAVD**.**

- Time series figures will be added for each of the model runs. These figures will be referenced in SSAR Sections 2.4.6.4.5, 2.4.6.4.6, and 2.4.6.4.7.

- A sentence will be added to end of SSAR Section 2.4.6.4.4 and a figure showing seiche effects (Figure 2.4.6-7) will be added.

- SSAR Section 2.4.6.4.5, second paragraph will be revised and a third paragraph added to better describe sensitivity experiments for Atlantic Margin Slides.

- SSAR Section 2.4.6.3.1 will be revised to describe landslide initial conditions for Currituck and SSAR Section 2.4.6.3.2 will be revised to describe N-wave source for Canary.

The staff verified that Revision 1 of the ESP application (May 21, 2012) contains the applicant's committed changes. Therefore, the staff considers RAI 20, Question 02.4.06-4 resolved.

The staff performed numerical modeling of three different tsunami sources to determine their impact on the PSEG Site. The three sources are a near field landslide source along the continental shelf break (the Currituck source), a far field landslide source with extremely large local waves (the Canary Islands source), and a far field earthquake source (the Puerto Rico Subduction Zone source). For all conditions, the most conservative source parameters were employed, even when arguably unphysical, to provide an absolute upper limit on the possible tsunami effects at the PSEG Site. The local (Currituck) landslide source proved to have the largest impact at the PSEG Site, with maximum 1HD water surface elevations due to the tsunami of 8.6 m (+28.2 ft) NAVD88 and maximum fluid speeds of 3.3 m/s (10.8 ft/s). Note that these elevations assume that the tsunami occurs at high tide (1.68 m (5.51 ft)) above Mean Low Water), with an additional depth of 0.75 m (2.46 ft) added for sea level rise. The Canary Islands source, despite generating sea surface elevation of 1 km (.62 mi) at the source, leads to a 1HD tsunami crest elevation of 4.8 m (+15.8 ft) NAVD88 near the PSEG Site. The earthquake source has by far the smallest effect on the site, with maximum 1HD water surface elevations

less than 0.25 m (0.82 ft). Thus the local Currituck-like landslide source is the PMT. However, the effects of the PMT are below that of the DBF of 9.78 m (32.1 ft).

2.4.6.4.6 Hydrography and Harbor or Breakwater Influences on Tsunami

Information Submitted by the Applicant

The Delaware River in the vicinity of the Site does not contain any harbors or breakwaters. Information on bathymetry and topography in the Site vicinity is provided in SSAR Section 2.4.6.4.3.

The Staff's Technical Evaluation

Based on the staff evaluation of the applicant's numerical simulations provided in SSAR Section 2.4.6.4.5, the staff concurs that the bathymetry of the Delaware Bay is adequately included in the tsunami propagation computations (See Section 2.4.6.4.4 for details).

2.4.6.4.7 Effects on Safety-Related Facilities

Information Submitted by the Applicant

In SSAR Section 2.4.6.5, the applicant indicated that the new plant grade will be established at an elevation of 11.25 m (36.9 ft) NAVD88, and that none of the maximum predicted runup elevations obtained in this study overtop this elevation. The applicant indicated that the PMT will not constitute a limiting design basis for the new plant.

The Staff's Technical Evaluation

The staff concurs that since the maximum tsunami water level associated with the PMT is below grade elevations at the site, there will be no onsite tsunami waves affecting safety-related facilities. Minimum low water levels associated with the PMT do not define the design basis for the safety-related ultimate heat sink (UHS) water intake structure.

2.4.6.4.8 Hydrostatic and Hydrodynamic Forces

Information Submitted by the Applicant

In SSAR Section 2.4.6.5, the applicant stated that hydrodynamic and hydrostatic forces will not impact any safety-related structures.

For the safety-related SSCs, the applicant indicated that the hydrostatic and hydrodynamic design bases are controlled by the PMSS and not by the PMT.

The Staff's Technical Evaluation

The staff concurs that the PMT does not define the hydrostatic and hydrodynamic design basis.

2.4.6.4.9 Debris and Water-Borne Projectiles

Information Submitted by the Applicant

In SSAR Section 2.4.6.6, the applicant indicated that as the grade elevation of the plant will not be flooded by the PMT, debris and waterborne projectiles will not come into contact with any safety-related structures. The applicant further indicated that the intake structure at the new plant will be designed to protect it from impacts of waves and waterborne projectiles.

The Staff's Technical Evaluation

The staff concurs that the grade elevation of the plant will not be flooded by the PMT. The intake design and details on impacts of waves and waterborne projectiles will be provided in the COL phase.

2.4.6.4.10 Effect of Sediment Erosion and Deposition

Information Submitted by the Applicant

In SSAR Section 2.4.6.7, the applicant acknowledged that strong water currents associated with tsunamis can cause erosion and deposition. However, the applicant indicates that the current speeds predicted near the site fall within the range of normal tidal current activity in the Delaware Bay and, therefore, a rapid morphologic response to tsunami activity at the site is not expected.

The Staff's Technical Evaluation

Using the staff 1HD tsunami analysis for the Currituck landslide, the results show that the channel just offshore of the EPS site has a local maximum in current velocity of 5.9 m/s (19.4 ft/s). However, this large current velocity is largely isolated to the Bay channel, and maximum speeds at the PSEG site reduce to 3.3 m/s (10.8 ft/s). Although the staff did not calculate current velocity for the 2D analysis, the 2D analysis shows approximately a 45 percent reduction in tsunami amplitude. A corresponding reduction in current velocity would result in a current velocity of 1.8 m/s (5.9 ft/s). The nominal tidal current in Delaware Bay can reach or exceed velocities around 1.0 m/s (3.3 ft/s). Thus, the staff agrees with the applicant that tsunami current velocities would create sediment and erosion within the range of normal tidal activity.

2.4.6.4.11 Consideration of Other Site-Related Evaluation Criteria

Information Submitted by the Applicant

In SSAR Section 2.4.6.8, the applicant indicated that of the three tsunami sources examined, two (the Currituck and La Palma landslides) are not necessarily tied to strong seismic activity. The applicant indicated that only the Hispaniola Trench source is associated with seismic activity, but is located 2,494 km (1,550 mi) away. For these reasons, the applicant stated that a combined tsunami and seismic event was not considered in designing safety-related SSCs for the plant.

The Staff's Technical Evaluation

The staff concurs that the PMT sources will not be combined with the design-basis earthquake when evaluating the design of safety-related SSCs.

2.4.6.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.6.6 Conclusion

The staff reviewed the applicant's submittals in SSAR Section 2.4.6 and in response to the RAIs. As set forth above, the applicant presented and substantiated sufficient information pertaining to estimates of the effects from probable maximum tsunami hazards at the proposed PSEG Site, and no outstanding information is required to be addressed in the SSAR for this section. Furthermore, the staff finds that 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 a sufficient margin for the limited accuracy, quantity, and period of time in which the historical data were accumulated.

The staff accepted the methodologies used by the applicant to determine the severity of the tsunami phenomena reflected in this analysis, as documented in this section of the report. In the context of the above discussion, the staff finds the applicant's analysis acceptable for use in establishing the design bases for SSCs important to safety. Accordingly, the staff concludes that the use of these methodologies results in an analysis containing a sufficient margin for the limited accuracy, quantity, and period of time in which the data were accumulated. Additionally, the 1HD PMT flood level 8.6 m (+28.2 ft) NAVD88 and 2D PMT flood level 1.0 m (+3.3 ft) estimated by the staff are below the bounding 2D PMSS water level of 9.78 m (32.1 ft) NAVD88 as well as the plant grade of 11.25 m (36.9 ft) NAVD88. The applicant provided a more conservative 2D PMT flood level of 1.72 m (+5.65 ft) NAVD88 which is also below the 2D PMSS and PSEG Site grade. Therefore, the staff concludes that the postulated PMT would not affect the proposed PSEG Site. Therefore, the staff finds the identification and consideration of the PMT hazards set forth above acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.23(d).

2.4.7 Ice Effects

2.4.7.1 Introduction

SSAR Section 2.4.7 addresses ice effects to ensure that safety-related facilities and water supply are not affected by ice-induced hazards.

The ice effects are addressed to ensure that safety-related facilities and water supply are not affected by ice-induced hazards. The specific areas of review are as follows: (1) regional history and types of historical ice accumulations (e.g., ice jams, wind-driven ice ridges, floes, frazil ice formation); (2) potential effects of ice-induced, high- or low-flow levels on safety-related facilities and water supplies; (3) potential effects of a surface ice sheet to reduce the volume of available liquid water in safety-related water reservoirs; (4) potential effects of ice to produce forces on, or cause blockage of, safety-related facilities; (5) potential effects of seismic and nonseismic data on the postulated worst-case icing scenario for the proposed plant site; (6) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.7.2 Summary of Application

In this section, potential ice effects at the proposed plant location are evaluated, including the review of ice formations or ice jams; modeling combined events to ensure protection of the safety-related facilities from ice-affected floods, and mitigation to protect safety-related structures from ice. Analysis of ice effects at the proposed plant includes review of historic winter conditions and the simulation of flooding due to an upstream ice jam break.

2.4.7.3 Regulatory Basis

The relevant requirements of the NRC regulations for identifying ice effects and the associated acceptance criteria, are in NUREG-0800, Section 2.4.7.

The applicable regulatory requirements for identifying ice effects are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirements to consider physical site characteristics in site evaluations are specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The staff also used the appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG-0800, Section 2.4.3:

- RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants,” as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, “Seismic Design Classification,” as it relates to those SSCs intended to protect against the effects of flooding.

- RG 1.59, “Design Basis Floods for Nuclear Power Plants,” as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, “Flood Protection for Nuclear Power Plants,” as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.7.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.7. The staff’s review confirmed that the information in the application addresses the relevant information related to the site ice effects. The staff’s technical review of this section includes an independent review of the applicant’s information in the SSAR, Revision 2.

The applicant modeled flooding caused by an upstream ice jam utilizing the historical record of surface water elevations, instantaneous failure of a historic upstream ice jam, 10 percent exceedance high tide, averaged spring base flows and wave runup resulting from the maximum 2-year wind in the critical direction to obtain peak surface water level elevations at the site. Additionally, low water levels were considered as a result of upstream river blockage from an ice jam. The staff independently assessed the potential for formation of ice at the PSEG Site using available data. This section of the report provides the staff's evaluation of the technical information presented in SSAR Section 2.4.7.

2.4.7.4.1 Historical Ice Accumulation

Information Submitted by the Applicant

Temperature records from 1894 to 2009 (NOAA, http://www.erh.noaa.gov/phi/climate/recsAndNormals/xml/KILG_recsAndNorms.xml) were reviewed to determine the minimum temperature for the analysis. The applicant used the lowest temperature (-26 °Celsius (C) (-15 °Fahrenheit (F))) on record for Wilmington, DE for the analysis rather than the value ((-21 °C (-6 °F)) available for the 32 year record at the site. Historically, surface ice has been observed at the PSEG Site during January and February, and conditions (i.e., air temperatures at or below -6 °C (21 °F), super cooled water below freezing, open water and clear nights), amenable for potential frazil ice formation may occur at the site.

The applicant reviewed the USACE CRREL Ice Jam Database and found no recorded ice jams on the Delaware River downstream of Trenton (RM 134) for the period of record (1780 through 2009). In combination with rapid snow melt, an ice jam on the Delaware River closest to the PSEG Site (RM 52) at Trenton (RM 134) during 1904 caused the highest recorded ice jam induced flooding on the river producing a maximum gauge height of 9.02 m (29.6 ft) NAVD88 at the Trenton, NJ, USGS gauge 01463500.

The Staff's Technical Evaluation

The staff reviewed historical temperature records and found the applicant's characterization to be reasonable and adequate for representation of potential surface and frazil ice formation. Although ice jam flooding has occurred approximately 132 km (82 mi) upstream of the PSEG Site, the staff reviewed the CRREL Ice Jam Database and confirmed that no record of ice jam flooding has occurred downstream of the site. Although the CRREL database lists an 1857 ice jam flooding event at Trenton that may have had a stage equal to or exceeding the 1904 event cited by the applicant, the record for the 1857 event lacks a comparable datum to the USGS gauge (the USGS was established in 1879). The staff finds the applicant's review and characterization of the historical record adequate.

2.4.7.4.2 High Water Levels

Information Submitted by the Applicant

To estimate high water levels the applicant used the HEC-RAS (NOAA, http://www.hec.usace.army.mil/software/hec-ras/) model to simulate an instantaneous breach of the 1904 ice jam event at Trenton, NJ. As an estimate of worst case conditions with the event, the applicant combined a 10 percent exceedance high tide, mean spring monthly discharge for the period of record (1913 through 2008) as a base flow, and 2-year wind effects of wave runup. Terrain models were based on the USGS digital elevation models and NOAA Estuarine

Bathymetry Data. Manning's *n* coefficient for the HEC-RAS modeling was set to 0.025 for non-tidal portions of the Delaware River and 0.05 for the flood plain areas. Discharge from the individual drainage areas developed in HEC-HMS (USACE, http://www.hec.usace.army.mil/software/hec-hms/) defined the inputs to the HEC-RAS modeling.

The 10 percent exceedance high tide (1.37 m (4.5 ft)) was based on linear interpolation to the PSEG Site of the tides between Lewes NOAA gauge (RM 0) and Reedy Point (RM 59). The highest monthly mean discharge for the period of record (1913 to 2008) was applied to the 10 percent exceedance high tide. The application of 10 percent exceedance high tide and the highest monthly mean discharge resulted in a maximum water surface elevation of 1.58 m (5.2 ft) NAVD88.

The ice jam at Trenton was assumed to instantaneously breach with a 2-year wind speed applied on the resulting water level in the critical direction to determine coincident wave runup. The ice jam flooding resulted in a 0.03 m (0.1 ft) increase in surface water level at the site. A 2-year annual extreme wind speed of 50 mph determined to be consistent with ANSI/ANS-2.8-1992 was adjusted for fetch and duration limits in accordance with the Coastal Engineering Manual (USACE, 2002). Based on the analysis, a maximum wave height of 1.7 m (5.6 ft) was determined with a runup of 0.85 m (2.8 ft) based on the Coastal Engineering Manual methods.

The applicant determined that the resulting water level at the site would be 2.47 m (8.1 ft) NAVD88 based on the sum of 10 percent exceedance high tide (1.37 m (4.5 ft)), spring base flows (0.21 m (0.7 ft)), Trenton ice jam (0.03 m (0.1 ft)), and the coincident wave runup from a 2-year wind speed in the critical direction (0.85 m (2.8 ft)).

The Staff's Technical Evaluation

Using discharge for the individual drainage areas generated by HEC-HMS (USACE, http://www.hec.usace.army.mil/software/hec-hms/), the applicant applied a HEC-RAS (USACE, http://www.hec.usace.army.mil/software/hec-ras/) surface water model to simulate the largest ice jam determined from the historical record in combination with a wind event in the critical direction similar to that applied to other types of flooding in the SSAR, Revision 2. Given the dominating tidal influence on the Delaware River adjacent to the site and the wide and open connection of the Delaware River to the Atlantic Ocean, ice jams upstream of the site are extremely unlikely to impact safety-related SSCs at the PSEG Site. The applicant's simulation of a major historic ice jam event is adequate and results in a flood level of 2.47 m (8.1 ft) NAVD88, which is below the design basis flood (9.78 m (32.1 ft) NAVD88).

Based on the staff's review of the physiography of the site location, the staff's review of the CRREL ice jam database, and the applicant's reasonable application of a conservative upstream ice jam analysis, the staff concludes that ice jams would have no high water safety-related impacts to the water supply intake or the water supply for the PSEG Site. The staff finds the applicant's analysis adequate.

2.4.7.4.3 Low Water Levels

Information Submitted by the Applicant

The ice jam low water condition and resulting effects are evaluated in SSAR Section 2.4.11.

The Staff's Technical Evaluation

Given the dominating tidal influence on the Delaware River adjacent to the site and the wide and open connection of the Delaware River to the Atlantic Ocean, ice jams upstream of the site are extremely unlikely to impact safety-related SSCs at the PSEG Site. The staff evaluated the applicant's assessment of low water levels in SSAR Section 2.4.11.

2.4.7.4.4 Ice Sheet Formation

Information Submitted by the Applicant

The applicant reviewed and summarized the historical record from the National Ice Center (http://www.natice.noaa.gov/) and found that sheet ice that has formed in the mid and upper portions of the Delaware Bay was not concentrated enough to be considered fast ice or ice that is anchored to the shore. The applicant summarized the thickness and concentration of the ice reported in the Delaware River transition zone to the Delaware Bay that is adjacent to the PSEG Site. The thickest portion of ice adjacent to the PSEG Site was estimated to be 12 to 28 in. for mature areas of ice and 0 to 4 in. for newly formed areas of ice.

The applicant stated that protective measures for the intake structure will be in accordance with ANSI/ANS-2.8-1992, Section 8.3, "Surface Ice," to mitigate potential effects from frazil ice, surface ice, and other dynamic forces associated with ice effects.

The Staff's Technical Evaluation

The staff reviewed the surface ice of record formed at the PSEG Site and agreed that the surface ice is neither continuous nor does it reduce access to available water for safety-related cooling. Since tidal effects dominate the flow adjacent to the PSEG Site, the water volume forming the surface ice is negligible in comparison to the tidally induced flows and the volume of the Delaware Bay. Therefore, there is no potential for surface ice to reduce the volume of water available for safety-related cooling. The applicant stated that protective measures in accordance with ANSI/ANS-2.8-1992 will be implemented to mitigate the potential effects of frazil ice, surface ice and other dynamic forces associated with ice on the intake structure. Since there is no potential to reduce safety-related cooling water from surface ice, the staff finds the applicant's approach to implement protective measures, as called out in ANSI/ANS-2.8-1992, adequate.

2.4.7.4.5 Potential Ice-Induced Forces and Blockages

Information Submitted by the Applicant

The applicant reviewed the tri-agency (U.S. Navy/NOAA/U.S. Coast Guard), National Ice Center data and noted that ice formed in the mid and upper portions of the Delaware River Bay was concentrated enough to form a solid sheet but not considered to be anchored to the shoreline. No ice blockages have occurred downstream of the PSEG Site based on the historical record. The potential formation of frazil ice was determined by the applicant using USACE CRREL design procedures (USACE, 1991). The applicant noted that the proposed plant is located in a tidal transition zone of the Delaware River and that the icing events depicted in this section represent worst case scenarios adjacent to the PSEG Site. The applicant stated that the intake structure at the new plant will be designed with protective measures in accordance with

ANSI/ANS-2.8-1992 to mitigate the potential effects of frazil ice, surface ice and other dynamic forces associated with ice.

The Staff's Technical Evaluation

The staff reviewed the applicant's evaluation of ice effects including the National Ice Center data and the applicant's analyses of frazil ice formation to determine the depth of frazil ice formation. This review included verification of historical reports of ice dams along with river stage data and discharge data downstream as available. At the PSEG Site location, the Delaware River is tidally influenced, 4.0 km (2.5 mi) wide, and progressively widens to 16.1 km (10 mi) at the entrance to the Delaware Bay with a lack of constricting terrain making the formation of a surface ice blockage extremely unlikely consistent with the lack of recorded ice jams downstream of the site. Additionally, after a reactor technology is selected, protective measures in accordance with ANSI/ANS-2.8-1992, Section 8.3, "Surface Ice," for an intake structure are acceptable to the staff for mitigation of frazil ice formation. Therefore, the staff finds the information and evaluation provided in the application adequate.

2.4.7.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.7.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the plant parameter envelope, and that there is no outstanding information required to be addressed in the SSAR related to this section.

As set forth above, the applicant has provided sufficient information pertaining to ice effects. Therefore, the staff concludes that the applicant has met the requirements concerning ice effects with respect to 10 CFR 52.17(a) and 10 CFR Part 100. Further, the applicant has considered the most severe 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, in establishing site characteristics pertaining to ice effects that are acceptable for design purposes.

2.4.8 Cooling Water Canals and Reservoirs

2.4.8.1 Introduction

The cooling water canals and reservoirs used to transport and impound water supplied to the SSCs important to safety are reviewed to verify their hydraulic design basis. The specific areas of review are as follows: (1) design bases postulated and used by the applicant to protect structures such as riprap, inasmuch as they apply to safety-related water supply; (2) design bases of canals pertaining to capacity, protection against wind waves, erosion, sedimentation, and freeboard and the ability to withstand a PMF (surges, etc.), inasmuch as they apply to a safety-related water supply; (3) design bases of reservoirs pertaining to capacity, PMF design basis, wind wave and run-up protection, discharge facilities (e.g., low-level outlet, spillways), outlet protection, freeboard, and erosion and sedimentation processes inasmuch as they apply to a safety-related water supply; (4) potential effects of seismic and nonseismic information on the postulated hydraulic design bases of canals and reservoirs for the proposed plant site.

2.4.8.2 Summary of Application

This section of the SSAR addresses the cooling-water canals and reservoirs used to transport and impound water supplied to the safety-related SSCs. This section of the report presents an evaluation of the design basis for the capacity and operating plan for safety-related cooling-water canals and reservoirs, and any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts of 10 CFR Part 52.

2.4.8.3 Regulatory Basis

The relevant requirements of NRC regulations for the cooling-water canals and reservoirs, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.4.8.

The applicable regulatory requirements for describing cooling-water canals and reservoirs are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The staff also used the appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG-0800, Section 2.4.8:

- RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, "Seismic Design Classification," as it relates to those SSCs intended to protect against the effects of flooding.

- RG 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, "Flood Protection for Nuclear Power Plants," as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.8.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.8. The staff confirmed that the information in the application addresses the relevant information related to the site cooling water canals and reservoirs. The staff's technical review of this section included an independent

review of the applicant's information in the SSAR. The staff supplemented this information with other publicly available sources of data. The staff's technical review of this section described below includes an independent review of the applicant's information provided in the SSAR.

Information Submitted by the Applicant

The proposed PPE does not include any safety-related canals or reservoirs used to transport or impound plant cooling water. Makeup to the safety-related UHS system and the non-safety-related cooling water system for the new plant is provided by an intake structure located on the east bank of the Delaware River, north of the existing HCGS service water intake structure. As the reactor technology for the new plant has not been chosen, the specific design of the intake structure is not finalized. The intake structure will be set at an elevation low enough that it can provide an uninterrupted supply of water to the proposed plant, even under extreme low water conditions.

The Staff's Technical Evaluation

The staff reviewed SSAR Section 2.4.8. The staff confirmed that the information in the application addresses the relevant information related to this section and is sufficient and appropriate. The staff concludes that because there are no safety-related reservoirs or canals proposed for the PPE design, Section 2.4.8 is not applicable to the PSEG Site.

2.4.8.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.8.6 Conclusion

The staff reviewed the application and confirmed that there are no safety-related reservoirs or canals proposed for the new plant in the plan parameter envelope. There is no outstanding information required to be addressed in the SSAR related to this section.

2.4.9 Channel Diversions

2.4.9.1 Introduction

This section of the SSAR addresses channel diversions. It evaluates plant and essential water supplies used to transport and impound water supplies to ensure that they will not be adversely affected by stream or channel diversions. The evaluation includes stream channel diversions away from the site (which may lead to a loss of safety-related water) and stream channel diversions toward the site (which may lead to flooding). In addition, in such an event, it must be ensured that alternate water supplies are available to safety-related equipment.

This section of the report presents an evaluation of the following specific areas: (1) historical channel migration phenomena including cutoffs, subsidence, and uplift; (2) regional topographic evidence that suggests a future channel diversion may or may not occur (used in conjunction with evidence of historical diversions); (3) thermal causes of channel diversion, such as ice jams, which may result from downstream ice blockages that may lead to flooding from backwater or upstream ice blockages that can divert the flow of water away from the intake; (4) potential for forces on safety-related facilities or the blockage of water supplies resulting from channel migration-induced flooding (flooding not addressed by hydrometeorologically induced

flooding scenarios in other sections); (5) potential of channel diversion from human-induced causes (i.e., land-use changes, diking, channelization, armoring, or failure of structures); (6) alternate water sources and operating procedures; (7) potential effects of seismic and nonseismic information on the postulated worst-case channel diversion scenario for the proposed plant site; (8) any additional information requirement prescribed in the “Contents of Application” sections of the applicable subparts of 10 CFR Part 52.

2.4.9.2 Summary of Application

In SSAR Section 2.4.9, the applicant described site-specific information related to the channel diversions.

2.4.9.3 Regulatory Basis

The relevant requirements of NRC regulations for channel diversions, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.4.9, and “Channel Diversions.”

The applicable regulatory requirements for identifying and evaluating channel diversions are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The staff also used the appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG-0800, Section 2.4.9.

- RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants,” as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, “Seismic Design Classification,” as it relates to those SSCs intended to protect against the effects of flooding.

- RG 1.59, “Design Basis Floods for Nuclear Power Plants,” as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, “Flood Protection for Nuclear Power Plants,” as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.9.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.9. The staff's review confirmed that the information in the application addresses the relevant information related to the channel diversions. The staff's technical review of this section includes an independent review of the applicant's information in the SSAR. The staff supplemented this information with other publicly available sources of data.

This section describes the staff's evaluation of the technical information presented by the applicant in SSAR Section 2.4.9.

2.4.9.4.1 Historical Channel Diversions

Information Submitted by the Applicant

Based on past studies (Delaware Department of Transportation, 1994), the applicant indicated that the Delaware River has been flowing in its current channel for approximately 10,000 years. There are no levees or dams on the Delaware River and collapse or breaching of levees or dams on tributaries will have little impact on surface water levels at the PSEG Site as discussed in SSAR Section 2.4.4.

The Staff's Technical Evaluation

The ancestral Delaware River followed a similar course to that of the present day for the last several thousand years (Delaware Department of Transportation, 1994), although undoubtedly not always precisely in its current channel. Given the low topographic relief, wide and open marine tidal connection of the Delaware River adjacent to the site, and lack of constricting topography from the PSEG Site to the mouth of the Delaware Bay, dam breaching or levee collapses along tributaries to the Delaware River would not significantly impact Delaware River water levels nor be reasonably expected to impact safety-related SSCs at the PSEG Site. The staff considers the applicant's evaluation adequate.

2.4.9.4.2 Regional Topographic Evidence

Information Submitted by the Applicant

The PSEG site is located in a region of relatively low relief in the Atlantic Coastal plain with highest land surface elevations (approximately 6.1 m (20 ft) NAVD88) in the vicinity of the site corresponding to man-made embankments along the Delaware River. The river is approximately 4.0 km (2.5 mi) wide at the PSEG Site and progressively widens to several kilometers (miles) at the mouth of the Delaware Bay. Given the low topographic relief and lack of constricting topography from the PSEG Site to the mouth of the bay, a blockage downstream causing a channel diversion that could affect the site SSCs designed to the selected DCD specifications is extremely unlikely.

The Staff's Technical Evaluation

Given the low topographic relief, wide and open tidal connection of the Delaware River adjacent to the site, and lack of constricting topography from the PSEG Site to the mouth of the Delaware Bay, topographic characteristics would not be amenable to a downstream blockage that would

create any significant flooding at the PSEG Site. The staff finds the applicant's evaluation and information adequate.

2.4.9.4.3 Ice Causes

Information Submitted by the Applicant

Ice blockages are discussed in SSAR Section 2.4.7. Given the wide and open marine connection of the Delaware River to tidal influences, tidal flow could easily supply sufficient cooling water for the proposed plant with upstream river ice blockages. The upstream river ice blockages would not be a threat to site SSCs.

The Staff's Technical Evaluation

The staff reviewed SSAR Section 2.4.7 and the physiographic nature of the tidally influenced Delaware River. Tidal flow at the PSEG Site ranges from 11,327 to 13,366 m^3 (400,000 to 472,000 ft^3) per second (USEPA, 2002 and USACE, 1992), which is sufficient to supply the required water (approximately 5 m^3 (177 ft^3) per second for the PPE cooling. Therefore, ice blockages causing channel diversions upstream of the PSEG Site would not limit the volume of safety-related water available for cooling. The staff finds the applicant's evaluation adequate.

2.4.9.4.4 Flooding of Site Due to Channel Diversions

Information Submitted by the Applicant

Physiographic characteristics of the PSEG Site and surrounding areas, and the tidal nature of the Delaware River make flooding due to channel diversions extremely unlikely at the PSEG Site. In addition, the tidal nature of the river at the PSEG Site results in ample cooling water availability for the plant.

The applicant indicated that even if (as yet un-designed) drainage ditches at a proposed plant are blocked due to ice formation, blockages will be bypassed as the water rises. Grading in the vicinity of the SSCs will be sloped away from each of the SSCs toward collection ditches. The grading plan will be adapted and designed for the specific technology selected at the COL application stage.

The Staff's Technical Evaluation

The PSEG Site is located in a tidal zone progressively widening into the Delaware Bay, which empties into the Atlantic. Given the wide and open connection with the Atlantic, there are no opportunities for channel diversions to impact the site as flood waters from channel diversions would flow unimpeded to the Atlantic.

Since the applicant has not selected a reactor technology, a site grading plan and storm water management system necessary to establish the maximum site water surface elevation due to collection ditch capacities and blockage has not been determined. A detailed analysis to determine the maximum site water level will be performed once a specific reactor technology is selected at the COL stage. While the staff finds the applicant's evaluation adequate, the staff is tracking the maximum site water level determination need via COL Action Item 2.4-1 (See Section 2.4.2.4.3 of this report).

2.4.9.4.5 Human-Induced Causes of Channel Diversion

Information Submitted by the Applicant

The Delaware River in the vicinity of the PSEG Site is actively maintained with dredging by the USACE as an established shipping channel. This regular maintenance, coupled with shoreline protection (e.g., river bank armoring) and water resource oversight by the DRBC, reduces the potential for anthropogenic-induced diversions of the Delaware River channel.

The Staff's Technical Evaluation

The Delaware River is an established major navigable waterway that is actively maintained by the USACE with protection and development of the Delaware River Basin water resources within the purview of the DRBC. Given the USACE maintenance and DRBC regulatory oversight, human-induced modifications are carefully monitored and unlikely to threaten the PSEG Site. The staff finds the applicant's evaluation adequate.

2.4.9.4.6 Alternative Water Sources

Information Submitted by the Applicant

The Delaware River safety-related water supply to the proposed plant consists primarily of tidal flow with much lesser contributions from freshwater flow of upstream tributaries. Historically, there are no recorded channel diversions of the Delaware River. Average annual freshwater flow at the Trenton, NJ gauge is 334 m^3 (11,780 ft^3) per second, while the proposed PPE intake is projected as 5 m^3 (175 ft^3) per second. Tidal flow at the PSEG Site ranges from 11,327 to 13,366 m^3 (400,000 to 472,000 ft^3) per second (USEPA, 2002 and USACE, 1992), which is more than sufficient for the required water supply.

The Staff's Technical Evaluation

The staff reviewed the physiographic characteristics of the PSEG Site area and publicly available tidal flow studies published by the USGS (e.g., USGS, 1962). The staff finds these characteristics and tidal flow rates to be consistent with those cited by the applicant and therefore, adequate and acceptable.

2.4.9.4.7 Consideration of Other Site-Related Evaluation Criteria

Information Submitted by the Applicant

Channel diversion from severe weather events (SSAR Sections 2.4.2 through 2.4.7) or seismic events is not considered to contribute to a loss of the proposed plant's cooling water supply. The wide Delaware River, low topography and gentle relief in the vicinity of the PSEG Site preclude impacts to SSCs from shoreline collapse due to seismic or severe weather events. The intake forebay will extend into the Delaware River and be dredged to an elevation sufficient to accommodate extreme low water elevation in the river. Periodic maintenance will be performed to remove accumulated silt and sedimentation to maintain the specified invert elevation.

The Staff's Technical Evaluation

The staff reviewed potential impacts from severe weather events (Sections 2.4.2 through 2.4.7 herein), and the potential for seismic events to contribute to a loss of the proposed plant's cooling water supply. Seismic-induced collapse of already low-lying landforms within the subdued topography in the vicinity of the plant would have no impacts to safety-related SSCs. The applicant will maintain the intake structure to accommodate low water and will perform sediment removal for a specified invert elevation. The staff finds the applicant's evaluation to be adequate.

2.4.9.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.9.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the plant parameter envelope, and that there is no outstanding information required to be addressed in the SSAR related to this section.

As set forth above, the applicant has provided information pertaining to channel diversions showing that channel diversion above the PSEG Site is not likely. Therefore, the staff concludes that the applicant has met the requirements regarding channel diversions, with respect to 10 CFR 52.17(a), 10 CFR Part 100. Additionally, the staff concludes that the applicant has considered the most severe 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 in establishing that channel diversion is not likely at this site.

2.4.10 Flooding Protection Requirements

2.4.10.1 Introduction

The flooding protection requirements address the locations and elevations of safety-related facilities and those of structures and components required for protection of safety-related facilities. These requirements are then compared with design-basis flood conditions to determine whether flood effects need to be considered in the plant's design or in emergency procedures. The specific areas of review are as follows: (1) safety-related facilities exposed to flooding; (2) type of flood protection (e.g., "hardened facilities," sandbags, flood doors, bulkheads) provided to the SSCs exposed to floods; (3) emergency procedures needed to implement flood protection activities and warning times available for their implementation reviewed by the organization responsible for reviewing issues related to plant emergency procedures; (4) potential effects of seismic and nonseismic information on the postulated flooding protection for the proposed plant site; and (5) any additional information requirements prescribed in the applicable subparts to 10 CFR Part 52.

2.4.10.2 Summary of Application

In SSAR Section 2.4.10, the applicant addressed the need for site-specific information on flood protection requirements.

2.4.10.3 Regulatory Basis

The relevant requirements of NRC regulations and the associated acceptance criteria for flood protection are specified in NUREG-0800, Section 2.4.10, "Flooding Protection Requirements."

The applicable regulatory requirements for identifying and evaluating flood protection are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The staff also used the appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG-0800, Section 2.4.9.

- RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, "Seismic Design Classification," as it relates to those SSCs intended to protect against the effects of flooding.

- RG 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, "Flood Protection for Nuclear Power Plants," as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.10.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.10 and confirmed that the information in the application addresses the relevant information related to the flooding protection requirements. The staff's technical review of this section includes an independent review of the applicant's information in the SSAR. This section describes the staff's evaluation of the technical information presented by the applicant in SSAR Section 2.4.10.

Information Submitted by the Applicant

As required by the selected technology, the applicant will conform with required design elevations of the safety-related SSCs corresponding to the DCD for the selected reactor technology. Subsequent to selection of a technology, the applicant will design site grading and

drainage systems to drain runoff up to and including the PMP away from safety-related SSCs into swales and pipes toward the Delaware River assuming all site drainage structures are blocked during the PMP event. These site drainage systems will be designed to prevent flooding of safety-related SSCs given the PMP event.

The PMSS (Section 2.4.5 of this report) is the determining event for the design basis flood at the PSEG Site. The PMSS combined with 10 percent exceedance high tide, wave runup and potential sea level rise produces a water level of 9.78 m (32.1 ft) NAVD88 as reviewed in Section 2.4.5 herein. Riprap of the appropriate designation will be placed on site slopes to provide wave runup protection. All safety-related SSCs will be designed with flood protection features to withstand the flood height of the DBF and associated effects as required for a selected reactor technology.

The Staff's Technical Evaluation

The staff reviewed the information submitted by the applicant related to flood protection at the PSEG Site. The maximum water level in the intake forebay is controlled by storm surge (SSAR Section 2.4.5). Appropriate erosion control technology will be implemented, where applicable, to protect the intake structure from wind-induced waves, runup, and associated erosion. Flood protection for the intake structure will be designed as part of the detailed design of the proposed plant at the COL stage. The intake structure will be designed to be protected from the effects of flooding and to withstand the applicable hydrodynamic forces, including wave forces, in accordance with RG 1.27, RG 1.59, and RG 1.102. Flood protection and procedures to address flooding protection requirements will be developed based on the detailed site design for review by staff at the COL stage. Consistent with the applicant's stated intention, the staff identified COL Action Item 2.4-2 to address this item.

COL Action Item 2.4-2

> An applicant for a COL or CP referencing this early site permit should address whether the intake structure of the selected design is a safety-related SSC. If so, the applicant should address necessary flooding protection for a safety-related intake structure at the ESP site based on the design basis flooding event and associated effects.

2.4.10.5 Post Early Site Permit Activities

The procedure to be developed for addressing flooding protection requirements based on the design-basis flood consistent with the detailed site design is being tracked as COL Action Item 2.4-2.

2.4.10.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the plant parameter envelope, and that there is no outstanding information required to be addressed in the SSAR related to this section.

As set forth above, the applicant presented and substantiated information to establish the site description. The staff reviewed the information provided and, for the reasons given above, concludes that the applicant has provided sufficient details about the site description to allow the staff to evaluate, as documented in Section 2.4.10 of this report, whether the applicant has met

the relevant requirements of 10 CFR 52.17(a)(1) and 10 CFR Part 100 with respect to determining the acceptability of the site. The staff concludes that the applicant has provided sufficient information pertaining to flood protection to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100. The COL applicant will address COL Action Item 2.4-2.

2.4.11 Low Water Considerations

2.4.11.1 Introduction

This SSAR section addresses natural events that may reduce or limit the available safety-related cooling-water supply. The applicant ensures that an adequate water supply will exist to shut down the plant under conditions requiring safety-related cooling.

This section of the report provides an evaluation of the following specific areas: (1) low-water conditions due to the worst drought considered reasonably possible in the region; (2) the effects of low water surface elevations caused by various hydrometeorological events and a potential blockage of intakes by sediment, debris, littoral drift, and ice because they can affect the safety-related water supply; (3) the effects of low water on the intake structure and pump design bases in relation to the events described in SSAR Sections 2.4.7, 2.4.8, 2.4.9, and 2.4.11, which consider the range of water supply required by the plant (including minimum operating and shutdown flows during anticipated operational occurrences and emergency conditions) compared with availability (considering the capability of the UHS to provide adequate cooling water under conditions requiring safety-related cooling); (4) the use limitations imposed or under discussion by Federal, State, or local agencies authorizing the use of the water; (5) the potential effects of seismic and non-seismic information on the postulated worst-case low-water scenario for the proposed plant site; and (6) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts of 10 CFR Part 52.

2.4.11.2 Summary of Application

In SSAR Section 2.4.11, the applicant addresses the impacts of low water on safety-related water supply.

2.4.11.3 Regulatory Basis

The relevant requirements of NRC regulations and the associated acceptance criteria for low water considerations are specified in NUREG-0800, Section 2.4.11, "Low Water Considerations."

The applicable regulatory requirements for identifying and evaluating low water considerations are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 100.23(d), as it sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.

The staff also used the appropriate sections of the following regulatory guides for the acceptance criteria identified in NUREG-0800, Section 2.4.9.

- RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," as it relates to providing high assurance that the water sources relied on for the sink will be available where needed.

- RG 1.29, "Seismic Design Classification," as it relates to those SSCs intended to protect against the effects of flooding.

- RG 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized.

- RG 1.102, "Flood Protection for Nuclear Power Plants," as it relates to providing assurance that SSCs important to safety have been designed to withstand the effects of natural flooding phenomena likely to occur at the site.

2.4.11.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.11. The staff confirmed that the information in the application addresses the relevant information related to the low water considerations. The staff's technical review of this section includes an independent review of the applicant's information in the SSAR and in the responses to the RAIs. The staff supplemented this information with other publicly available sources of data.

This section describes the staff's evaluation of the technical information presented in SSAR Section 2.4.11.

2.4.11.4.1 Historical Low Water Conditions and Effect of Tides

Information Submitted by the Applicant

The applicant reviewed the 22-year period of record (1987 to 2008) and determined an extreme low water level of -2.07 m (-6.8 ft) NAVD88 at Reedy Point which is the closest gauge to the PSEG Site. A 1962 USGS report (USGS, ftp://ftp.ncdc.noaa.gov/pub/data/) describes a cold front with a sustained northwest wind averaging 45 kph (28 mph) blowing for approximately 48 hours that coincided with an extremely low tide and resulted in an elevation of -2.62 m (-8.6 ft) NAVD88 at Reedy Point. The mean low tide at Reedy Point is -0.85 m (-2.8 ft) NAVD88. The applicant noted a 90 percent exceedance low tide (-1.56 m (-5.1 ft)) NAVD88) by interpolation between Reedy Point and Lewes, DE determined by a Department of Interior report (U.S. Department of the Interior, 1966).

The Staff's Technical Evaluation

As rationale for determining the 90 percent exceedance low-tide for the 22-year record at Reedy Point, the applicant cited ANSI/ANS 2.8, which is not routinely used for analysis of low water conditions. In RAI 27, Question 02.04.11-1, the staff requested that the applicant provide additional rationale for using ANSI/ANS 2.8 as a basis for determining the 90 percent low tide

exceedance for the 22-year record at Reedy Point. In a June 9, 2011, response to RAI 27, Question 02.04.11-1, the applicant noted that Standard Review Plan (SRP) Section 2.4.11 makes reference to using the same general methods of analysis as discussed in SRP Sections 2.4.5 and 2.4.6 that are applicable to low water estimates at coastal sites. In addition, the applicant noted that although SSAR Section 2.4.11 does not cite ANSI/ANS 2.8 directly, ANSI/ANS 2.8 references ANSI/ANS 2.13 as guidance when evaluating low water considerations. Therefore, the applicant's methodology used to develop the conceptual model of low tide was informed by ANSI/ANS methodology in the determination of low water conditions. The staff determined that the applicant provided a reasonable and adequate explanation detailing the rationale and justification for the use of ANSI/ANS methodology in its analysis, and that the determination of the 90 percent exceedance low tide for the Reedy Point record is adequate. Accordingly, the staff considers RAI 27, Question 02.04.11-1 resolved.

2.4.11.4.2 Low Water from Drought

Information Submitted by the Applicant

The applicant reviewed the water resource and management constraints imposed on the Delaware River basin, and the role of the DRBC flow management program for maintaining river flows. The DRBC, which was established in 1961, has a low Trenton flow objective of 84.95 m^3 (3,000 ft^3) per second although this flow rate has been modified by DRBC in times of drought (DRBC, 1999). The minimum daily flow at Trenton for the 89-year period of record (1913 through 2001) is 35.11 m^3 (1,240 ft^3) per second. More recent (1956 through 2001) 20-year daily low flows of 52.10 m^3 (1,840 ft^3) have been estimated by the USGS (USGS, http://nwis.waterdata.usgs.gov/nwis/dvstat?). The applicant is a co-owner of the Merrill Creek Reservoir, which is used for low flow augmentation during times of drought to allow the applicant to continue water withdrawal from the Delaware River for power generation.

To evaluate low flow conditions at the PSEG plant, the applicant simulated low flow conditions in conjunction with drought effects with the HEC-RAS model (USACE, http://www.hec.usace.army.mil/software/hec-ras/) from the USGS Trenton Gauge to the NOAA gauge at Lewes (i.e., the mouth of the Delaware Bay). Channel geometry and floodplain topography (Section 2.4.7) from the USGS, NOAA and the USACE and Manning's *n* coefficients were calibrated using tide data and stage-discharge data for Trenton. Downstream boundary conditions were representative of the 90 percent exceedance low tide and made consistent with the upstream tide cycle. The applicant simulated low flows for the 20-year drought low daily flow at Trenton (43.32 m^3 (1,530 ft^3) per second) and flow at Trenton of 0.03 m^3 (1 ft^3) per second. For the most conservative simulation (Trenton at 0.03m^3 (1 ft^3) per second), the minimum water level at the PSEG Site was estimated at -1.56 m (-5.1 ft) NAVD88, while the low daily flow simulation produced a low water level of -1.52 m (-5.0 ft) NAVD88 at the site. The simulation results indicated that even with negligible flow at Trenton, tidal flow rather than fresh water flow is capable of providing ample and sufficient cooling water supply. The applicant concluded that the 20-year drought low flow simulation is sufficient to simulate the minimum water level at the PSEG Site.

The Staff's Technical Evaluation

The staff reviewed the DRBC policies and USGS information submitted by the applicant. The staff found a longer period of record (1912 through 2013) published by the USGS (USGS, http://nwis.waterdata.usgs.gov/nwis/dvstat?) than the applicant described; however, the daily low flow estimate for this longer period of record remains 35.11 m^3 (1,240 ft^3) per second as

quoted by the applicant. The applicant is co-owner of the Merrill Creek Reservoir which could be used by the applicant for low flow augmentation of Delaware River flow.

The applicant's HEC-RAS (USACE, http://www.hec.usace.army.mil/software/hec-ras/) simulation of the 90 percent exceedance low tide in conjunction with 20-year drought low flows demonstrated that negligible freshwater flows make little difference in the minimum water level in the tidally influenced Delaware River at the PSEG Site. The applicant selected the 20-year drought low flow simulation as representative of producing minimum water levels at the PSEG Site. The staff finds the applicant's evaluation and discussion of drought low flow conditions adequate.

2.4.11.4.3 Low Water from Other Phenomena

Information Submitted by the Applicant

The applicant considered low water from other phenomena including hypothetical hurricane effects (SSAR Section 2.4.11), tsunami effects (SSAR Section 2.4.6), and winter low water with ice effects (SSAR Section 2.4.7).

The applicant reviewed the historical record for hurricanes passing within 100 nautical miles while noting that water levels from storm surge are lowest at the upwind area of semi-enclosed water bodies (Bretschneider, 1966) such as the Delaware Bay. The greater surge upwind is consistent with gauge observations at Reedy Point (an upwind, interior bay location) having higher magnitudes than those observations at Lewes located at the mouth of the Delaware Bay for storm-associated tides. Based on a review of the historical record, in addition to observations of greater surge at Reedy Point, the applicant concluded the following for tropical cyclones passing east of Delaware Bay:

- Negative surge in the Delaware Bay is caused by tropical cyclones passing near to and east of the bay

- Negative storm surge is greater if the storm passes close to the mouth of the bay while remaining offshore

- Increasing maximum sustained winds at the point of closest approach increase the negative surge

- Maximum negative surge occurs 2 to 10 hours after the closest approach and negative surge lasts less than 6 hours

To calculate negative surge, the applicant used an established equation:

$$\text{Negative surge (ft)} = A \times (\text{maximum sustained winds})^2$$

Where A is a constant dependent on the storm center difference from the bay at the closest approach with the sustained winds in units of knots (kt) (Bretschneider, 1966 and Einarsson and Lowe, 1968). To apply this relationship the applicant established hypothetical meteorological parameters based on NOAA Technical Report NWS 23 (NOAA/NWS, 1979) as follows:

- Central pressure, P_0 = 26.65 in mercury (Hg)
- Pressure drop, ΔP = 3.5 in Hg

- Radius of maximum winds, R = from 11 to 28 NM
- Forward speed, T = from 26 to 42 kt
- Track Direction (storm coming from) = from 70 to 185 degrees azimuthal
- Coefficient related to density of air, K = 68 (when parameters are in units of kt and in Hg)

To maximize strong northwesterly winds over the bay, the applicant chose a storm track direction of 185 degrees clockwise from true north. A slow forward speed (26 kt) was chosen by the applicant to maximize the duration of high windspeeds over the Delaware Bay, with the largest radius of maximum winds (28 nautical mi (NM) (51.86 km)) chosen to produce maximum negative surge. Based on procedures defined by NOAA (NOAA/NWS, 1979), the distance of closest approach to the mouth of the Delaware Bay was determined to be 20 NM (37 km).

Based on the selected parameters, the negative surge calculated is 3.32 m (10.9 ft). Combining this value with the negative surge from the 90 percent exceedance low tide and the 20-year drought low flow (SSAR Section 2.4.2.2) results in an overall negative surge of -4.85 m (-15.9 ft) NAVD88.

Details of the tsunami effect are presented in SSAR Section 2.4.6, Revision 2, reviewed herein and summarized in this section. The applicant analyzed tsunami sources from four sources:

- Currituck submarine landslide
- Currituck submarine landslide without bottom friction
- La Palma, Canary Island submarine landslide
- Hispaniola Trench earthquake

A minimum low water of -1.89 m (-6.2 ft) NAVD88 was determined by the applicant due to the Currituck submarine landslide without bottom friction as detailed in SSAR Section 2.4.6.

The low water effects from ice in conjunction with the 90 percent exceedance low tide and winter low flow, (52.10 m^3 (1,840ft^3)) per second at Trenton), were analyzed by the applicant to produce a minimum winter water level at the PSEG Site. The modified Stefan equation (USACE, 2004) is used to determine the maximum historical ice thickness. This equation uses a coefficient representative of the body of water and accumulated freezing degree days for ice thickness prediction and assumes a fresh water body. An ice thickness of 45.2 cm (17.8 in.) was determined and assumed to be conservative as the Delaware River near the new plant location is brackish and would actually have a lower freezing point resulting in a thinner ice estimate. The minimum water level from the low flow model was estimated as -1.52 m (-5.0 ft) NAVD88. Based on the above analyses, the applicant will design the intake structure such that surface ice effects occurring during low flow conditions would not prohibit or impede the operations of the intake structure.

The Staff's Technical Evaluation

The staff evaluated the applicant's consideration of low water from other phenomena including storm surge in Section 2.4.5, tsunami effects in Section 2.4.6, and winter low water with ice effects in Section 2.4.7 of this report.

The staff reviewed the applicant's descriptions of the historical negative surges and negative surge caused by a hypothetical hurricane (i.e., a PMH as defined in NOAA/NWS, 1979) as the most conservative condition for low water at the PSEG Site. The staff also reviewed the PMH parameters used by the applicant for a PMH passing by the Delaware Bay creating northerly

winds that could result in significant low water near the PSEG Site and finds the parameters to be reasonable. Consistent with previous studies (USACE, 1992 and Pape, et al., 1982), the applicant's surface water model simulations demonstrated that tidal flow dominates surface water levels at the PSEG Site and conservatively included a 90 percent exceedance low tide in the low water evaluation. By assuming this hurricane is coincident with a 20-year low flow in the Delaware River at Trenton, NJ and 90 percent exceedance low tide, the staff agrees that the applicant's evaluation demonstrated appropriately conservative assumptions and finds the applicant's evaluation for a resulting low water level of -4.85 m (-15.9 ft) NAVD88 adequate.

The staff reviewed the physiographic nature of the tidally influenced Delaware River. Tidal flow at the PSEG Site ranges from 11,327 to 13,366 m^3 (400,000 to 472,000 ft^3) per second (USEPA, 2002 and USACE, 1992), which is sufficient to supply the required water (projected to be 5 m^3 (175 ft^3) per second). Therefore, ice blockages upstream of the site would not limit the volume of safety-related water available for cooling and the staff finds the applicant's evaluation adequate.

In addition, in SSAR Section 2.4.7, the applicant stated that protective measures in accordance with ANSI/ANS-2.8-1992, Section 8.3, "Surface Ice," for the intake structure will be implemented which are acceptable to staff for mitigation of ice effects. Therefore, the staff finds the information and evaluation provided adequate.

2.4.11.4.4 Future Controls

Information Submitted by the Applicant

There are no dams on the main stem of the Delaware River. Its tributaries contain surface water impoundments that are used to manage the water supply, for flood protection, and recreation as overseen by the Delaware River Basin Commission, an independent legal authority.

The surface water elevations of the lower Delaware River (i.e., the upper Delaware Bay) are primarily dependent on tidal fluctuations. Therefore, the cooling water supply need not rely on fresh water flow to maintain an elevation sufficient for cooling water intake. There are no known controls on the Delaware River in the vicinity of the plant that could affect the availability of water or result in extreme low surface water elevations at the PSEG Site.

The Staff's Technical Evaluation

The staff evaluated the applicant's review and finds its assessment of future controls on the Delaware River basin adequate given the DRBC management of the Delaware River Basin and its water resources.

2.4.11.4.5 Plant Requirements

Information Submitted by the Applicant

The PPE intake structure requirements (approximately 5 m^3 (177 ft^3) per second), are far less than the tidal flows of the Delaware River at the PSEG Site ranging from 11,327 to 13,366 m^3 (400,000 to 472,000 ft^3) per second (USEPA, 2002 and USACE, 1992), which is sufficient for the cooling water intake supply.

The Staff's Technical Evaluation

The staff reviewed the PPE as presented in the SSAR and publicly available studies (Delaware Department of Transportation, 1994, USEPA, 2002, USGS, 1962) of the Delaware River tidal flows and finds the applicant's characterization of the tidal flows with respect to cooling water requirements adequate.

2.4.11.4.6 Heat Sink Dependability Requirements

Information Submitted by the Applicant

Depending on the technology selected, the intake structure provides either a non-safety-related or a safety-related source of water for the proposed plant. The applicant will design the UHS portion of the intake structure to the requirements of the selected technology to withstand extreme events including flooding from streams and rivers (SSAR Section 2.4.3), the PMSS (SSAR Section 2.4.5), the PMT (SSAR Section 2.4.6), winter ice effects (SSAR Section 2.4.7), and extreme low water conditions (SSAR Section 2.4.11). The invert elevations of the UHS makeup pumps will be set at an elevation sufficient to maintain plant operations during extreme low water conditions.

The Staff's Technical Evaluation

When the specific reactor technology is selected at the PSEG Site, the final design of the intake structure and invert elevation for maintenance of plant operations will be evaluated. The safety-related intake structure for the selected reactor technology will be designed to operate during the low water conditions as described in SSAR Section 2.4.11. The staff finds the applicant's evaluation and discussion adequate.

2.4.11.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.11.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the PPE, and that there is no outstanding information required to be addressed in the SSAR related to this section.

As set forth above, the applicant has provided information pertaining to low-water considerations, including hydrologic conditions that could lead to low river elevations, conditions that could result in use of a UHS, and potential effects of upstream land-use change in the drainage area. Therefore, the staff concludes that the applicant has met the requirements related to low-water considerations with respect to 10 CFR 52.17(a) and 10 CFR Part 100. Additionally, the staff concludes that, the applicant has considered the most severe 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 in establishing low-water conditions for use in design.

2.4.12 Groundwater

2.4.12.1 Introduction

SSAR Section 2.4.12 describes the hydrogeological characteristics of the site. A significant safety objective of groundwater investigations and monitoring at this site is to evaluate the effects of groundwater on plant foundations. The evaluation is performed to assure that the maximum groundwater elevation remains within the PPE value. The other significant objectives are to examine whether groundwater provides any safety-related water supply; to determine whether dewatering systems are required to maintain groundwater elevation below the required level; to measure characteristics and properties of the site needed to develop a conceptual site model of groundwater movement; and to estimate the direction and velocity of movement of potential radioactive contaminants.

Section 2.4.12 herein presents an evaluation of the following specific areas: (1) identification of the aquifers, types of onsite groundwater use, sources of recharge, present withdrawals and known and likely future withdrawals, flow rates, travel time, gradients (and other properties that affect the movement of accidental contaminants in groundwater), groundwater levels beneath the site, seasonal and climatic fluctuations, monitoring and protection requirements, and manmade changes that have the potential to cause long-term changes in local groundwater regime; (2) effects of groundwater levels and other hydrodynamic effects of groundwater on design bases of plant foundations and other SSCs important to safety; (3) reliability of groundwater resources and related systems used to supply safety-related water to the plant; (4) reliability of dewatering systems to maintain groundwater conditions within the plant's design bases; (5) potential effects of seismic and non-seismic information on the postulated worst-case groundwater conditions for the proposed plant site; and (6) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.12.2 Summary of Application

This SSAR section addresses groundwater conditions in terms of impacts on structures and water supply. The application section addresses these issues as follows:

- The applicant described geologic formations, and regional and local groundwater aquifers, sources, and sinks.
- The applicant described proposed groundwater use for PSEG Site operations consisting of sanitary/potable use, demineralized makeup water, and fire suppression.
- The applicant described dewatering that will be required during construction, but due to the proposed plant grade elevation, no dewatering will be required when the plant is operational.
- The applicant described the present and projected future regional water use, relying on reports and databases of the USGS, the U.S. Environmental Protection Agency (EPA), the State of New Jersey, and the Delaware River Basin Water Commission.
- The applicant described water levels and flow directions both regionally and onsite. The applicant provided groundwater level maps over the site and regional maps showing major hydrologic features.

2.4.12.3 Regulatory Basis

The relevant requirements of the NRC regulations for characterizing groundwater, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.4.12.

The applicable regulatory requirements for groundwater are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

The staff also used the acceptance criteria identified in NUREG-0800, Section 2.4.12:

- Local and Regional Groundwater Characteristics and Use: The applicant should supply a complete description of regional and local groundwater characteristics and groundwater use, groundwater monitoring and protection requirements, and any man-made changes with a potential to affect regional groundwater characteristics over a long period of time.

- Effects on Plant Foundations and other Safety-Related Structures, Systems, and Components: The applicant should supply a complete description of the effects of groundwater-surface elevations and other hydrodynamic effects on the design bases of plant foundations and other SSCs important to safety.

- Reliability of Groundwater Resources and Systems Used for Safety-Related Purposes: The applicant should supply a complete description of all SSCs important to safety that depend on groundwater, as well as data and analysis regarding the reliability of the groundwater source.

- Reliability of Dewatering Systems: The applicant should supply a complete description of the site dewatering system, including its reliability to maintain the groundwater conditions within the groundwater design bases of SSCs important to safety.

- Consideration of Other Site-Related Evaluation Criteria: The applicant should supply an assessment of the potential effects of seismic and non-seismic information about the postulated worst-case scenario related to groundwater effects for the proposed plant site.

2.4.12.4 Technical Evaluation

The staff reviewed the information in SSAR Section 2.4.12. The staff confirmed that the information in the application addresses the relevant information related to the groundwater considerations. The staff's technical review of this section includes an independent review of the applicant's information in the SSAR and in the responses to the RAIs. The staff supplemented this information with other publicly available sources of data.

The applicant identified aquifers, groundwater use categories, sources of recharge, present and future withdrawals, flow rates, travel times and gradients and other properties that affect transport of radionuclides, groundwater levels in the site vicinity including seasonal and climatic variations, monitoring and protection plans, and manmade changes that have the potential to cause long-term changes in the localized flow system. This section of the report provides the staff's evaluation of the technical information presented in SSAR Section 2.4.12.

2.4.12.4.1 Groundwater System

Information Submitted by the Applicant

The applicant supplied a narrative description of the hydrogeology of the region and the site. In the region, the aquifer/aquitard sequence contains the following units (Dugan, et al., 2008):

- Alluvium
- Kirkwood-Cohansey Formation
- Vincentown Formation
- Navesink-Hornerstown Formation
- Mount Laurel-Wenonah Formation
- Marshalltown Formation
- Englishtown Formation
- Woodbury Formation
- Merchantville Formation
- Potomac-Raritan-Magothy (PRM) Formation

The PRM system is the key regional potable groundwater source and is the formation used for onsite water withdrawals. Water withdrawal rates for the Salem Generating Station (SGS) and HCGS were given and estimated withdrawal rates were provided using a PPE as the final technology selection has not been made. The proposed PSEG Site operations will use groundwater for sanitary/potable use, demineralized makeup water, and fire suppression. Makeup to a safety-related ultimate heat sink (UHS) (if necessary) and the non-safety-related circulating water system (CWS) for the new plant will be drawn from the Delaware River. Dewatering will be required during construction but not when the plant is operational.

The Staff's Technical Evaluation

Although the applicant indicated that the aquifer/aquitard sequence for the site includes the Kirkwood-Cohansey Formation, the New Jersey Geological Survey (Dames & Moore, 1988) has indicated that this Formation is absent from the site area. Since the applicant performed field studies and derived parameters from these studies for the interval proposed to be the Kirkwood-Cohansey Formation, the formal name for this interval had no impact on the staff's evaluations and conclusions in this report.

The staff reviewed the information provided in SSAR Section 2.4.12, Revision 0 and determined that additional information was needed to describe the differing hydrologic units to confirm groundwater pathways and flow rates. Therefore, in RAI 29, Question 02.04.12-1, the staff requested that the applicant provide more detail on the hydraulic parameters for the hydrologic units. In a June 14, 2011, response to RAI 29, Question 02.04.12-1, the applicant provided the requested information as summarized here: the groundwater elevation will determine the hydrostatic loading on the plant foundations, which is safety-related. The new plant grade will

be at an elevation of 11.25 m (36.9 ft) NAVD88. Based on 1 year of data, the maximum measured groundwater level at the power block was 0.48 m (1.57 ft) NAVD88. After construction, the water level is anticipated to return to slightly higher levels due to the soil retention wall barrier used during dewatering that will be left in place. Anticipated water levels will be on average 0.9 – 1.2 m (3 - 4 ft) NAVD88 with a maximum elevation just above the retention wall at 1.6 m (5.2 ft) NAVD88. For analysis of hydrostatic loading, a water elevation of 1.8 m (6 ft) NAVD88 is used. At this elevation, the hydrostatic loads are much less than the maximum required of the potential technologies. The staff reviewed the applicant's response containing parameters as well as groundwater contour map and finds that the additional information in conjunction with the original description of the hydrological units and flow directions was adequate. The applicant committed to revise the SSAR with this information. The staff verified that Revision 1 of the ESP application (May 21, 2012) contains the applicant's committed information. Accordingly, the staff considers RAI 29, Question 02.04.12-1 resolved.

2.4.12.4.2 Groundwater Modeling During Operation

Information Submitted by the Applicant

The applicant provided a description of groundwater modeling efforts to support routine operations (Dames & Moore, 1988). The modeling study was performed to justify water withdrawal permits for the existing plants (SGS and HCGS) and included an assessment of the potential for saltwater intrusion in the Mount Laurel-Wenonah and PRM aquifers and the impact of water withdrawal on regional groundwater flow. The applicant concluded that there would be no major impact to the salinity of the Upper PRM even at simulated flows twice the level of the current pumping rate. Based on this information and the PPE for water withdrawal at the proposed plant, the applicant concluded that there was sufficient groundwater availability on site to meet the new plant's needs and not induce saltwater intrusion.

The Staff's Technical Evaluation

The staff reviewed the information provided in SSAR Section 2.4.12, Revision 0 and determined that additional information was needed to evaluate the groundwater modeling. Therefore, in RAI 29, Questions 02.04.12-1 through 02.04.12-5, the staff requested that the applicant provide the following information:

- Clarification on the use of site-specific parameters and data (specifically whether porosities values were effective or total porosity)
- Model calibration studies including comparison of model predictions with measured values
- The impacts of a) boundary conditions, b) horizontal grid size, and c) vertical grid size on model accuracy

In a June 14, 2011, response the applicant provided the requested information. The staff reviewed this response and concluded that the information provided was sufficient to evaluate the modeling used to support groundwater withdrawals for plant use. However, the applicant indicated that it believed that no changes to the SSAR were required. After discussion with the applicant, the staff issued RAI 38, Question 02.04.12-6, requesting that this information be included in the SSAR. In a September 22, 2011, response to RAI 38, Question 02.04.12-6, the applicant stated that the information would be incorporated into the next revision of the SSAR. The staff confirmed that these changes have been incorporated in Revision 1 of the ESP

application (May 21, 2012). Accordingly, the staff considers RAI 29, Questions 02.04.12-1 through 02.04.12-5, and RAI 38, Question 02.04.12-6 resolved.

2.4.12.4.3 Groundwater Modeling During Dewatering

Information Submitted by the Applicant

The applicant provided a description of groundwater modeling efforts to support dewatering operations required during construction of the new plant. The model simulated dewatering of the plant area down to the Kirkwood Formation over most of the proposed plant boundary and to the deeper Vincetown Formation beneath the safety-related structures. Dewatering will be accomplished by temporary wells around these two regions. The best estimate for the pumping rate to effectively dewater the site was estimated to be between 19,682 liters (l) (5,200 gallons (gal)) and 21,196 l (5,600 gal) per minute for the first year and decreasing afterwards. Sensitivity analysis indicated that the first year pumping rate could range from 11,355 l (3,000 gal) to 28,766 l (7,600 gal) per minute. Potentiometric surfaces based on the modeling were provided and existing structures that may be impacted were identified. During construction, the applicant noted that additional measures, such as sand drains, may be needed to effectively dewater the fill and alluvium. The design for such measures and the dewatering study will be refined when a final technology is selected.

The Staff's Technical Evaluation

The staff reviewed the information provided in SSAR Section 2.4.12, and determined that additional information was needed to evaluate the groundwater modeling used to support dewatering. Therefore, in RAI 29, Question 02.04.12-3, the staff requested that the applicant supply the reference material and information on model specific parameters (porosity, hydraulic conductivity, etc.) used in the analysis. In a June 14, 2011, response to RAI 29, Question 02.04.12-3, the applicant adequately addressed existing conditions as summarized here: during dewatering, the piezometric head is decreased, the effective vertical pressure exerted by the soil column is increased by the amount of that decrease times the unit weight of water. The increase in vertical effective pressure can cause settlement of soils. The settlement, in turn, can affect the performance of structures supported on the soil, or can add downward loads to pile foundations supporting the structures. Current water level contour maps in the vicinity of SGS and HCGS indicate that the safety of these foundations will not be compromised by dewatering. However, the applicant indicated that no changes to the SSAR were needed. After a teleconference with the applicant, the staff issued RAI 38, Question 02.04.12-6 requesting that this information be included in the SSAR. In a September 22, 2011, response to RAI 38, Question 02.04.12-6, the applicant committed to include the information into the next revision of the SSAR. The applicant further stated that groundwater modeling would be refined after the reactor vendor is selected, and the final excavation geometry is determined, and preparation of the COL application would require additional data, which would be obtained from pumping tests or other methods, to further refine hydrogeologic parameters and model estimates of dewatering rates and drawdowns beneath existing site structures. The staff finds the applicant's information and rationale adequate. The staff also confirmed that the applicant's committed changes have been incorporated in Revision 1 of the ESP application (May 21, 2012). Accordingly, the staff considers RAI 29, Question 02.04.12-3 and RAI 38, Question 02.04.12-6 resolved. Consistent with the applicant's stated intention, the staff identified COL Action Item 2.4-3 to address the review of future site characterization data, dewatering plans, and groundwater monitoring plans.

COL Action Item 2.4-3

> An applicant for a COL or CP referencing this early site permit should refine hydrogeologic parameters and model estimates of dewatering rates and drawdowns beneath existing site structures after determination of the final excavation geometry consistent with a selected reactor technology.

2.4.12.4.4 Groundwater Monitoring

Information Submitted by the Applicant

The applicant indicated that best management practices will be used to minimize impacts to the groundwater and that the monitoring programs will be developed once the final technology is selected.

The Staff's Technical Evaluation

Groundwater monitoring information will be reviewed by staff at the COL stage once a reactor technology is selected. The staff will be tracking the applicant's groundwater monitoring program via COL Action Item 2.4-3.

2.4.12.5 Post Early Site Permit Activities

The review of future site characterization data, dewatering plans, and groundwater monitoring plans at the COL stage is being tracked as COL Action Item 2.4-3.

2.4.12.6 Conclusion

The staff reviewed the application and confirmed that the applicant has demonstrated that the characteristics of the site fall within the site parameters specified in the plant parameter envelope, and that there is no outstanding information required to be addressed in the SSAR related to this section.

As set forth above, the applicant has provided sufficient information pertaining to groundwater. Therefore, the staff concludes that the applicant has met the requirements related to groundwater in 10 CFR 52.17(a), 10 CFR 100.23, and 10 CFR 100.20(c). The COL applicant will address COL Action Item 2.4-3.

2.4.13 Accidental Release of Radioactive Liquid Effluent in Ground and Surface Waters

2.4.13.1 Introduction

SSAR Section 2.4.13 considers the potential effects of relatively large accidental releases from systems that handle liquid effluents generated during normal plant operations. Such releases would have relatively low levels of radioactivity, but could be large in volume. Normal and accidental releases are also considered in the applicant's environmental report. The accidental release of radioactive liquid effluents in ground and surface waters is evaluated based on the hydrogeological characteristics of the site that govern existing uses of groundwater and surface water and their known and likely future uses.

The source term from a postulated accidental release is reviewed under NUREG-0800, Section 11.2, following the guidance in Branch Technical Position (BTP) 11-6, "Postulated

Radioactive Releases Due to Liquid-Containing Tank Failures." The source term is determined from a postulated release from a single tank outside of the containment. The results of a consequence analysis are evaluated against SRP Section 11.2 and BTP 11-6 guidance and effluent concentration limits (ECLs) of Table 2, Column 2 in 10 CFR Part 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," as SRP acceptance criteria. Under SRP guidance, the effluent concentration limits of 10 CFR Part 20, Appendix B are applied as acceptance criteria only for the purpose of assessing the acceptability of the results of the consequence analysis and are not intended for demonstrating compliance with ECLs.

The following specific areas are reviewed by the staff: (1) alternative conceptual models of the hydrology at the site that reasonably bound hydrogeological conditions at the site inasmuch as these conditions affect the transport of radioactive liquid effluent in the groundwater and surface water environment; (2) bounding set of plausible surface and subsurface pathways from potential points of an accidental release to determine the critical pathways that may result in the most severe impact on existing uses and known and likely future uses of groundwater and surface water resources in the vicinity of the site; (3) ability of the groundwater and surface water environments to delay, disperse, dilute, or concentrate accidentally released radioactive liquid effluent during its transport; (4) assessment of scenarios wherein an accidental release of radioactive effluents is combined with potential effects of seismic and non-seismic events (e.g., assessing effects of hydraulic structures located upstream and downstream of the plant in the event of structural or operational failures and the ensuing sudden changes in the regime of flow); and (5) any additional information requirements prescribed in the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

2.4.13.2 Summary of Application

This section provides an analysis of an accidental liquid release of effluents or radioactive wastes to the groundwater at the PSEG Site. The postulated accident scenario is combined with the conceptual site model to evaluate potential impacts to receptors should a catastrophic tank rupture occur during plant operations and instantaneously release radionuclides to the groundwater environment. The resulting calculated concentrations that would reach the potential surface water receptors are then compared to the ECLs published in 10 CFR Part 20, Appendix B. The calculated results are then assessed using the unity rule where the sum of the ratios of the calculated concentrations to the corresponding ECLs for all radionuclides in the effluent may not exceed one.

2.4.13.3 Regulatory Basis

The relevant requirements of NRC regulations for the pathways of liquid effluents in ground and surface waters, and the associated acceptance criteria, are specified in NUREG-0800, Section 2.4.13.

The applicable regulatory requirements for evaluating accidental release of radioactive liquid effluents in ground and surface waters are set forth in the following:

- 10 CFR 52.17(a)(1)(vi), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the

limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

The staff also used the acceptance criteria identified in NUREG-0800, Section 2.4.13:

- Alternate Conceptual Models: Alternate conceptual models of hydrology in the vicinity of the site are reviewed.

- Pathways: The bounding set of plausible surface and subsurface pathways from the points of release are reviewed.

- Characteristics that Affect Transport: Radionuclide transport characteristics of the groundwater environment with respect to existing and known and likely future users should be described.

- Consideration of Other Site-Related Evaluation Criteria: The applicant's assessment of the potential effects of site-proximity hazards, seismic, and non-seismic events on the radioactive concentration from the postulated tank failure related to accidental release of radioactive liquid effluents to ground and surface waters for the proposed plant site is needed.

- BTP 11-6 provides guidance in assessing a potential release of radioactive liquids after the postulated failure of a tank and its components, located outside of containment, and effects of the release of radioactive materials at the nearest potable water supply, located in an unrestricted area, for direct human consumption or indirectly through animals, crops, and food processing.

The staff used best current practices to analyze groundwater transport of radioactive liquid effluents. In addition, the hydrologic characteristics should conform to appropriate sections from RG 1.113, "Estimating Aquatic Dispersions of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I."

2.4.13.4 Technical Evaluation

The staff reviewed the SSAR, Revision 2, and subsequent responses to RAIs related to the accidental release of radioactive liquid effluents in ground and surface waters included under Section 2.4.13 of the application. The staff's review confirmed that the information in the application addresses the relevant information related to this section.

2.4.13.4.1 Release Site Location

This evaluation concerns the location of the spill release site and the conservatism of this assumption as discussed in the SSAR Sections 2.4.13.1.2 through 2.4.13.1.9.

Information Submitted by the Applicant

The applicant assumed in SSAR, Revision 0 that the radioactive release would occur on the western edge of the power block but not the eastern or northern edge. The applicant indicated that this was conservative (shortest travel time, least decay), because the nearest surface water receptor is located on the west side of the power block (Delaware River). In addition, it was determined that travel time to the northeast surface water receptor would take much longer and thus result in lower concentrations at the discharge to surface water.

The Staff's Technical Evaluation

The Delaware River is the closest surface water body to the power block and has a great dilution capacity, while the northern and eastern tidal streams are further away and have a much lower dilution capacity. The northeast migration path was not quantitatively addressed in the SSAR, Revision 0. The staff estimates indicate that concentrations from a spill reaching the tidal streams could be much higher than those estimated in the Delaware River by the applicant.

In RAI 31, Questions 02.04.13-5 (potential for release to the northeast) and 02.04.13-10 (conservatism of receptor locations), the staff communicated to the applicant concerns relating to a release toward the northeast, and requested that the applicant address these concerns. In a June 30, 2011, response, the applicant provided several qualitative arguments, summarized below, as to why a release toward the east side is the most conservative. The applicant also generated a site wide water table contour map (Figure 2.4.13-1 of this report) in response to RAI 29, Question 02.04.12-2, based on monthly water level data measured in 2009 to indicate predominant and sustained westerly groundwater flow across the PSEG Site with easterly components due to tidal fluctuation. These arguments for the conservatism of the westerly path noted that a substantially longer easterly travel time allowed for more radionuclide decay before discharge to surface water.

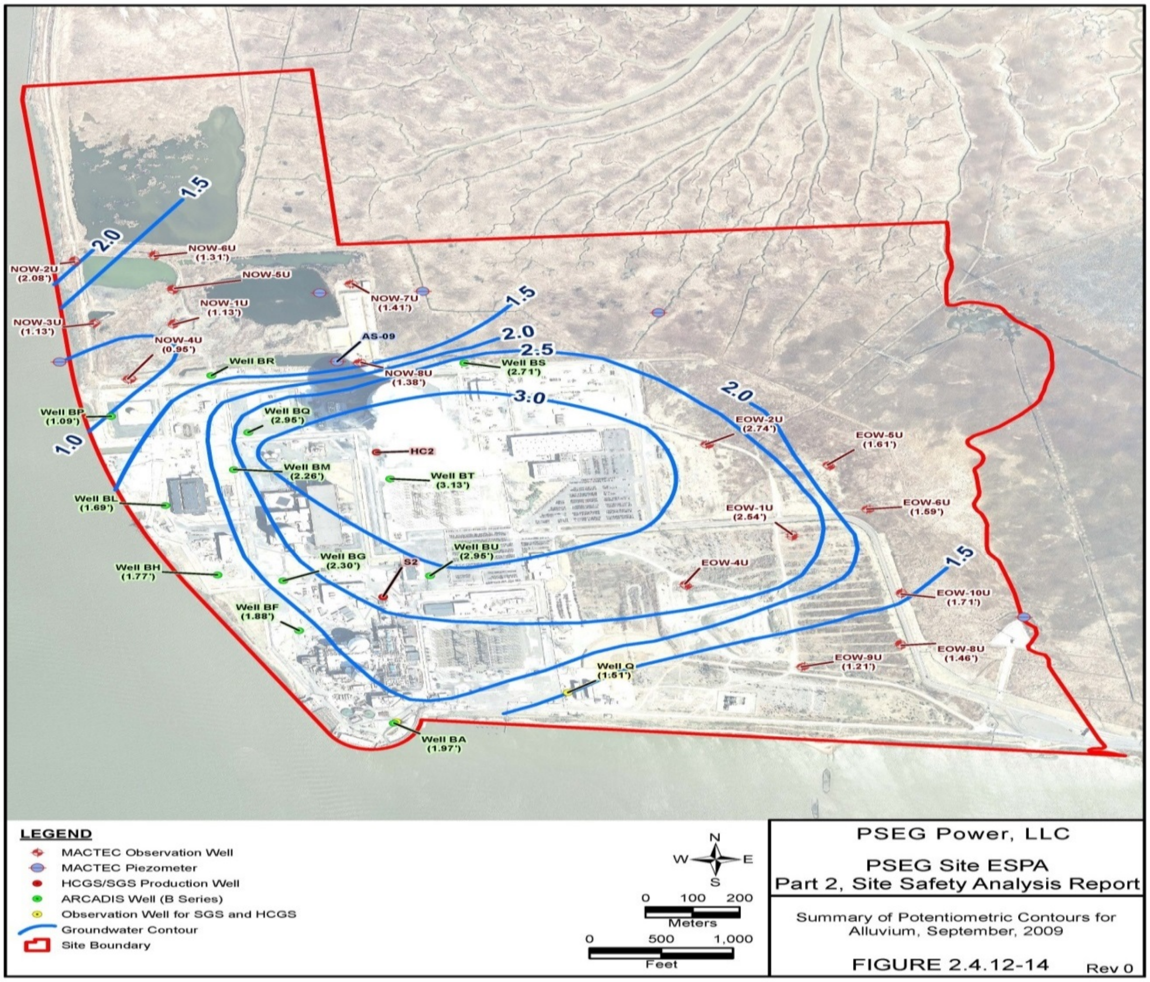

Figure 2.4.13-1 PSEG Site Wide Water Levels September 2009, (from SSAR Revision 3, Figure 2.4.12-14)

In a June 30, 2011, response to RAI 31, Question 02.04.13-10, the applicant explained that concentration attenuation factors in the accidental release scenario include sorption, decay, dilution, and dispersion vertically through migration into a lower, thicker aquifer. The release into the alluvium spans a relatively thin aquifer, whereas any further vertical migration into the next lower aquifer (the Vincentown) toward potential private well receptors (as well as the Delaware River) would be moderated by a longer flow path, additional dilution by dispersion, sorption, and added time for decay to occur which would indicate that migration through the alluvium is the more conservative pathway.

The staff confirmed that these qualitative explanations with respect to RAI 31, Question 02.04.13-10, were included in SSAR, Revision 1, and subsequently, Revision 2. While the staff concurs that the conceptual model contains several conservative assumptions, this does not imply that the entire analysis is conservative. Conservatism in the analysis depends on the choice of parameters that reasonably represent the physical properties of the system.

Further, the applicant did not address the difference in dilution capacity between the Delaware River and the tidal streams toward the northeast nor did it perform a quantitative evaluation of the potential northeasterly flow. A teleconference with the applicant was held on July 25, 2011, to discuss staff's additional information needs after the June 30, 2011, response to RAI 31, Question 02.04.13-5. In a July 25, 2011, response to RAI 31, Question 02.04.13-12, the applicant submitted changes to SSAR Section 2.4.13 and committed to incorporate these into the next SSAR revision. The staff verified that the applicant incorporated the committed changes in Revision 1 of the ESP application (May 21, 2012).

The applicant's July 25, 2011, response to RAI 31, Question 02.04.13-12, stated that flow directions are to the east and south for groundwater in the eastern portion of the facility. The applicant predicted post-construction groundwater mounding (SSAR Section 2.4.12) as a function of impacts due to post-construction features, the hydrogeologic properties of the alluvium, the distribution of recharge across the site, and distances and directions to groundwater sinks (i.e., locations where groundwater would discharge to surface water). A similar groundwater mounding pattern exists in the vicinity of the SGS and HCGS power block area (Figure 2.4-13-1 of this report).

Given that there were no available groundwater monitoring data points in the northeastern marsh area to indicate otherwise, that there is a reasonable possibility for easterly flow in the eastern portion of the power block area, and that the final plant design may result in a release on the east side of the power block, the staff requested supplemental information in RAI 60, Question 02.04.13-14, after a September 27, 2011, teleconference with the applicant.

The applicant addressed flow to the eastern portion of the site in a May 3, 2012, response. After reviewing the applicant's response, the staff communicated to the applicant in RAI 68, Question 02.04.13-15 further staff concerns related to the incorporation of post-construction groundwater conditions into the release scenarios, and requested that the applicant address these concerns. In a December 20, 2012, response, the applicant adequately and acceptably addressed staff concerns regarding post-construction groundwater conditions and release scenarios, which are discussed below in Section 2.4.13.4.4, "Migration Scenarios" of this report. Accordingly, the staff considers RAI 68, Question 02.04.13-15; RAI 31, Questions 02.04.13-5 and 02.04.13-10; and RAI 29, Question 02.04.12-2 resolved.

2.4.13.4.2 Postulated Release to Alluvium

This evaluation concerns the release of a spill directly to the alluvium aquifer that bypasses the hydraulic fill and whether this is a sufficiently conservative assumption as initially postulated in SSAR Revision 0, Section 2.4.13.1.3.

Information Submitted by the Applicant

The applicant stated that the release will be to the alluvium and no groundwater travel time for downward migration through the hydraulic fill is provided. Once in the alluvium, the contaminants migrate to the edge of the Delaware River where they discharge to the surface waters. The effect of dredging cutting into the alluvium along the river bank that would create a shorter travel time is conservatively incorporated into the conceptual model through the applicant's assumption of groundwater discharge through the west river bank immediately adjacent to the site rather than further offshore.

The Staff's Technical Evaluation

The applicant's evaluation in SSAR, Revision 0, did not fully explain the detail of transport of contaminants after being released into the structural fill of the power block area that will replace the existing and hydraulic fill and alluvium to be excavated. Therefore in RAI 31, Questions 02.04.13-6 and 02.04.13-7, the staff, requested that the applicant further clarify the hydraulic relationships between the structural fill, hydraulic fill, alluvium, and Delaware River to verify that the assumptions are conservative.

In a June 30, 2011, response, to RAI 31, Questions 02.04.13-6 and 02.04.13-7, the applicant provided further clarification indicating the spill would be released to the proposed structural fill and that this material would provide additional retention and decay time that is not included in the assumptions. In addition, the impact of dredging was included by assuming the discharge from the alluvium would be at the Delaware River bank (87 m (285 ft)) from the western edge of the proposed power block area and the assumed conservative release location).

The staff verified that based on the relatively low hydraulic conductivity of the hydraulic fill, groundwater will preferentially flow from the structural fill into the alluvium rather than the hydraulic fill at the edge of the power block area. Therefore, the assumption of an instant release of a surface spill to the alluvium ignores additional retention and decay within the structural fill that would be the case in an actual spill. This assumption is conservative because it transports radionuclides to the Delaware River faster than could actually occur. Therefore, the applicant provided an adequate and acceptably conservative response for the staff's evaluation, and the staff confirmed that the information was incorporated in Revision 1 of the ESP application (May 21, 2012). Accordingly, the staff considers RAI 31, Questions 02.04.13-6 and 02.04.13-7 resolved.

2.4.13.4.3 Impacts of Tidal Flushing on the Groundwater Flow Rate in the Alluvium

This evaluation concerns the applicant's calculation of hydraulic gradients in the alluvium towards the river without including explicit tidal effects as initially discussed in SSAR, Revision 0, Section 2.4.13.1.3.

Information Submitted by the Applicant

The applicant presented the probable maximum and average hydraulic gradients calculated for the alluvium as discussed in the SSAR, Revision 0. With the additional (hydraulic conductivity, porosity and discharge area) site data, the average and maximum groundwater velocities and flow rate are calculated.

The Staff's Technical Evaluation

Since the impacts from tidal influences were not explicitly discussed in the SSAR, Revision 0, the staff could not verify these calculations. Within the shallow groundwater system, the influence of the tidal cycle will continuously change the groundwater velocity and an estimate of the resultant velocity and groundwater flow direction needed to be made by the applicant.

In RAI 31, Question 02.04.13-3, the staff requested that the applicant provide clarification of how tidal influences from the Delaware River were taken into account and the rationale to support the premise that the predominant groundwater flows in the alluvium and the Vincentown are westward toward the Delaware River.

On June 30, 2011, the applicant provided initial response to RAI 31, Question 02.04.13-3, and following a clarifying teleconference with the staff, the applicant provided a supplemental response on July 25, 2011. The applicant modified the SSAR to explain that tidal flushing within the alluvium would lead to increased dilution, which is not accounted for in the model, and therefore, adds to the conservatism of the assumptions. Tidal flushing will impact the instantaneous groundwater flow into the river, but not the average flow. The average flow is controlled by the hydraulic gradients on land that are toward the Delaware River on the west side of the power block. The applicant's explanation and additional information was an adequate basis for the staff's evaluation, and the staff confirmed that this information was incorporated in Revision 1 of the ESP application (May 21, 2012). Accordingly, the staff considers RAI 31, Question 02.04.13-3 resolved.

2.4.13.4.4 Migration Scenarios

This evaluation relates to the staff's assessment of the applicant's consideration of the easterly release scenario as discussed in SSAR, Revision 0, Section 2.4.13.1.4, and a westerly release as initially described in SSAR, Revision 1, Section 2.4.13.1.4.

Information Submitted by the Applicant

The applicant stated in the SSAR, Revision 0, that the easterly migration scenario is less conservative than the westerly because the distance to tidal streams is longer than to the Delaware River; the release would need to migrate vertically upward through sediments of low permeability; and there would be dilution in the surface water due to tidal influences.

The Staff's Technical Evaluation

This scenario was not completely evaluated by the applicant and did not contain quantitative estimates as to travel time, dilution, and decay of the contaminants. Due to the lower flows and subsequent dilution capacity of the eastern tidal areas, there is a possibility that even with a longer travel time the concentration at the tidal streams could eventually be higher than that in the Delaware River. Without additional information the staff could not adequately evaluate this scenario.

Therefore in RAI 31, Question 02.04.13-4, the staff requested that the applicant provide clarification on this issue. After reviewing the applicant's initial and supplemental responses, dated June 30, 2011, and July 25, 2011, respectively, the staff had further questions. Subsequently, following a clarifying teleconference with the applicant on September 27, 2011, the staff requested supplemental information in RAI 60, Question 02.04.13-14.

Following a related March 1, 2012, teleconference with the applicant, the applicant committed to address this issue based on the final design at the COL stage. However, the applicant responded on May 3, 2012, to RAI 60, Question 02.04.13-14, with a proposed revision to the SSAR that addressed both the easterly and westerly release pathways.

In the release analysis, the applicant chose the northeast corner of the power block as the potential release site and Fishing Creek in a northeasterly direction as the groundwater discharge point. The staff independently verified from piezometer and well water level data the applicant's conceptualization that the streams closer to the postulated release point are not in contact with the groundwater but are tidally driven only.

Given the staff's hydrogeologic understanding of the site as well as the location of Fishing Creek at the old Delaware River shoreline, (i.e., the shoreline prior to the creation of Artificial Island with hydraulic fill), the applicant's choice of Fishing Creek as the discharge point of an accidental release into the alluvium is reasonable.

Using the highest measured groundwater elevation at the power block in the alluvium, (approximately 0.48 m (1.57 ft) NAVD88); the applicant calculated that 0.015 m^3/day (0.53 ft^3/day) would be needed to achieve the sum of radionuclide to ECL ratios of unity at the discharge point in Fishing Creek. Fishing Creek is estimated from aerial photographs to be approximately 61 m (200 ft) wide, therefore, this low flow rate is easily achieved. The staff confirmed that the analysis and discussion of an easterly release was incorporated in Revision 2 of the ESP application (March 31, 2013).

The staff noted that the groundwater elevation, 0.48 m (1.57 ft) NAVD88, used to calculate the hydraulic gradient to Fishing Creek is inconsistent with the mounded elevations 1.8 - 3 m (6 - 10 ft) NAVD88, assumed for the structural analysis and post construction modeling presented in the SSAR, Revision 1 (pages 2.4-164, 2.4-167, and 2.5-306). This inconsistency was discussed with the applicant during a November 15, 2012, conference call and subsequently documented in RAI 68, Question 02.04.13-15. The applicant responded to this RAI on December 20, 2012. For the release toward Fishing Creek, the applicant addressed with appropriate conservatism, a groundwater mound resulting from the construction of the power block by shortening the flow pathway from 1,280 m (4,200 ft) to 1,158 m (3,800 ft) (i.e., a transport pathway beginning just outside the influence of the mound). This raised the dilution capacity required to meet the Unity Rule at Fishing Creek from 0.015 m^3 (0.53 ft^3) per day to 0.06 m^3 (2.12 ft^3) per day. The staff finds the applicant's characterization of transport pathways and of the dilution capacity of Fishing Creek as a tidal stream adequate.

For a westerly transport flow path to the Delaware River considering post-construction mounding, the applicant determined that instead of 3.17 m^3 (112 ft^3) per second (without mounding), 9.52 m^3 (336 ft^3) per second of river flow for dilution would be required to meet the Unity Rule. There is no reasonably conceivable scenario in which the Delaware River adjacent to the site could fall below either flow rate. The staff finds the applicant's determination that groundwater mounding influencing westerly flow to the Delaware River would not significantly change, and calculations presented in the SSAR adequate. Accordingly, the staff considers RAI 31, Question 02.04.13-4, RAI 60, Question 02.04.13-14, and RAI 68, Question 02.04.13-15 resolved.

2.4.13.4.5 Average and Maximum Groundwater Velocities

This topic concerns the level of confidence the applicant has in both the average and maximum groundwater velocities in the contaminant migration estimates given the length of the monitoring record.

Information Submitted by the Applicant

In SSAR, Revision 0, Section 2.4.13.1.6, the applicant initially presented the estimated average and maximum groundwater flow velocities from the power block to the Delaware River bank (0.0024 and 0.029 meters per day (m/day) (0.00788 and 0.094 feet per day (ft/day)), respectively).

The Staff's Technical Evaluation

The specific methodology used to determine these migration estimates was not presented by the applicant; however, the applicant stated in the SSAR, Revision 0, that the net migration rates are estimated from site-specific data including the tidal influences.

In RAI 31, Question 02.04.13-8, the staff requested that the applicant present flow velocity calculations. In a June 30, 2011, response, the applicant provided information on the method used to calculate groundwater flow velocities and hydraulic data to calculate flow velocities. The staff confirmed the velocities calculated using the same method. The staff calculated a range of potential water velocities based on hydraulic potential maps supplied by the applicant and these values were always less than the maximum value determined by the applicant although based on existing conditions. In addition, existing conditions are inconsistent with the post-construction mounded elevations anticipated by the applicant. The applicant's post construction water levels of 1.8 to 3 m (6 to 10 ft) NAVD88 were presented in the SSAR markup. These higher post-construction groundwater elevations were incorporated into release scenarios as described in the applicant's December 20, 2012, response to RAI 68, Question 02.04.13-15 and included in Revision 2 of the ESP application (March 31, 2013). The staff considered the applicant's response to RAI 31, Question 02.04.13-8 in conjunction with the response to RAI 68, Question 02.04.13-15, and determined to be adequate. Accordingly, the staff considers RAI 31, Question 02.04.13-8 resolved.

2.4.13.4.6 Delaware River Dilution Calculations

This evaluation concerns the specific dilution estimates for groundwater discharge to the Delaware River.

Information Submitted by the Applicant

In SSAR, Revision 0, Sections 2.4.13.1.7 and 2.4.13.1.8, dilution factors for the discharge of groundwater to the Delaware River were presented as "substantial" but no supporting calculations were provided by the applicant. Only the comparison of the groundwater discharge to two thirds of the total average river flow is presented. The only quantitative estimate given is that a minimum of 3.17 m^3 (112 ft^3) per second is required to dilute the estimated radionuclide concentrations to below the unity rule in the groundwater flux of 0.24 m^3 (8.59 ft^3) per day.

The Staff's Technical Evaluation

In RAI 31, Question 02.04.13-11, the staff requested that the applicant address the rationale for calculating the minimum flow rate needed to achieve the unity rule while also presenting the much larger dilution capacity of two thirds of the Delaware River flow. In a June 30, 2011, response, the applicant included the changes to the SSAR to clarify that 3.17 m^3 (112 ft^3) per second flow rate in the river is the minimum needed to achieve the concentrations satisfying the unity rule. Dilution by two thirds of the river flow was presented in Tables 2.4.13-3 and 2.4.13-5 as a qualitative example of the potential ultimate dilution capacity of the river. The value of 3.17 m^3 (112 ft^3) per second is based on existing groundwater conditions and potential flow rates. The staff considers RAI 31, Question 02.04.13-11 resolved.

Potential effects of radionuclide retardation were also addressed in the applicant's June 30, 2011, response to RAI 31, Question 02.04.13-11. The applicant demonstrated that if retardation coefficients from NUREG/CR-5512, "Residual Radioactive Contamination From

Decommissioning: User's Manual DandD Version 2.1," were applied to the PSEG Site, the required flow to achieve the unity rule is reduced to about 0.2 cubic feet per second (cfs). In the response to RAI 68, Question 02.04.13-15, the applicant's calculation used flow rates based on the applicant's anticipated post-construction groundwater levels (1.8 - 3 m (6 - 10 ft) NAVD88). This was evaluated and included in the SSAR, Revision 2.

In RAI 31, Question 02.04.13-9, the staff requested that the applicant address its rationale for using the subset of all possible radionuclides that could contribute to the unity rule calculations. In a June 30, 2011, response, the applicant explained that very short half-lives of some of the radionuclides or low activity levels lead to their exclusion from further calculations. This information is incorporated into SSAR, Revision 2, Table 2.4.13-1, which contains the bounding activity concentrations for all the radionuclides initially considered, and identified the radionuclides eliminated due to short half-life or low activity concentration. Accordingly, the staff considers RAI 31, Question 02.04.13-9 resolved.

2.4.13.4.7 Potential Migration into Deeper Aquifers

Information Submitted by the Applicant

In SSAR, Revision 0, Section 2.4.13.1.9, the applicant stated that the spill could migrate into the Vincentown Formation in the power block area where the alluvium and underlying formation (also known as "Kirkwood") are excavated during construction or are thin or absent. The applicant stated that the initial dilution in the Vincentown would be 10 times greater than in the alluvium because the Vincentown is 10 times thicker than the alluvium. The applicant also stated that groundwater migration in the Vincentown is believed to be toward the Delaware River.

In SSAR Section 2.4.13.1.9 the applicant also stated that migration into the PRM aquifers could be induced by pumping wells but radial groundwater influx to the well due to pumping would dilute radionuclides below detectable levels.

The Staff's Technical Evaluation

If contaminated liquid migrates from the alluvium into the Vincentown the flow will be laminar and the assumption that the full aquifer thickness will be available for dilution is not appropriate. More likely, a thin layer of contaminated water will form at the top of the potentiometric surface in the Vincentown. The analysis required a realistic dilution assumption and a determination of the direction of flow within the Vincentown formation. In RAI 31, Questions 02.04.13-12 (1), (2), (3), (4), (5), and (6), the staff requested that the applicant address these issues. RAI 31, Question 02.04.13-12 (1) was discussed in Section 2.4.13.4.1, "Release Site Location" of this report.

In a June 30, 2011, response to RAI 31, Question 02.04.13-12 (2), the applicant indicated agreement that the full thickness of the Vincentown Formation should not be considered for dilution and revised SSAR Section 2.4.13.1.9 to clarify the assumptions inherent in a release that could reach and migrate through the Vincentown.

The applicant provided a description of the flow paths to the Vincentown Aquifer and stated that the flow paths in the Vincentown Aquifer would lead to the Delaware River either just to the west after migrating upward through the alluvium and Kirkwood units or 1.6 km or 3.2 km (1 or 2 mi) northwest of the site, where the Vincentown sub-crops beneath the Delaware River. In both

cases, the groundwater travel distances are much greater than distances through the alluvium. Hydraulic conductivity and gradient data suggest that the groundwater velocity in the Vincentown is about 15 percent faster than in the alluvium; however, this small difference is not enough to make the groundwater travel time through the Vincentown less than through the alluvium. The longer travel times in the Vincentown aquifer lead to greater radioactive decay and therefore lower predicted concentrations. Based on this reasoning, the applicant stated the alluvium was the most conservative release pathway and, therefore, did not address releases to the Vincentown or deeper aquifers and removed SSAR Section 2.4.13.1.9, Revision 0, while placing the discussion in SSAR, Revision 2, Section 2.4.13.1.3.

The staff verified that the travel time to the river was fastest through the alluvium and therefore, the most conservative assumption for a release scenario contamination to the Delaware River. The staff considers the applicant's evaluation reasonable and adequate. Accordingly, the staff considers RAI 31, Question 02.04.13-12 (2) resolved.

In a June 30, 2011, response to RAI 31, Questions 02.04.13-12 (3) and (4), the applicant described the two possible pathways for contaminants to enter the Delaware River from the Vincentown formation. One path is directly to the northwest where the Vincentown outcrops in the Delaware River (USGS, 2001), and the other is upward through the overlying alluvium. The staff finds this explanation adequate and reasonable. Accordingly, the staff considers Questions 02.04.13-12 (3) and (4) resolved.

In RAI 31, Question 02.04.13-12 (5), the staff requested that the applicant provide information on potential migration pathways into the deeper PRM aquifer system. In a June 30, 2011, response, the applicant explained that the lack of downward hydraulic head and the presence of intervening aquitards would lessen the possibility of downward migration. The applicant stated that SSAR Section 2.4.13.1.9 would be updated but this section was removed and incorporated within SSAR, Revision 1, and subsequently Revision 2, Section 2.4.13.1.3. Accordingly, the staff considers RAI 31, Question 02.04.13-12 (5) resolved.

In RAI 31, Question 02.04.13-12 (6), the staff requested that the applicant provide justification for why dilution of radionuclide concentrations in a pumping well to less than detectable levels is compliant with requirements. In a June 30, 2011 response, the applicant explained that the pumping well discussion was only qualitative and that it would be removed from the SSAR. The staff verified that the discussion was removed from the SSAR, Revision 1, and considers RAI 31, Question 02.04.13-12 (6) resolved.

Based on an independent evaluation of the local hydrogeologic units, lack of deep pumping, and the higher hydraulic conductivity of the alluvium, the staff finds the applicant's responses and discussions to RAI 31, Question 02.04.13-12 in its entirety adequate, and considers all parts of this RAI Question resolved.

2.4.13.4.8 Groundwater Model, Release Calculations, and Slug Test Calculations provided in Digital Format

In RAI 31, Question 02.04.13-13, the staff requested digital files for the dewatering modeling, transport analysis, and slug testing performed by the applicant. On July 25, 2011, the applicant submitted a response to RAI 31, Question 02.04.13-13, along with digital files for groundwater model that refers to the dewatering during construction. The aquifer slug test data needed to obtain hydraulic conductivity values to perform the transport calculations was received on discs and found to be consistent with the aquifer parameters provided by the applicant and those

used to calculate results included in Revision 1 of the ESP application. The staff finds the applicant's response adequate and, therefore, considers RAI 31, Question 02.04.13-13 resolved.

2.4.13.5 Post Early Site Permit Activities

There are no post ESP activities related to this section.

2.4.13.6 Conclusion

The staff reviewed the application and confirmed that the applicant addressed the relevant information and there is no outstanding information required to be addressed in the SSAR related to this section. As set forth above, the applicant has provided sufficient information pertaining to liquid pathways. Therefore, the staff concludes that the applicant has met the requirements related to liquid pathways of 10 CFR 52.17(a) and 10 CFR 100.20(c).

2.4.14 Site Characteristics and Bounding Design Parameters

This section of the report lists site characteristics and bounding design parameters as given in Tables 2.4.14-1 and 2.4.14-2 below that the staff has determined should be included in the ESP that may be granted for the PSEG Site. Figure 2.4.14-1 below, reproduced based on SSAR Figure 1.2-3, depicts the proposed PSEG site boundary areas.

Table 2.4.14-1 Proposed Site Characteristics Related to Hydrology

Site Characteristic	PSEG Site Value	Definition
Proposed Facility Boundaries	Figure 2.4.14-1 depicts the proposed facility area boundaries.	PSEG site boundary areas within which all safety-related SSCs will be located.
Maximum Groundwater	3.05 m (10 ft) NAVD88	The maximum elevation of groundwater at the PSEG Site.
Maximum Stillwater Flood Elevation (Storm Surge) + 10% Astronomical High Tide	7.53 m (24.7 ft) NAVD88	The stillwater elevation, without accounting for wind-induced waves, the water surface reaches during a flood event.
Wave Runup (Storm Surge)	2.26 m (7.4 ft) NAVD88	The height of water reached by wind-induced waves running up on the site.

Site Characteristic	PSEG Site Value	Definition
Combined Effects Maximum Flood Elevation (Design Basis Flood)	9.78 m (32.1 ft) NAVD88	The water surface elevation at the point in time where the combination of the still water level and wave runup is at its maximum.
Local Intense Precipitation	46.7 cm (18.4 in.) per hour	The depth of PMP for duration of 1 hour on a 1 square-mile drainage area. The surface water drainage system should be designed for a flood produced by the local intense precipitation.
Frazil, Surface or Anchor Ice	The PSEG Site has the potential for frazil and surface ice.	Potential for accumulated ice formation in a turbulent flow condition.
Minimum River Water Surface Elevation	-4.85 m (-15.9 ft) NAVD88 for less than 6 hours	The river surface water elevation and duration for which the low water level conditions exist at the PSEG Site.
Maximum Ice Thickness	45.2 cm (17.8 in.)	Maximum potential ice thickness on the Delaware River at the PSEG Site.
Hydraulic Conductivity	SSAR Table 2.4.12-9	Groundwater flow rate per unit hydraulic gradient.
Hydraulic Gradient	SSAR Tables 2.4.12-7 and 2.4.12-8	Slope of groundwater surface under unconfined conditions or slope of hydraulic pressure head under confined conditions.

Table 2.4.14-2 Bounding Design Parameters

Bounding Design Parameter	Value	Definition
Site Grade	11.25 m (36.9 ft) NAVD88	Finished plant grade for the power block area on the PSEG Site.

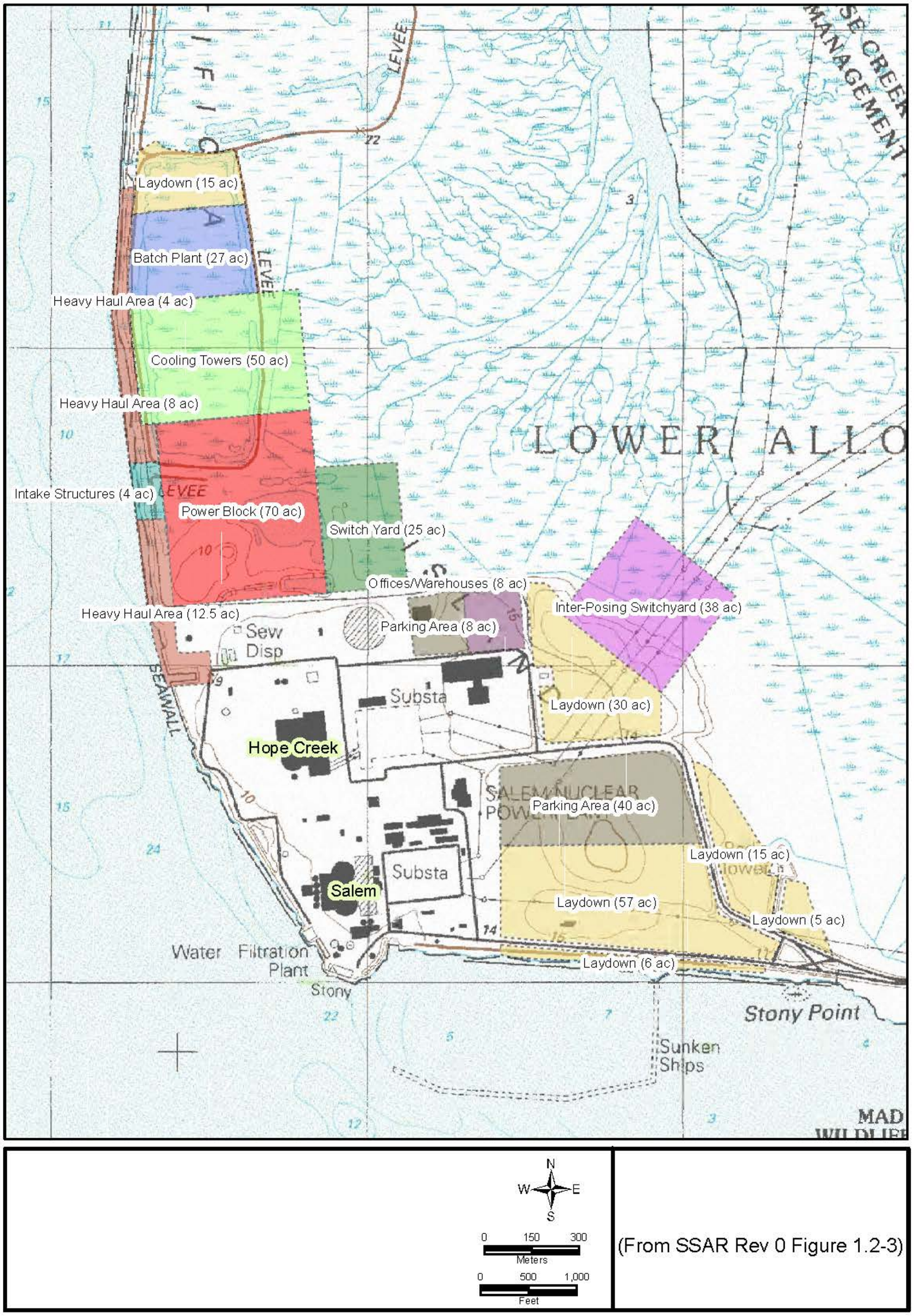

Figure 2.4.14-1 Proposed PSEG Site Layout (based on SSAR Revision 3, Figure 1.2-3)

When referenced by a COL applicant pursuant to 10 CFR 52.73, “Relationship to Subparts A and B,” this ESP is subject to these COL action items:

<u>COL Action Items 2.4-1 through 2.4-3</u>

2.4-1 An applicant for a COL or CP referencing this early site permit should design the site grading to provide flooding protection to safety-related structures at the ESP site based on a comprehensive flood water routing analysis for a local PMP event without relying on any active surface drainage systems that may be blocked during this event. (See Section 2.4.2.4 of this report.)

2.4-2 An applicant for a COL or CP referencing this early site permit should address whether the intake structure of the selected design is a safety-related SSC. If so, the applicant should address necessary flooding protection for a safety-related intake structure at the ESP site based on the design basis flooding event and associated effects. (See Section 2.4.10.4 of this report.)

2.4-3 An applicant for a COL or CP referencing this early site permit should refine hydrogeologic parameters and model estimates of dewatering rates and drawdowns beneath existing site structures after determination of the final excavation geometry consistent with a selected reactor technology. (See Section 2.4.12.4 of this report.)

2.5 Geology, Seismology, and Geotechnical Engineering

PSEG Site early site permit (ESP) application, Section 2.5, "Geology, Seismology, and Geotechnical Information," of the Site Safety Analysis Report (SSAR), Revision 3, contains information on geologic, seismic, and geotechnical characteristics of the proposed ESP Site. The applicant (PSEG) followed guidance in Regulatory Guide (RG) 1.208, "A Performance Based Approach to Define Site-Specific Earthquake Ground Motion," to define the following four zones around the site and conducted investigations in those zones that became progressively more detailed passing from site region to site location:

- Site region – Area within a 320-kilometer (km) (200-mile (mi)) radius of the site location
- Site vicinity – Area within a 40-km (25-mi) radius of the site location
- Site area – Area within an 8-km (5-mi) radius of the site location
- Site location – Area within a 1-km (0.6-mi) of the proposed plant

The applicant used the updated Final Safety Analysis Reports (UFSARs) for the Salem Generating Station (SGS) and the Hope Creek Generating Station (HCGS), which lie within the PSEG Site area, to provide certain data important for characterizing the geologic setting of the PSEG Site (PSEG, 2007 and PSEG, 2008 for SGS and HCGS, respectively). However, the applicant focused on data developed since publication of the SGS and HCGS UFSARs, as well as data derived from geologic, seismic, and geotechnical engineering investigations performed specifically for characterization of the PSEG Site.

In Revision 0 of the SSAR, dated May 25, 2010, the applicant used seismic source models developed in 1986 and 1989 by the Electric Power Research Institute (EPRI), as the starting point for characterizing potential regional seismic sources and resulting vibratory ground motion, and then updated these seismic source models in light of more recent data and evolving knowledge. The applicant also replaced the original EPRI (1989) ground motion models with more recent (2004 and 2006) EPRI models, and applied the performance-based approach described in RG 1.208, which incorporates probabilistic seismic hazard analysis (PSHA), to develop ground motion response spectra (GMRS) for the site.

As a result of U.S. Nuclear Regulatory Commission (NRC) actions implemented after the March 2011 Fukushima Dai-ichi nuclear power plant accident following the Great Tohoku earthquake and subsequent tsunami in Japan, the NRC formed a Near-Term Task Force (NTTF) that issued a series of recommendations for reevaluating the safety of nuclear power plant facilities located in the U.S. Consequently, on March 12, 2012[1], the NRC issued an information letter requesting that licensees of all operating nuclear power plants in the U.S. reevaluate seismic hazard at their respective plant sites using the most recent data and evaluation methodologies available. The information request letter also stated that licensees of operating nuclear power plant sites in the Central and Eastern United States (CEUS) should use the new seismic source model provided in NUREG-2115, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities," to characterize seismic hazard for their respective plants. Therefore, following issuance of the information request letter to licensees of

[1] NRC Letter dated March 12, 2012, "Request for information pursuant to title 10 of the *Code of Federal Regulations* 50.54(f) regarding recommendations 2.1, 2.3, and 9.3, of the near-term task force review of insights from the Fukushima Dai-ichi accident." (Agencywide Documents Access and Management Systems (ADAMS) Accession No. ML12053A340)

operating nuclear power plants, the staff also issued requests for additional information (RAIs) to all combined license (COL) and ESP applicants requesting that they reassess seismic hazard using the newly published NUREG-2115 seismic source model and modify their respective GMRS, if necessary. Accordingly, in SSAR Revision 2, Section 2.5, the applicant replaced the previous EPRI seismic source models with the CEUS Seismic Source Characterization (CEUS-SSC) model presented in NUREG-2115 as the starting point for developing the GMRS for the PSEG Site. With this change in the base seismic source model, some of the RAIs the staff previously asked of the applicant became unnecessary. Therefore, this safety evaluation report (SER) references only the most recent version of the SSAR and the staff's technical evaluation of that version without discussing the replaced portions of the previous ESP SSAR and some of the staff's earlier RAIs, which are now unnecessary and closed without specific resolution. The following sections of this report discuss the RAIs that remain applicable to the staff's review following the change in the base seismic source model, along with the new RAIs related to the most recent version of the SSAR.

Section 2.5 of this report is divided into five main parts that parallel the five SSAR sections prepared by the applicant as part of the PSEG Site ESP application. The five sections in this report are: Section 2.5.1, "Basic Geologic and Seismic Information"; Section 2.5.2, "Vibratory Ground Motion"; Section 2.5.3, "Surface Faulting"; Section 2.5.4, "Stability of Subsurface Materials and Foundations"; and Section 2.5.5, "Stability of Slopes" (including information regarding embankments and dams). These sections present the staff's evaluations and conclusions regarding the geologic, seismic, and geotechnical engineering characteristics of the proposed ESP site. Each section has two parts that consist of a summary and a detailed technical evaluation. The summary section presents the staff's summary of the materials provided by the applicant and the analyses, statements, and conclusions drawn by the applicant as documented in the SSAR. The technical evaluation section presents results of the staff's detailed safety review, the RAIs asked of the applicant by the staff, the staff's evaluation of the RAI responses, and the staff's conclusions and findings.

2.5.1 Basic Geologic and Seismic Information

2.5.1.1 Introduction

SSAR Section 2.5.1 describes basic geologic and seismic information collected by the applicant during site characterization investigations. This information addresses both regional and site-specific geologic and seismic characteristics. The investigations included surface and subsurface field studies, performed at progressively greater levels of detail nearer to the site, within each of the four circumscribed areas corresponding to site region, site vicinity, site area, and site location as defined above in Section 2.5. The applicant conducted these investigations to assess geologic and seismic suitability of the site; to determine whether new geologic or seismic data exist that could significantly impact seismic design based on results of probabilistic seismic hazard analysis (PSHA); and to provide geologic and seismic data appropriate for plant design. The applicant stated that content of SSAR Section 2.5.1 demonstrates compliance with regulatory requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) 100.23(c), which specifically state that geologic, seismic, and engineering characteristics of a site must be investigated in sufficient detail to permit an adequate evaluation of the proposed site; provide sufficient information for estimating the Safe Shutdown Earthquake (SSE) ground motion; and permit adequate engineering solutions for actual or potential geologic and seismic effects at the proposed site.

2.5.1.2 Summary of Application

SSAR Section 2.5.1 contains two main sections: SSAR Section 2.5.1.1, "Regional Geology," describes physiography and geomorphology, geologic history, stratigraphy, tectonic setting, seismic zones, and gravity and magnetic field data of the PSEG Site region. SSAR Section 2.5.1.2, "Site Geology," addresses physiography and geomorphology, stratigraphy and lithology, geologic history, and structural geology of the PSEG Site vicinity and site area, as well as site location for certain of these topics. SSAR Section 2.5.1.2 also evaluates engineering geology of the site vicinity, site area, and site location, as well as potential effects of human activities on the site.

The applicant developed SSAR Section 2.5.1 based on information derived from review of previously published reports prepared for SGS and HCGS (PSEG, 2007 and PSEG, 2008, respectively) and published geologic literature, as well as interpretation of aerial photography, subsurface investigations, geologic mapping, and aerial reconnaissance conducted specifically for characterization of the PSEG Site region, site vicinity, site area, and site location. Sections 2.5.1.2.1 and 2.5.1.2.2, of this report, summarize the basic geologic and seismic information described by the applicant in SSAR Section 2.5.1. The applicant specifically included potential tectonic features of Quaternary age (2.6 million years, or Ma to present) in this information.

2.5.1.2.1 Regional Geology

SSAR Section 2.5.1.1 discusses physiography, geomorphology, geologic history, stratigraphy, and tectonic setting of the PSEG Site region, defined as the area that lies within a 320 kilometers (km) (200 miles (mi)) radius of the site location. The applicant also addressed seismic zones defined by regional seismicity and regional gravity and magnetic data in SSAR Section 2.5.1.1. The following sections summarize information provided by the applicant in SSAR Section 2.5.1.1.

2.5.1.2.1.1 Regional Physiography and Geomorphology.

SSAR Section 2.5.1.1.1 describes physiography and geomorphology of the PSEG Site region. From east to west, the site region contains parts of the following physiographic provinces: The continental rise, continental slope, continental shelf (i.e., the submerged eastward continuation of the Coastal Plain province), Coastal Plain, Piedmont, New England, Blue Ridge, Valley and Ridge, and Appalachian Plateau provinces. Figure 2.5.1-1 of this report (Reproduced from SSAR Figure 2.5.1-4) shows the location of the PSEG Site within the Coastal Plain province.

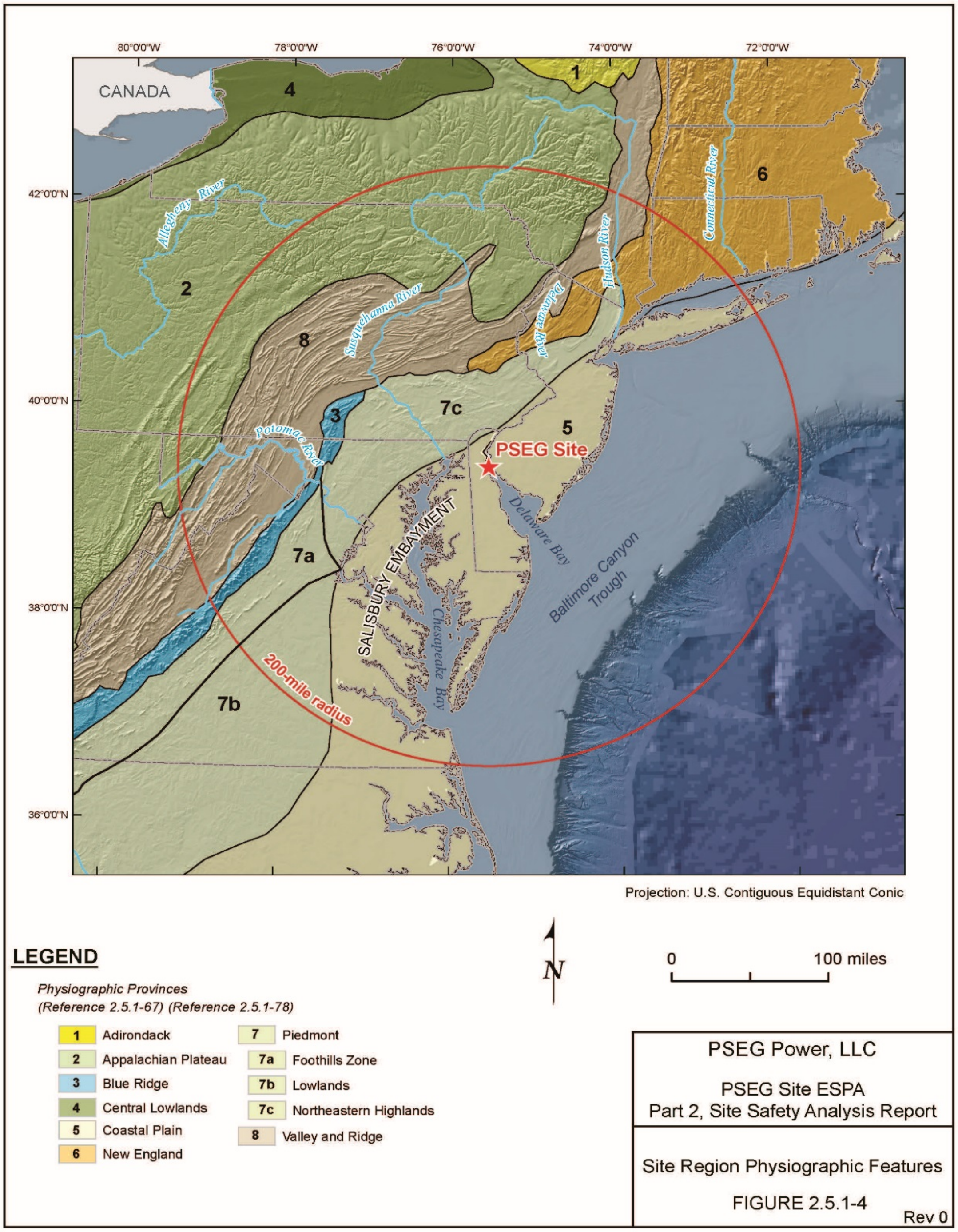

Figure 2.5.1-1 Regional physiographic map showing location of the PSEG Site (Reproduced from SSAR Figure 2.5.1-4)

In SSAR Section 2.5.1.1.1.1, the applicant stated that the Coastal Plain physiographic province characteristically exhibits a low and gently rolling terrain developed on clastic sedimentary sequences of deltaic, shallow marine, and continental shelf deposits made up of unconsolidated to partially consolidated gravels, sands, silts, and clays. These deposits dip gently southeast toward the Atlantic Ocean. The applicant explained that the Coastal Plain surface contains both erosional and depositional landforms associated with several transgressional and regressional marine cycles, and that the entire surface in and around the site vicinity shows the effects of climatic events related to glacial and interglacial periods.

In SSAR Sections 2.5.1.1.1.2 through 2.5.1.1.1.7, the applicant described characteristics of the remaining physiographic provinces that occur in the site region, noting that the Piedmont province lies immediately west of the Coastal Plain. The applicant indicated that the Piedmont Lowlands, the Foothills Zone, and the Northeastern Highlands subprovinces make up the Piedmont physiographic province in the site region (see Figure 2.5.1-1 of this report).

2.5.1.2.1.2 <u>Geologic History</u>.

SSAR Section 2.5.1.1.2 discusses Proterozoic (> 542 Ma), Paleozoic (542 to 251 Ma), Mesozoic (251 to 65.5 Ma), and Cenozoic (65.5 Ma to present) geologic history of the PSEG Site region. (The Quaternary Period is that part of the Cenozoic extending from 2.6 Ma to the present.) The applicant summarized geologic events ranging from deformation and metamorphism of ancestral North America (i.e., an ancient continental land mass known as Laurentia) that occurred during the Middle Proterozoic Grenville orogeny (1,300 to 1,000 Ma) to development of the present-day passive Atlantic coast continental margin during the Cenozoic.

2.5.1.2.1.2.1 *<u>Proterozoic, Paleozoic, and Mesozoic Geologic History</u>.*

In SSAR Sections 2.5.1.1.2.1 through 2.5.1.1.2.6, the applicant discussed Proterozoic, Paleozoic, and Mesozoic geologic history of the PSEG Site region. The applicant stated that, in the Late Proterozoic after deformation and metamorphism related to the Grenville orogeny ceased, Laurentia and ancestral Africa separated to form the proto-Atlantic Iapetus Ocean. During the Paleozoic, the margin of Laurentia experienced multiple phases of contractional deformation, and the Late Paleozoic Alleghany orogeny resulted in final closure of the Iapetus Ocean.

The applicant indicated that extensional rifting during the Mesozoic resulted in opening of the present Atlantic Ocean and development of a series of fault-bounded basins along the Atlantic margin. The applicant noted that, within the site region, the exposed fault-bounded Newark, Gettysburg, and Culpeper basins occur northwest of the site. Figure 2.5.1-2 of this report (Reproduced from SSAR Figure 2.5.1-9) illustrates the locations of both exposed and buried fault-bounded Mesozoic extensional basins in the site region. The applicant stated that, although the spatial distribution of basins and associated normal faults underlying Coastal Plain sediments is uncertain, pre-Mesozoic metamorphic basement rocks underlie the PSEG Site location rather than sediment-filled Mesozoic basins.

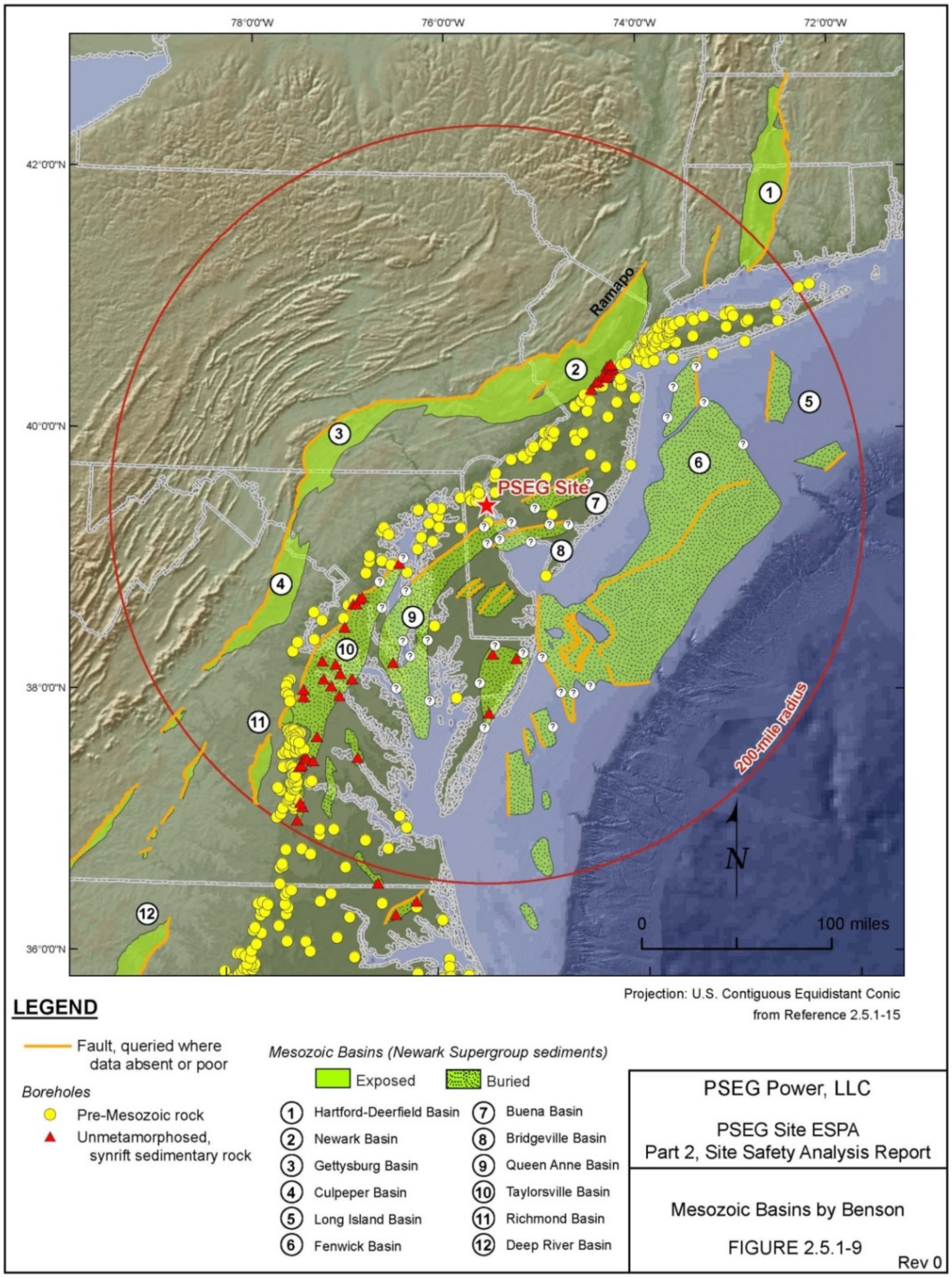

Figure 2.5.1-2 Fault-bounded Mesozoic extensional basins in the site region (Reproduced from SSAR Figure 2.5.1-9)

2.5.1.2.1.2.2 *Cenozoic Geologic History*.

In SSAR Section 2.5.1.1.2.7, the applicant stated that the Atlantic continental margin evolved into a passive, non-tectonic margin during the Cenozoic. This evolution involved cooling and subsidence of previously extended (i.e., during the Mesozoic) continental crust along the margin with a net eastward redistribution of mass related to erosion of the Appalachian Mountains and deposition of sediments above underlying metamorphic basement rocks in the Coastal Plain and offshore. The applicant indicated that these erosional processes resulted in isostatic, non-tectonic flexure of continental crust about a hinge line located approximately along the western edge of the Coastal Plain (i.e., the Fall Zone), with differential subsidence forming local arches and basins such as the South New Jersey Arch and the Salisbury Embayment (Figure 2.5.1-1 of this report). The applicant described the Fall Zone as non-tectonic in character, with lithologic contrast between metamorphic Piedmont rocks and more easily eroded Coastal Plain sedimentary rock units controlling the topographic escarpment that marks the zone.

2.5.1.2.1.3 Regional Stratigraphy.

SSAR Section 2.5.1.1.3 describes pre-Cenozoic (i.e., Late Proterozoic, Paleozoic, and Mesozoic) and Cenozoic (including Quaternary) stratigraphy of the PSEG Site region. The applicant noted that the site region contains portions of the entire Appalachian orogenic sequence, which records sedimentation, igneous activity, and metamorphism resulting from opening and closing of ancestral Atlantic Ocean basins in Late Proterozoic and Paleozoic time followed by opening of the present Atlantic Ocean during the Mesozoic. Sedimentation along the passive Atlantic margin occurred through the Cenozoic, including into the present, with development of the Coastal Plain sedimentary sequences and formation of the continental shelf, slope, and rise.

15.0.3.1.1.1.1 *Pre-Cenozoic (Late Proterozoic, Paleozoic, Mesozoic) Stratigraphy*.

In SSAR Sections 2.5.1.1.3.1 through 2.5.1.1.3.4.1, the applicant discussed development of stratigraphic sequences, including igneous activity, that occurred during the Late Proterozoic, Paleozoic, and Mesozoic, as well as pre-Mesozoic metamorphism. The applicant noted that the Hornerstown Formation contains basal beds of Late Cretaceous (i.e., Late Mesozoic) age (99.6 to 65.5 Ma) and upper beds of Paleocene age (65.5 to 55.8 Ma, Lower Tertiary), so this formation is transitional across the Cretaceous-Tertiary (and, consequently, the Mesozoic-Cenozoic) time boundary.

15.0.3.1.1.1.2 *Cenozoic Stratigraphy*.

In SSAR Section 2.5.1.1.3.4.2, the applicant stated that Cenozoic stratigraphy in the site region reflects an unconformity resulting in the absence of upper Eocene (40.4 to 33.9 Ma) and Lower Oligocene (33.9 to 23 Ma) strata, and that overlying Neogene strata (23 to 2.6 Ma) show a distinct increase of clastic sediments starting in the Lower Miocene (23 to 5.3 Ma). The applicant reported that only two Tertiary (65.5 to 2.6 Ma) formations, the Hornerstown and Vincentown Formations, outcrop north and south of the Delaware River in the site region. The Hornerstown is transitional across the Cretaceous-Tertiary boundary and the Vincentown,

the proposed foundation unit at the PSEG Site, contains both clastic and carbonate components.

15.0.3.1.1.1.3 *Quaternary Stratigraphy*.

The applicant noted that Quaternary strata in the site region resulted from fluvial and marine processes associated with changes in sea level or terminal glacial processes and glacial outwash. The applicant added that a Holocene (0.01 Ma to present) sea transgression resulted in removal of Pleistocene (2.6 to 0.01 Ma) sediments and deposition of sedimentary fill in the major estuaries within the site region.

2.5.1.2.1.4 Regional Tectonic Setting.

SSAR Section 2.5.1.1.4 describes the tectonic setting of the PSEG Site region. The applicant noted that the site region lies within the CEUS, which is a stable continental region characterized by low rates of tectonic crustal deformation and no active tectonic plate boundaries. SSAR Section 2.5.1.1.4 specifically addresses regional stress; principal regional tectonic structures interpreted to range in age from Late Proterozoic to Cenozoic, including the Quaternary (2.6 Ma to present); seismic zones defined by regional seismicity; and regional gravity and magnetic field data.

The applicant indicated that SSAR Section 2.5.1.1.4 summarizes the present state of knowledge regarding tectonic setting and structures in the site region that are relevant to the assessment of seismic sources, and cross-referenced SSAR Section 2.5.2, which provides an expanded discussion of the seismic source model used for the PSEG Site. The applicant concluded that no evidence exists for late Cenozoic (i.e., Quaternary) seismic activity associated with any tectonic feature or structure in the site region.

2.5.1.2.1.4.1 *Regional Stress*.

In SSAR Section 2.5.1.1.4.1, the applicant stated that analyses of regional tectonic stress in the CEUS conducted since the 1986 studies performed by EPRI, including updates done as part of NUREG-2115, have not significantly altered the interpretation of a northeast-southwest orientation for maximum principal compressive stress in the CEUS. The applicant noted that this orientation for regional stress applies to the PSEG Site region, and that there are no new significant implications for characterization of potential activity on tectonic structures due to the regional stress field.

2.5.1.2.1.4.2 *Principal Tectonic Structures*.

In SSAR Section 2.5.1.1.4.2, the applicant categorized and discussed principal tectonic structures in the site region based on timing of their development from Late Proterozoic through the Cenozoic, including the Quaternary.

Late Proterozoic, Paleozoic, and Mesozoic Tectonic Structures

In SSAR Sections 2.5.1.1.4.2.1 through 2.5.1.1.4.2.3, the applicant stated that Late Proterozoic, Paleozoic, and Mesozoic structures in the site region developed as a result of major plate tectonic events. The applicant indicated that Late Proterozoic structures in the site region include normal faults which formed during post-Grenville orogenic activity, and that Paleozoic structures within the site region include thrust and reverse faults which developed during

contractional orogenic events. The applicant noted that the only Paleozoic structure within the site vicinity is the northeast-striking, mylonitic Rosemont shear zone, located about 27 km (17 mi) northeast of the PSEG Site. The applicant described extensional rift basins and related normal boundary faults associated with formation of the present Atlantic Ocean as the primary Mesozoic tectonic features within the PSEG Site region. Based on a map illustrating locations of known exposed and possible buried Mesozoic extensional basins in the site region produced by Benson (1992), shown in Figure 2.5.1-2 of this report, the applicant stated that the fault-bounded Mesozoic basin nearest to the PSEG Site is the postulated extension of the buried Queen Anne basin, located about 24 km (15 mi) south-southeast of the site. The applicant noted that Benson (1992) indicated the actual extension of the basin to within that distance of the site is uncertain, as shown by the question marks on the boundary of the basin in Figure 2.5.1-2 of this report. The applicant stated that pre-Mesozoic basement lies beneath the site, and cross-referenced SSAR Section 2.5.1.2.4 (“Structural Geology”) for a discussion of the evidence for that statement. Section 2.5.1.2.2.4 of this report summarizes this evidence.

Cenozoic Tectonic Structures

In SSAR Section 2.5.1.1.4.2.4, the applicant discussed possible Cenozoic structures that occur within the site region. The applicant described only structures with suggested or demonstrated Cenozoic activity not discussed in the data compilations prepared by Crone and Wheeler (2000) and Wheeler (2005) for assessing potential Quaternary tectonic features in the CEUS. (SSAR Section 2.5.1.1.4.2.5 specifically discusses potential Quaternary tectonic features in the site region as summarized below.) The possible Cenozoic tectonic structures included the hypothesized fault of Pazzaglia (1993); the faults of Hansen (1978); the River Bend Trend interpreted by Marple (2004) to be an extension of the Stafford fault system northeastward from Virginia; the National Zoo faults; the Chesapeake Bay impact structure; and the Brandywine fault system. The applicant indicated that no geologic field evidence exists for the hypothesized fault of Pazzaglia; that geologic data suggest the faults of Hansen are Mesozoic in age; that the river bend trend proposed as marking an extension of the Stafford fault system (Marple, 2004) shows no geologic or geomorphic evidence of Cenozoic, including Quaternary, faulting; that geologic data suggest the National Zoo faults are Tertiary and not Quaternary in age; that the Chesapeake Bay structure resulted from a meteorite impact and not tectonic faulting; and that geologic field relationships show deformation related to the Brandywine fault system ceased in the Miocene (23 to 5.3 Ma) and is, therefore, pre-Quaternary in age.

Potential Quaternary Tectonic Features

In SSAR Section 2.5.1.1.4.2.5, the applicant described the following 17 potential Quaternary tectonic features that occur within the site region (Figure 2.5.1-3 of this report) based on the data compilations prepared by Crone and Wheeler (2000) and Wheeler (2005), which use published information to assess evidence for Quaternary fault activity rather than data derived from direct field examination of the actual features: the New Castle County, Upper Marlboro, Lebanon Church, New York Bight, East Border, Ramapo, Kingston, Mosholu, and Hopewell faults; the Central Virginia and Lancaster seismic zones; the Fall Lines of Weems (1998); the Everona-Mountain Run and Dobbs Ferry fault zones; the Stafford and east coast fault systems; and offset glacial surfaces. The classification scheme presented in the data compilations of Crone and Wheeler (2000) and Wheeler (2005) is as follows:

- Class A Features – Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether exposed or inferred from liquefaction or other deformation features.

- Class B Features – Geologic evidence demonstrates the existence of a fault or suggests Quaternary deformation, but the fault may not be a potential source of significant earthquakes or available data are not strong enough to assign the feature to Class A.
- Class C Features – Geologic evidence is insufficient to demonstrate the existence of a tectonic fault or Quaternary deformation associated with the feature.
- Class D Features – Geologic evidence demonstrates that the feature is not a tectonic fault.

The applicant indicated that the Central Virginia seismic zone is a Class A tectonic feature based on information provided by Crone and Wheeler (2000) and Wheeler (2005), while the remaining 16 potential Quaternary tectonic features are all Class C (see Figure 2.5.1-3 of this report (Reproduced from SSAR Figure 2.5.1-17)). The applicant noted that only the Class C New Castle County faults occur in the site vicinity. The applicant stated that investigations performed for the PSEG Site did not identify any potential Quaternary tectonic features in the site region other than the 17 discussed by Crone and Wheeler (2000) and Wheeler (2005). The following paragraphs summarize information about the 17 potential Quaternary tectonic features presented by the applicant in SSAR Section 2.5.1.1.4.2.5. Note that Feature #3, the Cacoosing Valley earthquake, is discussed within the paragraph about the Lancaster Seismic Zone, where it is interpreted as an anthropogenic earthquake, i.e., it is not a Quaternary tectonic feature.

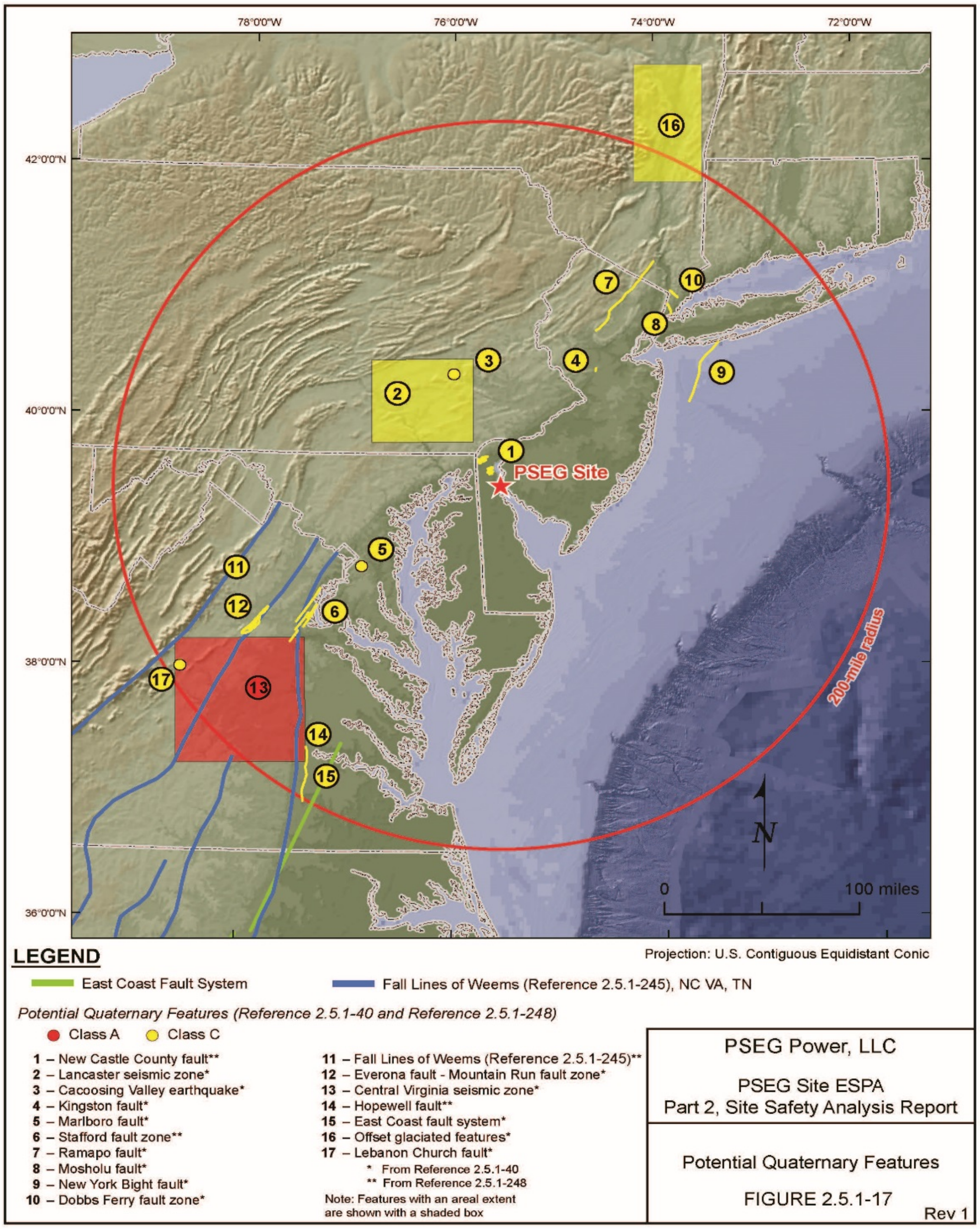

Figure 2.5.1-3 Potential Quaternary tectonic features in the site region (Reproduced from SSAR Figure 2.5.1-17)

Central Virginia seismic zone (Class A)

In SSAR Section 2.5.1.1.4.2.5.1, the applicant located the northernmost boundary of the Central Virginia seismic zone (CVSZ), an area of persistent low-level seismicity within the Piedmont physiographic province, about 274 km (170 mi) southwest of the PSEG Site (see Feature 13 in Figure 2.5.1-3 of this report). The applicant acknowledged that the August 2011 Mineral, VA, earthquake, which had an estimated moment magnitude of **M**5.8, was the largest historical earthquake to occur in the CVSZ. The applicant cross-referenced SSAR Section 2.5.2.1.3 for a detailed discussion of the August 2011 earthquake, but stated that it is difficult to uniquely attribute seismicity in the zone to any known causative geologic structure and that seismicity appears to extend both above and below the regional Appalachian detachment with a depth distribution of earthquake foci ranging between about 3 to 13 km (2 to 8 mi). The applicant indicated that two paleoliquefaction sites identified in the CVSZ by Obermeier and McNulty (1998) reflect prehistoric seismicity in the zone, but also do not define the location of a causative fault.

Lancaster seismic zone (Class C)

SSAR Section 2.5.1.1.4.2.5.2 describes the Lancaster seismic zone of Armbruster and Seeber (1987), which lies in southeastern Pennsylvania about 113 km (70 mi) northwest of the PSEG Site (Feature 2 in Figure 2.5.1-3 of this report). The applicant reported that the seismic zone includes exposed Piedmont rocks, which contain Paleozoic thrust faults, and the fault-bounded Newark-Gettysburg Triassic rift basin, which formed during Mesozoic crustal extension. The applicant stated that seismicity in at least the western part of the Lancaster seismic zone likely results from reactivation of Mesozoic extensional structures in the present-day northeast-southwest regional compressional stress field. The applicant also indicated that activities related to quarrying likely produced some recent earthquakes in the zone (e.g., the January16, 1994 E[**M]**4.1 Cacoosing earthquake, which is the largest instrumentally-recorded earthquake in the Lancaster seismic zone). The applicant noted that the CEUS-SSC seismicity catalog presented in NUREG-2115 does not include the Cacoosing earthquake because the earthquake was anthropogenic (i.e., the result of human activities related to quarrying), rather than tectonic, in origin.

Fall Lines of Weems (Class C)

SSAR Section 2.5.1.1.4.2.5.3 discusses the seven fall lines of Weems (1998) that occur within the Piedmont and Blue Ridge physiographic provinces in North Carolina and Virginia, and notes that the easternmost fall line (i.e., the "Tidewater Fall Line") terminates about 161 km (100 mi) southwest of the PSEG Site (Feature 11 in Figure 2.5.1-3 of this report). The applicant stated that Weems (1998) favored a tectonic origin for these features, which Weems interpreted to connect an alignment of short stream segments with anomalously steep gradients characterized by knickpoints and development of waterfalls. However, based on numerous studies performed in the Appalachian region that show development of knickpoints related to differential resistance of rock units to erosion rather than to tectonic activity, as well as the results of geologic and geomorphic analyses previously performed for the North Anna ESP application and evaluated by the staff in NUREG-1835, "Safety Evaluation Report for an Early Site Permit at the North Anna ESP Site," the applicant concluded that the fall lines of Weems (1998) are non-tectonic erosional features controlled by lithologies with different degrees of resistance to erosion.

Everona-Mountain Run fault zone (Class C)

In SSAR Section 2.5.1.1.4.2.5.4, the applicant described the Mountain Run fault zone, which lies about 241 km (150 mi) southwest of the PSEG Site along the eastern margin of the Culpeper Triassic basin in Virginia (Feature 12 in Figure 2.5.1-3 of this report). The applicant stated that the fault zone strikes northeast for a distance of 121 km (75 mi) across the Virginia Piedmont, with the Everona fault located about 0.8 km (0.5 mi) west of the zone. Based on proximity of the Everona fault to the Mountain Run fault zone and the fact that both features have a similar orientation and sense of slip, the applicant agreed with Crone and Wheeler (2000) that these two geologic structures comprise a single fault zone. The applicant cited the following information, derived from field and aerial reconnaissance and geomorphic analyses of features associated with the Mountain Run fault zone performed for the North Anna ESP application (Dominion, 2004), to conclude that the fault zone does not exhibit evidence for Quaternary displacement: (1) scarps observed to occur along the Mountain Run fault zone formed as a result of stream erosion, and (2) undeformed late Neogene (>2.6 Ma, so pre-Quaternary in age) colluvial deposits bury the fault zone between the Rappahannock and Rapidan Rivers.

New Castle County faults (Class C)

SSAR Section 2.5.1.1.4.2.5.5 describes the New Castle County faults (Feature 1 in Figure 2.5.1-3 of this report), located about 24 km (15 mi) north of the PSEG Site in Delaware, as an inferred set of subsurface normal faults that define a northeast-striking graben in buried Paleozoic basement rocks based on borehole data, including geophysical logging results, discussed by Spoljaric (1972 and 1973). The applicant indicated that the studies of Spoljaric (1972 and 1973) provided an estimated age of post-Paleozoic to pre-Cretaceous for the faults, and that McLaughlin et al. (2002) showed Cretaceous and younger strata to be undeformed across the inferred faults. Therefore, the applicant concluded that the New Castle County faults, if they exist, are not Quaternary in age.

Stafford fault system (Class C)

SSAR Section 2.5.1.1.4.2.5.6 discusses the Stafford fault system (Feature 6 in Figure 2.5.1-3 of this report) as a set of en echelon, northwest-dipping thrust faults that occur on or near the Fall Zone separating the Coastal Plain and Piedmont physiographic provinces in northeastern Virginia. The applicant stated that the individual faults in this fault system are 16 to 40 km (10 to 25 mi) long and separated by en echelon left stepovers that are 1.6 to 4.8 km (1 to 3 mi) wide. The applicant reported that most published data indicate this fault system, which lies about 209 km (130 mi) south of the PSEG Site, does not exhibit Quaternary displacement. The applicant noted that geomorphic analyses conducted for the North Anna ESP application (Dominion, 2004) demonstrated a lack of deformation of Neogene (23 to 2.6 Ma) marine deposits and Pliocene (5.3 to 2.6 Ma) and Quaternary (2.6 Ma to present) fluvial terraces along the Rappahannock River across the Stafford fault system in northeastern Virginia within the resolution limits of the data collected. The applicant stated that, in NUREG-1835, the staff agreed with the results of the geomorphic analyses presented in the North Anna ESP application (Dominion, 2004). Therefore, the applicant concluded that the Stafford fault system was not active during the Quaternary.

Upper Marlboro faults (Class C)

In SSAR Section 2.5.1.1.4.2.5.7, the applicant described the Upper Marlboro faults (Feature 5 in Figure 2.5.1-3 of this report), located in Maryland about 257 km (160 mi) southwest of the PSEG Site, as 3 small faults interpreted to offset Coastal Plain sediments in a single road cut. The applicant reported that, although Dryden (1932) proposed a potential displacement of as much as 4.6 m (15 ft) in a Pleistocene (2.6 to 1.8 Ma) unit, he also stated that the apparent faults could be erosional features. The applicant noted that, based on a critical review of published data, Wheeler (2006) interpreted the faults to be the result of surficial landslides because of the low dips and concavity of the failure planes. Therefore, the applicant concluded, as did Crone and Wheeler (2000) and Wheeler (2005) based on their data compilations, that geologic evidence was insufficient to demonstrate the existence of Quaternary deformation associated with the proposed Upper Marlboro faults.

Lebanon Church fault (Class C)

SSAR Section 2.5.1.1.4.2.5.8 describes the Lebanon Church fault (Feature 17 in Figure 2.5.1-3 of this report), located in Virginia about 305 km (190 mi) southwest of the PSEG Site, as a small reverse fault that offsets Miocene-Pliocene (23 to 2.6 Ma) terrace gravels up to about 1.5 m (5 ft) in a single road cut. Therefore, the applicant interpreted the fault to be pre-Quaternary in age.

New York Bight fault (Class C)

SSAR Section 2.5.1.1.4.2.5.9 discusses the New York Bight fault (Feature 9 in Figure 2.5.1-3 of this report), which is about 48 km (30 mi) long and occurs offshore of Long Island, NY, in Coastal Plain strata. The applicant reported that the fault does not offset units younger than Eocene (i.e., <33.9 Ma) within the resolution range of the seismic survey data used to identify this feature (Schwab et al., 1997), and concluded that the feature is pre-Quaternary in age.

East Border fault (Class C)

In SSAR Section 2.5.1.1.4.2.5.10, the applicant indicated that the East Border fault is the easternmost basin-bounding fault of the exposed Mesozoic Hartford Basin that lies in Connecticut and Massachusetts, with the southern end of the basin located about 290 km (180 mi) northeast of the PSEG Site. The applicant stated that the fault clearly offsets Jurassic (201.6 to 145.5 Ma) and Cretaceous (145.5 to 65.5 Ma) strata; but definitive evidence for Quaternary displacement along the fault has not been presented by researchers who postulated that Quaternary deformation may have occurred on this structure (e.g., Thompson et al., 2000). Therefore, the applicant concluded that the East Border fault is most likely Mesozoic in age and does not show this feature in Figure 2.5.1-3 of this report.

Ramapo fault (Class C)

SSAR Section 2.5.1.1.4.2.5.11 discusses the Ramapo fault (Feature 7 in Figure 2.5.1-3 of this report), located in northern New Jersey and southern New York State about 160 km (100 mi) northeast of the PSEG Site. The applicant indicated that this feature extends for about 80 km (50 mi) from Peapack, NJ to the Hudson River and comprises one segment of a system of northeast-striking, southeast-dipping normal faults bounding the northwest side of the Mesozoic Newark Basin (Figure 2.5.1-2 of this report). The applicant acknowledged that some earlier researchers considered the Ramapo fault to be seismically active (e.g., Page et al., 1968;

Aggarwal and Sykes, 1978; Kafka et al., 1985) and to represent a tectonically active Quaternary structure characterized by small slip events. The applicant cited more recent work by Sykes et al. (2008) that shows a concentration of seismicity extending west of the Ramapo fault and occurring in what they refer to as the Ramapo seismic zone, rather than along the known Ramapo fault. (SSAR Section 2.5.1.1.5.1 discusses the Ramapo seismic zone, and Section 2.5.1.2.1.4.3 of this report summarizes the information presented by the applicant in SSAR Section 2.5.1.1.5.1.) Based on interpretations made by Ratcliffe (1982) from rock core samples collected across the Ramapo fault, the applicant stated field evidence exists to indicate the Ramapo fault has not been reactivated since the latest episode of Mesozoic extension (i.e., during the Jurassic at 201.6 to 145.5 Ma). The applicant noted that NUREG-2115 does not include the Ramapo fault as a source of repeated large magnitude earthquakes in the CEUS.

Kingston fault (Class C)

SSAR Section 2.5.1.1.4.2.5.12 describes the Kingston fault (Feature 4 in Figure 2.5.1-3 of this report) as a normal fault offsetting Triassic (251 to 201.6 Ma) and Jurassic (201.6 to 145.5 Ma) rocks within the Mesozoic Newark Basin with undeformed Cretaceous (145.5 to 65.5 Ma) strata overlying the fault. This information, derived by the applicant from Parker and Houghton (1990), suggests a Mesozoic age for the Kingston fault. The applicant reported that Stanford et al. (1995) discussed field data suggesting the fault may have been active during the Pliocene (5.3 to 2.6 Ma) and into Middle Pleistocene (about 1.8 Ma), but that no data from those studies unequivocally demonstrated Quaternary deformation along the fault since variations in thickness of the marker units could be fluvial in character rather than the result of faulting.

Dobbs Ferry fault zone (Class C)

SSAR Section 2.5.1.1.4.2.5.13 discusses the Dobbs Ferry fault zone (Feature 10 in Figure 2.5.1-3 of this report), a northwest-striking 1.9 km (1.2 mi) long fault zone marked by dense fracturing and slickensides north of New York City. The feature lies about 241 km (150 mi) northeast of the PSEG Site. The applicant indicated that additional field work by Dawes and Seeber (1991) extended the fracture zone to the southeast for a total of about 8 to 10 km (5 to 6 mi) and connected epicenters of the 1985 Ardsley earthquake (moment magnitude **M**3.7) and two additional fractured outcrops. The applicant reported that no field data (e.g., liquefaction features or faulted Quaternary deposits) suggest prehistoric seismicity, and that the best estimate for age of faulting along the extended Dobbs Ferry fault zone is Paleozoic or younger based on age of the rock units affected by fault displacement.

Mosholu fault (Class C)

SSAR Section 2.5.1.1.4.2.5.14 describes the Mosholu fault (Feature 8 in Figure 2.5.1-3 of this report), an approximately 12 km (7.5 mi) long, northwest-striking, near-vertical, right-lateral oblique-slip fault mapped in New York City. This feature lies about 201 km (125 mi) northeast of the PSEG Site. The applicant stated that the faulting is not demonstrably of Quaternary age, and the only constraint regarding timing of faulting is that the feature is younger than the Paleozoic deformation in rock units cut by the fault.

Offset glacial surfaces (Class C)

In SSAR Section 2.5.1.1.4.2.5.15, the applicant stated that surfaces with glacial striations exhibit offsets with variable and inconsistent orientations throughout New York, Vermont, New Hampshire, and Canada (Feature 16 in Figure 2.5.1-3 of this report). The applicant

reported a common association of these features with wedge-shaped voids in the outcrops, which Ratcliffe (1982) interpreted as evidence for the features having an origin related to ice wedging or frost heaving rather than tectonic deformation. The applicant indicated that the features are not likely to be of tectonic origin.

Hopewell fault (Class C)

SSAR Section 2.5.1.1.4.2.5.16 describes the Hopewell fault (Feature 14 in Figure 2.5.1-3 of this report) as a 48 km (30 mi) long, north striking, steeply east dipping, reverse fault located in Virginia about 143 km (89 mi) southwest of the PSEG Site. The applicant reported that the fault displaces a Paleocene-Cretaceous contact that is 65.5 Ma in age with an inferred offset of Pliocene (5.3 to 2.6 Ma) strata. Based on results of geologic mapping performed by Mixon et al. (1989), the applicant stated that the Hopewell fault lies buried beneath undeformed Quaternary units.

East Coast fault system (Class C)

SSAR Section 2.5.1.1.4.2.5.17 describes the east coast fault system (Feature 15 in Figure 2.5.1-3 of this report), a feature postulated by Marple and Talwani (2000) to extend for about 595 km (370 mi) in three segments from the area of Charleston, SC northeastward into Virginia. The applicant noted that Marple and Talwani (1993) attributed the southernmost segment, located in South Carolina, to the presence of a buried fault (i.e., the Woodstock fault) interpreted by Marple and Talwani (2000) to be the causative fault for the 1886 Charleston earthquake. The applicant stated that the southern segment of the postulated east coast fault system is the most well-defined segment based on geomorphology and microseismicity. This segment of the fault system has been considered in seismic source characterization studies by the U.S. Geological Survey (Frankel et al., 2002), while the central segment in North Carolina and the northern segment in Virginia have not. The applicant indicated that the central and northern segments of the postulated fault system exhibit little evidence for Quaternary deformation or seismicity, and concluded that the northern segment, which lies approximately 274 km (170 mi) southwest of the PSEG Site, does not show any indication of Quaternary faulting.

2.5.1.2.1.4.3 *Seismic Zones Defined by Regional Seismicity*.

In SSAR Section 2.5.1.1.5, the applicant discussed two potential seismic sources of local interest for the PSEG Site. The applicant described the Ramapo seismic zone (Sykes, et al., 2008) within the PSEG Site region, and the proposed Peekskill-Stamford seismic boundary of Sykes et al. (2008) just outside the site region. SSAR Sections 2.5.1.1.4.2.5.1 and 2.5.1.1.4.2.5.2 discuss, respectively, the Central Virginia and Lancaster seismic zones, both of which lie within the site region, as summarized in Section 2.5.1.2.1.4.2 of this report. The applicant addressed other regional seismic sources (i.e., the Charlevoix, Charleston, and New Madrid seismic zones) in SSAR Section 2.5.2 based on information provided in NUREG-2115. Figure 2.5.1-4 of this report illustrates seismicity within and outside of the site region.

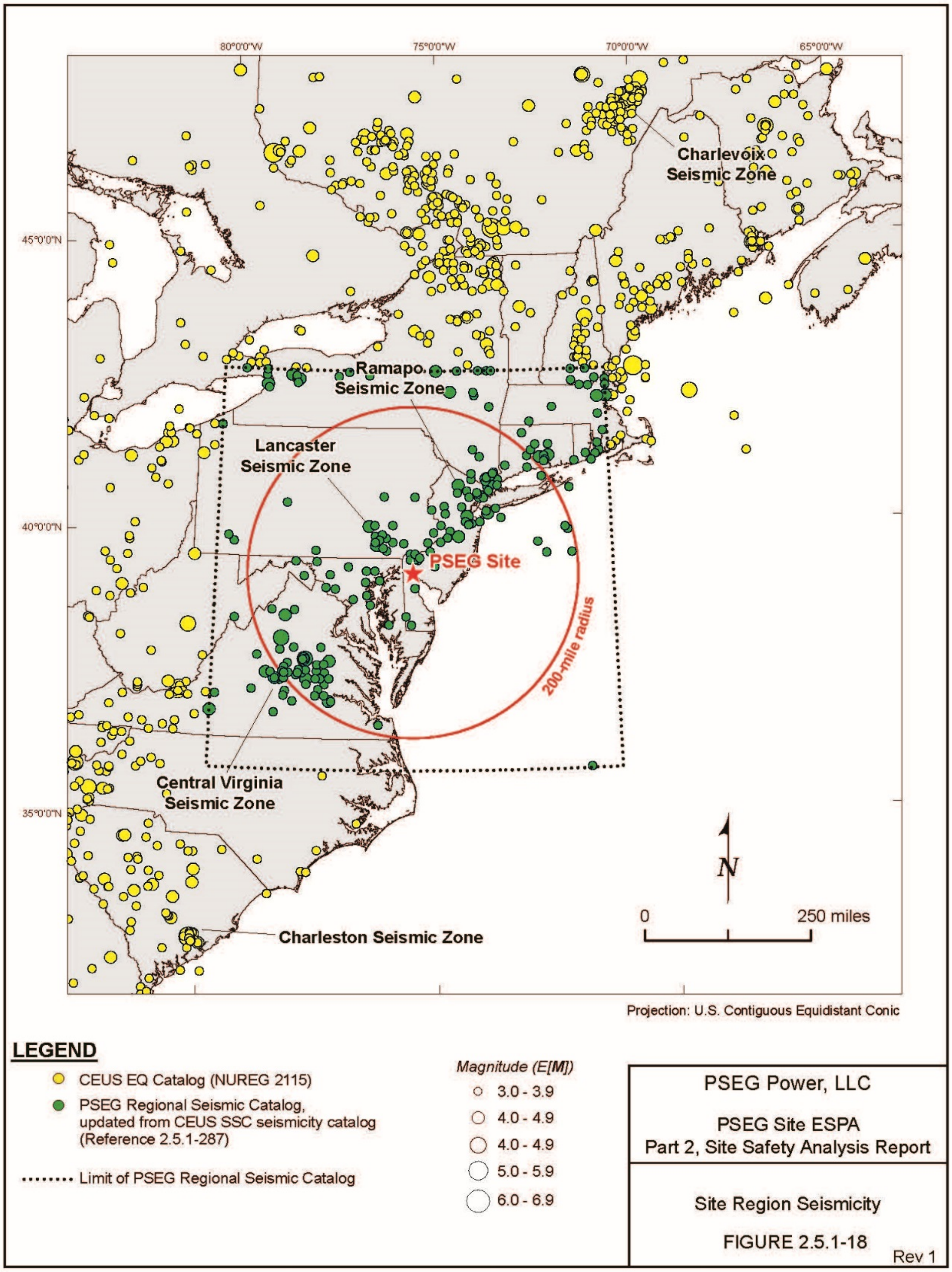

Figure 2.5.1-4 Seismicity within and outside of the site region (Reproduced from SSAR Figure 2.5.1-18)

Ramapo Seismic Zone

In SSAR Section 2.5.1.1.5.1, the applicant stated that the Ramapo seismic zone is a region of increased seismicity located west of the Ramapo fault in northern New Jersey and southern New York. The applicant reported that, although researchers initially proposed that this increased seismicity occurred due to slip on the Ramapo fault (e.g., Page et al., 1968; Aggarwal and Sykes, 1978; Kafka et al., 1985), results of investigations conducted by Ratcliffe et al. (1986) demonstrated that the Ramapo fault has not been active since Jurassic time (201.6 to 145.5 Ma). The applicant indicated that, as described by Sykes et al. (2008), the Ramapo seismic zone trends northeast for about 129 km (80 mi) from northern New Jersey into southern New York State; lies approximately 160 km (100 mi) north of the PSEG Site; and has no known active faults specifically associated with it. The applicant reported that earthquakes within the zone occur within highly deformed Middle Proterozoic to Early Paleozoic crystalline basement west of the Mesozoic Newark basin. The applicant stated that SSAR Section 2.5.2 incorporates data from the seismicity catalogue developed by Sykes et al. (2008) for seismic hazard assessment of the PSEG Site by using the updated CEUS-SSC model and associated seismicity catalogue in NUREG-2115.

Proposed Peekskill-Stamford Seismic Boundary

In SSAR Section 2.5.1.1.5.2, the applicant discussed the Peekskill-Stamford seismic boundary postulated by Sykes et al. (2008). The applicant indicated Sykes et al. (2008) suggest this proposed seismic boundary is subparallel to brittle faults that occur farther south, and, therefore, is a similar fault zone. Sykes et al. (2008) also speculate that these brittle features possibly formed between the Mesozoic Newark, Hartford, and New York bight basins to accommodate Mesozoic extension. The applicant remarked that Sykes et al. (2008) did not present any data or discussion to support their suggestion, and concluded that the seismic source model provided in NUREG-2115 need not be modified to represent potential seismic hazard at the PSEG Site due to the proposed Peekskill-Stamford seismic boundary.

2.5.1.2.1.4.4 *Regional Gravity and Magnetic Fields.*

In SSAR Section 2.5.1.1.6, the applicant described the major anomalous features shown by regional gravity and magnetic field data in the site region. The applicant stated that low amplitude gravity and magnetic anomalies generally indicate the presence of rocks of granitic composition because of their typical low density and magnetization, and that the relatively higher density and magnetization characteristics of mafic lithologies result in coincident high amplitude gravity and magnetic anomalies in the site region.

Regional Gravity Field Data

The applicant explained that two anomalous gravity highs transecting the site region in a northeast-southwest direction are first-order features of the regional gravity field in the site region. The applicant stated that the southeastern-most gravity high anomaly reflects bathymetry defining the continental shelf edge, and that the other gravity high, located northwest of the shelf edge anomaly, is a fundamental component of the gravity field of the Appalachian orogen known as the Piedmont Gravity High. The applicant noted that the regional gravity field obscures the signature of Mesozoic extensional basins on the gravity field in the site region, rendering the basins indistinct in the gravity field patterns in most cases.

Regional Magnetic Field Data

The applicant stated that the regional magnetic field shows a band of linear, short-wavelength, relatively high amplitude magnetic highs and lows through the approximate center of the site region northwest of the Coastal Plain. The applicant noted that these magnetic anomalies impart a well-defined fabric to the magnetic field that is similar to the northeast-southwest Appalachian tectonic fabric for the region. The applicant also noted that the higher frequency magnetic anomalies extend into the Coastal Plain where they are progressively damped to the southeast as thickness of the non-magnetic Coastal Plain sediments increases, indicating that Piedmont basement rocks underlie Coastal Plain stratigraphic sequences.

The applicant stated that the New York-Alabama Lineament in the site region forms an abrupt linear boundary in magnetic field fabric and appears to be a major crustal boundary. The applicant reported that the East Coast magnetic anomaly in the site region is a northeasterly-oriented linear magnetic high near the shelf edge that extends along the Atlantic margin. The applicant explained that the East Coast magnetic anomaly marks the transition from continental to oceanic crust and involves a combination of extended continental crust and magnetized intrusions. The applicant stated that sediments filling the Mesozoic basins are relatively nonmagnetic and generally tend to produce a subdued magnetic field over the basins, although magnetic Mesozoic intrusive and extrusive rocks complicate the generalized model and may be hard to distinguish from basement.

2.5.1.2.2 Site Geology

SSAR Section 2.5.1.2 discusses physiography and geomorphology, stratigraphy and lithology, geologic history, structural geology, and site engineering geology of the PSEG Site vicinity and site area. SSAR Section 2.5.1.2 also discusses certain of these topics specifically for the site location, including assessment of the effects of human activity. The following sections of this report provide a summary of the information presented by the applicant in SSAR Section 2.5.1.2.

2.5.1.2.2.1 Physiography and Geomorphology.

In SSAR Section 2.5.1.2.1, the applicant described physiography and geomorphology of the site area. The applicant stated that the PSEG Site area lies almost completely within the Outer Coastal Plain subprovince of the Coastal Plain physiographic province, with the central portions of the site area occupied by the Delaware River channel (Figure 2.5.1-5 of this report (Reproduced from SSAR Figure 2.5.1-6)). The applicant indicated that eastern portions of the PSEG Site east of the Delaware River generally exhibit an extremely flat, low-lying topography that is only a few feet above sea level and underlain by Holocene (0.01 Ma to present) Delaware Bay estuarine (i.e., tidal salt marsh) deposits, while the portions west of the Delaware River consist of incised Quaternary terrace uplands underlain mainly by the Late Pleistocene (1.8 to 0.01 Ma) Scott Corners formation. The applicant stated that current elevations in the site area range from sea level to about 4.9 m (16 ft) above sea level.

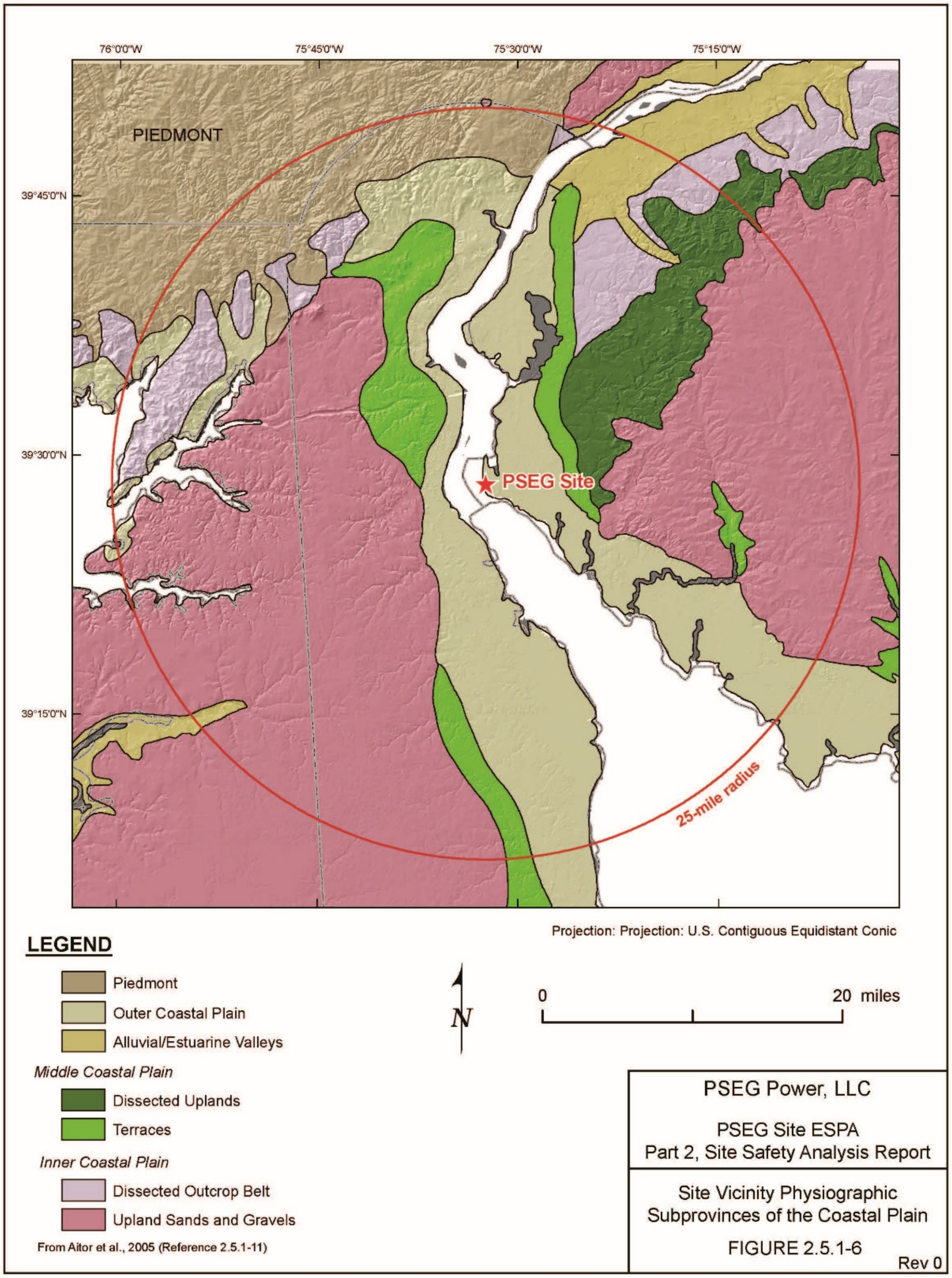

Figure 2.5.1-5 Site vicinity physiographic subprovinces of the Coastal Plain (Reproduced from SSAR Figure 2.5.1-6)

The applicant reported that the PSEG Site location occurs on an artificial island on the eastern bank of the Delaware River. The applicant also reported that the western portions of the site location lie in the Delaware River; artificial fill underlies the eastern portions; and marsh deposits overlying artificial fill occurs in the northeastern parts of the site location. The applicant indicated historical aerial images reveal that the center of the PSEG Site sits atop what was originally a bar in the Delaware River built up from dredging spoil.

2.5.1.2.2.2 Stratigraphy and Lithology.

SSAR Section 2.5.1.2.2 discusses stratigraphy and lithology of the PSEG Site area (SSAR Section 2.5.1.2.2.1) and site location (SSAR Section 2.5.1.2.2.2), stating that the site area occurs entirely within the Salisbury Embayment (Figure 2.5.1-1 of this report) and contains Coastal Plain sediments ranging in age from Early Cretaceous to Holocene (145.5 to 0.01 Ma). The applicant indicated these sediments cover a basement complex of rifted continental crust that lies beneath the pre-Cretaceous (>145.5 Ma) unconformity marking the base of the Coastal Plain stratigraphic sequences. The applicant provided a detailed discussion of the stratigraphic column for the PSEG Site area and site location, including basement complex lithologies and the Coastal Plain stratigraphic sequence. Figure 2.5.1-6 of this report (Reproduced from SSAR Figure 2.5.1-34) shows a stratigraphic column that generally applies for both the PSEG Site area and site location.

		Formation/Unit	Lithologies	Thickness
QUATERNARY	Holocene (recent)	Artificial fill	clays, silts, and sands of various proportions along with clayey and silty gravels	4.1 ± 5.1 feet
		Hydraulic fill	soft clayey silts, sandy silts and organic clays	33.5 ± 12.3 feet
	Pleistocene	Alluvium	fine to coarse sand and gravel; peat and organic rich soils; silt and clay near base	12.7 ± 12.3 feet
		~~ unconformity ~~~~~~~~~~~~~~~~~~~~		
TERTIARY	Upper Tertiary (Neogene)	Kirkwood Formation	*Upper member:* greenish-gray, silty, fine sand, fine sand and greenish-gray to brown organic clay with organic material and shell fragments; *Lower member:* fine to coarse sand and gravel with variable amounts of silt and clay	*Upper member:* 14.5 ± 7.7 feet; *Lower member:* 7.2 ± 7.8 feet
		~~ unconformity ~~~~~~~~~~~~~~~~~~~~		
	Lower Tertiary (Paleogene)	Vincentown Formation	greenish-gray, fine to medium grained silty sand with some zones of clayey sand; variably glauconitic; cemented zones	52.0 ± 26.1 feet
		Hornerstown Formation	greenish-gray to dark green silty and clayey quartz and glauconitic sand with indurated zones	18.6 ± 3.2 feet
CRETACEOUS	Upper Cretaceous	Navesink Formation	fossiliferous, dark green to greenish-black glauconitic sand; pelecypod fragments	24.3 ± 2.3 feet
		Mount Laurel Formation	brownish gray to dark green, fine to coarse grained sand; variable amounts of silt and clay; coarsening upward sequence	10.3 ± 3.5 feet
		Wenonah Formation	sandy clay with clayey sand	15 feet
		Marshalltown Formation	glauconitic, silty and clayey fine sand	25 feet
		Englishtown Formation	dark gray to black sandy clay to clayey sand with shell fragments grades to black silt with trace amounts of mica and glauconite	44 feet
		Woodbury Formation	black, micaceous clay	36 feet
		Merchantville Formation	dark greenish-black glauconitic silts and clays with variable amounts of sand	30 feet
		Magothy Formation	interbeds of gray to dark gray, locally mottled silts and clays that are interbedded with sands; trace amounts of lignite and carbonaceous material	52 feet
		~~ unconformity ~~~~~~~~~~~~~~~~~~~~		
	Lower Cretaceous	Potomac Group (Formation)	red, gray, and white mottled clay	1300 feet (Reference 2.5.1-17) PSEG No. 6 Production Well
		~~ pre-Cretaceous unconformity ~~~~~~~~~~~~~~~		
PRECAMBRIAN TO PALEOZOIC	NeoProterozoic to Paleozoic	**Basement Complex**		
		Philadelphia Terrane	Wissahickon Schist – reported as residual clay (PSEG No. 6 Production Well)	undetermined

PSEG Power, LLC

PSEG Site ESPA
Part 2, Site Safety Analysis Report

Site Location Stratigraphy

FIGURE 2.5.1-34

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Figure 2.5.1-6 Stratigraphic column for the site area and location (Reproduced from SSAR Figure 2.5.1-34)

Unit thicknesses shown may vary from those reported at the site location.

2.5.1.2.2.2.1 *Basement Complex Lithologies*.

The applicant indicated that either Precambrian to Paleozoic age metamorphosed igneous and sedimentary rocks of the Carolina Superterrane or aluminous to quartz-rich gneisses with interlayered amphibolites of the Philadelphia Terrane make up crystalline basement complex lithologies that underlie the Coastal Plain sedimentary sequences in the site area. The applicant noted that a single well drilled about 1 km (0.6 mi) from the center of the PSEG Site (i.e., near the site location) penetrated Wissahickon schist at a depth of 549 m (1,800 ft). The Wissahickon schist represents crystalline basement rock of the Philadelphia Terrane, and this data point indicates depth to basement near the site location. The applicant stated that considerable uncertainty exists regarding the existence and locations of sediment-filled Mesozoic extensional basins, and that these basins may exist in the site area. The applicant noted that buried Mesozoic basins have been interpreted to occur in the site vicinity.

2.5.1.2.2.2.2 *Coastal Plain Stratigraphic Sequences*.

The applicant indicated that units of the Coastal Plain sedimentary sequences, which range in age from Early Cretaceous (145.5 to 99.6 Ma) to Holocene (0.01 Ma to present), are generally similar for both the site area and site location. The applicant reported that the Lower Tertiary (65.5 to 23 Ma) Vincentown formation, the planned foundation-bearing unit, is silty sand with some clayey sand zones. The Vincentown ranges in thickness from 11 to 24 m (35 to 79 ft) at the site location because the top of the formation is an eroded surface, but is approximately 27 m (90 ft) thick over the site area. The applicant stated that Quaternary sediments exposed in the site area consist mainly of estuarine terrace or marsh deposits with isolated exposures of fluvial units, and the marsh deposits primarily comprise muck, peat, silt, clay and sand deposited along the margins of tidal creeks. The applicant also stated that alluvial material ranging in thickness from 1.5 to 7 m (5 to 23 ft), deposited on the bed of the Delaware River and made up of fine to coarse sand and gravels interbedded with peat and organic-rich soils, represents the uppermost strata at the site location. The applicant reported that material derived from dredging operations starting in the early 1900s and structural fill placed during construction of the Hope Creek and Salem Generating Stations overlie the alluvium, and that the structural fill has a variable thickness of up to 3 m (10 ft).

2.5.1.2.2.3 Geologic History.

SSAR Section 2.5.1.2.3 discusses geologic history of the site vicinity and site area. The applicant indicated that the crystalline basement complex which underlies the site formed during Precambrian and Paleozoic time, and that extension and rifting of the basement complex formed the present Atlantic Ocean basin during the Mesozoic. The applicant stated that lithology of the crystalline basement complex in the PSEG Site vicinity and site area is somewhat unclear because the site vicinity and area lie near the boundary between the Philadelphia Terrane and the Carolina Superterrane. The Carolina Superterrane consists of Neoproterozoic (1,000 to 542 Ma) to Early Cambrian (542 to 521 Ma) meta-igneous rocks overlain by metamorphosed clastic sedimentary sequences of Cambrian (542 to 488 Ma) to Ordovician (488 to 444 Ma) age. The Philadelphia Terrane comprises metasedimentary sequences intruded by a diverse suite of igneous rocks between 485 to 475 Ma and again at approximately 434 Ma.

The applicant stated that sedimentary sequences of the Coastal Plain, which range in age from Early Cretaceous (145.5 to 99.6 Ma) into the Quaternary (2.6 Ma to present), overlie the crystalline basement complex. The applicant indicated that, in the site vicinity,

glacial-interglacial cycles resulted in deposition of fluvial sequences, formation of estuarine terraces, and subsequent incision of the terraces and fluvial sequences. The applicant noted interglacial sea level transgressions during the Late Pleistocene resulted in deposition of the Scotts Corners and Cape May Formations, which consist of incised terraces in the eastern and western portions of the site area. The applicant indicated that, beginning in the Late Pleistocene and into the present, the Delaware Bay experienced deposition of estuarine sediments in tidal marsh settings.

2.5.1.2.2.4 Structural Geology.

SSAR Section 2.5.1.2.4 discusses structural geology of the site vicinity (SSAR Section 2.5.1.2.4.1), as well as the site area and site location (SSAR Section 2.5.1.2.4.2). The applicant used the following sources to derive information presented in SSAR Section 2.5.1.2.4: published geologic mapping of Pickett and Spoljaric (1971), Newell et al. (1998), Owens et al. (1999), and Schenck et al. (2000); detailed boring and geophysical logs of southern New Jersey, northern Delaware, and eastern Maryland from Bell et al. (1988) and Sugarman and Monteverde (2008); results of earlier investigations performed at the PSEG Hope Creek site (PSEG, 2008) and the nearby Delmarva Power and Light Summit site (Delmarva P&L, 1974); and results of reconnaissance and subsurface investigations performed specifically for the PSEG ESP application.

2.5.1.2.2.4.1 *Site Vicinity.*

The applicant stated that, although no Mesozoic rift basins have been identified beneath the PSEG Site, such basins occur or have been inferred to occur beneath Coastal Plain sediments in Virginia, Maryland, Delaware, and New Jersey. Since Benson (1992) hypothesized that the northern extension of a buried Mesozoic basin (i.e., the Queen Anne basin) may lie within 24 km (15 mi) of the site, the applicant examined data relevant to the characteristics of basement rock units underlying the site. The applicant reported that more than 6 wells drilled within 16 km (10 mi) of the site did not encounter Triassic rift sediments, but rather revealed Cretaceous Coastal Plain sediments overlying metamorphosed crystalline basement rocks of probable Precambrian or Paleozoic age. The applicant also indicated that seismic velocities derived from a seismic refraction transect east of the PSEG Site were consistent with velocities for crystalline basement rocks rather than Triassic rift basin sediments. The applicant concluded that available data from the site and from multiple wells located within 13-48 km (8-30 mi) of the site do not support the existence of a Mesozoic basin in the site vicinity or area or at the site location.

The applicant noted that two categories of faults occur within the site vicinity, namely, Piedmont faults observed in northernmost Delaware and basement faults underlying Coastal Plain strata. Based on the data sources stated in Section 2.5.1.2.2.4 of this report, the applicant concluded that Tertiary and younger strata within the site vicinity are not deformed by tectonic faulting.

2.5.1.2.2.4.2 *Site Area and Site Location*.

The applicant stated that no evidence exists for tectonic faults or folds within 8 km (5 mi) of the PSEG Site (i.e., within the site area), and that planar, undeformed Cretaceous and Tertiary strata dipping gently to the southeast characterize the site. The applicant noted that the contact of the Vincentown Formation (the probable foundation unit at the PSEG Site) with the overlying Kirkwood Formation traces a channeled erosional surface at the top of the Vincentown with up to 10 m (35 ft) of relief at the proposed site location. The applicant concluded that the existence

of planar and undeformed contacts between stratigraphic units that occur both above and below the irregular Vincentown-Kirkwood contact rule out faulting as the cause of variability in elevation of the top of the Vincentown formation.

2.5.1.2.2.5 Site Engineering Geology Evaluation.

SSAR Section 2.5.1.2.5 presents an evaluation of site engineering geology related to both natural and manmade conditions for the site vicinity, site area, and site location that may pose a potential hazard to the site. The applicant discussed dynamic behavior during prior earthquakes; zones of mineralization, alteration, weathering, and structural weakness; unrelieved residual stresses in bedrock; groundwater conditions; and effects of human activity.

In SSAR Section 2.5.1.2.5.1, the applicant stated that no earthquakes larger than **M**3.77 have been recorded in the site vicinity and that no paleoliquefaction studies in the site region revealed any earthquake-induced liquefaction features. The applicant noted that the area surrounding the site location provides few suitable exposures for evaluating the presence of liquefaction features, but reported that review of aerial photographs and inspections of the site area from low altitude flights for the PSEG ESP application did not reveal any earthquake-induced liquefaction features. The applicant also noted that excavation mapping for the existing Hope Creek unit did not reveal earthquake-induced liquefaction features.

In SSAR Section 2.5.1.2.5.2, the applicant did not report any issues related to engineering properties associated with zones of mineralization, alteration, weathering, or structural weakness at the site location. The applicant stated that the upper 24 m (80 ft) of the materials underlying the site location consist of hydraulic fill, alluvium from the adjacent Delaware River, and silty clays and sands of the Tertiary age Kirkwood formation, which overlies the Vincentown formation. The applicant indicated that these materials will be removed to an elevation within the Vincentown formation, which is the proposed foundation-bearing layer at the site. The applicant reported that characteristics of the Vincentown at the site location were consistent with those described in the Final Safety Analysis Report for the existing Hope Creek unit (PSEG, 2008), including the presence of varying amounts of calcium carbonate, and that extensive boring, aerial photography, and construction excavation mapping for the Hope Creek unit did not reveal karst features in the Vincentown formation. The applicant indicated that the nearest karst terrain, related to dissolution of marble in the metamorphic Cockeysville Formation, is about 32 km (20 mi) northwest of the site. Therefore, the applicant concluded that no hazards exist due to the presence of karst features in the site area or at the site location.

In SSAR Section 2.5.1.2.5.3, the applicant stated that there is no evidence for unrelieved residual stress in the bedrock or overlying sediments that pose a hazard for the site location. The applicant reported that subsidence resulting from isostatic adjustment due to glacial rebound characterizes the site region, and that studies of paleoshorelines on the continental shelf offshore of New Jersey indicate relatively stable isostatic conditions in the site vicinity.

In SSAR Section 2.5.1.2.5.4, the applicant indicated that the groundwater level at the PSEG Site location is a few feet below the surface, and that the area is surrounded by natural estuaries and tidal marshes in addition to artificial channels and drainage cuts. The applicant stated that these features do not represent a hazard for the site location. The applicant cross-referenced SSAR Section 2.5.4.6 for discussion of groundwater conditions during construction excavation.

In SSAR Section 2.5.1.2.5.5, the applicant stated that human activities, including surface and subsurface mining as well as oil and gas extraction and injection, have not been reported in the site area. Therefore, the applicant concluded that no human activities pose a hazard at the PSEG Site location.

2.5.1.3 Regulatory Basis

The applicable regulatory requirements for basic geologic and seismic information that must be included in an ESP application are as follows:

1. 10 CFR 52.17(a)(1)(vi), as it relates to identifying geologic, site characteristics with appropriate consideration of the most severe natural phenomena that have been historically reported for the site and surrounding area, and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2. 10 CFR 100.23, "Geologic and Seismic Siting Criteria," as it relates to the suitability of a proposed site and the adequacy of the design basis based on consideration of geologic, geotechnical, geophysical, and seismic characteristics of the proposed site. Geologic and seismic siting factors must include the SSE for the site and the potential for surface tectonic and non-tectonic deformation. The site-specific GMRS satisfies requirements of 10 CFR 100.23 with respect to the development of the SSE.

The related acceptance criteria from NUREG-0800, Section 2.5.1 are as follows:

1. Regional Geology: For meeting requirements of 10 CFR 52.17 and 10 CFR 100.23, SSAR Section 2.5.1.1 will be considered acceptable if it contains complete documented discussions of all geologic (both tectonic and non-tectonic), seismic, geophysical, and geotechnical characteristics, as well as conditions caused by human activities, deemed important for safe siting and design of the plant.

2. Site Geology: For meeting requirements of 10 CFR 52.17 and 10 CFR 100.23 and the guidance presented in RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants"; RG 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants"; RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites" and RG 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion"; SSAR Section 2.5.1.2 will be considered acceptable if it contains a description and evaluation of geologic features (both tectonic and non-tectonic), seismic conditions, geotechnical characteristics, and conditions caused by human activities at appropriate levels of detail within area defined by circles drawn around the site using radii of 40 km (25 mi) for the site vicinity, 8 km (5 mi) for the site area and 1 km (0.6 mi) for the site location.

In addition, the geologic characteristics should be consistent with appropriate sections from RG 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion"; RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants"; RG 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants"; and RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites."

2.5.1.4 Technical Evaluation

The staff reviewed SSAR, Section 2.5.1 to ensure that the materials provided by the applicant represent the required data related to basic geologic and seismic information. The staff's review confirmed that data contained in the application address the information required for this topic.

The technical information presented in SSAR Section 2.5.1 resulted from the applicant's review of published literature as well as regional and site-specific studies involving aerial reconnaissance; interpretation of aerial photography; surface and subsurface field investigations, including geologic mapping, assessment of possible tectonic structures, geotechnical borings, and geophysical testing; and description of potential seismic source zones conducted specifically for characterization of the PSEG Site. The applicant also provided information applicable to the site derived from the updated FSARs for the SGS and HCGS Generating Stations (PSEG, 2007 and PSEG, 2008), although the primary focus was on data developed since publication of those two updated FSARs. In addition, the applicant performed laboratory tests on samples collected for characterization of material properties at the site. Through review of SSAR Section 2.5.1, the staff determined whether the applicant had complied with applicable regulatory requirements in 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d) and conducted the site characterization investigations at the appropriate levels of detail in accordance with guidance in RG 1.208.

RG 1.208 recommends that an applicant evaluate any significant new geologic, seismic, and geophysical data to determine whether revisions to existing seismic source models and ground motion attenuation relationships are necessary. SSAR Section 2.5.1 includes geologic and seismic information collected by the applicant to support the analysis of vibratory ground motion and development of site-specific GMRS, as discussed in SSAR Section 2.5.2. RG 1.208 also recommends that an applicant evaluate faults encountered at a site to determine whether they are seismogenic or may cause surface deformation. SSAR Section 2.5.1 includes information related to assessment of the potential for future tectonic and non-tectonic deformation at the site, discussed in more detail by the applicant in SSAR Section 2.5.3.

The staff visited the PSEG Site on January 22, 2009, to observe pre-application subsurface investigation activities. A second visit, a site audit performed over September 29-30, 2011, after PSEG had submitted the ESP application, focused on examination of samples of the Vincentown formation and pertinent outcrops, as well as interactions with the ESP applicant and its consultants in regard to the geologic, seismic, geophysical, and geotechnical investigations being conducted for characterization of the proposed site. Regarding the geologic field observations, the staff examined outcrops of estuarine sediments comprising the Early Pleistocene (2.6 to 1.8 Ma) Turkey Point Beds near the boundary of the PSEG Site vicinity west of the site for field evidence of a fault postulated by Pazzaglia (1993) to extend into the Chesapeake Bay west of the site. Pazzaglia (1993) postulated this fault based on interpreted elevation differences between Turkey Point Beds on opposite sides of the Bay. The staff noted no field evidence for this proposed fault.

Sections 2.5.1.4.1, "Regional Geology"; and 2.5.1.4.2, "Site Geology," of this report present the staff's evaluation of information provided by the applicant in SSAR Section 2.5.1 and the applicant's responses to RAIs for that SSAR section. All RAIs posed by the staff and discussed in the following sections of this report assure the applicant's compliance with 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and10 CFR 100.23(d), as well as conformance with NUREG-0800, Section 2.5.1. In addition to the RAIs addressing specific technical issues

related to regional and site geology of the PSEG Site, discussed in detail below, the staff also prepared several editorial RAIs to further clarify certain descriptive statements made by the applicant in the SSAR and to better qualify specific geologic features illustrated in figures in the SSAR. This technical evaluation does not include a discussion of these editorial RAIs.

2.5.1.4.1 Regional Geology

The staff focused the review of SSAR Section 2.5.1.1 ("Regional Geology") on descriptions provided by the applicant for physiography and geomorphology, geologic history, stratigraphy, tectonic setting, seismic zones defined by seismicity, and gravity and magnetic fields within 320 km (200 mi) of the site location (i.e., the site region). The staff particularly concentrated on the descriptions of potential Quaternary tectonic features within the site region, including seismic zones and possible fault systems, fault zones, and faults.

2.5.1.4.1.1 Regional Physiography, Geomorphology, and Geologic History.

In SSAR Section 2.5.1.1.1, the applicant discussed physiography and geomorphology of the PSEG Site region and noted that the PSEG Site lies within the Coastal Plain physiographic province. Figure 2.5.1-1 of this report shows the location of the PSEG Site in the Coastal Plain province relative to the other physiographic provinces which occur in the site region. In SSAR Section 2.5.1.1.2, the applicant discussed geologic history of the site region, covering the Proterozoic (> 542 Ma), Paleozoic (542 to 251 Ma), Mesozoic (251 to 65.5 Ma), and Cenozoic (65.5 Ma to present). The Quaternary Period is that part of the Cenozoic extending from 2.6 Ma to the present.

The staff focused the review of SSAR Section 2.5.1.1.1 on statements in SSAR Section 2.5.1.1.1.3, "Piedmont Physiographic Province," which describe river drainage patterns (including those for the Potomac, Susquehanna, and Delaware Rivers) near the Fall Zone (a boundary that separates the Piedmont physiographic province from the Coastal Plain province) that exhibit complex longitudinal profiles and consistently show right-stepping bends. The applicant did not explain whether tectonic or non-tectonic processes produced these right-stepping bends in the river drainage patterns. In addition, the staff focused its review on SSAR Section 2.5.1.1.2.7, "Cenozoic Passive Margin Development," in which the applicant stated that the Fall Zone is a topographic escarpment controlled mainly by lithologic contrasts rather than faulting, and that differential subsidence, not tectonic deformation, produced local arches and basins (e.g., the South New Jersey Arch and the Salisbury Embayment) within the Coastal Plain. The applicant did not provide references to support the interpretation that the Fall Zone and arches and embayments in the Coastal Plain province near the Fall Zone are non-tectonic in character. To document the non-tectonic character of the Fall Zone and arches and embayments in the Coastal Plain adjacent to the Fall Zone, in RAI 2.5.1-1 the staff requested that the applicant provide references supporting the interpretation that the Fall Zone formed primarily due to lithologic contrasts, rather than faulting; to discuss existing evidence that secondary faulting along the Fall Zone may have enhanced development of the zone; and to provide references supporting the interpretation that uplifts and embayments located near the Fall Zone in the Coastal Plain resulted from differential subsidence. Since the applicant's December 28, 2011, response to RAI 42, Question 02.05.01-1 required further clarification, the staff issued follow-up RAI 63, Question 02.05.01-19 to assist with assessing information provided by the applicant that suggested a non-tectonic origin for both the Fall Zone and arches and embayments in the Coastal Plain adjacent to the Zone. Specifically, in follow-up RAI 63, Question 02.05.01-19, the staff requested that the applicant provide the following materials:

a) Additional information, including consideration of references that propose faulting to be associated with some segments of the Fall Zone (e.g., Pazzaglia and Gardner, 1994), to justify interpretations that the Fall Zone and adjacent arches and embayments are non-tectonic in origin and that no evidence exists for primary or secondary Quaternary faulting associated with the Fall Zone in the site region.

b) A summary of pertinent data derived from references cited in the response to RAI 42, Question 02.05.01-1 and used to suggest that regional geophysical data document a non-tectonic origin for the arches and embayments occurring in the Coastal Plain adjacent to the Fall Zone.

c) Additional information to explain how Cumbest et al. (2000), cited in the response to RAI 42, Question 02.05.01-1, indicates that interpretations of faulting along the Fall Zone result from a sampling bias.

In a September 25, 2012, response to follow-up RAI 63, Question 02.05.01-19, Part (a), and based on information provided by Pazzaglia and Gardner (1994), the applicant reported that relief along the Fall Zone primarily results from contrast in hardness between metamorphic crystalline rocks of the Piedmont and Coastal Plain sediments, and secondarily from non-tectonic flexural upwarping of the Piedmont, rather than faulting. The applicant stated that Pazzaglia and Gardner (1994) provided the best evidence for the Fall Zone being non-tectonic in origin and for uplift in the Piedmont and Fall Zone being the result of epeirogenic (i.e., the product of vertical movement) flexure of the Piedmont lithosphere due to sediment loading to the east in the Coastal Plain. The applicant made this statement because Pazzaglia and Gardner (1994) reproduced paleotopographic profiles along the Susquehanna River as far back as Middle Miocene (about 13.8 Ma) using a model of flexural isostatic bending of the lithosphere, indicating that uplift in the Piedmont near the Fall Zone could occur as a result of sediment loading along the coast in combination with erosion of the Appalachian Mountains. The applicant indicated that the epeirogenic uplift rate calculated by Pazzaglia and Gardner (1994) was about 0.0023 mm (9.055×10^{-5} in) per year near the Fall Zone, a rate consistent with the interpretation that small deformations near the Fall Zone most likely occur due to isostatic bending of Piedmont lithosphere as a result of epeirogenic flexure, rather than tectonic faulting resulting from horizontal stresses.

Also, in the September 25, 2011, response to RAI 63, Question 02.05.01-19, Part (a), the applicant explained that, although some researchers reported a coincidence of Cenozoic faulting with the Fall Zone (e.g., Mixon and Newell, 1977; Mixon and Powars, 1984), no investigations revealed evidence of a Quaternary age for those faults. Examples of Cenozoic tectonic features near the Fall Zone in the site region include the Stafford fault system in Virginia; the National Zoo faults in Washington, D.C.; the hypothesized fault of Pazzaglia (1993); and one of the seven (i.e., the Tidewater fall line) Fall Lines of Weems (1998). The applicant reported that the Stafford fault system and the National Zoo faults are probably Tertiary in age based on observed field relationships, and that studies conducted for the North Anna ESP application (Dominion, 2004) revealed a Pliocene (5.3 to 2.6 Ma) sand unit overlying the Tidewater fall line without deformation. The applicant further reported that the fault of Pazzaglia (1993), postulated to extend up the Chesapeake Bay into the site vicinity because of an apparent 8 m (26 ft) elevation difference in Pleistocene (2.6 to 1.8 Ma) strata outcropping more than 15 km (9 mi) apart on opposite sides of the Chesapeake Bay, is most likely the result of variations in the paleotopographic surface developed on those strata. During the site field audit

conducted over September 29-30, 2011, the staff examined these same strata in the field and found no evidence for Quaternary faulting as postulated by Pazzaglia (1993).

In a September 25, 2012, response to RAI 63, Question 02.05.01-19, Part (b), the applicant reported that researchers have recognized morphology and variations in sediment thickness associated with arches and embayments in the Coastal Plain dominantly reflect properties of underlying basement rocks rather than recent tectonic deformation. Karner and Watts (1982) analyzed gravity anomalies along linear profiles adjacent to passive continental margins around the world, including eastern North America, and predicted the style of basement flexure changes during margin evolution based on isostasy due to sediment loading without any influence from faulting. In addition, Wyer and Watts (2006) used gravity anomaly data to determine that arches and embayments show an association with lithospheric strength (i.e., generally stronger lithosphere under arches and weaker under embayments). Based on the reasoning developed in Karner and Watts (1982) and Wyer and Watts (2006) explaining how geophysical data (i.e., gravity anomalies) support a non-tectonic origin for the arches and embayments occurring in the Coastal Plain adjacent to the Fall Zone in the site region, the applicant concluded that arches and embayments of the Coastal Plain resulted from non-tectonic processes associated with isostasy and strength of the lithosphere.

In a September 25, 2012, response to RAI 63, Question 02.05.01-19, Part (c), the applicant indicated that Cumbest et al. (2000) pointed out the sampling bias for interpretations of faulting along the Fall Zone due to the fact that recognition of faults in Paleozoic crystalline rocks adjacent to the Fall Zone is easier than in younger Coastal Plain sediments east of the Fall Zone. The applicant noted that the structures identified by Cumbest et al. (2000) are Cretaceous and Tertiary in age, not Quaternary, so that study also did not document an increased possibility of Quaternary faulting associated with the Fall Zone.

Based on its review of the December 28, 2011, and September 25, 2012, responses to RAI 42, Question 02.05.01-1 and follow—up RAI 63, Question 02.05.01-19, respectively, and SSAR Sections 2.5.1.1.1.3 and 2.5.1.1.2.7, as well as independent examination of references cited by the applicant, the staff concludes that sufficient field evidence exists to support the interpretation of a non-tectonic origin for the Fall Zone and arches and embayments occurring in the Coastal Plain adjacent to the Fall Zone. The staff makes this conclusion because a preponderance of information derived from analysis of field data by multiple researchers suggests a non-tectonic origin for these features. Accordingly, the staff considers RAI 42, Question 02.05.01-1 and RAI 63, Question 02.05.01-19 resolved.

Based on review of SSAR Sections 2.5.1.1.1 and 2.5.1.1.2 and the applicant’s responses to RAI 42, Question 02.05.01-1 and follow-up RAI 63, Question 02.05.01-19, as well as independent review of literature cited by the applicant in the SSAR, the staff finds that the applicant provided a thorough and accurate description of regional physiography, geomorphology, and geologic setting in support of the PSEG ESP application.

2.5.1.4.1.2 Regional Stratigraphy.

In SSAR Section 2.5.1.1.3, the applicant discussed stratigraphy of the site region, including stratigraphic successions formed during Late Proterozoic, Paleozoic, Mesozoic, and Cenozoic, which encompasses the Quaternary Period. The applicant briefly described characteristics of the Lower Tertiary Vincentown Formation, the proposed foundation unit at the site.

The staff focused the review of SSAR Section 2.5.1.1.3 on the applicant's descriptions of Quaternary stratigraphic units to ensure that no sedimentation patterns suggested Quaternary tectonic deformation in the site region. Based on its review of SSAR Section 2.5.1.1.3 as well as independent review of literature cited by the applicant in that section, the staff concludes that Quaternary deposits in the site region resulted from fluvial and marine processes associated with sea level changes or terminal glacial effects, including glacial outwash. The staff draws this conclusion because considerable field data exist to document characteristics of the Quaternary section in the site region.

Based on its review of SSAR Section 2.5.1.1.3 and independent examination of references cited by the applicant in the SSAR, the staff finds that the applicant provided a thorough and accurate description of regional stratigraphy in support of the PSEG ESP application.

2.5.1.4.1.3 Regional Tectonic Setting

In SSAR Section 2.5.1.1.4, the applicant discussed regional tectonic setting, including regional stress and principal tectonic structures of Late Proterozoic, Paleozoic, Mesozoic, and Cenozoic found in the site region. The principal structures included 17 potential Quaternary tectonic features reported to occur in the site region, as described in SSAR Section 2.5.1.1.4.2.5 and summarized in Section 2.5.1.2.1.4.2 of this report.

The staff focused the review of SSAR Section 2.5.1.1.4 on understanding ages of the principal tectonic structures that occur in the site region, concentrating specifically on Cenozoic and potential Quaternary features, to ensure that none of the features represented tectonic structures that may pose a geologic or seismic hazard to the site.

2.5.1.4.1.3.1 *Principal Tectonic Structures.*

Cenozoic Tectonic Structures

Hypothesized Fault of Pazzaglia

SSAR Section 2.5.1.1.4.2.4.1 describes a fault postulated by Pazzaglia (1993), trending along the northeastern end of the Chesapeake Bay and projecting into the site vicinity, that may offset Early Pleistocene (2.6 to 1.8 Ma) sedimentary Turkey Point Beds near the Fall Zone in Maryland. The applicant stated that Pazzaglia (1993) proposed this fault based on a difference in elevation of the sedimentary beds on opposite sides of the fault along the eastern and western shores of the Chesapeake Bay, a distance of more than 15 km (9 mi), and reported that field and aerial reconnaissance studies performed for the PSEG ESP application did not reveal any evidence for this postulated fault. The applicant concluded that this feature, if it exists, does not pose a hazard to the site. However, the applicant did not present the data specifically used to support this conclusion. Therefore, in RAI 42, Question 02.05.01-4, the staff requested that the applicant discuss the data used to conclude that the proposed fault of Pazzaglia (1993), if it exists, does not pose a hazard to the site since it projects into the site vicinity. The staff also requested that the applicant clarify whether the evaluation of the proposed fault of Pazzaglia (1993) took into account interpretations by other researchers who have postulated the existence of Quaternary faulting along the Fall Zone at other locations.

In a January 13, 2012, response to RAI 42, Question 02.05.01-4, the applicant reiterated that aerial reconnaissance and field examination of outcrops in the site vicinity did not reveal any evidence for the fault proposed by Pazzaglia (1993), reinforcing statements made by Pazzaglia

to the applicant during personal interviews that no physical evidence exists for faulting and original relief on depositional sedimentary surfaces of the Turkey Point beds was equally plausible as the cause of observed differences in elevation of the beds on opposite sides of the proposed fault. The applicant noted further that no information from any other studies conclusively demonstrated the existence of the fault proposed by Pazzaglia (1993). In addition, during the September 2011, site audit, the staff examined Pleistocene estuarine sediments comprising the Turkey Point Beds in the vicinity of the Turkey Point Lighthouse, located on the eastern side of Chesapeake Bay and west of the PSEG Site near the boundary of the site vicinity, and found no field evidence for Quaternary faulting.

Based on its review of SSAR Section 2.5.1.1.4.2.4.1 and the January 13, 2012, response to RAI 42, Question 02.05.01-4, field examination of stratigraphic units in September 2011 that did not exhibit any evidence of Quaternary faulting, and independent examination of literature cited by the applicant, the staff concludes that no definitive field evidence exists for the fault proposed by Pazzaglia (1993). The staff draws this conclusion because no field data support the existence of this fault, and original relief on depositional surfaces of strata is a highly plausible explanation for the observed differences in elevations of strata on opposite sides of the proposed fault. Accordingly, the staff considers RAI 42, Question 02.05.01-4 resolved.

River Bend Trend/Stafford Fault of Marple

SSAR Section 2.5.1.1.4.2.4.3 discusses the River Bend Trend/Stafford Fault of Marple (2004). The applicant stated that trend of the river bends, which Marple (2004) associated with faulting along the northeast-striking Stafford fault of proposed Tertiary age, likely represent migration of the rivers from old entrenched channels in erosion-resistant Piedmont rocks to lower-gradient meandering streams flowing across less erosion-resistant Coastal Plain sediments. In RAI 42, Question 02.05.01-5, the staff requested that the applicant describe the field locations examined to document the conclusion that no relationship exists between the River Bend Trend, which occurs in the site vicinity, and Quaternary faulting. The staff also requested that the applicant provide more complete references to support this conclusion.

In a December 28, 2011, response to RAI 42, Question 02.05.01-5, the applicant reported that aerial reconnaissance and examination of aerial photographs provided the primary means for assessing deformation of Quaternary sediments along the River Bend Trend, but that field reconnaissance of outcrops at Turkey Point just west of the River Bend Trend (and east of the fault proposed by Pazzaglia, 1993) revealed undeformed sedimentary units of the Pliocene (5.3 to 2.6 Ma) Pensauken Formation and overlying Pleistocene (2.6 Ma to 0.01 Ma) Turkey Point beds. The applicant also pointed out that Marple (2004) indicated Pleistocene age river terraces in the Salisbury embayment area showed no deformation along the River Bend Trend, indicating that deformation had ceased by Quaternary time. In addition, the applicant stated that the Preliminary Safety Analysis Report (PSAR, 1970) for the Newbold Island Nuclear Generating Station, located about 100 km (62 mi) northeast of the PSEG Site along the River Bend Trend, did not identify any faulting associated with that trend. As discussed above for the evaluation of RAI 42, Question 02.05.01-4, during the site audit conducted over September 29-30, 2011, the staff examined Pleistocene sediments comprising the Turkey Point beds in the vicinity of the Turkey Point Lighthouse and found no field evidence for Quaternary faulting.

Based on its review of SSAR Section 2.5.1.1.4.2.4.3 and the December 28, 2011, response to RAI 42, Question 02.05.01-5, field examination of stratigraphic units in September 2011 that did

not exhibit any evidence of Quaternary faulting, and independent examination of literature cited by the applicant, the staff concludes that no definitive field evidence exists for the River Bend Trend/Stafford fault of Marple (2004) in the site vicinity. The staff draws this conclusion because no field data support the existence of faulting along the River Bend Trend in the site vicinity. Accordingly, the staff considers RAI 42, Question 02.05.01-5 resolved.

National Zoo Faults

SSAR Section 2.5.1.1.4.2.4.4 describes the National Zoo faults in Washington, DC and states that these faults are probably Tertiary in age. In RAI 42, Question 02.05.01-6, the staff requested that the applicant provide references and field data to document the conclusion that the National Zoo faults are likely Tertiary, not Quaternary, in age. In a December 28, 2011, response to RAI 42, Question 02.05.01-6, the applicant cited Fleming et al. (1994) to document field relationships indicating that Pliocene sediments are the youngest units cut by these faults, qualifying them as pre-Quaternary structures.

Based on its review of SSAR Section 2.5.1.1.4.2.4.4 and the December 28, 2011, response to RAI 42, Question 02.05.01-6, and independent examination of literature cited by the applicant, the staff concludes that the National Zoo faults are pre-Quaternary in age. The staff draws this conclusion because existing field data indicate the youngest stratigraphic units cut by the faults are Pliocene (5.3 to 2.6 Ma). Accordingly, the staff considers RAI 42, Question 02.05.01-6 resolved.

Potential Quaternary Tectonic Features

Ramapo Fault

SSAR Section 2.5.1.1.4.2.5.11 discusses the Ramapo fault and references results of work by Sykes et al. (2008) that indicates the fault is Mesozoic in age and work by Ratcliffe (1982 and 1990) that demonstrates Quaternary units are not offset by the fault. However, the staff notes that Newman et al. (1987) proposed evidence for downfaulting and presented radiocarbon dates that may suggest post-Mesozoic movement on the fault. In RAI 42, Question 02.05.01-7, the staff requested that the applicant discuss information related to the premise that the Ramapo fault may have experienced post-Mesozoic activity.

In a January 13, 2012, response to RAI 42, Question 02.05.01-7, the applicant cited information from multiple investigators who indicated that considerable uncertainty exists for activity of the Ramapo fault based on analysis of seismicity and did not interpret the fault as active fault based on a lack of associated seismicity (e.g., Seborowski et al., 1982, Quittmeyer et al., 1985; Thurber and Caruso, 1985; Kafka and Miller, 1996). With regard to the work by Newman et al. (1987), the applicant reported that their radiocarbon dates from peat deposits have considerable uncertainty and their assessment actually predicts normal faulting, a sense of displacement that does not agree with the current state of stress, which would result in reverse faulting. The applicant reiterated that Sykes et al. (2008) found no evidence for seismicity associated with the Ramapo fault, and Ratcliffe (1982 and 1990) found definitive geologic field evidence demonstrating a lack of Quaternary deformation along the fault (i.e., Quaternary strata cross the fault without any offset).

Based on its review of SSAR Section 2.5.1.1.4.2.5.11 and the January 13, 2012, response to RAI 42, Question 02.05.01-7, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that the Ramapo fault is pre-Quaternary in

age. The staff draws this conclusion because there is a lack of seismicity associated with the fault and Quaternary strata cross the fault without offset. Accordingly, the staff considers RAI 42, Question 02.05.01-7 resolved.

Everona-Mountain Run Fault Zone

SSAR Section 2.5.1.1.4.2.5.4 discusses the Everona-Mountain Run fault zone, citing Manspeizer et al. (1989) who interpreted the Everona segment of the fault zone to offset Pleistocene (2.6 Ma to 0.01 Ma) stream gravels by about 1.5 m (5 ft) in a reverse motion sense. The applicant described field investigations conducted along the Mountain Run fault zone in support of the North Anna ESP application (Dominion, 2004), but did not address the Everona segment of the fault zone. Therefore, in RAI 42, Question 02.05.01-10, the staff requested that the applicant describe field investigations performed specifically to analyze the Everona segment of the Everona-Mountain Run fault zone, and explain the field data used to assess the Everona segment and conclude that the fault zone does not pose a geologic or seismic hazard to the site. The staff also requested that the applicant describe any evidence that supports or contradicts the interpretation of Manspeizer et al. (1989).

In a December 28, 2011, response to RAI 42, Question 02.05.01-10, the applicant explained that Manspeizer et al. (1989) did not provide enough details about the field observations used to interpret offset of Pleistocene gravels to distinguish their work from that of Pavlides et al. (1983), who indicated that the faulted unit was probably of late Tertiary, rather than Quaternary, age. The applicant noted later work by Pavlides (1994) reports that the Everona segment of the fault zone shows minor late Cenozoic reverse movement, and that Manspeizer et al. (1989) and Pavlides et al. (1983) remarked that this feature has no geomorphic expression. The applicant stated that uncertainty about the age of the faulted strata hinders a refined assessment of the timing of deformation along the Everona segment of the Everona-Mountain Run fault zone, and that age of last movement could be late Tertiary or younger (i.e., Quaternary). The applicant noted that studies conducted for the North Anna ESP application (Dominion, 2004) did not include a detailed assessment of the Everona segment of the fault zone, possibly because of its lack of geomorphic expression.

Based on review of SSAR Section 2.5.1.1.4.2.5.4 and the December 28, 2011, response to RAI 42, Question 02.05.01-10, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes definitive data do not exist for stating that the Everona segment of the Everona-Mountain Run fault zone is Quaternary in age. The staff makes this conclusion because the age of units disrupted by the Everona segment is somewhat uncertain, field evidence for the associated Mountain Run fault zone indicates the fault zone is pre-Quaternary in age (i.e., undeformed pre-Quaternary colluvial deposits bury the fault zone between the Rappahannock and Rapidan Rivers), and there is no geomorphic expression of the Everona segment. Accordingly, the staff considers RAI 42, Question 02.05.01-10 resolved.

New Castle County Faults

SSAR Section 2.5.1.1.4.2.5.5 discusses the inferred pre-Cretaceous New Castle County faults, stating that satellite imagery revealed no evidence of disrupted topography or Quaternary deformation along lineaments identified in the imagery or above any basement faults identified based on subsurface borehole and geophysical data. However, the applicant did not include those images in the SSAR. Therefore, in RAI 42, Question 02.05.01-11, the staff requested that the applicant provide images used to conclude that there is no evidence of surface deformation

along these faults, and explain the specific topographic features used to conclude that there is no Quaternary deformation along the New Castle County faults in the site region.

In a January 13, 2012, response to RAI 42, Question 02.05.01-11, the applicant provided the images used to support the statement that they revealed no evidence of disrupted topography or Quaternary deformation along lineaments identified in the imagery or above any basement faults, including the inferred buried basement features labeled by Spoljaric (1972 and 1973) as the New Castle County faults. The applicant noted that shorelines, stream drainage patterns, and topographic ridges cross lineaments mapped by Spoljaric (1979) in the site area, some of which he described as proposed faults, without deflection or any other geomorphic indication of Quaternary deformation. The applicant also reiterated that the New Castle County faults, inferred from subsurface borehole and geophysical data, are located in the Piedmont of Delaware and exhibit no field evidence for Quaternary deformation.

Based on its review of SSAR Section 2.5.1.1.4.2.5.5 and the January 13, 2012, response to RAI 42, Question 02.05.01-11, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that satellite imagery revealed no evidence of disrupted topography or Quaternary deformation along lineaments identified in the imagery or above any buried basement faults identified based on subsurface borehole and geophysical data, including the New Castle County faults. The staff makes this conclusion because it is strongly supported by existing data. Accordingly, the staff considers RAI 42, Question 02.05.01-11 resolved.

Dobb's Ferry Fault Zone

SSAR Section 2.5.1.1.4.2.5.13 discusses the Dobb's Ferry fault zone and states that the best estimate for timing of displacement along the fault zone (i.e., Paleozoic or younger) is based on the oldest rock deformed. However, the applicant did not describe the field relationships that may suggest an age for youngest displacement along the zone. Therefore, in RAI 42, Question 02.05.01-12, the staff requested that the applicant discuss information on observed field relationships for clarifying age of the youngest rock unit deformed by the fault zone to provide a minimum age for most recent displacement along the zone.

In a December 28, 2012, response to RAI 42, Question 02.05.01-12, the applicant reported that the Dobbs Ferry fault zone occurs in rock units that are Proterozoic to Precambrian and Cambrian-Ordovician in age, and no field relationships indicate Quaternary deformation along the trace of the fault zone. The applicant stated that features observed during site characterization investigations conducted for the PSEG ESP application did not reveal any evidence for Quaternary deformation along the fault zone, and noted that no new literature contains more recent information about timing of deformation along the zone.

Based on its review of SSAR Section 2.5.1.1.4.2.5.13 and the December 28, 2011, response to RAI 42, Question 02.05.01-12, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that the Dobb's Ferry fault zone does not reveal any definitive evidence for Quaternary deformation. The staff makes this conclusion in light of the fact that observable deformation related to the fault zone occurs only in Precambrian and Paleozoic age rock units and there is no field evidence for Quaternary displacement along the fault zone. Accordingly, the staff considers RAI 42, Question 02.05.01-12 resolved.

East Coast Fault System

SSAR Section 2.5.1.1.4.2.5.17 describes the postulated characteristics of the proposed northern segment of the East Coast Fault System (ECFS). The applicant reported that the only basis for the existence of the northern segment of the ECFS is a variety of anomalous river features, and that no coincidence with faulting has been demonstrated. Therefore, in RAI 42, Question 02.05.01-13, the staff requested that the applicant describe any observed field relationships used to conclude that the ECFS is not a zone of Quaternary faulting in the site region.

In a December 28, 2011, response to RAI 42, Question 02.05.01-13, the applicant indicated that published geologic mapping (Gilmer and Berquist, 2011; Mixon et al., 1989) within the site region where the proposed trace of the northern segment of the ECFS would extend does not show any evidence for fault-related deformation of Quaternary units.

Based on its review of SSAR Section 2.5.1.1.4.2.5.17 and the December 28, 2011, response to RAI 42, Question 02.05.01-13, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that the northern extent of the ECFS exhibits no evidence for Quaternary deformation due to faulting. The staff makes this conclusion because geologic mapping in the site region where the northern segment of the ECFS would extend does not reveal any field evidence for fault-related disruption of Quaternary units. Accordingly, the staff considers RAI 42, Question 02.05.01-13 resolved.

Based on its review of SSAR Section 2.5.1.1.4 and responses to RAI 42, Questions 02.05.01-4 through 02.05.01-7 and 02.05.01-10 through 02.05.01-13, as well as independent examination of literature cited by the applicant in the SSAR and the RAI responses, the staff finds that the applicant provided a thorough and accurate description of regional tectonic setting (including regional stress and principal tectonic structures ranging in age from Late Proterozoic to Cenozoic) in support of the PSEG ESP application.

2.5.1.4.1.3.2 Seismic Zones Defined by Regional Seismicity.

Proposed Peekskill Stamford Seismic Boundary

SSAR Section 2.5.1.1.5.2 discusses the proposed Peekskill-Stamford seismic boundary of Sykes et al. (2008), but states that they did not present any data to support the inference regarding the association of this proposed boundary with brittle faults farther south that may have formed to accommodate Mesozoic extension. Therefore, in RAI 42, Question 02.05.01-3, the staff requested that the applicant provide any additional information regarding faulting and potential seismic hazard related to this seismic boundary.

In a January 13, 2012, response to RAI 42, Question 02.05.01-3, the applicant stated that this proposed boundary, which extends between Peekskill, NY and Stamford, CT, is not a tectonic feature, but rather a boundary between a proposed aseismic region along the southern New York and Connecticut border and seismicity further to the south-southeast in the Newark Basin. The applicant indicated that the weak inference of an association with faulting does not stand when compared with investigations (as discussed in SSAR Sections 2.5.1.1.2, 2.5.1.1.4, 2.5.1.1.5, and 2.5.1.1.6) that have not identified any geologic structure associated with this boundary. The applicant reiterated that the seismic source model provided for the CEUS in NUREG-2115 need not be modified to represent potential seismic hazard at the PSEG Site due to the proposed Peekskill-Stamford seismic boundary.

Based on its review of SSAR Section 2.5.1.1.5.2 and the January 13, 2012, response to RAI 42, Question 02.05.01-3, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that no definitive data exist to equate the Peekskill-Stamford seismic boundary with faulting. The staff makes this conclusion because the preponderance of data does not reveal any faulting associated with this proposed boundary. Accordingly, the staff considers RAI 42, Question 02.05.01-3 resolved.

Based on its review of SSAR Section 2.5.1.1.5 and the response to RAI 42, Question 02.05.01-3 as well as independent examination of references cited by the applicant in the SSAR and the RAI response, the staff finds that the applicant provided a thorough and accurate description of seismic zones defined by regional seismicity (including the Ramapo seismic zone and the proposed Peekskill-Stamford seismic boundary) in support of the PSEG ESP application.

2.5.1.4.1.3.3 *Staff Conclusions Regarding Regional Tectonic Setting and Seismic Zones Defined by Regional Seismicity*

Based on its review of SSAR Sections 2.5.1.1.4, “Regional Tectonic Setting”; and 2.5.1.1.5, “Seismic Zones Defined by Regional Seismicity”; the applicant’s responses to RAIs 42, Questions 02.05.01-3 through 02.05.01-7 and 02.05.01-10 through 02.05.01-13, independent review of references cited in the SSAR and the RAI responses, and direct examination of outcrops of Early Pleistocene strata near the boundary of the site vicinity for field evidence of a fault postulated by Pazzaglia (1993) to extend into the Chesapeake Bay west of the PSEG Site, the staff concludes that the applicant provided thorough and accurate descriptions of regional tectonic setting and seismic zones defined by regional seismicity. The staff also concludes that the descriptions provided by the applicant in the SSAR and RAI responses reflect the current state of knowledge and meet the regulatory requirements defined in 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d).

2.5.1.4.1.3.4 *Regional Gravity and Magnetic Fields.*

Regional Gravity Field Data

SSAR Section 2.5.1.1.6.1 states that seismic reflection data show portions of the low gravity anomaly located east of the PSEG Site to be associated with sediments deposited in a Mesozoic extensional basin (Sheridan et al., 1991). SSAR Section 2.5.1.1.6.3 suggests Mesozoic basins other than the Buena Basin may occur east of the site, but the applicant reported that the existence of these other basins has not been proven. It is unclear to the staff whether the gravity low identified east of the site and described in SSAR Section 2.5.1.1.6.1 reflects an extension of the Buena Basin to the southwest, placing it nearer to but east of the PSEG Site, or another Mesozoic extensional basin. Therefore, in RAI 42, Question 02.05.01-14, the staff requested that the applicant clarify whether the Mesozoic basin identified in seismic reflection data reflects the Buena Basin or another Mesozoic extensional basin.

In a December 28, 2011, response to RAI 42, Question 02.05.01-14, based on information provided by Saltus and Blakely (2011), the applicant reported that the gravity data would be generally consistent with either extension of the Buena Basin into the site area or the presence of a separate basin containing low-density sedimentary fill. However, the applicant concluded that, due to uncertainties associated with characterizing Mesozoic basins using gravity data, no clear evidence exists for extending the Buena Basin into the area east of the site beyond the

limits currently reported in the literature. Based on its review of published data derived from combined magnetic and gravity studies, the applicant also concluded that no known Mesozoic basins other than those already discussed in the SSAR need be postulated to occur in the site vicinity.

Based on its review of SSAR Section 2.5.1.1.6.1 and the December 28, 2011, response to RAI 42, Question 02.05.01-14, independent examination of references cited by the applicant in the SSAR and the RAI response, and observations made during the September 2011 site field audit, the staff concludes that there is no definitive evidence to support extending the Buena Basin into the area east of the site. The staff makes this conclusion, although existing gravity data would be consistent with either extension of the Buena Basin east of the site into the site area or the presence of a separate basin containing low-density sedimentary fill, because of the inherent uncertainty in characterizing subsurface Mesozoic extensional basins using gravity data. In addition, no results from combined magnetic and gravity studies require an extension of the Buena Basin into the area east of the site. The staff also makes this conclusion because no field, borehole, or geophysical data indicate the presence of fault-bounded Mesozoic basins in the site area or at the site location. Accordingly, the staff considers RAI 42, Question 02.05.01-14 resolved.

Based on its review of SSAR Section 2.5.1.1.6 and the December 28, 2011, response to RAI 42, Question 02.05.01-14, as well as independent examination of references cited by the applicant in the SSAR and the RAI response, the staff finds that the applicant provided a thorough and accurate description of regional gravity and magnetic fields in support of the PSEG ESP application.

2.5.1.4.2 Site Geology

The staff focused the review of SSAR Section 2.5.1.2, “Site Geology,” on descriptions provided by the applicant for physiography and geomorphology, stratigraphy and lithology, geologic history, structural geology, and engineering geology of the PSEG Site vicinity and site area. The staff also focused the review on certain of these topics for the site location, including assessment of the effects of human activity.

2.5.1.4.2.1 Physiography and Geomorphology.

In SSAR Section 2.5.1.2.1, the applicant discussed physiography and geomorphology of the site area. The applicant stated that the PSEG Site location occurs on an artificial island on the eastern bank of the Delaware River.

The staff focused its review of SSAR Section 2.5.1.2.1 on the Outer Coastal Plain subprovince of the Coastal Plain physiographic province, within which the site almost completely lies, as well as the central portions of the site area occupied by the Delaware River channel, to ensure that the descriptions of physiography and geomorphology of the site area included any information related to evidence of possible Quaternary tectonic features. Based on its review of SSAR Section 2.5.1.2.1, as well as independent review of literature cited by the applicant in that section, the staff concludes that neither physiographic nor geomorphic characteristics of the site area reflect Quaternary tectonic features. The staff makes this conclusion because adequate data exist to support the interpretation that no physiographic or geomorphic characteristics of the site area indicate the presence of Quaternary tectonic features.

Based on its review of SSAR Section 2.5.1.2.1 and independent examination of references cited by the applicant in the SSAR, the staff finds that the applicant provided a thorough and accurate description of physiography and geomorphology of the site area in support of the PSEG ESP application.

2.5.1.4.2.2 Stratigraphy and Lithology.

In SSAR Section 2.5.1.2.2, the applicant discussed stratigraphy and lithologies of the site area and site location. The applicant described the stratigraphic column for the PSEG Site area and site location, including basement complex lithologies and Coastal Plain stratigraphic sequences.

The staff focused the review of SSAR Section 2.5.1.2.2 on the Coastal Plain stratigraphic sequences that lie above basement complex rock units in the site area and at the site location, including the Lower Tertiary Vincentown Formation, the planned foundation-bearing unit at the PSEG Site. This focus ensured that no features in the stratigraphic sequences which occur in the site area and at the site location suggested the presence of Quaternary tectonic structures. Based on its review of SSAR Section 2.5.1.2.2, as well as independent review of literature cited by the applicant in that section and direct examination of stratigraphic units in the field during the September 2011 site audit, the staff concludes that no geologic features in the stratigraphic sequences show any evidence for Quaternary tectonic deformation in the site area or at the site location. The staff makes this conclusion because adequate data exist to strongly support it.

Based on its review of SSAR Section 2.5.1.2.2 and independent examination of references cited by the applicant in the SSAR, the staff finds that the applicant provided a thorough and accurate description of stratigraphy and lithology (including basement complex lithologies and Coastal Plain stratigraphic sequences) for the site area and site location in support of the PSEG ESP application.

2.5.1.4.2.3 Geologic History.

In SSAR Section 2.5.1.2.3, the applicant discussed the geologic history of the site vicinity and site area. The applicant indicated that the crystalline basement complex, which underlies Coastal Plain sediments in the site vicinity and site area, formed during Precambrian and Paleozoic time, and that extension and rifting of the basement complex formed the present Atlantic Ocean basin during the Mesozoic. The applicant reported that deposition of Coastal Plain sedimentary sequences occurred from Early Cretaceous time into the Quaternary, and that Pleistocene (1.8 to 0.01 Ma) glacial-interglacial cycles resulted in deposition of fluvial sequences, development of estuarine terraces, and subsequent incision of the terraces and fluvial sequences.

The staff focused the review of SSAR Section 2.5.1.2.3 on geologic history in regard to tectonic deformation and other relevant geologic events in the site vicinity and site area to ensure that no tectonic or non-tectonic features developed that may detrimentally affect the site. Based on its review of SSAR Section 2.5.1.2.3, as well as independent review of literature cited by the applicant in that section and direct examination of geologic features in the field during the September 2011 site audit, the staff concludes that no evidence exists for potentially detrimental tectonic or non-tectonic features in the site vicinity and site area. The staff makes this conclusion because the independent literature review and direct field observations strongly support it.

Based on its review of SSAR Section 2.5.1.2.3 and independent examination of references cited by the applicant in the SSAR, the staff finds that the applicant provided a thorough and accurate description of geologic history of the site vicinity and site area in support of the PSEG ESP application.

2.5.1.4.2.4 Structural Geology.

In SSAR Section 2.5.1.2.4, the applicant discussed structural geology of the site vicinity, site area, and site location. The applicant stated that no fault-bounded Mesozoic extensional basins have been identified beneath the site location, although known or inferred buried Mesozoic basins occur beneath Coastal Plain sediments in Virginia, Maryland, Delaware, and New Jersey to include the site vicinity; that borehole data from the site location and from wells located between about 13 to 48 km (8 to 30 mi) from the site refute the existence of a Mesozoic basin in the site area; and that no tectonic faults or folds occur within the site area. In addition, as discussed in Section 2.5.1.4.1.3.4, "Regional Gravity and Magnetic Fields," of this report, in the December 28, 2011, response to RAI 42, Question 02.05.01-14, the applicant stated that due to uncertainties associated with characterizing Mesozoic basins using gravity data, no clear evidence exists for extending a basin (specifically the Buena Basin but also the Queen Anne Basin, for which the extension east of the PSEG Site is highly uncertain as discussed in Section 2.5.1.2.1.4.2 of this report) into the area east of the site beyond the limits currently reported in the literature. Figure 2.5.1-2 of this report shows the locations of fault-bounded Mesozoic extensional basins in the site region based on Benson (1992).

The staff focused the review of SSAR Section 2.5.1.2.4 on understanding the interpreted locations of buried, fault-bounded Mesozoic extensional basins to ensure that none occurred beneath the site location or in the site area. Based on its review of SSAR Section 2.5.1.2.4 as well as independent review of references cited by the applicant in that section, direct examination of geologic features in the field during the September 2011 site audit, and review of information provided by the applicant in the December 28, 2011, response to RAI 42, Question 02.05.01-14 (as discussed in Section 2.5.1.4.1.3.4 of this report), the staff concludes that no definitive evidence exists for the presence of buried fault-bounded Mesozoic basins in the site area or at the site location. The staff makes this conclusion because no field, borehole, or geophysical data indicate the presence of such basins in the site area or at the site location.

Based on its review of SSAR Section 2.5.1.2.4, independent examination of references cited by the applicant in the SSAR, direct examination of geologic features in the field during the September 2011 site audit, and review of information provided by the applicant in the December 28, 2011, response to RAI 42, Question 02.05.01-14 as discussed above in Section 2.5.1.4.1.3.4 of this report, the staff finds that the applicant provided a thorough and accurate description of the structural geology of the site vicinity, site area, and site location in support of the PSEG ESP application.

2.5.1.4.2.5 Site Engineering Geology Evaluation.

In SSAR Section 2.5.1.2.5, the applicant discussed engineering geology of the site vicinity, site area, and site location. The applicant addressed dynamic behavior during earthquakes; zones of mineralization, alteration, weathering, and structural weakness; unrelieved residual stresses in bedrock; groundwater conditions, and effects of human activity.

The staff focused the review of SSAR Section 2.5.1.2.5 on the applicant's discussions of dynamic behavior during earthquakes (SSAR Section 2.5.1.2.5.1) and zones of mineralization,

alteration, weathering, and structural weakness (SSAR Section 2.5.1.2.5.2). In SSAR Section 2.5.1.2.5.1, the applicant stated that no field investigations (e.g., regional studies in NUREG/CR-5613), examination of aerial photography, inspection from low-altitude overview flights, or excavation mapping at the existing Hope Creek unit revealed the presence of earthquake-induced liquefaction features. SSAR Section 2.5.1.2.5.1 also states that SSAR Section 2.5.4.7.3, “Effects of Prior Earthquakes on Site,” indicates there is little exposure for evaluating the presence of liquefaction features. The applicant did not discuss susceptibility of materials surrounding the PSEG Site to earthquake-induced liquefaction, or what, if any, field studies conducted for the site analyzed the presence or absence of liquefaction features. Therefore, in RAI 42, Question 02.05.01-17, the staff requested that the applicant describe materials around the site that may be susceptible to earthquake-induced liquefaction and to discuss any field investigations conducted for the site for assessing the presence of liquefaction features in the site region, site vicinity, and site area and at the site location.

In a December 28, 2011, response to RAI 42, Question 02.05.01-17, the applicant stated that surficial soils east and south of the plant location consist of artificial fill and that salt marsh deposits (i.e., clays, silts, and sands with varying amounts of clay and silt) occur to the northeast. The applicant noted that the fill, emplacement of which started in the early 1900s, has not experienced historical earthquakes large enough to liquefy the fill materials. The applicant indicated that constant reworking of the salt marsh deposits, which are also relatively young, obscures surficial evidence of liquefaction. The applicant explained that examination of marsh deposits and fill in the site area and at the site location did not reveal any evidence for earthquake-induced liquefaction. In addition, based on aerial and ground reconnaissance in the low topographic relief site area and site vicinity and review of published literature, the applicant reported that no liquefaction features occurred. The applicant did not conduct specific field investigations for assessing the presence or absence of liquefaction beyond the site vicinity.

Based on its review of SSAR Section 2.5.1.2.5 and the December 28, 2011, response to RAI 42, Question 02.05.01-17, as well as independent examination of the reference cited by the applicant in the SSAR (i.e., NUREG/CR-5613) and field observations made during the September 2011 site audit, the staff concludes that no field evidence exists for liquefaction features in the site region, site vicinity, and site area or at the site location. The staff makes this conclusion because the field evidence derived from multiple sources strongly supports it. Accordingly, the staff considers RAI 42, Question 02.05.01-17 resolved.

In SSAR Section 2.5.1.2.5.2, the applicant stated that karst terrain associated with dissolution of marble in the Cockeysville Formation occurs about 32 km (20 mi) northwest of the site in the Delaware Piedmont (i.e., within the site vicinity). SSAR Section 2.5.1.2.5.2 further states that karst is not a hazard for the PSEG Site area or site location, but the applicant did not address whether the Cockeysville Formation underlies the site at depth, which could result in zones of subsurface dissolution. Therefore, in RAI 42, Question 02.05.01-18, the staff requested that the applicant clarify whether or not the Cockeysville Formation, which is greater than 444 Ma in age, underlies the site at depth.

In a December 28, 2011, response to RAI 42, Question 02.05.01-18, the applicant stated that data defining the rock units associated with the lithotectonic terranes beneath the PSEG Site (i.e., the Carolina Superterrane or the Philadelphia Terrane, as discussed in SSAR Section 2.5.1.2.2 and summarized in Section 2.5.1.2.2.2.1 of this report) indicate the Cockeysville Formation does not underlie the site location.

Based on its review of SSAR Section 2.5.1.2.5 and the December 28, 2011, response to RAI 42, Question 02.05.01-18, as well as independent examination of references cited by the applicant in the SSAR and the RAI response, the staff concludes that the Cockeysville Formation does not underlie the PSEG Site location. The staff makes this conclusion because data related to which rock units comprise lithotectonic terranes beneath the site location indicate that the formation does not underlie the site location at depth. Accordingly, the staff considers RAI 42, Question 02.05.01-18 resolved.

Based on its review of SSAR Sections 2.5.1.2.5 and the December 28, 2011, responses to RAI 42, Question 02.05.01-17 and Question 02.05.01-18, as well as independent review of literature cited by the applicant in the SSAR and the RAI responses, the staff finds that the applicant provided a thorough and accurate description of engineering geology of the site vicinity, site area, and site location in support of the PSEG ESP application.

2.5.1.5 Permit Conditions

There are no Permit Conditions related to SSAR Section 2.5.1. However, in Section 2.5.3.5, "Geologic Mapping Permit Condition," of this report, the staff identified Permit Condition 3 related to detailed geologic mapping of safety-related excavations at the PSEG Site as the responsibility of the COL or CP applicant.

2.5.1.6 Conclusion

As documented in Sections 2.5.1.1 through 2.5.1.4 of this report, the staff reviewed and evaluated the basic geologic and seismic information submitted by the applicant in SSAR Section 2.5.1. This review and evaluation made it possible for the staff to confirm that this information provides an adequate basis for concluding that no tectonic or nontectonic features occur in the site region, site vicinity, and site area or at the site location with the potential for adversely affecting suitability and safety of the PSEG Site.

The staff also concludes that the applicant identified and appropriately characterized all seismic sources significant for determining the SSE for the PSEG Site, in accordance with regulatory requirements stated in 10 CFR 100.23(c) and 10 CFR 100.23(d) and guidance provided in RG 1.208 and NUREG-0800, Section 2.5.1. In addition, based on results of the investigations presented in SSAR Section 2.5.1, the staff concludes that the applicant properly characterized geology of the site region (including physiography and geomorphology, geologic history, stratigraphy, tectonic setting and principal tectonic structures, seismic zones defined by regional seismicity, and gravity and magnetic fields) and geology of the site vicinity, site area and site location (including physiography and geomorphology, stratigraphy and lithology, geologic history, structural geology, and engineering geology).

The staff further concludes that the applicant appropriately assessed the potential for possibly detrimental effects of human activity within the site area, including surface and subsurface mining, oil and gas extraction or injection, and groundwater injection or withdrawal that could compromise the safety of the site. Since the applicant documented a lack of any of these activities in the site area based on published information, the staff concludes that no potential exists for detrimental effects at the site location as a result of human activity.

Finally, based on results of the review and evaluation of SSAR Section 2.5.1, the staff concludes that the applicant provided a thorough and accurate description of the basic geologic and seismic characteristics of the proposed PSEG Site (including the site region, site vicinity,

site area, and site location) in full compliance with regulatory requirements in 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d) and in accordance with guidance in RG 1.208.

2.5.2 Vibratory Ground Motion

2.5.2.1 Introduction

The vibratory ground motion is evaluated based on seismological, geological, geophysical, and geotechnical investigations carried out to determine the site-specific ground motion response spectrum, which must meet the regulations for the safe shutdown earthquake provided in 10 CFR 100.23. The GMRS is defined as the free-field horizontal and vertical ground motion response spectra at the plant site. The development of the GMRS is based upon a detailed evaluation of earthquake potential, taking into account the regional and local geology, Quaternary tectonics, seismicity, and site-specific geotechnical engineering characteristics of the site subsurface material. The specific investigations necessary to determine the GMRS include the seismicity of the site region and the correlation of earthquake activity with seismic sources. Seismic sources are identified and characterized, including the rates of occurrence of earthquakes associated with each seismic source. Seismic sources that have any part within 320 km (200 mi) of the site must be identified. More distant sources that have a potential for earthquakes large enough to affect the site must also be identified. Seismic sources can be capable tectonic sources or seismogenic sources. The staff’s review covers the following specific areas: (1) Seismicity; (2) geologic and tectonic characteristics of the site and region; (3) correlation of earthquake activity with seismic sources; (4) probabilistic seismic hazard analysis and controlling earthquakes; (5) seismic wave transmission characteristics of the site; (6) site-specific ground motion response spectrum; and (7) any additional information requirements prescribed within the “Contents of Application” sections of the applicable 10 CFR Part 52 Subparts.

2.5.2.2 Summary of Application

SSAR Section 2.5.2 describes the potential vibratory ground motion at the PSEG Site. To estimate the vibratory ground motion at the site, the applicant chose to use the NUREG-2115, “Central and Eastern United States Seismic Source Characterization for Nuclear Facilities,” seismic source model and EPRI 2004 and 2006 Ground Motion Prediction Equations (GMPE) in its PSHA analysis. The applicant stated that it developed the GMRS based on the performance-based approach recommended by RG 1.208. In the SSAR, the applicant presented the following information related to the vibratory ground motion at the PSEG Site.

2.5.2.2.1 Seismicity

SSAR Section 2.5.2.1 states that the applicant used the most recent earthquake catalog published as part of NUREG-2115 in its seismic hazard assessment at the PSEG Site. The NUREG-2115 earthquake catalog covers earthquakes in the CEUS region from 1568 through 2008. Since the NUREG-2115 earthquake catalog covers only through 2008, the applicant developed a separate earthquake catalog covering from 2009 until the end of 2011. After declustering this new earthquake catalog to eliminate dependent earthquakes, the applicant merged the two catalogs and used the updated catalog in its seismic hazard evaluation at the PSEG Site. The updated catalog identified 19 additional earthquakes in the 320 km (200 mi) site region. The applicant indicated that among the earthquakes listed in the 2009-2011 earthquake catalog, the Mineral, VA, earthquake with a moment magnitude of **M**5.8

that occurred on August 23, 2011, was the most significant earthquake. Beyond the Mineral, VA earthquake of 2011, the applicant identified eight other moderate-sized earthquakes within the 320 km (200 mi) site region. The magnitudes of these moderate-sized earthquakes range from 4.5 to 5.1. The applicant also noted that all of the new earthquakes identified in the region had magnitudes lower than the seismic sources' assigned maximum magnitudes and that the updated earthquake catalog did not impact for the NUREG-2115 seismic source model parameters. Figure 2.5.2-1 of this report shows the seismicity of the PSEG Site region and its surroundings.

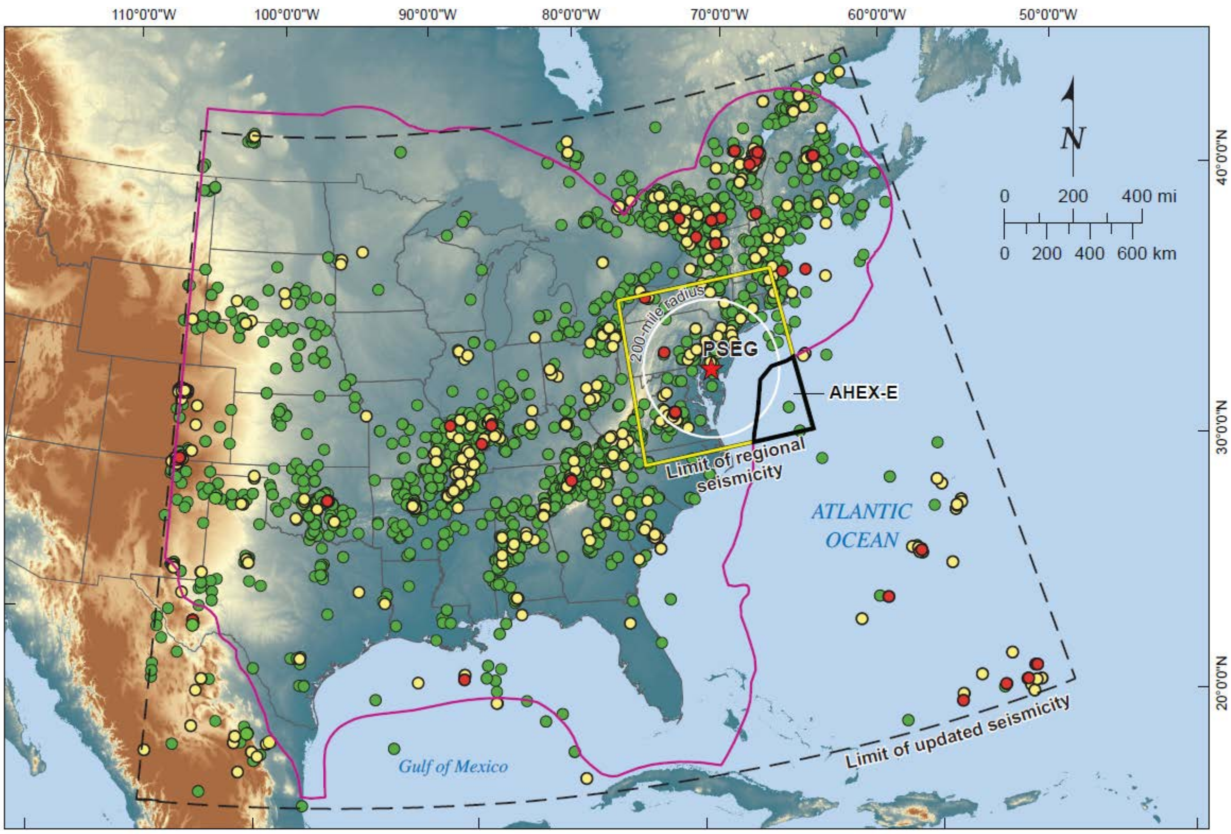


Figure 2.5.2-1 Map showing the earthquake activity in the CEUS region and the PSEG Site. The yellow box around the PSEG Site represents the area in which the applicant updated the original NUREG-2115 earthquake catalog to extend the temporal coverage from 2009 through 2011. Green, yellow, and red circles represent earthquakes with magnitudes less than 4, 4 to 5, and greater than 5, respectively. (Ref. SSAR Revision 3, Figure 2.5.2-57)

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 seismic model parameters that the applicant used to calculate the seismic ground motion hazard at the PSEG Site. The applicant used the NUREG-2115 regional seismic source characterization model developed for the CEUS region as a starting point for its seismic ground motion hazard. The NUREG-2115 seismic source model is a model published in January 2012. The model development followed the Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 procedures as outlined in NUREG/CR-6372, "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on

Uncertainty and Use of Experts." The NUREG-2115 states that this is a regional seismic source model to be used as a starting model in seismic hazard calculations for nuclear facilities in the CEUS region. The applicant stated that it conducted a review of the CEUS-SSC model to identify whether there is a need to update any of the seismic sources. Based on its review results, the applicant stated that the regional model, as published, is adequate for use in seismic hazard calculations for the PSEG Site. The following describes a summary of the CEUS-SSC model.

Summary of the NUREG-2115 Seismic Source Model

The ESP applicant stated that the CEUS-SSC model described in NUREG-2115 contains two types of seismic sources: (1) Distributed seismicity sources; and (2) repeated large magnitude earthquake sources (RLME). While the distributed seismicity sources were developed based on available earthquake locations and regional geologic/tectonic characterizations, the RLME sources were based on geologic and paleo-earthquake records. The RLME sources represent the zones of repeated (two or more) large magnitude earthquakes (**M**>6.5) in the CEUS region.

The CEUS-SSC model categorizes the distributed seismicity sources into two subgroups: M_{max} zones and seismotectonic zones. These subgroups represent uncertainties in source characterizations and differences of opinions in seismic source identification in this region. In hazard estimates, the M_{max} and seismotectonics sources are weighted by 40 percent and 60 percent, respectively, to determine their contributions to the total seismic hazard at the site. The M_{max} zones are broad seismic sources identified based on limited tectonic information and represent potential seismic sources of future earthquakes. The seismotectonic sources are those developed by extensive analyses of regional geology, tectonics, and seismicity in the CEUS region. Both the M_{max} and the seismotectonics zones also include alternative source geometries, accommodating inherent uncertainty in seismic source characterization. The RLME sources are superimposed on the distributed seismicity sources.

2.5.2.2.3 Correlation of Earthquake Activity with Seismic Sources

SSAR Section 2.5.2.3 describes the applicant's correlation of updated seismicity with the NUREG-2115 seismic source model. The applicant provided the following conclusions regarding the correlation of earthquake activity with the seismic sources.

- The updated seismicity catalog does not contain any earthquakes within the site region that can be positively associated with a known geologic structure.

- The updated seismicity catalog does not show a pattern of seismicity different from that of the CEUS-SSC catalog that would suggest a new seismic source in addition to those included in the CEUS-SSC characterizations. For the PSEG ESP application, a new seismic source zone (AHEX-E) is created, as this small area in and adjacent to the PSEG Site Region is not included in the original CEUS-SSC catalog.

- The updated seismicity catalog does show a similar spatial distribution of earthquakes to that of the CEUS-SSC catalog, suggesting that no significant revisions to the geometry of seismic sources defined in the CEUS-SSC characterization is required.

- The updated seismicity catalog does not contain any earthquakes that suggest revisions to the M_{max} distributions for CEUS-SSC zones is required.

- Seismicity rates determined from the updated catalog are not significantly different than those determined from the original CEUS-SSC catalog.

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 PSEG Site. In performing this analysis, the applicant followed the guidance provided in RG 1.208 to determine the seismic hazard curves and controlling earthquakes for the PSEG Site. The applicant based its analyses on the NUREG-2115 seismic source model and the EPRI (2004, 2006) ground motion prediction equations. The PSHA curves generated by the applicant represent generic hard rock conditions characterized by a shear wave velocity (V_S) in excess of 2.8 kilometers per second (km/s) (9,200 feet per second (fps)). The applicant also described the earthquake potential for the site in terms of a Uniform Hazard Response Spectra (UHRS) and the controlling earthquakes, the most likely earthquake magnitudes and source-site distances. The applicant determined the low- and high-frequency controlling earthquakes by deaggregating the PSHA curves at selected probability levels. The summary of the applicant's PSHA study is described below.

2.5.2.2.4.1 PSHA Inputs.

To conduct the PSHA and obtain the UHRS at the site, it is necessary to study the site location and its surrounding regions to determine geological and seismological properties, as outlined in RG 1.208. This requires determinations of active seismic source zones in the area, the seismic sources' model parameters, and appropriate GMPE for the region. The following subsections summarize the applicant's efforts in these areas.

2.5.2.2.4.1.1 *Seismic Source Models and Parameters*.

The input model for the PSEG PSHA study is primarily the NUREG-2115 seismic source model. Since the NUREG-2115 model does not cover the PSEG Site region fully (a radius of 320 km (200 mi)), the applicant developed a small regional seismic source to be added onto the NUREG-2115 model to cover the site area fully. The applicant named this new source 'Atlantic Highly Extended crust (AHEX-E)' and developed earthquake recurrence rates within this source using the same process utilized in the NUREG-2115 model. The applicant's AHEX-E source is shown as the black polygon in Figure 2.5.2-1 of this report.

SSAR Section 2.5.2.2.1 describes how the applicant updated its seismicity catalog to create a comprehensive list of earthquakes for the PSEG Site to assess the overall seismicity in the region and also to assess the validity of the earthquake recurrence rates described in NUREG-2115. The applicant found no significant changes in the seismicity rates that would necessitate changes to the seismicity rates published in NUREG-2115.

2.5.2.2.4.1.2 *Ground Motion Models*.

In SSAR Section 2.5.2.4.3, the applicant stated that it used the CEUS ground motion prediction model developed by EPRI in 2004 for its PSHA calculations, with the updates published by EPRI in 2006. These models were reviewed by the staff as part of the prior ESP and COL applications' reviews and the staff concluded that they adequately represent the expected ground motions in the CEUS region.

2.5.2.2.4.2 PSHA Methodology and Calculation.

Using the updated NUREG-2115 seismic source characteristics and the EPRI 2004 ground motion models with updated uncertainties as inputs (EPRI 2006), the applicant performed PSHA calculations for peak ground acceleration (PGA) and spectral acceleration at ground motion frequencies of 0.5, 1.0, 2.5, 5, 10, and 25Hz. The applicant performed PSHA calculations for the PSEG Site assuming generic hard rock conditions at the site with V_S of 2.8 km/s (9,200 fps). The applicant first calculated mean and fractile rock seismic hazard curves at particular spectral frequencies (0.5, 1.0, 2.5, 5, 10, 25, and PGA (100 Hz)) and annual frequencies of exceedance (10^{4}, 10^{-5}, and 10^{-6}). Then, the applicant deaggregated the results as described in RG 1.208 to calculate the controlling earthquakes for low-frequency (LF) and high-frequency (HF) ground motions. Finally, the applicant used the PSEG controlling earthquakes, and hard rock spectral shapes for CEUS earthquake ground motions recommended in NUREG/CR-6728 to calculate the final PSEG generic hard rock UHRS.

2.5.2.2.4.3 PSHA Results.

In SSAR Section 2.5.2.4.4, the applicant stated that local earthquakes are the major contributor to seismic hazard at the PSEG Site for both high frequencies (5 and 10 Hz) and low frequencies (1 and 2.5 Hz). However, there is some contribution from the large seismic sources outside the site region, such as the New Madrid seismic zone. The applicant identified that hazard contributions of the other large seismic sources in the CEUS regions, such as the Charleston and the Charlevoix seismic sources, to the total hazard is minimal.

The applicant also calculated the controlling earthquakes' distances and magnitudes for the high-and low-frequency earthquakes using the generic rock hazard curves. Table 2.5.2-1 of this report shows the results of the applicant's calculations.

Table 2.5.2-1 Controlling earthquakes for the PSEG Site (Ref. SSAR Revision 3, Table 2.5.2-34)

Structural Frequency	Annual Frequency of Exceedence	All R		R < 100 km		R > 100 km	
		M	R, km	M	R, km	M	R, km
5 & 10 Hz	1E-04	5.9	27	5.8	22	6.7	180
1 & 2.5 Hz	1E-04	6.6	68	6.2	21	7.3	540
5 & 10 Hz	1E-05	6.0	12	6.0	12	7.1	140
1 & 2.5 Hz	1E-05	6.6	27	6.4	16	7.6	570
5 & 10 Hz	1E-06	6.3	9	6.3	9	7.5	130
1 & 2.5 Hz	1E-06	6.7	13	6.7	12	7.7	420

a) Light-gray cells indicate high frequency controlling earthquakes and dark-gray cells indicate low frequency controlling earthquakes.

Following the calculations of the controlling earthquake distances and magnitudes, the applicant determined the smoothed UHRS at the generic rock level (Figure 2.5.2-2 of this report).

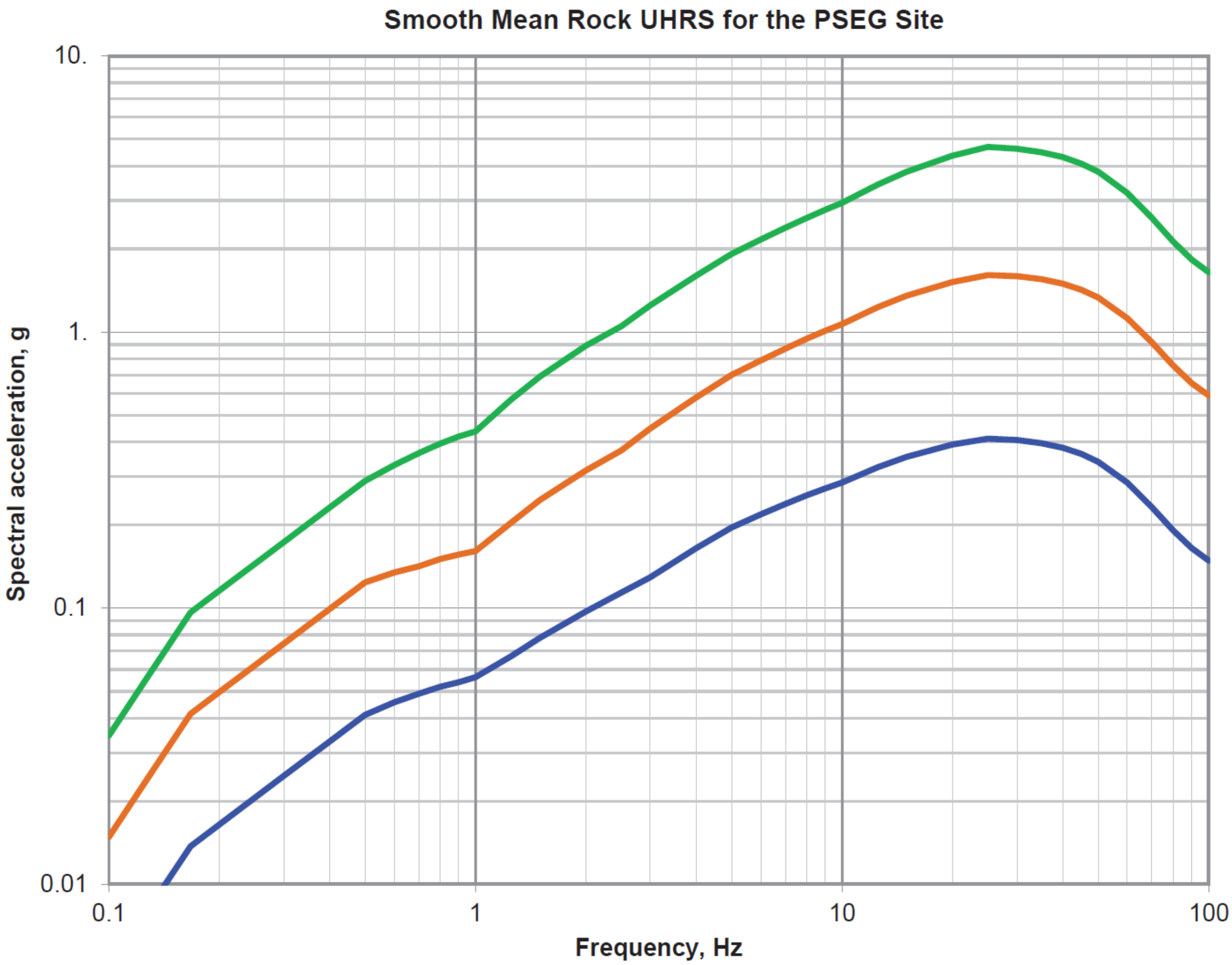


Figure 2.5.2-2 Smooth uniform hazard response spectra for the generic rock conditions at the PSEG Site. PSHA results calculated using the NUREG-2115 seismic source model and the EPRI (2004 and 2006) ground motion prediction models at the seven defined frequencies were used in calculating these UHRA curves for 10^{-4}, 10^{-5}, and 10^{-6} annual exceedance levels (blue, red, and green, respectively. These curves were then smoothed to obtain the spectra shown above (Ref. SSAR Revision 3, Figure 2.5.2-76).

2.5.2.2.5 Seismic Wave Transmission Characteristics of the Site

SSAR Section 2.5.2.5 describes the applicant's development of a site-specific seismic velocity model to address seismic wave transmission characteristics at the PSEG Site. The EPRI (2004) ground motion prediction models are representative of vibratory ground motion at hard rock sites, which are characterized as sites with seismic shear wave velocities of about 2.8 km/s (9,200 fps). For the PSEG Site, these hard rock conditions exist at a depth of approximately 550 m (1,800 ft) beneath the ground surface; while rock of lower velocities exists in the upper 550 m (1,800 ft). The applicant conducted a site response analysis to determine the impacts of the lower velocity rocks on the calculated seismic hazard values. The applicant first developed a site response model and then used the random vibration theory (RVT) methodology to calculate the site amplification functions to transfer the generic hard rock hazard

curves to the GMRS elevation. The following sections summarize the applicant's site response calculation procedures.

2.5.2.2.5.1 Site Response Model.

The applicant developed a site-specific mean V_S profile for the upper 550 m (1800 ft) of the PSEG Site. Below this depth, the applicant determined that rocks with shear wave velocities of at least 2,800 m/s (9,200 ft/s) exist. The mean V_S profile is based on the results of four compression (P) and shear (S) wave P-S suspension logging surveys ranging to a depth of approximately 91 to 192 m (300 to 630 ft), two crosshole velocity testing boreholes extending to a depth of approximately 61 m (200 ft), one down-hole seismic velocity measurement to a depth of approximately 61 m (200 ft), and one deep production well extending to the top of basement (at approximately 550 m (1800 ft)) located approximately 1 km (0.6 mi) from the center of the PSEG Site. The applicant divided its site-specific V_S profile into a shallow profile from the surface to approximately 122 m (400 ft) and a deep profile from 122 m (400 ft) to basement. The shallow profile represents the depth to which extensive characterization was performed. As provided In SSAR Section 2.5.4.5, the applicant determined that the top of the competent layer has a mean depth of 20 m (67 ft), so following RG 1.208, the applicant only used the soil properties above this depth for the purposes of confining stress. The applicant will excavate to the competent layer elevation during construction. Figure 2.5.2-3 of this report shows the applicant's site-specific mean V_S profile and 60 alternative (randomized) profiles used in the site response calculations to be consistent with RG 1.208.

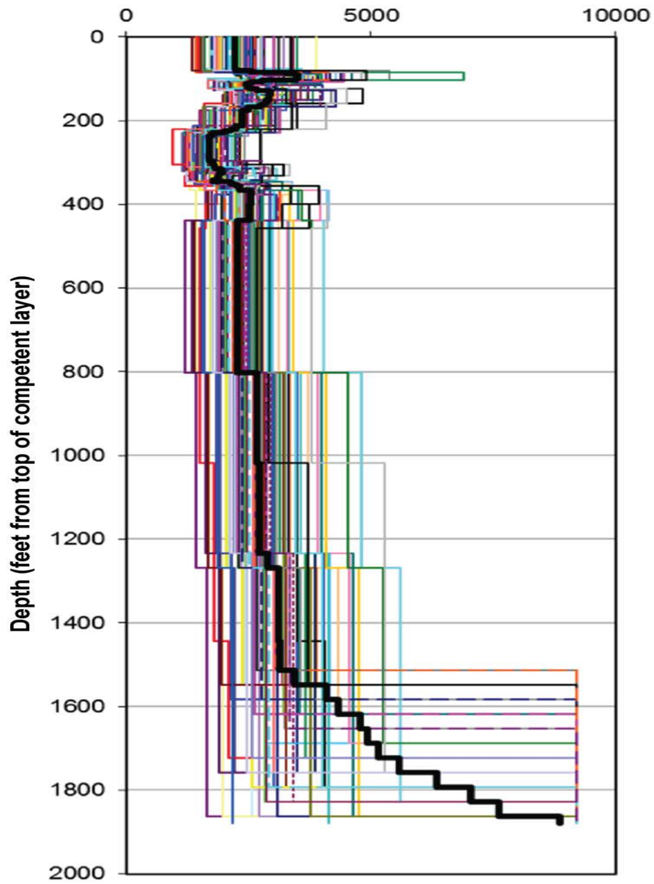


Figure 2.5.2-3 The log mean (black) and 60 randomized shear wave velocity (ft/s) profiles used in the site response calculations for the PSEG ESP Site (Ref. SSAR Revision 3, Figure 2.5.2-34)

2.5.2.2.5.2 Site Response Methodology and Results.

Consistent with RG 1.208, the applicant first generated 60 randomized site model profiles and associated shear moduli and damping parameters that represent possible departures from the base seismic model. Then the applicant calculated site response amplification functions for each randomized profile using the RVT methodology and used the rock UHRS at 10^{-4}, 10^{-5}, and 10^{-6} annual exceedance frequencies as the input ground motions in these analyses. The use of RVT in site response calculations is mentioned in RG 1.208 as a possible methodology that can be used. Similar to the time series methodology, RVT analysis produces an amplification function that is then applied to the rock spectra to obtain the response spectra defined at the ground surface (or at any intermediate point within the soil profile), which accounts for the effects of soil amplification (or deamplification) on the input base hard rock ground motion.

The applicant's site response calculations resulted in six median amplification functions for LF and HF input ground motions defined at the 10^{-4}, 10^{-5}, and 10^{-6} annual exceedance frequencies. Figure 2.5.2-4 of this report shows the amplification functions for low-frequency ground motions.

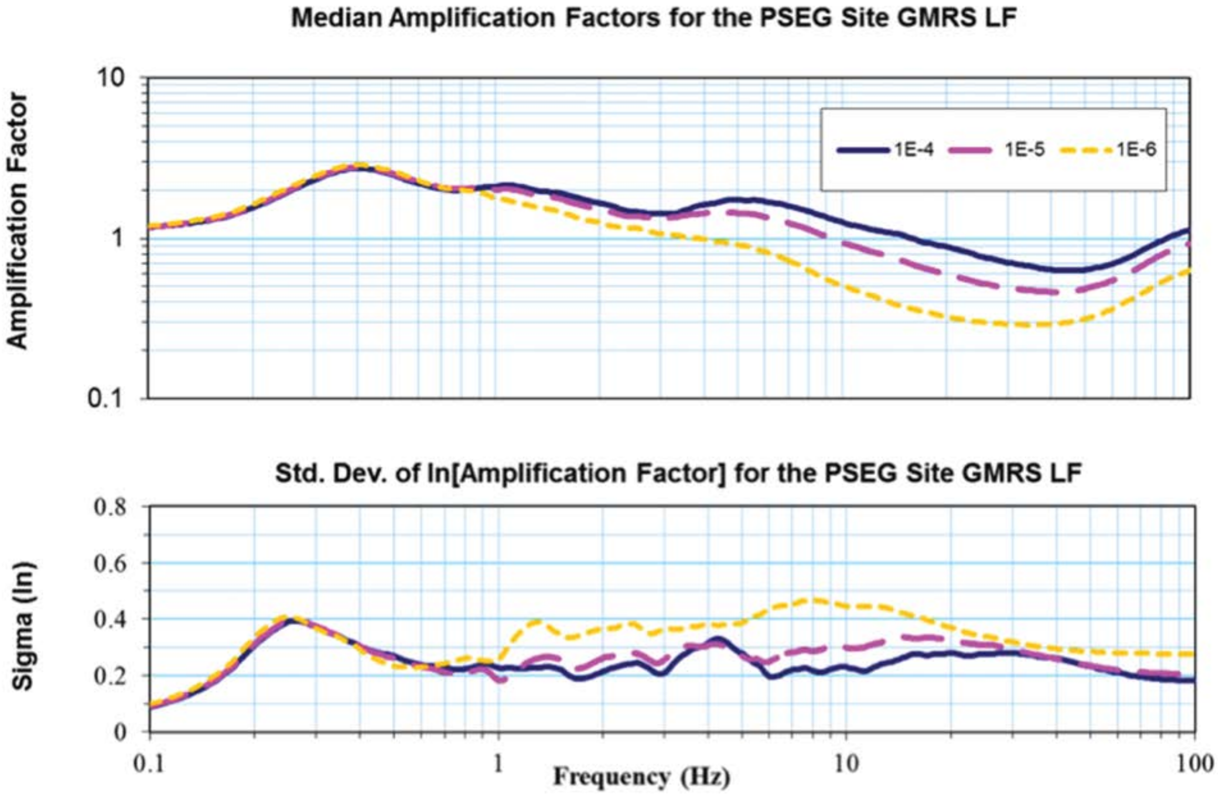


Figure 2.5.2-4 LF site median amplification functions for 10-4 (blue), 10-5 (dashed purple), and 10-6 (dashed yellow) annual exceedance frequencies (top) and the standard deviations for the same annual exceedance frequencies (below) (Ref. SSAR Revision 3, Figure 2.5.2-43)

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 GMRS. The applicant first developed the horizontal GMRS and then obtained the vertical GMRS using vertical-to-horizontal (V/H) ratios. The applicant stated that it did not use the Cumulative Absolute Velocity (CAV) model in its final hazard calculation.

2.5.2.2.6.1 Horizontal GMRS.

The applicant calculated a horizontal, site-specific, performance-based GMRS using the method described in RG 1.208. The performance-based method achieves the annual target performance goal (P_F) 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 GMRS is calculated using the following relationship.

$$GMRS = UHRS * DF$$

where

$$UHRS = \text{Mean } 10^{-4} \text{ UHRS}$$
$$DF = \max \{1.0, 0.6 (A_R)^{0.8}\}$$
$$A_R = \text{1E-05 UHRS / 1E-04 UHRS}$$

RG 1.208 also states, if A_R, as defined above, is greater than 4.2, then this relationship is no longer valid. In this case, RG 1.208 recommends setting the GMRS to 45 percent of the 10^{-5} site-specific surface UHRS curve. Figure 2.5.2-5 of this report shows the horizontal GMRS curve calculated for the PSEG Site.

2.5.2.2.6.2 Vertical GMRS.

In SSAR Section 2.5.2.6.1.2, the applicant calculated the vertical GMRS by deriving frequency-dependent V/H spectral ratios and applying them to the horizontal GMRS. The applicant used three alternative methodologies to estimate V/H ratios. First, the applicant used the V/H ratio function defined in NUREG/CR-6728 for PGA values between 0.2g and 0.5g for the PSEG Site. Then, the applicant obtained two other V/H ratios estimated from empirical studies. The applicant determined a V/H ratio function by enveloping all three alternative V/H ratio values. The PSEG vertical GMRS was then computed by multiplying the horizontal GMRS by the V/H ratio function. The resulting vertical GMRS is shown in Figure 2.5.2-5 of this report.

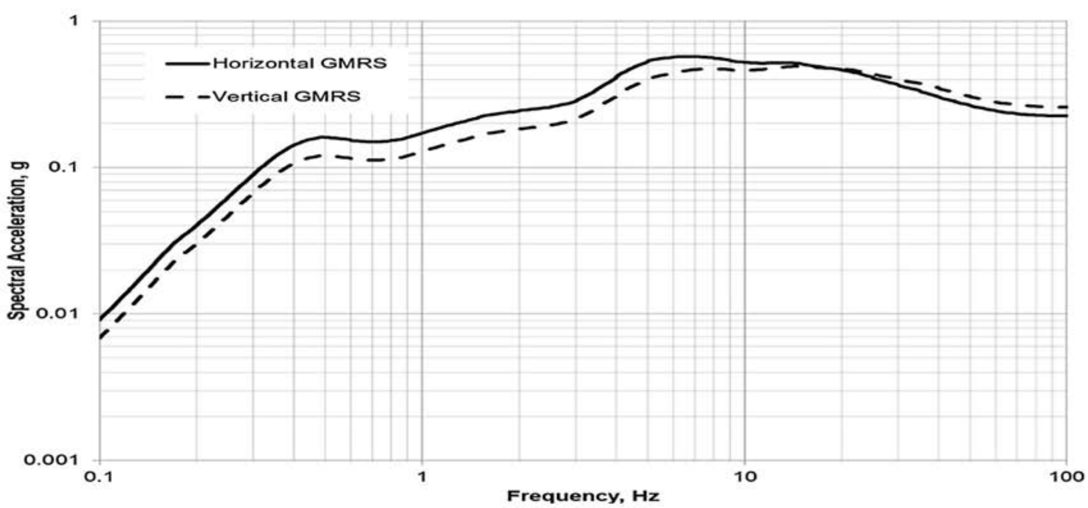


Figure 2.5.2-5 Horizontal (solid line) and vertical (dashed line) GMRS (Ref. SSAR Revision 3, Figure 2.5.2-54)

2.5.2.3 Regulatory Basis

The applicable regulatory requirements for reviewing the applicant's discussion of vibratory ground motion are as follows:

- 10 CFR 100.23, as it relates to obtaining geologic and seismic information necessary to determine site suitability and ascertain that any new information derived from site-specific investigations does not impact the GMRS derived by a probabilistic seismic hazard analysis.

- 10 CFR 52.17(a)(1)(vi), as it relates to consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity and period of time in which the historical data have been accumulated.

In addition, the related acceptance criteria from NUREG-0800, Section 2.5.2 are summarized as follows:

- Seismicity: To meet the requirements in 10 CFR 100.23, this section is accepted when the complete historical record of earthquakes in the region is listed and when all available parameters are given for each earthquake in the historical record.

- Geologic and Tectonic Characteristics of Site and Region: Seismic sources are identified and characterized.

- Correlation of Earthquake Activity with Seismic Sources: To meet the requirements in 10 CFR 100.23, acceptance of this section is based on the development of the relationship between the history of earthquake activity and seismic sources of a region.

- Probabilistic Seismic Hazard Analysis and Controlling Earthquakes: For CEUS sites relying on NUREG-2115 methods and data bases, the staff will review the applicant's PSHA, including the underlying assumptions and how the results of the site investigations are used to update the existing sources in the PSHA, how they are used to develop additional sources, or how they are used to develop a new data base.

- Seismic Wave Transmission Characteristics of the Site: In the PSHA procedure described in RG 1.208, the controlling earthquakes are determined for generic rock conditions.

- Ground Motion Response Spectra: In this section, the staff reviews the applicant's procedure to determine the GMRS. In addition, the geologic and seismic characteristics should be consistent with appropriate sections from: RG 1.60, “Design Response Spectra for Seismic Design of Nuclear Power Plants”; RG 1.132; RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”; and RG 1.208.

2.5.2.4 Technical Evaluation

The staff reviewed SSAR Section 2.5.2 to verify that the information represented the complete scope of information relating to this review topic. The staff’s review confirmed that the PSEG ESP application addresses the required information related to the vibratory ground motion.

Section 2.5.2.4 of this report provides the staff’s evaluation of the seismic, geologic, geophysical, and geotechnical investigations carried out by the applicant to determine the site-specific GMRS leading to the estimation of the SSE ground motion for the PSEG Site. The development of the GMRS is based upon a detailed evaluation of earthquake potential, taking into account the regional and local geology, Quaternary tectonics, seismicity, and site-specific geotechnical engineering characteristics of the PSEG Site subsurface material.

On January 22, 2009, during the early site investigation stage, the staff visited the site and interacted with the applicant regarding the geologic, seismic, and geotechnical investigations conducted for the ESP application. The staff made an additional visit to the PSEG Site in September 2011, to confirm interpretations, assumptions, and conclusions presented by the

applicant related to potential geologic and seismic hazards. As discussed at the beginning of, this report (Section 2.5, “Geology, Seismology, and Geotechnical Engineering”), the staff issued several RAIs to the applicant and evaluated the responses received during the review process. However, following the Fukushima accident in Japan in March 2011, and the subsequent NRC Near-Term Task Force (NTTF) recommendations as well as the NRC March 12, 2012, letter, “Request for information pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) regarding recommendations 2.1, 2.3, and 9.3 of the near-term task force review of insights from the Fukushima Dai-ichi accident,” (ADAMS Accession No. ML12053A340) requesting the operating nuclear power plants to re-assess seismic hazards at their sites using the most recent seismic source models, the staff issued an RAI to all COL and ESP applicants (RAI 61, Question 02.05.02-10 was issued to PSEG) to reassess the seismic hazard at their sites using the new seismic source models. In its December 20, 2012 and January 11, 2013, responses, the applicant revised the SSAR significantly, especially, SSAR Section 2.5.2 related to seismic hazard calculations. As part of this SSAR revision, the applicant replaced the EPRI (1986) seismic source models previously used in the seismic hazard calculations at the site with the newly published NUREG-2115 CEUS-SSC model. With this change in the base seismic source model, many of the earlier RAIs became irrelevant and were closed. The staff’s evaluations of many of these earlier RAIs are not part of this report. However, a few of the original RAIs are still applicable to the staff’s review and these are discussed below along with the new RAIs that the staff developed in response to the revised SSAR.

2.5.2.4.1 Seismicity

SSAR Section 2.5.2.1 states that the earthquake catalog used for the PSEG Site seismic hazard assessment is the NUREG-2115 earthquake catalog. The earthquake catalog published as part of the NUREG-2115 seismic source model covers the entire CEUS region from 1568 through 2008 and includes a uniform moment magnitude scale for all earthquakes listed in the catalog. Since the staff reviewed the NUREG-2115 earthquake catalog previously, the staff’s technical evaluation of SSAR Section 2.5.2.1 focused on the applicant’s efforts to update the NUREG-2115 earthquake catalog for use in the PSEG Site PSHA. Since the NUREG-2115 earthquake catalog covers the seismicity in the region through 2008, the applicant provided a quantitative analysis of earthquakes occurring within 320 km (200 mi) of the site from 2009 through 2011 in the SSAR. In addition to documenting the seismic activity within the site region, the earthquake catalog also provides critical data to assess seismic source model parameters used in the PSEG PSHA study. Seismic source model parameters, such as M_{max} and earthquake recurrence rates, are primarily determined based on information available in the earthquake catalog.

As part of its confirmatory analysis, the staff developed a supplementary earthquake catalog covering the CEUS region from 2009 through October 15, 2013. The staff used this earthquake catalog to confirm the applicant’s updated catalog and to determine whether there are new earthquakes in the CEUS region since the submission of the PSEG ESP application that might impact either the maximum magnitude distribution of the seismic sources identified in the NUREG-2115 model or the earthquake recurrence rates calculated for each of the seismic sources used in the PSEG Site PSHA study. The staff used the United States Geological Survey (USGS) Advanced National Seismic Network earthquake catalog (ANSS)[2] for this analysis. The staff searched for earthquakes with magnitudes 3.0 and above within the time

[2] Advanced National Seismic System (ANSS), ANSS Catalog Search, http://www.ncedc.org/anss/catalog-search.html.

window covering 2009 through October 15, 2013, throughout the CEUS as defined by NUREG-2115. The staff's supplementary earthquake catalog confirmed that the applicant adequately updated its catalog from 2009 through 2011. In addition, the staff's catalog showed that there are 173 earthquakes in the CEUS region (Figure 2.5.2-6 of this report) that occurred between 2012 and October 15, 2013. None of these earthquakes have moment magnitudes (**M**) equal to or greater than **M**5.0. The staff identified 15 earthquakes in the range between **M**4.0 and 4.9 distributed over the CEUS region. The majority of the earthquakes (158 of the 173) in the updated catalog are small magnitude earthquakes (**M** < 4.0). Therefore, the staff concludes from its confirmatory analysis that the earthquakes in the staff's supplementary catalog are located within identified active CEUS seismic regions and do not add any new information to the catalog used by the applicant.

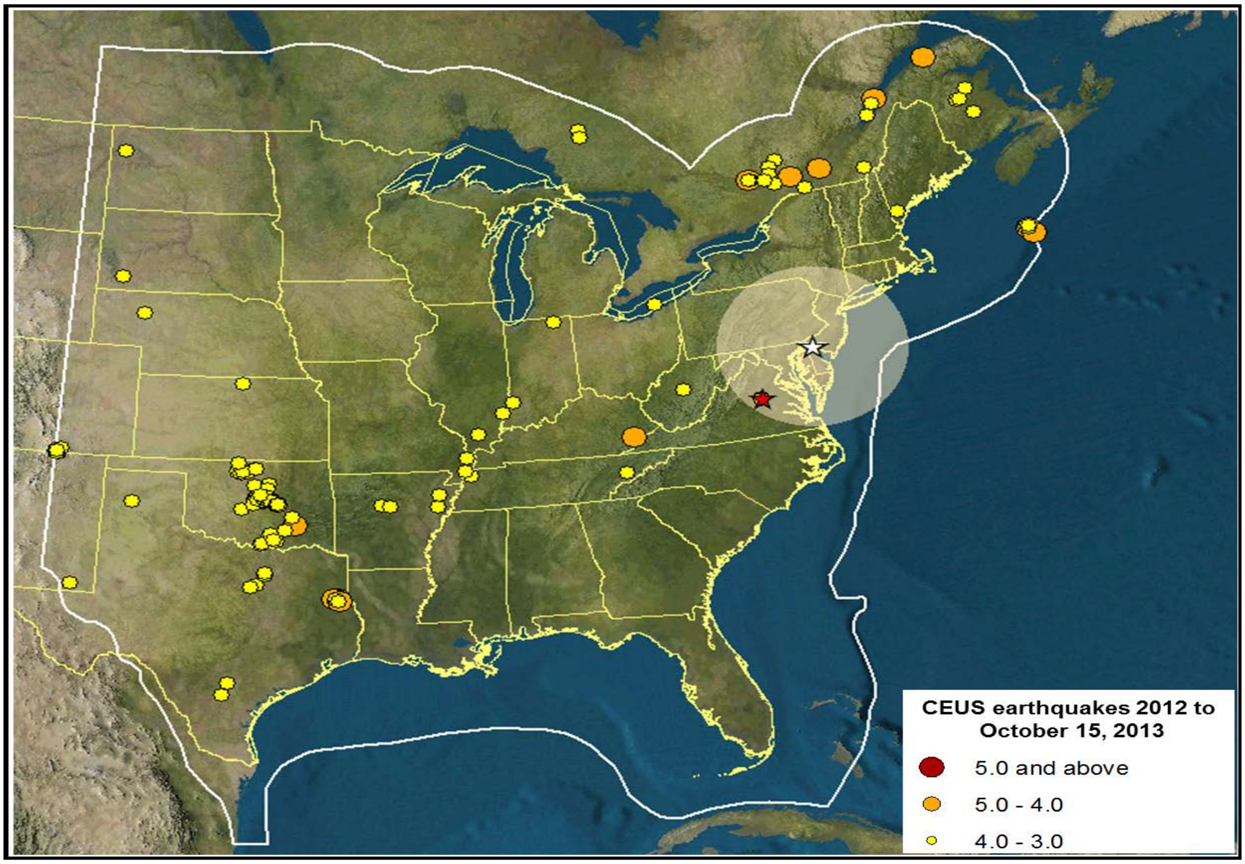


Figure 2.5.2-6 Earthquakes with moment magnitudes (M) equal to or greater than 3.0 in the CEUS between 2012 and October 15, 2013. The white star is the PSEG Site location, the beige circle is the 320 km (200 mi) site radius, and the red star is the location of the August 23, 2011, M5.8 Mineral, VA earthquake.

Staff Conclusions Regarding Seismicity

Based upon its review of the applicant's SSAR Section 2.5.2.1 and the staff's supplemental seismicity catalog, the staff concludes that the applicant developed a complete and accurate earthquake catalog for the region surrounding the PSEG Site. The staff concludes that the seismicity catalog as described by the applicant in SSAR Section 2.5.2.1 forms an adequate

basis for the seismic hazard characterization of the site and meets the requirements of 10 CFR 52.17(a)(1)(vi) and 10 CFR 100.23.

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 PSEG Site. Specifically, the applicant described the seismic source model published as part of NUREG-2115 in 2012. The staff previously reviewed the NUREG-2115 seismic source model and approved its use as a starting regional model for nuclear power plant applications. However, the NUREG-2115 model is a regional model and NUREG-2115 specifically states that it should be compared against the local data and information, and if needed, appropriate local adjustments must be conducted. As such, the staff primarily focused on the applicant's investigation of potential local seismic source and source parameter adjustments to the NUREG-2115 model.

2.5.2.4.2.1 Modifications to NUREG-2115 model due to updated earthquake catalog.

The applicant's updated earthquake catalog identified nine moderate-sized earthquakes ranging from **M**4.5 to 5.8 within the 320 km (200 mi) site region. The most significant earthquake identified is the Mineral, VA, earthquake with a moment magnitude of **M**5.8 that occurred on August 23, 2011, and was located approximately 270 km (170 mi) southwest of the PSEG Site. All new earthquakes in the region had magnitudes lower than the seismic sources' assigned maximum magnitudes and the applicant concluded that these updated earthquakes did not impact the NUREG-2115 seismic source model parameters.

However, due to the large magnitude of the **M**5.8 Mineral, VA earthquake, the staff inquired further and issued to the applicant two RAIs regarding the impact of the 2011, Mineral, VA earthquake on the PSEG Site seismic hazard analysis. Specifically, in RAI 71, Question 02.05.02-11, the staff requested that the applicant assess the impact of the 2011, Mineral, VA earthquake on the PSEG Site seismic hazard analysis regarding potential changes in earthquake recurrence rates in the vicinity of the earthquake's hypocenter, and their potential impacts on the site's calculated hazard. In an August 29, 2013, response to RAI 71, Question 02.05.02-11, the applicant performed sensitivity calculations to demonstrate that using updated earthquake recurrence rate parameters, to include the **M**5.8 Mineral, VA earthquake, had no significant effect on the seismic hazard at the PSEG Site. The applicant performed the sensitivity calculations using the four NUREG-2115 seismic source zones (ECC-AM, MESE-N, MESE-W and STUDY-R) that host the **M**5.8 Mineral, VA earthquake. The applicant compared calculations of the mean annual earthquake recurrence rate per degrees squared (for magnitudes greater than 5) and the b-values for the three NUREG-2115 magnitude weighting cases for the four source zones. The applicant concluded that trends in b-values and recurrence rates in the comparisons showed little difference around the **M**5.8 Mineral, VA earthquake. Additionally, the applicant compared its original calculations of mean background hazard and mean total hazard at the PSEG Site for 1, 10, and 100 Hz (PGA) with those calculations including the **M**5.8 Mineral, VA earthquake. In the August 29, 2013, response to RAI 71, Question 02.05.02-11, the applicant stated:

> The results from this sensitivity analysis show that the change in total mean background and total mean site hazard at the PSEG Site, when the four largest contributing background sources are re-run using updated earthquake recurrence parameters, is minimal. The largest differences in total mean

background hazard and total mean site hazard are 1.4% and 0.9%, respectively, indicating that the percent difference is within the levels of precision.

Based on the staff's review of the applicant's assessment of the **M**5.8 Mineral, VA earthquake in the SSAR and in its August 29, 2013, response to RAI 71, Question 02.05.02-11, the staff concludes that the effect of the **M**5.8 Mineral, VA earthquake on the mean background hazard and the total mean site hazard at the PSEG Site is negligible and that the applicant's use of the original CEUS-SSC model earthquake recurrence parameters is acceptable. Accordingly, the staff considers RAI 71, Question 02.05.02-11 resolved.

2.5.2.4.2.2 Modifications to NUREG-2115 seismic source model.

NUREG-2115, Chapter 9, "Use of the CEUS-SSC Model in PSHA", details a few model simplification tests that applicants may implement when using NUREG-2115 CEUS-SSC model. However, NUREG-2115 also states that site-specific sensitivity studies should be conducted to confirm that such simplifications are appropriate for use at specific sites. Therefore, in RAI 71, Question 02.05.02-12, the staff requested that the applicant describe any implemented model simplifications used for the PSEG seismic hazard analysis and to provide justification for using those simplifications. In an August 27, 2013, response to RAI 71, Question 02.05.02-12, the applicant stated it implemented the full CEUS-SSC model without simplifications to the RLME seismic source parameters and that it implemented one simplification in modeling the background sources. The simplification applied to the background sources was to apply the point source model as described in NUREG-2115, Section 9.3.1.11, instead of the finite rupture mode that used multiple fault orientations, dips, and crustal thicknesses. The applicant performed sensitivity calculations and compared the hazard from using the simplified point source model for background sources in the PSHA analysis to the hazard from using the finite rupture model. Table 2.5.2-2 of this report shows the applicant's comparison at 1 Hz, 10 Hz, and PGA for the four largest contributing background sources at the PSEG Site. For ground motions with a frequency of exceedance of 10^{-4}, the difference in hazard is ≤ 3.5 percent. For ground motions with a frequency of exceedance of 10^{-5}, the difference in hazard is < 10 percent with the exception of the ECC-AM source. For the ECC-AM source at 10^{-5}, the difference 10-15 percent. The staff notes that the results shown in Table 2.5.2-2 of this report are for individual seismic sources' contributions, and the overall percentage increases in the total seismic hazard values at the site will be lower. Further, for the GMRS calculations 10^{-4} and 10^{-5} annual frequency of exceedances are the key levels of interest. Therefore, the staff considers the differences calculated in this sensitivity study to be within the uncertainty in the overall PSHA calculations. Accordingly, the staff considers RAI 71, Question 02.05.02-12, resolved.

Table 2.5.2-2 Percent difference between the point source and finite rupture model for the four largest contributing background sources at the PSEG Site (Response to RAI 71, Question 02.05.02-12, Table RAI 71-12-5)

ECC-AM		
Frequency	AFE	% Difference
1 Hz	10^{-4}	2.7%
	10^{-5}	10.4%
	10^{-6}	27.2%
10 Hz	10^{-4}	3.5%
	10^{-5}	13.7%
	10^{-6}	33.9%
PGA	10^{-4}	3.5%
	10^{-5}	14.7%
	10^{-6}	37.9%
MESE-N		
Frequency	AFE	% Difference
1 Hz	10^{-4}	0.7%
	10^{-5}	5.4%
	10^{-6}	17.2%
10 Hz	10^{-4}	1.5%
	10^{-5}	7.4%
	10^{-6}	22.9%
PGA	10^{-4}	1.5%
	10^{-5}	6.4%
	10^{-6}	25.4%

STUDY-R		
Frequency	AFE	% Difference
1 Hz	10^{-4}	0.6%
	10^{-5}	5.1%
	10^{-6}	16.3%
10 Hz	10^{-4}	1.4%
	10^{-5}	7.0%
	10^{-6}	22.1%
PGA	10^{-4}	1.4%
	10^{-5}	6.4%
	10^{-6}	24.3%
MESE-W		
Frequency	AFE	% Difference
1 Hz	10^{-4}	-0.3%
	10^{-5}	2.3%
	10^{-6}	9.5%
10 Hz	10^{-4}	0.1%
	10^{-5}	3.4%
	10^{-6}	12.8%
PGA	10^{-4}	0.1%
	10^{-5}	3.3%
	10^{-6}	13.7%

2.5.2.4.2.3 Staff Conclusions Regarding Geologic and Tectonic Characteristics of the Site and Region.

Based upon its review of SSAR Sections 2.5.2.2 and 2.5.2.4 and the applicant's responses to RAI 71, Questions 02.05.02-11 and 02.05.01-12, the staff concludes that the applicant adequately assessed the NUREG-2115 seismic sources as the input to its PSHA for the PSEG Site. In addition, the staff concludes that the applicant adequately considered modifications to the NUREG-2115 seismic sources for the PSEG Site. The staff concludes that the applicant's use of NUREG-2115 seismic source models as described by the applicant in SSAR Sections 2.5.2.2 and 2.5.2.4 forms an adequate basis for the seismic hazard characterization of the site and meets the requirements of 10 CFR 52.17(a)(1)(vi) and 10 CFR 100.23.

2.5.2.4.3 Correlation of Earthquake Activity with Seismic Sources

SSAR Section 2.5.2.3 describes the correlation of seismicity in the region with the seismic source model used in the PSEG PSHA study. The applicant noted that the NUREG-2115 model uses earthquake locations and characteristics in defining the seismic source geometries. The applicant compared the NUREG-2115 seismicity catalog and the applicant's updated

catalog to assess any changes in the patterns of seismicity or if there exists any correlation between geologic structures and seismicity not identified within the CEUS-SSC study that needs to be accounted for at the PSEG Site. Based on the applicant's assessment, the staff's updated seismicity catalog, the staff's confirmatory analysis described in Section 2.5.2.4.1 of this report, and the applicant's August 29, 2013, response to RAI 71, Question 02.05.02-11 described in Section 2.5.2.4.2 of this report, the staff concludes that the applicant's characterization of the correlation of earthquake activity is adequate.

2.5.2.4.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes

In SSAR Section 2.5.2.4, the applicant stated that it used the NUREG-2115 seismic model in the probabilistic seismic hazard calculations at the PSEG Site and the procedures outlined therein. Using the NUREG-2115 CEUS-SSC model sources, the applicant's additional AHEX-E source (described in Section 2.5.2.4.4.1 of this report), and the EPRI (2004 and 2006) GMPEs, the applicant calculated generic hard rock seismic hazard curves at the seven frequencies defined by the EPRI (2004, and 2006) GMPEs. Using the hard rock seismic hazard curves, the applicant obtained uniform hazard response spectra at the annual frequency of exceedances of 10^{-4}, 10^{-5}, and 10^{-6}. Using the procedures outlined in RG 1.208, the applicant also developed the controlling earthquakes' magnitudes and distances. The following describes the staff's assessment of the applicant's PSHA calculations and the determination of the controlling earthquakes and their parameters.

2.5.2.4.4.1 PSHA Inputs.

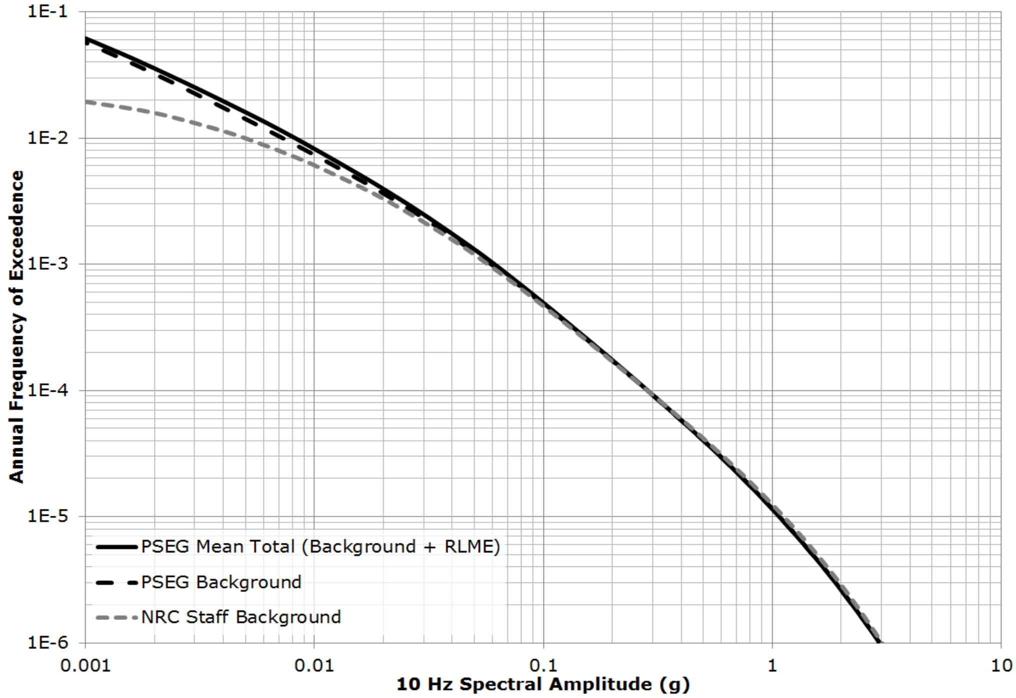
As described in Section 2.5.2.2.4 of this report, the applicant implemented the entire NUREG-2115 model with no modifications and with one addition. Since the NUREG-2115 model does not cover the 320 km (200 mi) PSEG Site region, the applicant developed a small regional seismic source to be added onto the NUREG-2115 model to cover the site area fully. The applicant named the source AHEX-E, as shown in Figure 2.5.2-1 of this report, and developed earthquake recurrence rates within this source using the same process utilized in the NUREG-2115 model. The staff evaluated this small new source developed by the applicant and concluded that because of very limited seismicity in this region, any potential contribution from this source is quite limited and there is no significant impact on the total seismic hazard calculations. With this small source addition, the applicant's PSHA inputs are consistent with RG 1.208; therefore, the staff concludes that the applicant's PSHA inputs are adequate.

2.5.2.4.4.2 PSHA Calculation and Confirmatory Analysis.

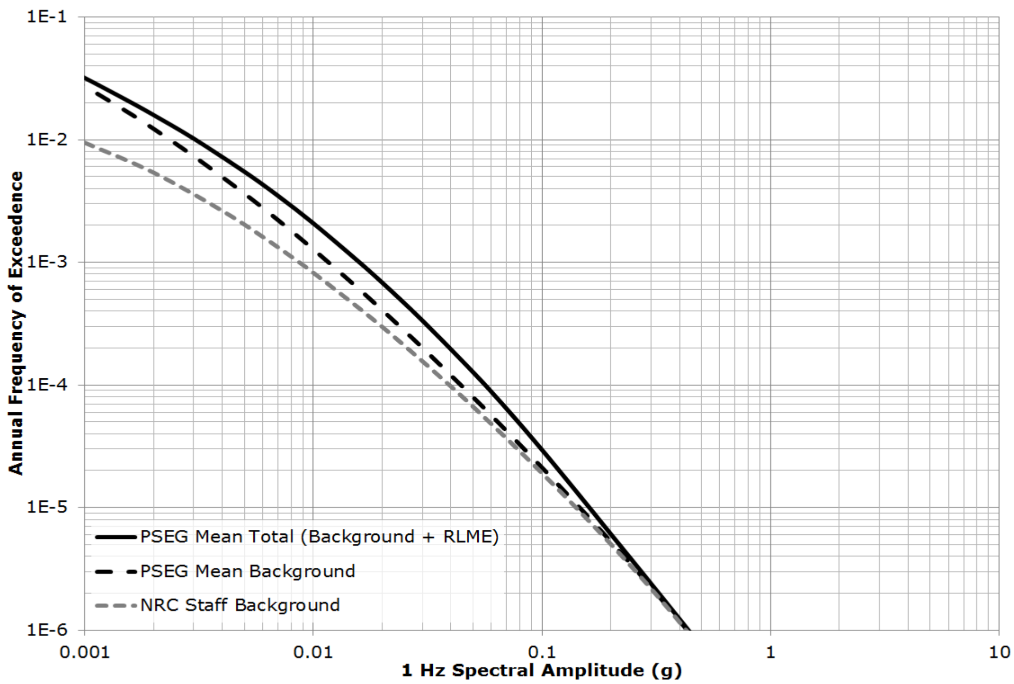
Using the NUREG-2115 CEUS-SSC model, the applicant's additional AHEX-E source, and the EPRI (2004, 2006) GMPEs, the applicant performed PSHA calculations for PGA and ground motion frequencies of 25, 10, 5, 2.5, 1, and 0.5 Hz. As described in Section 2.5.2.4.2 of this report, the applicant implemented a simplification in the seismic hazard calculations of the background seismic sources used to determine total seismic hazard at the site. The applicant's simplification was to implement the point source model as described in NUREG-2115, Section 9.3.1.11, when calculating the hazard of background sources instead of the finite rupture model. As described in Section 2.5.2.4.2.2 of this report, the applicant's sensitivity study conducted in response to RAI 71, Question 02.05.02-12 clarified for the staff that the applicant's simplification was reasonable and would result in the adequate calculation of seismic hazard at the PSEG Site.

During the development of the applicant's response to RAI 61, Question 02.05.02-10, the staff conducted software audits to distinct seismic hazard calculation software being used by the industry to respond to the NTTF Recommendation 2.1 seismic RAIs submitted to all COL and ESP applicants. The purpose of these audits was to review seismic hazard software and examine the implementation of the new seismic source models described in NUREG-2115. The objective was to gain in-depth understanding of the seismic software being used and review the implementation of the new seismic source model into the existing codes. The applicant contracted Fugro Consultants, Inc. (Fugro), to perform its seismic hazard calculations. The Fugro software audit took place on September 25 and 26, 2012. The staff's software audit summary is available in ADAMS Accession No. ML12311A341. During the software audit, the staff reviewed software runs and reviewed several quality assurance documents related to Fugro's seismic hazard code.

As part of its confirmatory analysis, the staff used the NUREG-2115 CEUS-SSC model background (distributed seismicity) sources and independently calculated the seismic hazard curves at the PSEG Site for all seven ground motion frequencies defined in the EPRI (2004, 2006) ground motion prediction models. The staff's confirmatory calculations did not include the RLME sources. These sources exist at distances beyond 800 km (500 mi) from the PSEG Site and are expected to contribute only at low frequencies such as 0.5 and 1 Hz. From the NUREG-2115 seismic source model, the staff first selected all background seismic sources that are within the 320 km (200 mi) the site region. For those seismic sources which are partly within the 320 km (200 mi) site region, but with boundaries extending beyond the site region, the staff used a distance cut off of 500 km (312 mi). Beyond that distance, their hazard contributions will be negligible. Figure 2.5.2-7 of this report shows the staff's results as compared to the applicant's for PGA and ground motion frequencies of 10 and 1 Hz. The staff's confirmatory calculations show that for the annual frequency of exceedances of 10^{-4}, 10^{-5}, and 10^{-6}, the staff's seismic hazard curves are in good agreement with the applicant's background seismic hazard curves. The difference observed between the background seismic source hazard curves and the total seismic hazard curve at 1Hz shown in Figure 2.5.2-7 of this report is attributed to the contribution of the RLME seismic sources at large distances. As shown in SSAR Figures 2.5.2-25 through 2.5.2-30, at low frequencies, such as 2.5, 1, and 0.5 Hz, distant RLME sources contribute to the hazard at the site. In contrast, at high frequencies only local sources contribute to the hazard. Based on this analysis, the staff concludes the applicant adequately characterized the mean seismic hazard at the PSEG Site.



1E-1
1E-2
1E-3
1E-4
1E-5
1E-6
Annual Frequency of Exceedence
PSEG Mean Total (Background + RLME)
PSEG Background
NRC Staff Background
0.001
0.01
0.1
1
10
10 Hz Spectral Amplitude (g)



1E-1
1E-2
1E-3
1E-4
1E-5
1E-6
Annual Frequency of Exceedence
PSEG Mean Total (Background + RLME)
PSEG Mean Background
NRC Staff Background
0.001
0.01
0.1
1
10
1 Hz Spectral Amplitude (g)

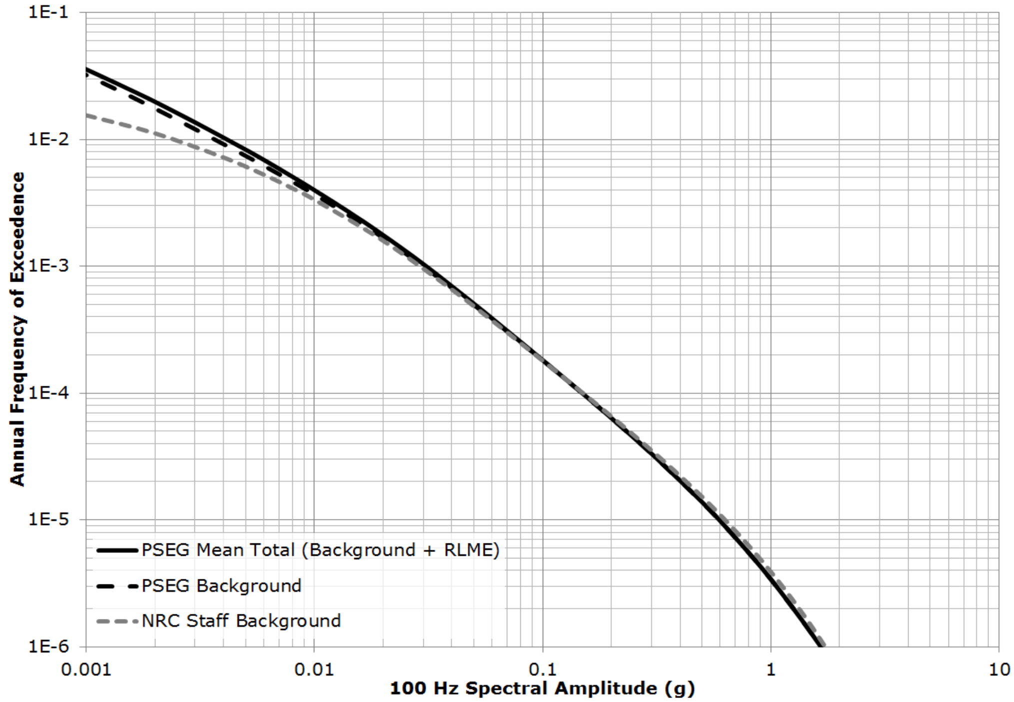


Figure 2.5.2-7 Staff confirmatory analysis of PSHA calculations for PGA (100 Hz) and ground motion frequencies of 10 and 1 Hz. The solid black lines represent the applicant's mean total hazard with contributions from both background and RLME sources. The black dashed lines represent the applicant's mean hazard from background sources only. The gray dashed lines represent the staff's confirmatory calculation of the contributions to hazard from the background sources out to 500 km (310 mi).

2.5.2.4.4.3 Controlling earthquakes.

To determine the low- and high-frequency controlling earthquakes' magnitudes and distances, the applicant used a procedure called deaggregation of the seismic hazard. The applicant followed the deaggregation procedures outlined in RG 1.208, Appendix D. The deaggregation results showed that local seismic sources within 30 km (18 mi) of the PSEG Site are the primary contributors to the high-frequency seismic hazard at the site, while the RLME sources as well as regional sources were contributors to the low-frequency seismic hazard at the PSEG Site. Table 2.5.2-1 of this report shows the applicant's deaggregation results for the mean 10^{-4}, 10^{-5}, and 10^{-6} PSHA results. The applicant calculated the controlling earthquakes for three different cases: Overall hazard; hazard from earthquakes located less than 100 km (62 mi) away; and hazard from earthquakes located beyond 100 km (62 mi). As shown in the deaggregation, Table 2.5.2-1 of this report, for the high-frequency hazard, the controlling earthquakes are those with magnitudes about **M**6 occurring at short distances. For the low frequency hazard, the controlling earthquakes are several hundred kilometers away with magnitudes greater than **M**6.5. The applicant selected the gray shaded values shown in Table 2.5.2-1 of this report as representative of the controlling earthquakes for the PSEG Site.

Since the applicant used the guidance outlined in RG 1.208 to determine the controlling earthquakes and their magnitudes and distances, the staff concludes that the procedures used by the applicant are adequate and the resultant controlling earthquake parameters are representative of the controlling earthquakes in this region.

2.5.2.4.4.4 Staff Conclusions Regarding PSHA and Controlling Earthquakes.

After its review of the applicant's PSHA and controlling earthquake determination, the applicant's response to RAI 71, Question 02.05.02-12, the staff's confirmatory calculations, and the staff's review of the code used by PSEG during the software audit, the staff concludes that the applicant's PSHA adequately characterizes the seismic hazard for the PSEG Site and that the controlling and deaggregation earthquakes determined by the applicant are representative of earthquakes that would be expected to contribute the most to the hazard.

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 PSEG Site free-field soil UHRS. The seismic hazard curves calculated by the applicant are defined for generic hard rock conditions characterized by a shear wave (S-wave) velocity of at least 2.8 km/s (9,200 ft/s). The applicant stated that these hard rock conditions exist at a depth of approximately 550 m (1,800 ft) below the ground surface at the PSEG Site. To determine the impact of the soil column between the hard rock and the surface, the applicant performed a site response analysis. The output of the applicant's site response analysis are the site amplitude functions, which are then used to determine the soil UHRS at three hazard levels (10^{-4}, 10^{-5}, and 10^{-6} annual frequency of exceedances).

2.5.2.4.5.1 Site Response Inputs and Methodology.

In SSAR Sections 2.5.4.2, 2.5.4.4 and 2.5.4.7, the applicant summarized the low strain S-wave velocity, material damping, and strain-dependent properties of the base case soil and rock profile, which the applicant used as the input model to its site response calculations. The applicant stated that the upper portion of the profile of the PSEG Site subsurface was investigated using test borings, and geophysical methods. For the deeper sedimentary rocks, the applicant obtained the information from nearby wells and geological data sets.

The applicant used the RVT methodology to calculate the site response amplification function at the PSEG Site. The use of RVT in site response calculations is mentioned in RG 1.208 as an acceptable alternative to the time series approach. RG 1.208 specifically states, "…, RVT methods are acceptable as long as the strain dependent soil properties are adequately accounted for in the analysis." Following RG 1.208, the staff focused its review on the input parameters used in the site response calculations. Inputs to the RVT method include response spectra which are based on the hard rock UHRS, 60 randomized soil profiles, effective strain ratio, and strong motion duration. The applicant estimated the strong-motion durations to be used in the site response calculations using the mean magnitudes and distances from the ESP site's controlling earthquakes and the relationship provided in Rathje and Ozbey (2006). The staff's sensitivity studies indicated that site response amplification functions are not overly sensitive to the duration value as long as the value used is within a certain expected range. Having reviewed the applicant's duration values, the staff concludes that the applicant's selection of duration values is adequate for site response calculations at the PSEG Site.

The applicant stated that it calculated the effective strain ratios using the formulation provided in Idriss (1992) and confirmed the resultant values with the possible range of values determined by empirical calculations described in Kramer (1996). The staff confirmed these values and concludes that the input effective strain ratios determined by the applicant are within the acceptable values commonly used by the engineering community.

2.5.2.4.5.2 NRC Site Response Confirmatory Analysis.

To determine the adequacy of the applicant's site response calculations, the staff performed its own confirmatory site response calculations. As input, the staff used the static and dynamic soil properties provided in SSAR Section 2.5.4. To represent the input rock motions, the staff used the applicant's low- and high-frequency 10^{-5} rock spectra. The staff performed its site response calculations using the Strata software (Kottke and Rathje 2008). The staff's site amplification function results are compared with the applicant's results in Figure 2.5.2-8 of this report, which shows that the staff's calculation is similar to the applicant's site amplification factor across the frequency range typically important for engineering purposes (i.e., 0.5 to 10 Hz) and they are within the limits of uncertainties expected from these calculations. Based on this assessment, the staff concludes that the applicant's site response calculations adequately characterize the site effects at the PSEG Site.

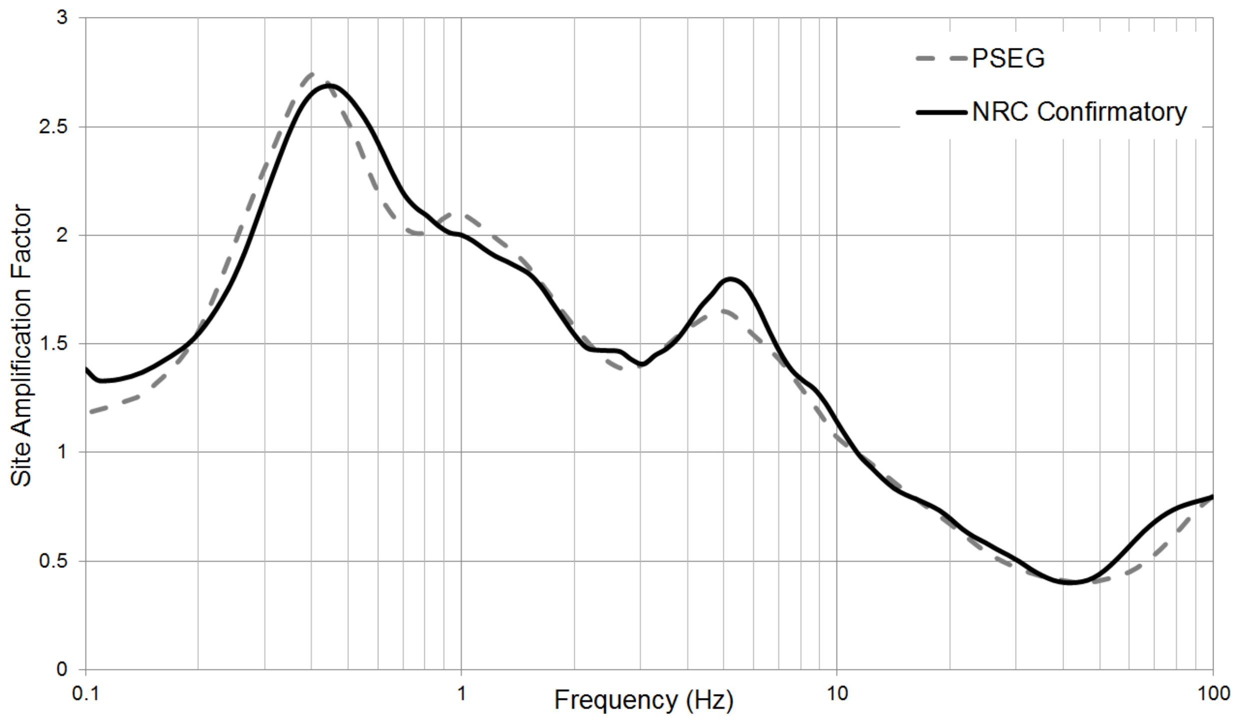


Figure 2.5.2-8 Comparisons of the staff's site response amplification function with the amplification function determined by the PSEG applicant for the 10-5 annual frequency of exceedance

2.5.2.4.5.3 Staff Conclusions Regarding Seismic Wave Transmission Characteristics of the Site.

The staff concludes that the applicant's site response methodology and results are acceptable since the applicant followed the general guidance provided in RG 1.208 in its site response calculations and used an adequate range of input parameters. The staff's confirmatory analysis also showed that the applicant's calculations are accurate.

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 American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard 43 05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities." SSAR Section 2.5.2.6, states that the horizontal GMRS (for each spectral frequency), is obtained by scaling the 10^{-4} soil UHRS by the design factor specified in RG 1.208. The final GMRS is shown in Figure 2.5.2-5 of this report.

In SSAR Section 2.5.2.6.1.2, the applicant stated that it multiplied the horizontal GMRS by a frequency-dependent scaling factor in order to obtain the vertical GMRS. The applicant used the envelope of three V/H ratios calculated using three different methods as its final V/H ratio to calculate the vertical GMRS. Since the applicant used an accepted methodology presented in NUREG/CR-6728, Appendix J, along with two other methods, and enveloped the results to obtain a conservative result for its final V/H ratio function, the staff concludes that the applicant's V/H ratios are adequate for the use of the PSEG Site vertical GMRS.

Staff Conclusions Regarding Ground Motion Response Spectra

Since the applicant used the standard procedures outlined in RG 1.208 to calculate the final horizontal GMRS, and conservatively estimated the vertical GMRS, the staff concludes that the applicant's GMRS adequately represents the site ground motion and that the GMRS calculated meets the requirements of 10 CFR 100.23.

2.5.2.5 Conclusion

The staff reviewed the PSEG ESP application. The staff confirmed that the applicant addressed the required information relating to vibratory ground motion, and that there is no outstanding information expected to be addressed in the SSAR related to this subsection. Accordingly, the staff considers RAI 61, Question 02.05.02-10, which is the RAI issued after the NTTF recommendation following the Fukushima accident in Japan in March 2011, resolved.

As set forth above, the staff reviewed the seismic 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 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 adequately addressed the uncertainties inherent in the characterization of these seismic sources through a PSHA, and that this PSHA follows the guidance provided in RG 1.208. 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 PSEG 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 site subsurface properties. The staff concludes that the proposed ESP site is acceptable from a geologic and seismologic standpoint and meets the requirements of 10 CFR 100.23.

2.5.3 Surface Faulting

2.5.3.1 Introduction

SSAR, Section 2.5.3 evaluates the potential for tectonic and non-tectonic surface deformation at the PSEG Site. The applicant stated that SSAR Section 2.5.3 demonstrates compliance with regulatory requirements in 10 CFR 100.23 by providing information on the following topics: geologic, seismic, and geophysical investigations (SSAR Section 2.5.3.1); geologic evidence, or absence of evidence, for tectonic surface deformation (SSAR Section 2.5.3.2); correlation of earthquakes with capable tectonic sources (SSAR Section 2.5.3.3); ages of most recent deformations (SSAR Section 2.5.3.4); relationship of tectonic structures in the site area to regional tectonic structures (SSAR Section 2.5.3.5); characterization of capable tectonic sources (SSAR Section 2.5.3.6); designation of zones of Quaternary deformation in the site region (SSAR Section 2.5.3.7); and potential for tectonic surface deformation or non-tectonic deformation at the site (SSAR Section 2.5.3.8). Based on this information, the applicant concluded there are no faults within the site vicinity that can generate both tectonic surface deformation and vibratory ground motion, which the applicant indicated would represent a capable fault (i.e., a capable tectonic source) after the definition in RG 1.208, Appendix A. The applicant also concluded that no potential exists for non-tectonic surface deformation within the site vicinity or for tectonic or non-tectonic surface deformation in the site area or at the site location.

2.5.3.2 Summary of Application

The applicant developed SSAR Section 2.5.3 based on review of existing information in the following primary sources related to the potential for tectonic and non-tectonic surface deformation at the PSEG Site: Geologic maps of onshore and offshore areas published by the USGS, state geological surveys, and other researchers; literature published in journals and field trip guidebooks, with emphasis on materials published since the 1986 studies conducted by EPRI, including instrumental and historical seismicity data; reports on previous site investigations for the SGS (PSEG, 2007) and HCGS (PSEG, 2008), respectively; and the CEUS-SSC model presented in NUREG-2115. In addition to the review of this existing information, the applicant also performed the following activities to further assess the potential for tectonic and non-tectonic surface deformation within the site area: examination and interpretation of aerial photographs and remote sensing imagery, conduct of aerial and geologic field reconnaissance, and collection of subsurface data from boreholes. Sections 2.5.3.2.1 through 2.5.3.2.8 of this report summarize the information described by the applicant in the eight sections of SSAR, Section 2.5.3.

2.5.3.2.1 Geologic, Seismic and Geophysical Investigations

SSAR Section 2.5.3.1 discusses the geologic, seismic, and geophysical investigations performed by the applicant to evaluate the potential for tectonic (i.e., due to faulting and folding) and non-tectonic (e.g., collapse resulting from karst development and human-induced activities) surface deformation in the site vicinity and site area and at the site location.
Sections 2.5.3.2.1.1 through 2.5.3.2.1.7 of this report summarize the results of these investigations.

2.5.3.2.1.1 Published Geologic Mapping.

SSAR Section 2.5.3.1.1 indicates the published geologic maps reviewed by the applicant to evaluate the potential for tectonic and non-tectonic surface deformation in the site vicinity. The applicant referred to geologic maps of Delaware (Picket and Spoljaric, 1971), Maryland (Higgins and Conant, 1990), and New Jersey (Owens et al., 1999; Newell et al., 2000) and concluded that none of these maps show faults of Quaternary age (2.6 Ma to present) in the site vicinity.

2.5.3.2.1.2 Regional Geologic Studies.

SSAR Section 2.5.3.1.2 discusses regional geologic investigations that proved useful for evaluating the potential for tectonic and non-tectonic surface deformation in the site vicinity. Based on Benson (2006), the applicant reported a possible buried fault offset, located about 24 km (15 mi) north-northwest of the PSEG Site, which does not disrupt Quaternary strata. Figure 2.5.3-1 of this report shows the location of the surface projection of this inferred subsurface fault offset as a blue triangle. The applicant also referred to the fault data compilations of Crone and Wheeler (2000) and Wheeler (2005), which indicated that the only potential Quaternary tectonic features in the site vicinity are the New Castle County faults postulated by Spoljaric (1972, 1973, 1974, and 1979). Figure 2.5.3-2 of this report illustrates the locations of the postulated New Castle County faults, which include both buried basement faults inferred by Spoljaric (1972 and 1973) and surficial lineaments identified by Spoljaric (1974 and 1979) from satellite imagery that he suggested could possibly be associated with faulting. The applicant stated that existing field evidence suggests these faults, if they exist, are not Quaternary in age and concluded that they are not capable of producing tectonic surface deformation in the site vicinity.

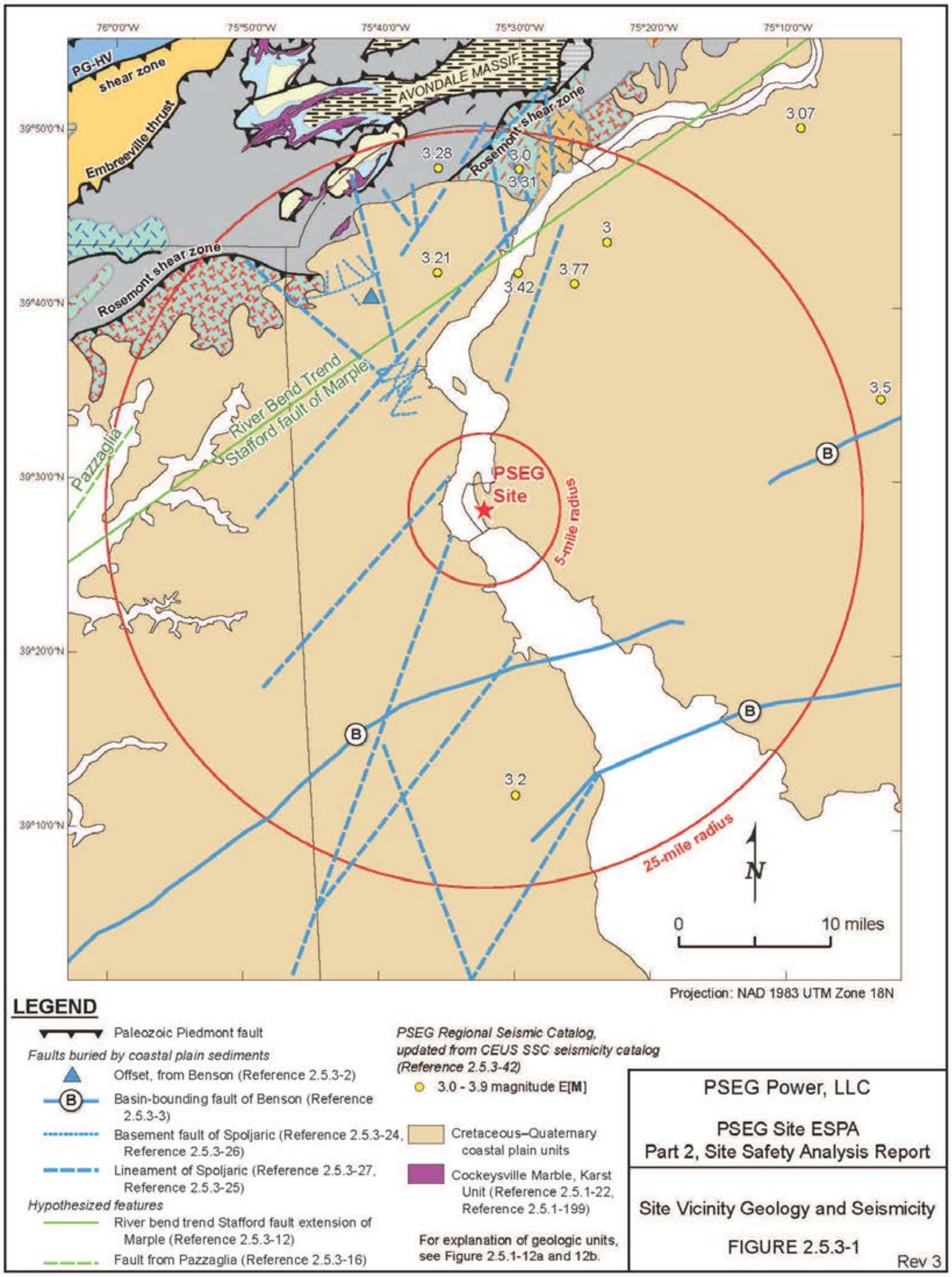


Figure 2.5.3-1 Site vicinity and site area geology and seismicity (Reproduced from SSAR Figure 2.5.3-1)

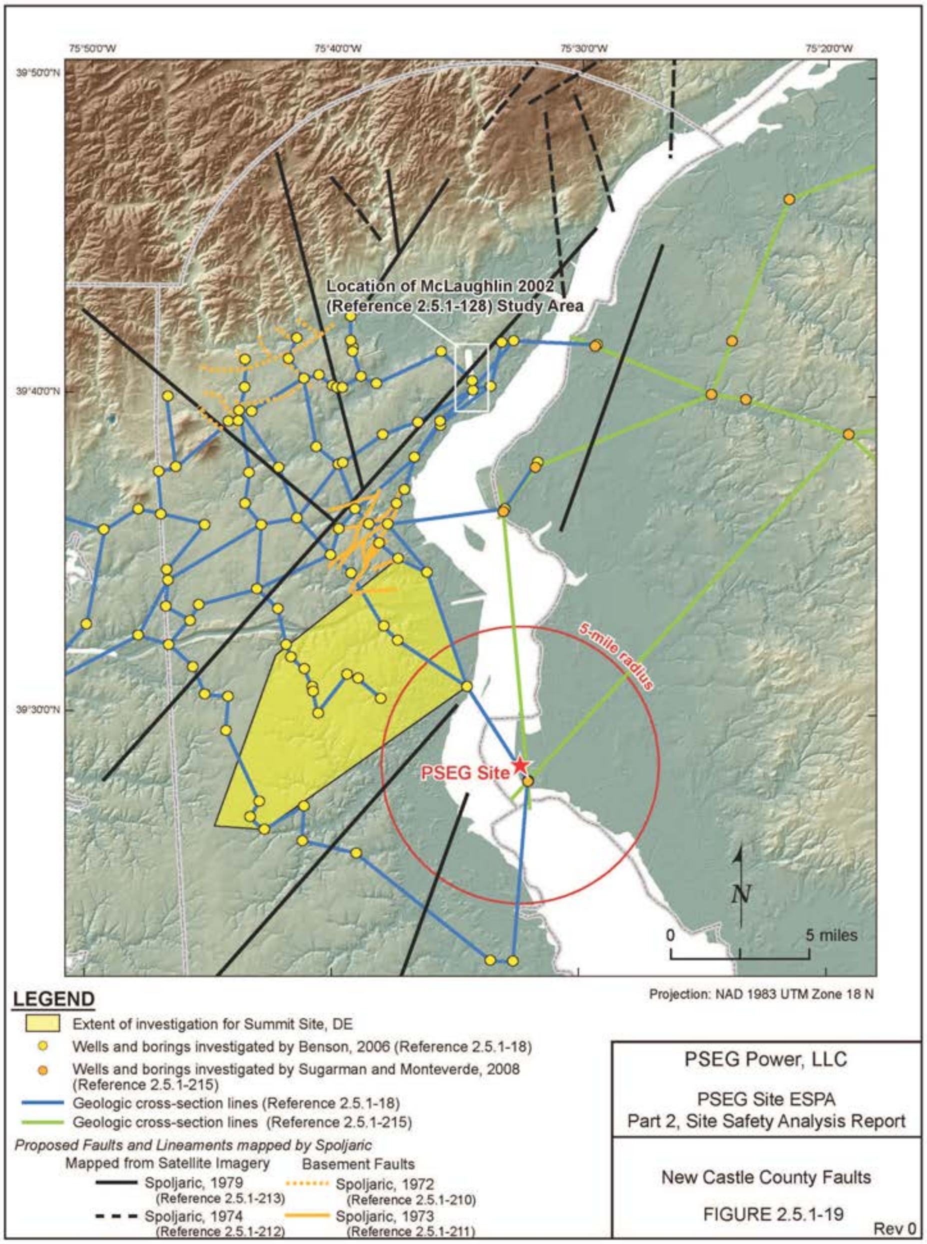


Figure 2.5.3-2 New Castle County faults and location of the McLaughlin et al. (2002) study area (Reproduced from SSAR Figure 2.5.1-19)

2.5.3.2.1.3 Seismicity Data.

SSAR Section 2.5.3.1.3 addresses seismicity data derived from the CEUS-SSC study as presented in NUREG-2115. Figure 2.5.3-1 of this report illustrates that there are no earthquake locations in the site area, and that eight earthquakes with expected moment magnitude (E[**M**]) estimates of 3.0 or greater occurred in the site vicinity. The applicant noted that the largest earthquake in the site vicinity was the instrumentally-recorded E[**M**] 3.77 event, which occurred

about 30.6 km (19 mi) north of the site on February 28, 1973. Based on information collected for the HCGS updated FSAR (PSEG, 2008) and data presented by Sbar et al. (1975), the applicant reported that none of the seismic events can be associated with any faults postulated to occur in the site vicinity.

2.5.3.2.1.4 Previous Site Investigations.

SSAR Section 2.5.3.1.4 presents the conclusions drawn based on previous site investigations conducted for the SGS (PSEG, 2007) and HCGS (PSEG, 2008). The applicant indicated that these investigations resulted in the following conclusions: (1) No surficial faulting or folding exists in the site area; (2) Surficial materials in the site area revealed no evidence of prior earthquakes; and (3) Stratigraphic units are planar and show no disruption by tectonic faulting or folding at the site location.

2.5.3.2.1.5 Aerial Imagery Analysis.

SSAR Section 2.5.3.1.5 discusses the results of analyses performed by the applicant to identify surficial features that could indicate the presence of surface or near-surface tectonic structures (i.e., warping, folds, or faults) in the site area. In combination with topographic maps, the applicant examined historical black and white aerial photographs from the 1930s, more recent color aerial photographs from 2007, and modern high-resolution light detection and ranging (LIDAR) elevation data from 2007 and 2008 for the site area. The applicant identified a total of 58 lineaments in the site area related to type, density, and distribution of vegetation; reaches of rivers, creeks, and streams; geomorphic features associated with topography; differences in tonal contrast; and curvilinear paleoshorelines separating differences in topography. Since many of the lineaments identified from the imagery and topographic maps were not directly accessible in the field due to the low-relief marshy landscape that characterizes the site area, the applicant attempted to further evaluate the linear features either on the ground from nearby vantage points or by aerial reconnaissance. The applicant concluded that none of the linear features investigated within the site area exhibited any evidence for surface or near-surface tectonic deformation related to faulting, folding, or warping.

2.5.3.2.1.6 Current Aerial and Field Reconnaissance.

SSAR Section 2.5.3.1.6 describes the aerial and field reconnaissance investigations conducted by the applicant in the site vicinity and site area. The applicant indicated that the field reconnaissance activities included observing landscape morphology and examining pertinent outcrops; visiting locations of accessible lineaments identified on aerial imagery; and evaluating continuity of paleoshorelines west of the site location. The applicant did not identify any evidence for tectonic surface deformation as a result of the field reconnaissance investigations.

During the aerial reconnaissance investigations, the applicant examined lineaments identified in both historical and modern aerial images, including those linear features that were not accessible on the ground; inspected the land surface around the potential tectonic structures postulated by Pazzaglia (1993) and Marple (2004), located on Figure 2.5.3-1 of this report; and searched for evidence of other faults and earthquake-induced paleoliquefaction features.
The applicant did not identify any anomalous features clearly associated with tectonic deformation, including faulting, in the site area as a result of the aerial reconnaissance investigations. However, the applicant did identify elliptical to rounded, light-colored patches northeast of the site location that could have resulted from earthquake-induced paleoliquefaction. The applicant reported that a broad distribution of these features occurs in

the Delaware Bay area, and indicated that researchers attributed them to periglacial processes (i.e., processes occurring at the immediate margins of former and existing glaciers and ice sheets that may extend beyond the periphery of the ice due to periglacial climatic conditions) based on information presented by French and Demitroff (2001) and French et al. (2003, 2005, and 2007). The applicant also reported that the land surface adjacent to portions of the Chesapeake Bay and the Susquehanna and Delaware Rivers near the postulated features of Pazzaglia (1993) and Marple (2004) showed no evidence for faulting.

2.5.3.2.1.7 Current Site Subsurface Investigations.

SSAR Section 2.5.3.1.7 describes subsurface investigations conducted by the applicant to evaluate subsurface stratigraphy and structural geology at the site location. The applicant supplemented the more than 130 borings previously completed for the HCGS and SGS site investigations with 16 new geotechnical borings. Based on data derived from the borings, the applicant reported planar, undisrupted sedimentary layering beneath the site location and concluded that the boring data confirmed a lack of near-surface faulting at the site location.

2.5.3.2.2 Geologic Evidence, or Absence of Evidence, for Tectonic Surface Deformation

SSAR Section 2.5.3.2 addresses the presence or absence of evidence for tectonic surface deformation in the site vicinity and site area. The applicant discussed Paleozoic (542 to 251 Ma) structures exposed in the Piedmont west of the site; Mesozoic (251 to 65.5 Ma) faults overlain by undeformed Coastal Plain sediments of Cretaceous (145.5 to 65.5 Ma) or Tertiary (65.5 to 2.6 Ma) age; and hypothesized tectonic features with no recognized surface expression. Figure 2.5.3-1 of this report illustrates the known and postulated geologic features, both exposed and buried, identified in the site vicinity. Sections 2.5.3.2.2.1 through 2.5.3.2.2.3 of this report summarize the information presented by the applicant in SSAR Section 2.5.3.2 on Paleozoic structures exposed in the Piedmont faults buried beneath Coastal Plain sediments, and hypothesized faults.

2.5.3.2.2.1 Paleozoic Structures Exposed in the Piedmont.

SSAR Section 2.5.3.2.1 describes two primary tectonic structures of Paleozoic age mapped within the site vicinity, namely, the Rosemont shear zone and thrust faults bordering exposures of the Baltimore gneiss (e.g., in the Avondale massif), as shown in Figure 2.5.3-1 of this report. Based on field relationships, the applicant reported that these tectonic features have not been active since the Paleozoic, and concluded that they do not pose a surface faulting hazard at the site location.

2.5.3.2.2.2 Faults Buried beneath Coastal Plain Sediments.

SSAR Section 2.5.3.2.2 discusses buried, basin-bounding Mesozoic faults overlain by undeformed sedimentary Coastal Plain strata of Cretaceous age and younger in the site vicinity. Benson (1992) proposed these faults based on information derived from gravity and magnetic field data, boreholes, and seismic lines. Based on data from Benson (1992), the applicant described three buried Mesozoic basin-bounding faults that may extend into the southern part of site vicinity as illustrated in Figure 2.5.3-1 of this report. The applicant noted that, regardless of whether these basin-bounding faults extend into the site vicinity or not, no evidence exists that they deform Cretaceous strata. Therefore, the applicant concluded that there is no potential for surface deformation at the site location related to the postulated buried basin-bounding faults of Benson (1992).

In addition, the applicant reported a buried fault inferred by Benson (2006), based on geophysical well log data, to offset Cretaceous strata in the subsurface at the location of the blue triangle shown in Figure 2.5.3-1, of this report. The applicant stated that undeformed Quaternary units overlie this inferred buried fault and concluded that, even if the feature exists, it is pre-Quaternary in age and does not pose a hazard from tectonic surface deformation at the site location.

SSAR Section 2.5.3.2.2 also describes the New Castle County faults postulated by Spoljaric (1972, 1973, 1974 and 1979) to occur in the site vicinity and site area. The New Castle County faults include subsurface faults offsetting buried crystalline basement rocks as interpreted from borehole data (Spoljaric, 1972 and 1973), as well as lineaments and inferred faults derived from satellite imagery (Spoljaric, 1974 and 1979). Figure 2.5.3-1 of this report illustrates the locations of the lineaments, two of which extend into the site area and the buried basement faults, both of which collectively comprise the New Castle County faults. Regarding the inferred basement faults, based on data reported by Spoljaric (1972 and 1979) and Hansen (1978) documenting that these faults do not cut overlying Cretaceous or Tertiary strata, the applicant indicated that offset along these faults, if they exist, is demonstrably pre-Cretaceous in age. Regarding the lineaments, the applicant reported the following field evidence to counter the interpretation that they represent faults: (1) Borings that cross the projection of the lineaments failed to identify offsets in near-surface strata based on data from Benson (2006); and (2) trenches, borings, and a seismic line located near one of the lineaments north of the site revealed unfaulted Cretaceous and Quaternary strata at the surface based on McLaughlin et al. (2002). Figure 2.5.3-2 of this report illustrates the location of the area investigated by McLaughlin et al. (2002) relative to the lineaments defined by Spoljaric (1974 and 1979), as well as his inferred buried basement faults (Spoljaric, 1972 and 1973). In addition, the applicant found no evidence that the lineaments represented faults based on the analyses of aerial photographs and satellite imagery conducted for the PSEG ESP application. The applicant pointed out that Spoljaric (1979) stated no evidence existed for surface faulting related to the lineaments. The applicant also reported that results of other investigations (Ramsey, 2005 and PSEG, 2008) do not support a faulting interpretation for the lineaments. Therefore, the applicant concluded there are no basement faults buried beneath Coastal Plain sediments or faults associated with lineaments that pose a hazard due to tectonic surface deformation at the site location.

2.5.3.2.2.3 Hypothesized Features.

SSAR Section 2.5.3.2.3 discusses two additional faults postulated to occur in the site vicinity, namely, the River Bend Trend/Stafford Fault of Marple (2004) and the fault of Pazzaglia (1993). Figure 2.5.3-1 of this report shows the proposed traces of these two hypothesized features, which extend into the site vicinity northwest of the site. The applicant reported that Marple (2004) defined his feature based on an interpreted extension of the Stafford fault northeastward from Virginia connecting the southwest-trending portions of the Delaware and Susquehanna Rivers. The applicant stated that both field and aerial reconnaissance studies conducted for characterizing the PSEG Site confirmed a lack of observable faulting in rock units located along the trace of this postulated tectonic feature, including within the site vicinity. The applicant cited multiple references that provided a similar interpretation regarding a lack of faulting along the trace of this postulated feature based on detailed geologic mapping (e.g., Schenck et al., 2000; Ramsey, 2005; Stanford, 2006; Stanford and Sugarman, 2006).

Regarding the fault of Pazzaglia (1993), the applicant indicated that he proposed this feature to explain the apparent difference in elevations of the lower contact of the Pleistocene (2.6 to 0.01 Ma) Turkey Point Beds in Maryland on opposite sides of the fault (i.e., on the eastern and western sides of Chesapeake Bay). The applicant stated that aerial reconnaissance along the trace of the hypothesized fault where it would extend onshore within the site vicinity, also conducted for characterizing the PSEG Site, confirmed a lack of observable deformation associated with this feature. The applicant noted that topographic relief on the lower contact of the Turkey Point Beds could also produce the elevation differences of this contact on opposite sides of the Chesapeake Bay. The applicant concluded there is no geologic evidence that either of these hypothesized faults, if they exist, deform any rock units within the site vicinity, and that neither of these two features pose a surface faulting hazard at the site location.

2.5.3.2.3 Correlation of Earthquakes with Capable Tectonic Sources

SSAR Section 2.5.3.3 evaluates the correlation of earthquakes with capable tectonic sources. As previously explained in Section 2.5.3.1 of this report, the applicant equated a capable tectonic source, or capable fault, with a structure that could generate both tectonic surface deformation and vibratory ground motion based on the definition RG 1.208, Appendix A. The applicant stated that none of the earthquakes that occurred in or near the site vicinity, located in Figure 2.5.3-1 of this report, have been correlated with any known fault or capable tectonic source, including the instrumentally-recorded E[**M**] 3.77 event of February 28, 1973, discussed by Sbar et al. (1975). Therefore, the applicant concluded no data suggest there are capable tectonic sources that could generate tectonic surface deformation and vibratory ground motion within the site vicinity.

2.5.3.2.4 Ages of Most Recent Deformations

SSAR Section 2.5.3.4 evaluates ages of most recent deformations within the site area. The applicant stated that there is no evidence for surface tectonic deformation related to faulting or folding in the site area based on investigations performed for characterization of the site. In addition, based on results of subsurface investigations for both the SGS (PSEG, 2007) and HCGS (PSEG, 2008), the applicant reported that bedding in stratigraphic units of Cretaceous age and younger (i.e., < 145.5 Ma) beneath the site is planar and does not exhibit any deformation related to faulting.

2.5.3.2.5 Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures

SSAR Section 2.5.3.5 addresses the relationship of tectonic structures in the site area to regional tectonic structures. The applicant cross-referenced the discussion of geologic evidence for tectonic surface deformation in SSAR Section 2.5.3.2, summarized in Section 2.5.3.2.2 of this report, and stated that no tectonic faults exist within the site area. Therefore, the applicant concluded that there is no correlation of tectonic structures in the site area with any regional tectonic structures.

2.5.3.2.6 Characterization of Capable Tectonic Sources

SSAR Section 2.5.3.6 addresses the need for characterization of capable tectonic sources that could generate both tectonic surface deformation and vibratory ground motion within the site area. Based on information provided in detailed discussions in SSAR Sections 2.5.1.1.4.2, “Principal Tectonic Structures”; 2.5.1.2.2.4, “Structural Geology”; 2.5.2.2, “Geologic and

Tectonic Characteristics of the Site and Region”; 2.5.2.3, “Correlation of Earthquake Activity with Seismic Sources”; 2.5.2.4.2.2, “New Seismic Source Characterizations”; and 2.5.3.3, “Correlation of Earthquakes with Capable Tectonic Sources”; the applicant concluded there are no capable tectonic sources within the site area that require characterization.

2.5.3.2.7 Designation of Zones of Quaternary Deformation in the Site Region

SSAR Section 2.5.3.7 addresses designated zones of Quaternary deformation in the site region that may require detailed investigations. The applicant cross-referenced information presented in SSAR Section 2.5.1.1.4.2.5, “Potential Quaternary Tectonic Features within the Site Region,” and stated that the site region does not contain any zones of Quaternary deformation that would require additional detailed investigations. The applicant also reiterated that review of aerial photographs and geotechnical boring logs and aerial and field reconnaissance investigations conducted to characterize the site did not identify any zones of Quaternary deformation in the site area.

2.5.3.2.8 Potential for Surface Tectonic Deformation or Non-Tectonic Deformation at the Site

SSAR Section 2.5.3.8 assesses the potential for surface tectonic and non-tectonic deformation at the site location. Regarding tectonic surface deformation, including faults and folds, the applicant stated that current and previous subsurface investigations in the site area showed Miocene and younger (i.e., < 23.0 Ma) strata to be planar and nearly flat-lying without any evidence of faulting or folding. The applicant also stated that examination of aerial imagery and LIDAR data collected to characterize the site did not reveal any evidence for faulting. The applicant concluded that there is no potential for surface tectonic deformation to pose a hazard at the site location.

Regarding non-tectonic surface deformation, particularly that induced by human activities (e.g., groundwater use, oil and gas extraction, and mining) or by collapse resulting from dissolution of carbonate rocks (i.e., development of karst features), the applicant stated that no evidence exists for these types of non-tectonic deformation in the site area or at the site location. The applicant cross-referenced information presented in SSAR Section 2.5.1.2.5.5, “Effects of Human Activity,” and indicated that no detrimental human-related activities are on-going at the site location. The applicant also noted that, although karst features related to dissolution of the Cockeysville Marble exist in the site vicinity associated with surface exposures of the marble, there are no karst features in the site area because the marble does not occur there. The applicant concluded that there is no potential for non-tectonic surface deformation to pose a hazard at the site location.

2.5.3.3 Regulatory Basis

The applicable regulatory requirements for tectonic and non-tectonic surface deformation that must be considered in an ESP application are as follows:

- 10 CFR 52.17(a)(1)(vi), as it relates to the requirement for an ESP applicant to prepare a SSAR that contains information on geologic and seismic characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, and with sufficient margin for the limited accuracy, quantity and period of time in which the historical data have been accumulated.

- 10 CFR 100.23(c), as it relates to the requirement for 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 for estimating the Safe Shutdown Earthquake ground motion; and to permit adequate engineering solutions for actual or potential geologic and seismic effects at the proposed site.

- 10 CFR 100.23(d), as it relates to the requirement for an ESP applicant to consider geologic and seismic siting factors for determining the SSE ground motion for the site; the potential for surface tectonic and nontectonic deformations; 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 information on tectonic and non-tectonic surface deformation provided by the applicant in compliance with the above regulatory requirements should also be sufficient to allow a determination at the COL application stage regarding whether the proposed facility complies with the following requirements in 10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants,” and 10 CFR Part 50, Appendix S.IV, “Application to Engineering Design”:

- General Design Criteria (GDC 2) of 10 CFR Part 50, Appendix A requires that SSCs important to safety be designed to withstand effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiche without loss of capability to perform their safety functions.

- 10 CFR Part 50, Appendix S.IV requires that vibratory ground motion and the potential for surface deformation be taken into account in the design of the nuclear power plant.

To the extent applicable in the regulatory requirements cited above and in accordance with Review Standard-002 (RS-002), “Processing Applications for Early Site Permits,” the staff applied methods and approaches specified in NUREG-0800, Section 2.5.3, “Surface Faulting,” for evaluation of information characterizing tectonic and non-tectonic surface deformation at the proposed site, presented by the applicant in SSAR Section 2.5.3, as recommended in RG 1.208. The acceptance criteria for tectonic and non-tectonic surface deformation presented in SSAR Section 2.5.3, defined in NUREG-0800, Section 2.5.3, are as follows. In addition, information provided by the applicant in SSAR Section 2.5.3 should be consistent with appropriate sections from RG 1.132, Revision 2; RG 1.198; and RG 1.208.

- Geologic, Seismic, and Geophysical Investigations: Requirements of 10 CFR 100.23 are met and guidance in RG 1.132, Revision 2, RG 1.198, and RG 1.208 is followed for this area of review if discussions of Quaternary tectonics, structural geology, stratigraphy, geochronologic methods used for age dating, paleoseismology, and geologic history of the site vicinity, site area, and site location are complete, compare well with studies conducted by others in the same area, and are supported by detailed investigations performed by the applicant.

- Geologic Evidence, or Absence of Evidence, for Surface Tectonic Deformation: Requirements of 10 CFR 100.23 are met and guidance in RG 1.132, Revision 2, RG 1.198, and RG 1.208 is followed for this area of review if sufficient surface and subsurface information is provided by the applicant for the site vicinity, site area, and site location to confirm the presence or absence of surface tectonic deformation (i.e., faulting) and, if present, to demonstrate the age of most recent fault displacement and ages of previous displacements.

- Correlation of Earthquakes with Capable Tectonic Sources: Requirements of 10 CFR 100.23 are met for this area of review if all reported historical earthquakes within the site vicinity are evaluated with respect to accuracy of hypocenter location and source, and if all capable tectonic sources that could, based on fault orientation and length, extend into the site area or site location are evaluated with respect to the potential for causing surface deformation. (Note: The applicant equated a capable tectonic source, or capable fault, with a structure that could generate both tectonic surface deformation and vibratory ground motion after the definition in RG 1.208, Appendix A.)

- Ages of Most Recent Deformations: Requirements of 10 CFR 100.23 are met for this area of review if every significant surface fault and feature associated with a blind fault, any part of which lies within the site area, is investigated in sufficient detail to demonstrate, or allow relatively accurate estimates of, the age of most recent fault displacement and enable identification of geologic evidence for previous displacements (if such evidence exists).

- Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures: Requirements of 10 CFR 100.23 are met for this area of review by discussion of structural and genetic relationships between site area faulting or other tectonic deformation and the regional tectonic framework.

- Characterization of Capable Tectonic Sources: Requirements of 10 CFR 100.23 are met for this area of review when it has been demonstrated that investigative techniques employed by the applicant are sufficiently sensitive to identify all potentially capable tectonic sources, including faults or structures associated with blind faults, within the site area; and when fault geometry, length, sense of movement, amount of total displacement and displacement per faulting event, age of latest and any previous displacements, recurrence rate, and limits of the fault zone are provided for each capable tectonic source.

- Designation of Zones of Quaternary Deformation in the Site Region: Requirements of 10 CFR 100.23 regarding designation of zones of Quaternary (2.6 Ma to present) deformation in the site region are met if the zone (or zones) designated by the applicant as requiring detailed faulting investigations is of sufficient length and width to include all Quaternary deformation features potentially significant to the site as described in RG 1.208.

- Potential for Surface Tectonic Deformation at the Site Location: To meet requirements of 10 CFR 100.23 for this area of review, information must be presented by the applicant if field investigations reveal that surface or near-surface tectonic deformation along a known capable tectonic structure related to a fault or blind fault must be taken into account at the site location.

2.5.3.4 Technical Evaluation

The staff reviewed SSAR, Section 2.5.3 to ensure that the materials provided by the applicant represent the required data related to assessment of the potential for tectonic and non-tectonic surface and near-surface deformation. The staff's review confirmed that data contained in the application address the information required for this topic.

The technical information presented in SSAR Section 2.5.3 resulted from the applicant's review of onshore and offshore geologic maps published by the USGS, state geological surveys, and other research workers; literature published in journals and data included in field guidebooks; reports on previous site investigations for the SGS (PSEG, 2007) and HCGS (PSEG, 2008); and the CEUS-SSC model presented in NUREG-2115. The applicant also collected information by performing the following activities to assess the potential for tectonic and non-tectonic surface deformation within the site area: Examination and interpretation of aerial photographs and remote sensing imagery; aerial and geologic field reconnaissance; and subsurface boring investigations. Through its review of SSAR Section 2.5.3, the staff determined whether the applicant had complied with applicable regulatory requirements in 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d) and conducted the site characterization investigations at the appropriate levels of detail in accordance with guidance in RG 1.208.

RG 1.208 recommends that an applicant evaluate any significant new geologic, seismic, and geophysical data to determine whether revisions to existing seismic source models and ground motion attenuation relationships are necessary. SSAR Section 2.5.3 includes geologic and seismic information collected by the applicant to support the analysis of vibratory ground motion and development of site-specific GMRS, as discussed in SSAR Section 2.5.2. RG 1.208 also recommends that an applicant evaluate faults encountered at a site to determine whether they are seismogenic or may cause surface deformation. SSAR Section 2.5.3 specifically includes information related to assessment of the potential for future tectonic and non-tectonic surface deformation at the site location.

The staff visited the PSEG Site on January 22, 2009, to observe pre-application subsurface investigation activities (ADAMS Accession No. ML090510065). A second visit, a site audit performed over September 29-30, 2011, after PSEG had submitted the ESP application, focused on examination of samples of the Vincentown Formation and pertinent outcrops, as well as interactions with the ESP applicant and its consultants in regard to the geologic, seismic, geophysical, and geotechnical investigations being conducted for characterization of the proposed ESP site. Regarding the geologic field observations made during the September 2011 site audit, the staff examined outcrops of estuarine sediments comprising the Early Pleistocene (2.6 to 1.8 Ma) Turkey Point Beds near the boundary of the PSEG Site vicinity to the west of the site for field evidence of a fault postulated by Pazzaglia (1993) to extend into the Chesapeake Bay west of the site. Pazzaglia (1993) postulated this fault based on interpreted elevation differences between Turkey Point Beds on opposite sides of the Bay. The staff noted no field evidence for this inferred fault.

Sections 2.5.3.4.1 through 2.5.3.4.8 of this report present the staff's evaluation of information provided by the applicant in SSAR Section 2.5.3 and the applicant's responses to RAIs for that SSAR section. The RAIs posed by the staff and discussed in the following sections of this report assure the applicant's compliance with 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d) as well as conformance to NUREG 0800, Section 2.5.3. In addition to the RAIs addressing specific technical issues related to the potential for future tectonic and

non-tectonic surface deformation at the site location, discussed in detail below, the staff also prepared editorial RAIs to further clarify certain descriptive statements made by the applicant in the SSAR and to better qualify specific geologic features illustrated in figures in the SSAR. This technical evaluation does not include a discussion of these editorial RAIs.

2.5.3.4.1 Geologic, Seismic and Geophysical Investigations

The staff focused the review of SSAR Section 2.5.3.1, "Geologic, Seismic and Geophysical Investigations," on information presented by the applicant related to published geologic maps, regional geologic studies, seismicity data, previous site investigations, aerial imagery analysis, current aerial and field reconnaissance, and current site subsurface investigations. The staff particularly concentrated on the descriptions of regional geologic studies, previous site investigations, aerial imagery analysis, and current aerial and field reconnaissance for evaluating the potential for surface tectonic deformation in the site vicinity and site area and at the site location.

2.5.3.4.1.1 Regional Geologic Studies.

In SSAR Section 2.5.3.1.2, the applicant described regional geologic studies. The applicant discussed the subsurface tectonic features postulated by Benson (2006) and Spoljaric (1972, 1973, 1974, and 1979) to occur in the site vicinity. Figure 2.5.3-1 of this report locates the postulated fault offset of Benson (2006), related to a buried fault inferred from borehole data, about 24 km (15 mi) north-northwest of the site location. Figures 2.5.3-1 and 2.5.3-2 of this report locate the inferred basement structures of Spoljaric (1972 and 1973), as well as the lineaments he postulated (Spoljaric, 1974 and 1979) to be related to faulting, which he collectively referred to as the New Castle County faults and which Crone and Wheeler (2000) and Wheeler (2005) interpreted to be a Class C structure (i.e., a feature with insufficient evidence to demonstrate the existence of a tectonic fault or associated Quaternary deformation).

The staff focused the review of SSAR Section 2.5.3.1.2 on the discussions of these inferred subsurface tectonic features for evaluating the potential for faulting in the site vicinity. The applicant reported that the inferred subsurface fault of Benson (2006) deforms the Lower Cretaceous (145.5 to 99.6 Ma) Potomac Formation but does not disrupt overlying Quaternary age (2.6 Ma to present) strata. However, the applicant did not indicate whether the interpretation that no deformation occurs in the Quaternary units overlying this buried offset came from Benson (2006), from interpretations by other researchers, or from investigations conducted for characterization of the PSEG ESP site. Therefore, in RAI 44, Question 02.05.03-1, the staff requested that the applicant clarify the source of data used to conclude that the fault offset proposed by Benson (2006) does not affect stratigraphic units of Quaternary age in the site vicinity. In a January 25, 2012, response to RAI 44, Question 02.05.03-1, the applicant stated that a cross section constructed by Benson (2006) based on the borehole data indicated the proposed fault offset does not deform overlying Quaternary units.

Based on its review of SSAR Section 2.5.3.1.2 and the January 25, 2012, response to RAI 44, Question 02.05.03-1, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that the postulated fault of Benson (2006), while it likely exists in the subsurface, does not deform overlying Quaternary units and does not exhibit any surface expression in the site vicinity. The staff makes this conclusion because the

subsurface data provided by Benson (2006) strongly support it. Accordingly, the staff considers RAI 44, Question 02.05.03-1 resolved.

Regarding the New Castle County faults postulated by Spoljaric (1972, 1973, 1974, and 1979), the applicant stated that no published geologic studies reviewed for the PSEG Site indicated the presence of these features or any other possible Quaternary structures capable of producing tectonic surface deformation in the site vicinity. However, the applicant did not provide the specific published information sources used to conclude that no geologic studies indicate the presence of tectonic structures of Quaternary age, including the New Castle County faults, in the site vicinity. Therefore, in RAI 44, Question 02.05.03-2, the staff requested that the applicant clarify the published data sources used to make the conclusion and to summarize the relevant data supporting it. In a January 25, 2012, response to RAI 44, Question 02.05.03-2, the applicant cited multiple references presenting results of geologic mapping and data from borings and other subsurface investigation methods that document a lack of faulting of the Quaternary strata in the site vicinity (e.g., Stanford, 2004 and 2006; Benson and Pickett, 1986; Woodruff and Thompson, 1972; Pickett, 1970).

Based on its review of SSAR Section 2.5.3.1.2 and the January 25, 2012, response to RAI 44, Question 02.05.03-2, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that the inferred basement faults of Spoljaric (1972 and 1973) and his postulated faults related to lineaments (Spoljaric, 1974 and 1979), which comprise the New Castle County faults, if they exist, do not deform Quaternary deposits in the site vicinity or site area. The staff makes this conclusion because field data, including that documented by geologic mapping and borehole logs, strongly support it. Accordingly, the staff considers RAI 44, Question 02.05.03-2 resolved.

2.5.3.4.1.2 Previous Site Investigations.

In SSAR Section 2.5.3.1.4, the applicant discussed previous site investigations and summarized information derived from the updated FSARs for the SGS (PSEG, 2007) and HCGS (PSEG, 2008). Since the proposed PSEG Site lies immediately north of these two operating plants, information in the two updated FSARs is important for qualifying geologic characteristics of the proposed site.

The staff focused the review of SSAR Section 2.5.3.1.4 on statements made by the applicant that investigations performed for the two operating plants did not reveal any evidence for surficial folding or faulting or prior earthquakes in the site area, and that near-surface stratigraphic units exhibit planar bedding without any indication of disruption by faulting beneath the PSEG Site location. Although the applicant made these important conclusions, SSAR Section 2.5.3.1.4 does not summarize the relevant information from the two updated FSARs used to support them. Therefore, in RAI 44, Question 02.05.03-3, the staff requested that the applicant summarize the relevant information from the two updated FSARs that support the conclusions presented in SSAR Section 2.5.3.1.4.

In a January 25, 2012, response to RAI 44, Question 02.05.03-3, the applicant provided additional information supporting each of the conclusions. In regard to a lack of evidence for folding or faulting in the site area, the applicant reported that HCGS site characterization investigations supplied supporting data based on literature reviews, 100 subsurface borings, seismic refraction surveys, and examination and geologic mapping of site excavations.
The applicant also reported that SGS site characterization investigations provided supporting data from literature reviews, geologic reconnaissance of the site and surrounding area,

35 subsurface borings, and geophysical tests. Regarding the lack of evidence for prior earthquakes, the applicant explained that examination of excavation walls and borehole data at the HCGS site revealed no evidence of earthquake-induced liquefaction on foundation soils. The applicant also explained that there was no indication of earthquake-induced liquefaction of surficial soil materials at the SGS site. Regarding the planar characteristics of bedding in stratigraphic units underlying the PSEG Site area, the applicant stated that borehole data, seismic reflection data, and geologic mapping of the plant excavation discussed in the HCGS updated FSAR documented that contacts between stratigraphic units were planar and did not show any abrupt changes in elevations due to faulting. In addition, the applicant noted that borehole data from SGS site investigations indicated the base of the Quaternary was uniform across the site at a depth of approximately 10.7 m (35 ft) and Cretaceous strata were planar with gentle dips to the southeast beneath the site.

Based on its review of SSAR Section 2.5.3.1.4 and the January 25, 2012, response to RAI 44, Question 02.05.03-3, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that no tectonic surface faulting or folding exists in the site area; surficial materials in the site area exhibit no evidence for prior earthquakes as could be indicated by liquefaction; and planar stratigraphic units show no disruption due to tectonic faulting or folding at the site location. The staff makes this conclusion because field data derived from site characterization investigations for the SGS and HCGS strongly support it, as do field observations made by staff during the September 2011 field audit. Accordingly, the staff considers RAI 44, Question 02.05.03-3 resolved.

2.5.3.4.1.3 Aerial Imagery Analysis.

In SSAR Section 2.5.3.1.5, the applicant described aerial imagery analysis and discussed lineaments identified on aerial imagery by Spoljaric (1974 and 1979) that trend into the site vicinity, two of which also extend into the site area. Figure 2.5.3-1 of this report shows the locations of these surficial linear features, which the applicant analyzed because they could possibly indicate the presence of near-surface tectonic structures such as folds or faults.

The staff focused the review of SSAR Section 2.5.3.1.5 on understanding the process used by the applicant to document the conclusion that none of the lineaments identified by Spoljaric (1974 and 1979) in the site vicinity or site area exhibited any evidence of surface faulting or folding, particularly since certain of these lineaments were not accessible for direct field examination due to the low-relief marshy landscape that characterizes much of the site area. The applicant indicated that further evaluation of the inaccessible lineaments relied on aerial reconnaissance and ground observations from nearby vantage points. Therefore, in RAI 44, Question 02.05.03-4, the staff requested that the applicant explain the process used for documenting that none of the lineaments in the site vicinity or site area showed features indicative of surface or near-surface tectonic deformation (i.e., faulting or folding); to identify the lineaments evaluated directly in the field; and to more clearly describe the approach applied to evaluate those features determined to be inaccessible.

In a January 25, 2012, response to RAI 44, Question 02.05.03-4, the applicant described ground reconnaissance traverses performed in the site vicinity and site area in March, May, and July 2009 and an aerial reconnaissance study conducted in connection with the July 2009 ground reconnaissance. The applicant provided figures illustrating locations of lineaments relative to the track logs for the March, May, and July 2009 ground reconnaissance traverses and the July 2009 aerial reconnaissance investigations, as well as points marking the positions

of stops made to directly examine specific features during the May and July 2009 ground reconnaissance traverses. The applicant evaluated the lineaments in relation to their possible association with alignment of vegetation, cultural features, and tectonic surface deformation, and stated that the only observation of inaccessible lineaments was from the air. The applicant also provided figures that showed there was little to no surface expression of many of the lineaments, and certainly no evidence of tectonic deformation features in the site vicinity or site area. The applicant reiterated that the ground and aerial reconnaissance investigations did not reveal any association of lineaments with tectonic surface deformation.

Based on its review of SSAR Section 2.5.3.1.5 and the January 25, 2012, response to RAI 44, Question 02.05.03-4, including examination of figures provided in the RAI response illustrating locations of lineaments relative to track logs for ground and aerial reconnaissance of the lineaments and points marking positions of stops made to directly examine specific features during foot traverses, the staff concludes there is no indication that any of the lineaments identified by Spoljaric (1974 and 1979) show features indicative of tectonic surface or near-surface folding or faulting. The staff makes this conclusion because the ground and aerial reconnaissance investigations of the lineaments performed by the applicant strongly support it. Accordingly, the staff considers RAI 44, Question 02.05.03-4 resolved.

2.5.3.4.1.4 Current Aerial and Field Reconnaissance.

In SSAR Section 2.5.3.1.6, the applicant discussed current aerial and field reconnaissance investigations implemented for evaluating the faults postulated by Pazzaglia (1993) and Marple (2004) to extend into the site vicinity and the possible presence of paleoliquefaction features in the site vicinity. Figure 2.5.3-1 of this report shows the locations of the postulated faults of Pazzaglia (1993) and Marple (2004).

In the January 13, 2012, and December 28, 2011, responses to RAI 42, Question 02.05.01-4 and RAI 42, Question 02.05.01-5, respectively, the applicant provided a detailed discussion of the postulated faults of Pazzaglia (1993) and Marple (2004) and the rationale for concluding that none of these features exhibits any evidence for tectonic deformation in the site vicinity. Section 2.5.1.4.1.3.1 of this report presents the staff's evaluation of these two RAI responses. Therefore, the staff focused the review of SSAR Section 2.5.3.1.6 on understanding the approach implemented to document the apparent lack of earthquake-induced paleoliquefaction features in the site vicinity as reported by the applicant. SSAR Section 2.5.3.1.6 did not include a description of the investigative approach. Therefore, in RAI 44, Question 02.05.03-5, the staff requested that the applicant describe the approach used to search for paleoliquefaction features in the site vicinity, and also to discuss the susceptibility of materials examined to assess the presence of paleoliquefaction features.

In a January 11, 2012, response to RAI 44, Question 02.05.03-5, the applicant stated that the approach to documenting the presence of paleoliquefaction features and possible associated faults in the site vicinity involved examination of historical and recent aerial photographs and aerial and ground reconnaissance. Regarding properties of the materials examined for assessing the presence of paleoliquefaction features in the site vicinity, the applicant indicated that the greatest likelihood for formation and preservation of liquefaction features would occur in association with the youngest (i.e., at the lowest elevation) fluvial terraces along the Delaware Bay and its tributaries and the Delaware River. The applicant explained that a sedimentary sequence with appropriate material properties (i.e., fine-grained sands capped by non-porous silty and clay-rich layers to provide a hydrologic confining unit) and a shallow water table were

most likely to exist for the youngest terraces, rendering them more susceptible to earthquake-induced liquefaction. The applicant referred to a figure provided in the January 13, 2012, response to RAI 42, Question 02.05.01-4, which showed extensive coverage of areas containing the materials most appropriate for forming and preserving liquefaction features by ground and aerial reconnaissance investigations conducted for characterization of the proposed PSEG Site, none of which revealed any evidence for earthquake-induced paleoliquefaction features or possible associated faults. The applicant acknowledged that large portions of the site vicinity are tidal salt marshes and any liquefaction features developed in that environment would be relatively quickly degraded and not easily recognized during aerial or ground reconnaissance investigations.

Based on its review of SSAR Section 2.5.3.1.6 and the January 11, 2012, response to RAI 44, Question 02.05.03-5, including the figure provided in the January 13, 2012, response to RAI 42, Question 02.05.01-4, the staff concludes that the applicant implemented the proper approach for assessing the presence of earthquake-induced paleoliquefaction features without finding any evidence for earthquake-induced paleoliquefaction features or possible associated faults. The staff makes this conclusion because the applicant applied the appropriate ground and aerial reconnaissance investigations without revealing any evidence for such features or associated faults. Accordingly, the staff considers RAI 44, Question 02.05.03-5 resolved.

In addition, the applicant identified elliptical to round, light-colored patches in the field near the proposed PSEG Site and on aerial photographs of the Delaware Bay area as a result of the reconnaissance studies performed to determine whether earthquake-induced paleoliquefaction features occurred in the site vicinity. The applicant stated that these features formed as a result of periglacial processes, but did not address the possibility that they may have formed in response to earthquake-induced paleoliquefaction. Therefore, in RAI 44, Question 02.05.03-6, the staff specifically requested that the applicant discuss the approach used to evaluate the patches described in SSAR Section 2.5.3.1.6 leading to the conclusion that the features formed as a result of periglacial processes rather than earthquake-induced paleoliquefaction. In a January 11, 2012, response to RAI 44, Question 02.05.03-6, the applicant indicated that direct field examination of one water-filled, light-colored patch did not reveal any definitive evidence of a liquefaction origin for the patch. The applicant explained that these patches occur over a broad area on both the Delmarva Peninsula, which includes most of Delaware and portions of Maryland and Virginia, and in the Coastal Plain of New Jersey, and cited references (e.g., Newell, 2005; Losco et al., 2010) indicating these features are most likely the result of periglacial processes based on their characteristically broad distribution.

Based on its review of SSAR Section 2.5.3.1.6 and the January 11, 2012, response to RAI 44, Question 02.05.03-6, and independent examination of literature cited by the applicant in the SSAR and the RAI response, the staff concludes that the elliptical to round, light-colored patches that occur in the site vicinity most likely formed as a result of periglacial processes. The staff makes this conclusion because these features show a broad distribution within an area characterized by periglacial affects, and there is no evidence for the presence of earthquake-induced paleoliquefaction features or associated faulting in the site vicinity. Accordingly, the staff considers RAI 44, Question 02.05.03-6 resolved.

Based on its review of SSAR Section 2.5.3.1 and the January 11, 2012, responses to RAI 44, Questions 02.05.03-5 and 02.05.03-6, January 25, 2012, response to RAI 44, Questions 02.05.03-1 through 02.05.03-4, and independent review of references cited in the SSAR and the RAI responses, the staff finds that the applicant provided a thorough and

accurate description of geologic, seismic, and geophysical investigations in support of the PSEG ESP application.

2.5.3.4.2 Geologic Evidence, or Absence of Evidence, for Tectonic Surface Deformation

The staff focused the review of SSAR Section 2.5.3.2, "Geologic Evidence, or Absence of Evidence for Tectonic Surface Deformation," on the discussions of Paleozoic structures exposed in the Piedmont; faults buried by Coastal Plain sediments; and hypothesized tectonic features provided by the applicant. The staff particularly concentrated on developing a better understanding of the degree of resolution of data used to confirm a lack of displacement of Quaternary strata overlying postulated buried faults in the site vicinity to clarify what amount of displacement would not be detectable, and of the locations of trenches placed to investigate lineaments defined by Spoljaric (1979) in the site vicinity.

2.5.3.4.2.1 Paleozoic Structures Exposed in the Piedmont.

In SSAR Section 2.5.3.2.1, the applicant discussed Paleozoic structures exposed in the Piedmont and described the Rosemont shear zone and thrust faults bordering exposures of the Baltimore gneiss, which are the two primary Paleozoic tectonic structures mapped within the site vicinity. Figure 2.5.3-1 of this report shows the locations of these features.

The staff focused the review of SSAR Section 2.5.3.2.1 on the applicant's discussion of published information documenting a Paleozoic age for these structures (Valentino et al., 1995; Woodruff and Thompson, 1975; Krol et al., 1999; Alcock, 1994; Faill, 1998; Wagner and Srogi, 1987). Based on data from these information sources, the applicant reported that timing of displacement along the Rosemont shear zone was Devonian to Carboniferous (> 299 Ma), and that for the bordering thrust faults was greater than 251 Ma.

Based on its review of SSAR Section 2.5.3.2.1 and independent examination of references cited therein, the staff concludes that the Rosemont shear zone and thrust faults bordering exposures of the Baltimore gneiss are Paleozoic in age. The staff makes this conclusion because radiometric age dates and field relationships strongly support it.

2.5.3.4.2.2 Faults Buried by Coastal Plain Sediments.

In SSAR Section 2.5.3.2.2, the applicant described faults buried by Coastal Plain sediments. The applicant discussed subsurface faults and possible faults and surficial lineaments interpreted by Spoljaric (1972, 1973, 1974 and 1979) to occur in the site vicinity and site area, known collectively as the New Castle County faults. The applicant also discussed the buried faults proposed by Benson (1992 and 2006) to occur in the site vicinity, including Mesozoic basin-bounding faults (Benson, 1992) and one basement offset (Benson, 2006).
Figures 2.5.3-1 and 2.5.3-2 of this report show the locations of the postulated basement faults and fault-related lineaments, which comprise the New Castle County faults of Spoljaric (1972, 1973, 1974 and 1979). Figure 2.5.3-1 of this report also shows the locations of the buried structures proposed by Benson (1992 and 2006).

The staff focused the review of SSAR Section 2.5.3.2.2 on the applicant's discussion of the subsurface investigative methods used by Benson (1992 and 2006) to determine that the buried faults he described are pre-Quaternary in age and that locations of the faults are accurate. The staff also focused its review on the applicant's statement that McLaughlin et al. (2002) implemented trenching, borehole, and seismic investigations to assess a lineament identified by

Spoljaric (1979) based on satellite imagery for evidence of Quaternary deformation. Figure 2.5.3-2 of this report illustrates the location of the area investigated by McLaughlin et al. (2002) relative to the lineaments identified by Spoljaric (1974 and 1979), which, along with his inferred basement faults (Spoljaric, 1972 and 1973), comprise the postulated pre-Cretaceous New Castle County faults.

In RAI 44, Question 02.05.03-8, the staff requested that the applicant clarify the degree of resolution in the data (i.e., gravity and magnetic anomaly maps, boreholes, and seismic lines) used by Benson (1992) to determine that there was no evidence for displacement of Quaternary stratigraphic units in the site vicinity related to faults bounding three buried Mesozoic basins, and whether adequate data existed to eliminate concern about a subsurface Mesozoic basin and an associated basin-bounding fault underlying the site area. In a February 10, 2012, response to RAI 44, Question 02.05.03-8, the applicant reported that seismic reflection data derived from Sheridan et al. (1991), used to image Mesozoic basin-bounding faults and conclude that no rock units younger than Cretaceous (145.5 to 65.5 Ma) reveal any disruption by faulting, have a vertical resolution of about 9 m (30 ft). This resolution is relatively close to the maximum reported offset of 13.7 m (45 ft) in the Cretaceous stratigraphic section. The applicant pointed out that resolution from field and aerial reconnaissance is not easily quantified, and is strongly dependent on vegetation density. The applicant also stated that LIDAR data for the site area give elevation ranges for topographic expression of surficial features (particularly terraces along the Delaware estuary) on the order of 6 to 9 m (20 to 30 ft), which makes correlation of individual topographic surfaces problematic and limits the use of the terrace surfaces for detecting tectonic deformation. In addition, resolution limits for detecting faults in borings is dependent on spacing of boreholes and regional dip and orientation of geologic strata as well as assumptions on strata variability. Finally, the applicant noted that identification of Mesozoic basins from magnetic and gravity data alone is uncertain because anomalies result from multiple geologic conditions other than the presence of a basin. The applicant concluded that the map produced by Benson (1992) continues to provide the best available representation of Mesozoic basins and basin-bounding faults for the site vicinity, and the data from Benson (1992) do not show conclusive evidence for the presence of a basin within the site area.

Based on its review of SSAR Section 2.5.3.2.2 and the February 10, 2012, response to RAI 44, Question 02.05.03-8, and independent examination of references cited in the SSAR and the RAI response, the staff concludes that data resolution is adequate to detect fault displacements of around 6 to 9 m (20 to 30 ft) and no evidence currently exists to indicate the presence of a Mesozoic basin or basin-bounding fault in the site area. The staff makes this conclusion because the subsurface investigative methods have well-documented resolutions and no investigations have indicated the presence of a Mesozoic basin in the site area. Accordingly, the staff considers RAI 44, Question 02.05.03-8 resolved.

In RAI 44, Question 02.05-03-9, the staff requested that the applicant clarify the degree of resolution in the geophysical well log data used by Benson (2006) to determine that the subsurface offset in basement rock units, located about 24 to 32 km (15 to 20 mi) north-northwest of the site, does not disrupt stratigraphic units of Quaternary age. In a February 10, 2012, response to RAI 44, Question 02.05.03-9, the applicant reported that Benson (2006) interpreted the apparent fault offset, discovered in a geophysical well log study based on two boreholes on opposite sides of the inferred fault, based on different elevations of marker stratigraphic units in the Cretaceous Potomac Group. The applicant stated that continuous logging occurred, suggesting a high degree of vertical resolution in the logs for

registering vertical offset on the inferred structure. The applicant also reported that borings near a location having a surface exposure of the base of the Quaternary did not reveal any disruption of that surface due to faulting.

Based on its review of SSAR Section 2.5.3.2.2 and the February 10, 2012, response to RAI 44, Question 02.05.03-9, and independent examination of references cited in the SSAR and the RAI response, the staff concludes that, within the resolution limits of the methods applied, Quaternary units do not show any deformation related to the inferred basement fault of Benson (2006). The staff makes this conclusion because subsurface data strongly support it. Accordingly, the staff considers RAI 44, Question 02.05.03-9 resolved.

In RAI 44, Question 02.05.03-10, the staff requested that the applicant specify the locations of the seismic reflection line, trenches, and boreholes placed by McLaughlin et al. (2002) to investigate surficial conditions across one of the northeast-trending lineaments defined by Spoljaric (1979) and used to support the conclusion that the lineaments do not represent Quaternary faults. The staff also requested that the applicant provide details about the information derived from the trenches, borehole logs, and seismic line. Figure 2.5.3-2 of this report shows the location of the seismic line relative to the lineaments that comprise the New Castle County faults. In a February 10, 2012, response to RAI 44, Question 02.05.03-10, the applicant stated that the information reported by McLaughlin et al. (2002) included a seismic reflection line designed to image the top 457 m (1500 ft) of subsurface stratigraphy, three borings 107 to 158 m (350 to 550 ft) in depth designed to intersect postulate faults, and five 1.5 to 2.4 m (5 to 8 ft) deep trenches for examining surficial strata. The applicant stated that location of the borings and trenches along the seismic line was within a mile of the northeast-trending lineament, and that the PSEG Site was about 19.3 km (12 mi) south of the study area of McLaughlin et al. (2002) as shown in Figure 2.5.3-2 of this report. The applicant reported that the field investigations conducted by McLaughlin and others (2002) did not reveal any evidence of shallow tectonic deformation due to folding or faulting associated with the lineament along the seismic transect.

Based on its review of SSAR Section 2.5.3.2.2 and the February 10, 2012, response to RAI 44, Question 02.05.03-10, and independent examination of references cited in the SSAR and the RAI response, the staff concludes that no geologic evidence exists for faulting associated with the lineaments defined by Spoljaric (1974 and 1979). The staff makes this conclusion because the field evidence strongly supports it. Accordingly, the staff considers RAI 44, Question 02.05.03-10 resolved.

2.5.3.4.2.3 Hypothesized Features.

In SSAR Section 2.5.3.2.3, the applicant discussed potential tectonic features hypothesized to occur in the site vicinity and site area, specifically the faults of Pazzaglia (1993) and Marple (2004).

The staff focused the review of SSAR Section 2.5.3.2.3 on the applicant's descriptions of the hypothesized faults of Pazzaglia (1993) and Marple (2004). As indicated in Section 2.5.3.4.1.4 of this report, the applicant provided a detailed discussion of these two postulated faults and the rationale for concluding that neither of these features exhibit any evidence for tectonic deformation in the site vicinity in the responses to RAI 42, Questions 02.05.01-4 and 02.05.01-5. Section 2.5.1.4.1.3.1 of this report presents the staff's technical evaluation of these two RAI responses.

Based on its review of SSAR Section 2.5.3.2.3 and information provided by the applicant in the January 13, 2012, and December 28, 2011, responses to RAI 42, Question 02.05.01-4, and RAI 42, Question 02.05.01-5, respectively, discussed in Section 2.5.1.4.1.3.1 of this report, and independent examination of references cited in the SSAR and RAI responses, the staff concludes no evidence exits that either of these two hypothesized features, it they exist, are faults in the site vicinity. The staff makes this conclusion because field data strongly support it. In addition, during the site audit conducted in September 2011, the staff examined Pleistocene (2.6 to 0.01 Ma) estuarine sediments comprising the Turkey Point Beds in the vicinity of the Turkey Point Lighthouse, located on the eastern side of Chesapeake Bay and west of the PSEG Site near the boundary of the site vicinity, and found no field evidence for Quaternary faulting associated with the hypothesized fault of Pazzaglia (1993).

Based on its review of SSAR Section 2.5.3.2 and the February 10, 2012, response to RAI 44, Questions 02.05.03-8 through 02.05.03-10, independent examination of references cited in the SSAR and RAI responses, and field observations made during the September 2011 site audit, the staff finds that the applicant provided a thorough and accurate description of geologic evidence, or absence of evidence, for tectonic surface deformation in support of the PSEG ESP application.

2.5.3.4.3 Correlation of Earthquakes with Capable Tectonic Sources

In SSAR Section 2.5.3.3, the applicant addressed the correlation of earthquakes with capable tectonic sources that could generate tectonic surface deformation and vibratory ground motion. Based on information derived for the HCGS site (PSEG, 2008) and assessment of the instrumentally-recorded February 28, 1973, event by Sbar and others (1975), the applicant concluded no earthquakes that occurred in or near the site vicinity have been correlated with a known capable tectonic source.

The staff focused the review of SSAR Section 2.5.3.3 on the applicant's statement that no earthquakes that occurred in or near the site vicinity have been correlated with a known capable tectonic source. Based on its review of SSAR Section 2.5.3.3 and independent examination of references cited in that SSAR section, the staff concludes that no earthquakes within the site vicinity can be correlated with tectonic sources capable of generating tectonic surface deformation and vibratory ground motion. The staff makes this conclusion because geologic and seismic data strongly support it.

Based on its review of SSAR Section 2.5.3.3 and independent examination of references cited in the SSAR, the staff finds that the applicant provided a thorough and accurate description of the correlation of earthquakes with capable tectonic sources in support of the PSEG ESP application.

2.5.3.4.4 Ages of Most Recent Deformations

In SSAR Section 2.5.3.4, the applicant addressed ages of most recent deformations. The applicant concluded no evidence exists for surficial tectonic deformation related to faulting or folding within the site area based on investigations performed for characterization of the PSEG Site, as well as data presented in the updated FSARs for both the SGS (PSEG, 2007) and HCGS (PSEG, 2008).

The staff focused the review of SSAR Section 2.5.3.4 on the applicant's statement that no evidence exists for surficial tectonic deformation within the site area. Based on its review of

SSAR Section 2.5.3.4 and independent examination of references cited in the SSAR, the staff concludes that there are no surficial deformation features requiring an age assessment. The staff makes this conclusion because field data strongly support it.

Based on its review of SSAR Section 2.5.3.4 and independent examination of references cited in the SSAR, the staff finds that the applicant provided a thorough and accurate description of ages of most recent deformation in support of the PSEG ESP application.

2.5.3.4.5 Relationship of Tectonic Structures in the Site Area to Regional Tectonic Structures

In SSAR Section 2.5.3.5, the applicant addressed the relationship of tectonic structures in the site area to regional tectonic structures. The applicant concluded that, since no evidence exists for tectonic deformation in the site vicinity or site area as reported in SSAR Section 2.5.3.2, "Geologic Evidence, or Absence of Evidence, for Tectonic Surface Deformation," and summarized in Section 2.5.3.2.2 of this report, there is no relationship of tectonic structures in the site area to any regional tectonic features.

The staff focused the review of SSAR Section 2.5.3.5 on the applicant's statement that there is no relationship of tectonic structures in the site area to any regional tectonic features. Based on its review of SSAR Section 2.5.3.5 and independent examination of references cited in SSAR Section 2.5.3.2, which provided the rationale for stating that there is no evidence for tectonic deformation in the site vicinity or site area, the staff concludes that no relationship exists between tectonic structures in the site area and regional tectonic features. The staff makes this conclusion because field data document a lack of tectonic deformation features in the site area.

Based on its review of SSAR Section 2.5.3.5 and independent examination of references cited in SSAR Section 2.5.3.2, the staff finds that the applicant provided a thorough and accurate description of the relationship of tectonic structures in the site area to regional tectonic structures in support of the PSEG ESP application.

2.5.3.4.6 Characterization of Capable Tectonic Sources

In SSAR Section 2.5.3.6, the applicant addressed the characterization of capable tectonic sources that could generate tectonic surface deformation and vibratory ground motion within the site area. The applicant concluded no capable tectonic sources exist within the site area that would require characterization.

The staff focused the review of SSAR Section 2.5.3.6 on the applicant's statement that no capable tectonic sources exist within the site area which would require characterization. Based on its review of SSAR Section 2.5.3.6, as well as detailed discussions in SSAR Sections 2.5.1.1.4.2, "Principal Tectonic Structures"; 2.5.1.2.2.4, "Structural Geology"; 2.5.2.2, "Geologic and Tectonic Characteristics of the Site and Region"; 2.5.2.3, "Correlation of Earthquake Activity with Seismic Sources"; 2.5.2.4.2.2, "New Seismic Source Characterizations"; and 2.5.3.3, "Correlation of Earthquakes with Capable Tectonic Sources"; and independent examination of references cited in the SSAR sections, the staff concludes that there are no capable tectonic sources within the site area that require characterization. The staff makes this conclusion because there is a preponderance of geologic and seismic data that strongly support it, including direct field observations made by staff during the September 2011 site audit.

Based on its review of SSAR Section 2.5.3.6 and other multiple SSAR sections as specified in the above paragraph, independent examination of references cited in the SSAR sections, and field observations made during the September 2011 site audit, the staff finds that the applicant provided a thorough and accurate description of the characterization of capable tectonic sources in support of the PSEG ESP application.

2.5.3.4.7 Designation of Zones of Quaternary Deformation in the Site Region

In SSAR Section 2.5.3.7, the applicant addressed the designation of zones of Quaternary deformation in the site region. The applicant cross-referenced SSAR Section 2.5.1.1.4.2.5, "Potential Quaternary Tectonic Features within the Site Region," which documents a lack of Quaternary tectonic deformation features or zones in the site region, and concluded the site region does not contain any zones of Quaternary deformation that require additional detailed investigations.

The staff focused the review of SSAR Section 2.5.3.7 on the applicant's statement that no zones of Quaternary deformation occur in the site region. Based on its review of SSAR Section 2.5.3.7 and SSAR Section 2.5.1.1.4.2.5 and independent examination of references cited in the SSAR sections, the staff concludes that no evidence exists for zones of Quaternary deformation in the site region. The staff makes this conclusion because there is a considerable geologic data to support it, including direct field observations made by staff during the September 2011 site audit.

Based on its review of SSAR Sections 2.5.3.7 and 2.5.1.1.4.2.5, independent examination of references cited in the SSAR sections, and field observations made during the September 2011 site audit, the staff finds that the applicant provided a thorough and accurate description of the designation of zones of Quaternary deformation in the site region in support of the PSEG ESP application.

2.5.3.4.8 Potential for Surface Tectonic Deformation and Non-Tectonic Deformation at the Site

In SSAR Section 2.5.3.8, the applicant addressed the potential for tectonic and non-tectonic surface deformation at the site location. The applicant cross-referenced SSAR Section 2.5.3.1.6, "Current Aerial and Field Reconnaissance," which documents that examination of aerial imagery and LIDAR data collected to characterize the PSEG Site did not reveal any evidence for surface tectonic deformation at the site location, and concluded that no potential exists for surface tectonic deformation at the site location. Regarding non-tectonic surface deformation, the applicant cross-referenced SSAR Section 2.5.1.2.5, "Site Engineering Geology Evaluation," which documents the absence of human-induced activities and ground collapse due to dissolution of carbonate rocks, and concluded that no potential exists for non-tectonic surface deformation at the site location.

The staff focused the review of SSAR Section 2.5.3.8 on the applicant's statement that no potential exists for tectonic or non-tectonic surface deformation at the site location. Based on its review of SSAR Sections 2.5.3.8, 2.5.3.1.6, and 2.5.1.2.5, as well as independent examination of references cited in those SSAR sections, the staff concludes that there is no potential for tectonic or non-tectonic surface deformation at the site location. The staff makes this conclusion because current and previous subsurface investigations in the site area indicate strata younger than 23 Ma are planar without any evidence of tectonic deformation; aerial imagery and LIDAR data collected to characterize the site did not reveal any evidence for faulting; karst features related to dissolution of the Cockeysville Marble, which do exist in the

site vicinity, do not occur in the site area since that unit is not present there; and no potentially detrimental human-related activities are on-going at the site location. Direct field observations made by the staff during the September 2011 site audit also support the staff's conclusion.

Based on its review of SSAR Sections 2.5.3.8, 2.5.3.1.6, and 2.5.1.2.5, independent examination of references cited in those SSAR sections, and field observations made during the September 2011 site, the staff finds that the applicant provided a thorough and accurate description of the potential for both tectonic and non-tectonic surface deformation at the site location in support of the PSEG ESP application.

2.5.3.5 Geologic Mapping Permit Condition

For evaluation of suitability of a proposed site, requirements in 10 CFR 100.23, "Geologic and Seismic Siting Criteria," specifically 10 CFR 100.23(c), indicate that geologic data on tectonic and non-tectonic surface deformation must be obtained through review of pertinent literature and field investigations. 10 CFR 100.23(d) explicitly states that geologic and seismic siting factors considered for design must include determination of the potential for tectonic and non-tectonic surface deformation at the proposed site. In addition, guidance in RG 1.132 indicates that excavations for safety-related structures and other excavations important for verifying subsurface conditions at the site should be mapped in detail by geologists. RG 1.208 specifically states that faults exposed in site excavations should be mapped and assessed in regard to rupture potential while walls and floors of the excavations are exposed, to include assessment of non-tectonic surface deformation. In SSAR Section 2.5.4.5.4.1, "Mat Foundation Evaluation," the applicant acknowledged the need to perform geologic mapping for documenting the presence or absence of faults and shear zones in plant foundation materials. Therefore, the staff considers it the responsibility of the COL or CP applicant to perform geologic mapping of future excavations for safety-related structures at the PSEG Site. This activity is Permit Condition 3, the required actions for which are as follows:

Permit Condition 3

> An applicant for a COL or CP referencing this early site permit shall perform detailed geologic mapping of excavations for safety-related structures; examine and evaluate geologic features discovered in those excavations; and notify the Director of the Office of New Reactors, or the Director's designee, once excavations for safety-related structures are open for examination by NRC staff.

2.5.3.6 Conclusion

As documented in Sections 2.5.3.1 through 2.5.3.4 of this report, the staff reviewed and evaluated information related to surface tectonic and non-tectonic deformation submitted by the applicant in SSAR Section 2.5.3 of the PSEG ESP application. The review and evaluation made it possible for the staff to confirm that this information provides an adequate basis for concluding that there is no potential for tectonic and non-tectonic surface deformation in the site vicinity and site area or at the site location that could adversely affect suitability of the PSEG Site.

The staff further concludes that the applicant identified and appropriately characterized all seismic sources significant for determining the SSE for the ESP site in accordance with regulatory requirements stated in 10 CFR 100.23(c) and 10 CFR 100.23(d) and guidance provided in RG 1.208 and NUREG-0800, Section 2.5.3. In addition, the staff finds that the

applicant properly characterized the potential for tectonic and non-tectonic surface deformation in the site vicinity and site area and at the site location. The staff also concludes there is no potential for the effects of human activity, including surface or subsurface mining, oil or gas extraction or injection, or groundwater injection or withdrawal, to compromise the safety of the site.

Finally, based on results of the review and evaluation of SSAR Section 2.5.3, and subject to Permit Condition 3, the staff concludes that the applicant provided a thorough and accurate description of the potential for tectonic and non-tectonic surface deformation in the site vicinity and site area and at the site location in full compliance with regulatory requirements in 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d) and in accordance with guidance in RG 1.208 and NUREG-0800, Section 2.5.3.

2.5.4 Stability of Subsurface Materials and Foundations

2.5.4.1 Introduction

In SSAR Section 2.5.4, the applicant presented its evaluation of the stability of subsurface materials and foundations that relate to the PSEG Site. The properties and stability of the soil and rock underlying the site are important to the safe design and siting of the plant. The information provided by the applicant in SSAR Section 2.5.4 addresses: (1) Geologic features in the site vicinity; (2) static and dynamic engineering properties of soil and rock strata underlying the site; (3) the relationship of the foundations for safety-related facilities and the engineering properties of underlying materials; (4) results of geophysical surveys, including in-hole and cross-hole explorations; (5) safety-related excavation and backfill plans and engineered earthwork analysis and criteria; (6) groundwater conditions and piezometric pressure in all critical strata as they affect the loading and stability of foundation materials; (7) responses of site soils or rocks to dynamic loading; (8) liquefaction potential and consequences of liquefaction of all subsurface soils, including the settlement of foundations; (9) earthquake design bases; (10) results of investigations and analyses conducted to determine foundation material stability, deformation, and settlement under static conditions; (11) criteria, references, and design methods used in static and seismic analyses of foundation materials; (12) techniques and specifications to improve subsurface conditions, which are to be used at the site to provide suitable foundation conditions; and any additional information deemed necessary in accordance with 10 CFR Part 52.

2.5.4.2 Summary of Application

In SSAR Section 2.5.4, the applicant provided a set of bounding parameters, as part of the applicant's plant parameter envelope (PPE). The applicant used design parameter information from the following reactor designs in development of the PPE: Single Unit U.S. Evolutionary Power Reactor (U.S. EPR), Single Unit Advanced Boiling Water Reactor (ABWR), Single Unit U.S. Advanced Pressurized-Water Reactor (US-APWR), and Dual Unit Advanced Passive 1000 (AP1000) (See Table 1.3-1, "Plant Parameter Envelope," in SSAR Section 1.3.3, "PSEG SITE PLANT PARAMETER ENVELOPE").

2.5.4.2.1 Geologic Features and Site Stratigraphy

SSAR Section 2.5.4.1 refers to SSAR Section 2.5.1.1 and 2.5.1.2 for a complete description of the regional and site geology, including, physiography and geomorphology, geologic history, stratigraphy, tectonic setting, seismicity, structural geology, and site engineering geology

evaluation. In SSAR Section 2.5.4.1.1, the applicant described the PSEG Site stratigraphy. The applicant stated that it performed 16 geotechnical borings divided into two groups: NB - represents the borings covering the northern portion of the site, and EB – represents the borings covering the eastern portion of the site. The applicant indicated in SSAR Figure 2.5.4.1-2 that the nuclear island will be located at the northern portion of the site. Based on the information collected during the site investigation, the applicant identified 14 stratigraphic layers. The geotechnical engineering strata listed from the ground surface are: Artificial Fill, Hydraulic Fill, Alluvium, Kirkwood Formation, Vincentown and Hornerstown Formations, Navesink Formation, Mount Laurel Formation, Wenonah Formation, Mashalltown Formation, Englishtown Formation, Woodbury Formation, Merchantville Formation, Magothy Formation, and Potomac Formation. Figure 2.5.4-1 of this report shows a stratigraphic cross-section oriented along the regional southeastward dip.

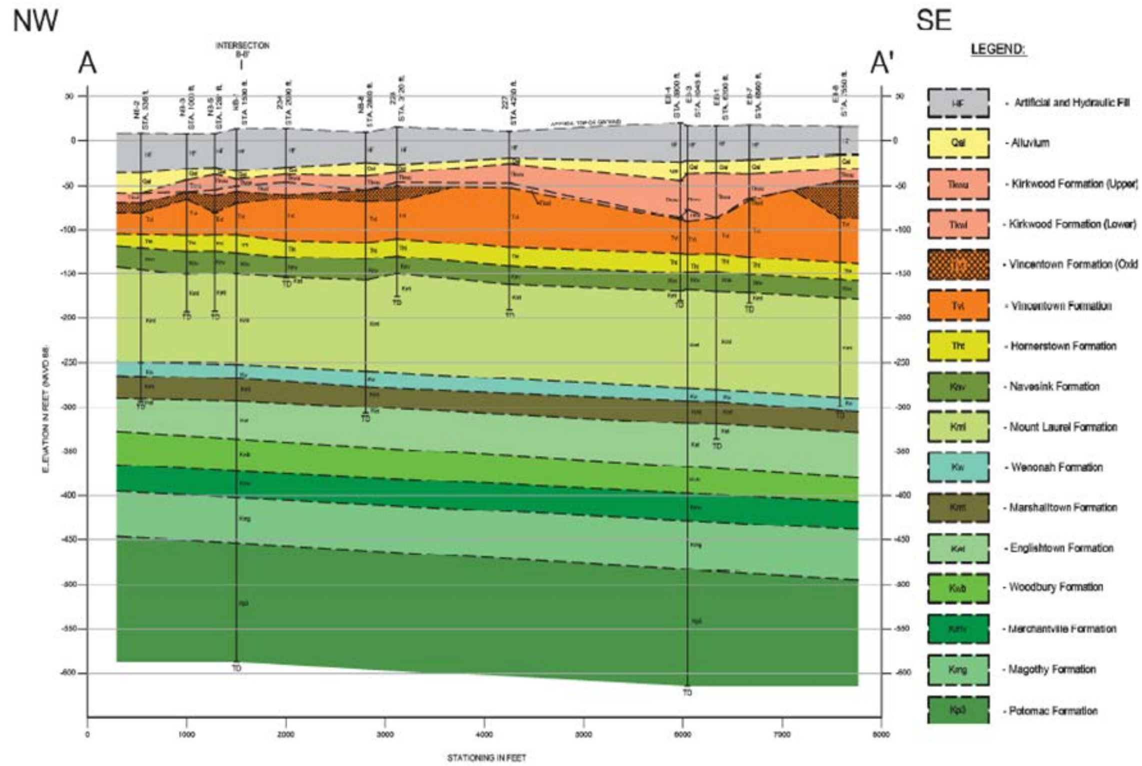


Figure 2.5.4-1 Stratigraphic Cross-Section (Reproduced from SSAR Figure 2.5.4.1-4)

SSAR Table 2.5.4.1-1 contains a summary of the PSEG Site stratigraphic data elevations at the top of formations, and SSAR Table 2.5.4.1-2 shows a comparison of the geologic stratigraphy for the ESP Site and the previous geotechnical studies performed at the HCGS. In SSAR Section 2.5.4.1.2, the applicant stated that it performed the subsurface investigation at the PSEG Site between the ground surface and 192.5 m (631.5 ft); below ground surface or elevation -187.5 m (615.0 ft) using the North American Vertical Datum (NAVD). The applicant noted that the stratigraphy at the PSEG Site is generally sub-horizontal and of a consistent thickness, with the exception of an erosional surface at the top of the Vincentown Formation. The applicant determined that the Vincentown Formation will be the foundation bearing layer and that regardless of the technology selected in the future, the vertical excavation for Seismic Category I structures will be down to elevation -20 m (-67 ft) NAVD. The applicant indicated

that the boring and the seismic velocity logging data shows that materials in the Hydraulic Fill, Alluvium and Kirkwood Formation are soft clays and exhibit shear wave velocities less than 304.8 meters per second (m/s) (1,000 feet per second (ft/s)), making these materials unsuitable as bearing layers for the technologies in consideration. The applicant plans to remove these materials in order to reach the foundation bearing layer. The Vincentown Formation is encountered at elevation -10 to -21 m (-33 to -70 ft) NAVD in the northern portion of the site. The formation overlies the Hornerstown Formation and shows significant relief in its upper portion. The applicant indicated that subaerial exposure and fluvial erosion prior to deposition of the overlying sediments, as well as groundwater movement through the formation are contributors to the weathered and oxidized nature of the formation. In addition, the applicant indicated that the oxidized and unoxidized sediments display a weak to strong reaction with 10 percent hydrochloric acid, which indicates the presence of calcareous sands.

The applicant grouped the stratigraphic layers into five categories, based on geologic ages, from youngest to oldest: Quaternary, Neogene (Upper Tertiary), Paleogene (Lower Tertiary), Upper Cretaceous, and Lower Cretaceous. Table 2.5.4-1 of this report describes the site stratigraphy and provides the average thickness in the northern portion of the site where the nuclear island will be located, and the average field standard penetration test (SPT) N values in blows per foot (bpf) for all borings across the site.

Table 2.5.4-1 PSEG Site Stratigraphy

Geologic Age	Formation	Description	Average Thickness Northft (m)	Average Field SPT N values (bpf)
Quaternary	Artificial fill	silt, clay, and sand with variable silt and clay contents, and clayey and silty gravels.	4 (1.2)	22
	Hydraulic Fill	highly plastic clay and silt with trace to organic material, locally interbedded discontinuous clay and silt layers.	33 (10)	3
	Alluvium	fine to coarse sand with gravel, silt and clay content.	13 (4)	14
Neogene	Kirkwood	clay and silt, fine to medium sand and fine to coarse gravel.	17 (5.2)	12
Paleogene	Vincentown (bearing layer)	oxidized and unoxidized glauconitic, calcareous, silty and clayey, fine to medium sand, and fine to medium sand with variable silt content; medium dense to very dense consistency; 0.1 to 1 ft discontinuous friable to indurated calcium carbonate cemented sandstone layers.	52 (16)	37
	Hornerstown	silty and clayey, fine to medium sand with trace shell segments and glauconite.	20 (6.1)	37

Geologic Age	Formation	Description	Average Thickness Northft (m)	Average Field SPT N values (bpf)
Upper Cretaceous	Navesink	silty and clayey, fine to medium grained glauconite, and quartz sand with trace to little shell fragments	24 (7.3)	72
	Mount Laurel	clayey and silty, fine to medium sand, grading with depth into fine to medium sand with variable silt and clay content, all with trace to little glauconite and shell fragments	103 (31)	91
	Wenonah	sandy clay with trace shell fragments and trace to few glauconites	15 (5)	41
	Marshalltown	of clayey and silty, fine to medium sand, and fine sandy clay of variable plasticity, all with trace to little glauconite content	25 (8)	41
	Englishtown	micaceous, sandy silt and clay to clayey sand, with trace shell fragments and trace to little glauconite	44 (13)	32
	Woodbury	highly plastic clay with trace glauconite, fine sand, mica, and shell fragments; and locally with trace indurated layers	36 (11)	32
	Merchantville	dark greenish-black glauconitic silts and clays with varying sand content.	30 (9)	50
	Magothy	carbonaceous/lignitic clay and silt, interbedded with sands at the upper portion and with variable silt and clay content at the bottom of the layer	52 (16)	85
Lower Cretaceous	Potomac	upper portion is composed of dark gray to gray clay and sand with variable silt content and the deeper portion of the formation the sediments are mottled, gray and red clay	>134 (41)	92

2.5.4.2.2 Properties of Subsurface Materials

SSAR Section 2.5.4.2 describes the static and dynamic engineering properties of the PSEG Site subsurface materials, including field investigations, laboratory tests, and engineering properties determined from the subsurface exploration and historical data. The applicant stated that the field and laboratory investigations for determining the engineering properties of soil materials follow the guidance of RG 1.132 and RG 1.138, respectively. The applicant extended its site-specific investigation to a depth of about 183 m (600 ft) in the northern portion of the site where the nuclear island will be located. Below that depth no site-specific shear wave or compressive wave velocity data were obtained; however, regional data were used.

2.5.4.2.2.1 Laboratory Testing.

SSAR Section 2.5.4.2.1 describes the applicant's laboratory testing and sample control procedures. The applicant recovered split-spoon samples and intact samples during site investigation activities and conducted static and dynamic analysis. The applicant performed the testing in accordance with American Society for Testing and Materials (ASTM) and other applicable standards. The applicant identified the type, number and industry standard for each type of laboratory test, including: testing for the Natural Moisture Content; Specific Gravity of Soils by Water Pycnometer; Particle-Size Distribution (Gradation) not including hydrometer; Particle-Size Analysis of Soils; Atterberg Limits; Unconsolidated Undrained Triaxial Strength; Consolidated Undrained Triaxial Strength; One-Dimensional Consolidation Properties of Soils using incremental loading; and Resonant Column Torsional Shear (RCTS). The applicant stated that since concrete foundations will not be in contact with in-situ material, it did not conduct testing of in-situ soils for sulfate and chloride.

The applicant also conducted dynamic laboratory testing on six intact samples using the RCTS method following the procedure of the University of Texas. The applicant indicated that a result from one test was not considered for further analysis due to high void ratios, which is inconsistent with the sampled formation.

2.5.4.2.2.1.1 *Sample Control*.

The applicant used the ASTM D 4220 standard for material storage and handling and used either a Shelby tube sampler or a rotary pitcher sampler to retrieve the undisturbed samples. The applicant obtained disturbed samples from SPT split-spoon sampling and placed the samples in glass jars and sealed the jars using moisture-tight lids. The applicant established an onsite storage facility for soil sample retention, an inventory system, and a chain of custody form to record all samples removed from the facility.

2.5.4.2.2.2 Material Engineering Properties.

2.5.4.2.2.2.1 *Static Material Properties*.

SSAR Table 2.5.4.2-8 summarizes the design values for static engineering properties of the subsurface materials based on the values determined during the ESP exploration. The applicant classified the subsurface materials in accordance with the Unified Soil Classification System (USCS). The applicant combined the Vincentown and Hornerstown formations into one engineering layer due to their similar engineering properties and reported the field and laboratory test results together. The applicant classified the Vincentown and Hornerstown formation as silty sands (SM, SP-SM) and less commonly, clayey sand (SC, SC-SM), silt (ML, MH) and clay (CL). The applicant determined the static laboratory indices for 40 SPT samples and seven intact samples of the Vincentown and Hornerstown formations collected during the ESP subsurface investigation. Laboratory testing, including sieve analysis with hydrometer, No. 200 sieve analysis wash test, Atterberg limits, specific gravity and moisture content, were performed to determine the soil index properties of the Vincentown and Hornerstown formations. The applicant performed three consolidated undrained (CU) triaxial compression tests on intact samples of the Vincentown and Hornerstown formations for the ESP application. The results of CU tests indicate average shear strength values: Cohesion (c) of 1.28 tons per square foot (tsf), and friction angle (Φ) of 20 degrees for total stress, and effective cohesion (c') of 0.40 tsf, and effective friction angle (Φ') of 37 degrees for effective stress. The applicant calculated the total unit weight from 13 intact samples of the Vincentown

and Hornerstown formations and values ranged from 17.4 to 20.5 kilonewtons per cubic meter (kN/m^3) (110.9 to 130.2 pounds per cubic foot (lb/ft^3).

The applicant encountered the Navesink and Mount Laurel formations in all the borings performed for the subsurface investigation. The applicant classified these formations as silty and clayey sands (SM, SC-SM, and SC). Underlying these formations, the Wenonah and Marshalltown formations were encountered and classified as clayey sands (SC) and, less commonly, silty sand (SM) and clay (CL). The applicant penetrated the Englishtown and Woodbury formations in two borings, NB-1 and EB-3 and classified these formations as clay (CL and CH). The applicant classified the Merchantville Formation as clay (CL), the Magothy Formation as clay and clayey sand (CH, SC), and the Potomac Formation as clay (CL).

2.5.4.2.2.2.2 *Dynamic Material Properties*.

In SSAR Section 2.5.4.2.2.2, the applicant explained that due to the presence of cemented layers, RCTS results presented in SSAR Table 2.5.4.2-9 are not representative. The applicant relied on the in situ Vs measurements to obtain the in situ Vs profile for the overall strata. SSAR Section 2.5.4.7 provides a more detailed description of the soil dynamic properties and the computational methods that the applicant used to develop the shear modulus reduction and the dynamic characteristics for the dynamic profile.

2.5.4.2.3 Foundation Interfaces

In SSAR Section 2.5.4.3, the applicant described the foundation interface conditions at the PSEG Site and geotechnical exploration and testing activities. The applicant stated that the field investigations for determining the engineering properties of soil materials follow the guidance of RG 1.132.

The applicant indicated that the site grade of the new proposed plant will be at elevation 11.2 m (36.9 ft) NAVD and that 7.6 to 9.1 m (25 to 30 ft) of fill will be required to achieve it. The range of embedment depths from the four reactor technologies considered for the site varies from 12 m (39 ft) to 25.7 m (84.3 ft) below the plant grade. Based on the selected elevation of the new plant, the bottom of the foundation will be at 6.1 to 20 m (20 to 65 ft) above the top of the competent foundation bearing material, which is in the Vincentown Formation. SSAR Figure 2.5.4.3-3 presents a cross-section illustrating the position of subsurface stratigraphy relative to the upper and lower bounds of embedment depths for safety-related structures within the PPE.

2.5.4.2.3.1 Exploratory Borehole Drilling and Sampling.

2.5.4.2.3.1.1 *SPT N-values*.

SSAR Section 2.5.4.3.1.2 states that the applicant performed a total of 16 borings. The applicant obtained the SPT soil samples at 0.8 m (2.5-foot) intervals for the first 4.6 m (15 ft) depth, at 1.5 m (5 ft) intervals from 4.6 to 61 m (15 to 200 ft) depth; and at 3 m (10 ft) (intervals from 61 to 157 m (200 ft to 450 ft) depth. The applicant extended the two deepest borings, NB-1 and EB-3, below 157 m to 183 m (450 to 600 ft) and 193 m (631 ft) depth, respectively. The applicant corrected the N-values measured in the field for overburden pressure and hammer energy.

2.5.4.2.3.1.2 *In-Situ Geophysical Testing*.

In SSAR Section 2.5.4.3.1.3, the applicant stated that the in-situ geophysical testing performed at the PSEG Site included: Downhole geophysical testing; borehole deviation; natural gamma; resistivity; caliper logging; suspension P-S velocity logging; crosshole seismic velocity testing; and downhole seismic velocity testing. Section 2.5.4.2.4 of this report describes these tests in greater detail.

2.5.4.2.3.1.3 *Observation Wells*.

The applicant installed 32 observation wells in 16 locations during exploration using rotosonic drilling methods. The applicant installed eight well pairs in each of the northern and eastern portions of the site. One well of each pair was installed in the hydraulic fill or alluvium and the other well in the pair was installed in the Vincentown Formation. The applicant used the soil lithology identified in adjacent geotechnical borings to determine the screen interval and the well completion depths.

2.5.4.2.4 Geophysical Surveys

SSAR Section 2.5.4.4 describes the geophysical survey methods that the applicant used to conduct its subsurface investigation at the PSEG Site.

2.5.4.2.4.1 Downhole Geophysical Testing and Suspension P-S Velocity Logging.

The applicant performed downhole geophysical testing in four borings (NB-1, NB-8, EB-3, EB-8G) ranging to depths of 96 to 192 m (315 to 630 ft). Figure 2.5.4-2 of this report provides a plan view of the exploration locations. The applicant conducted borehole deviation, natural gamma, resistivity, and caliper logging in each of the four boreholes. To measure in-situ compression (P) wave and horizontal shear (S) wave the applicant used the suspension P-S velocity logging method at 0.5 to 1 m (1.65 ft to 3.3 ft) intervals. The applicant used a technical procedure developed by GEOVision. The applicant indicated that the tests show similar P-wave and S-wave velocities along the four logged profiles.

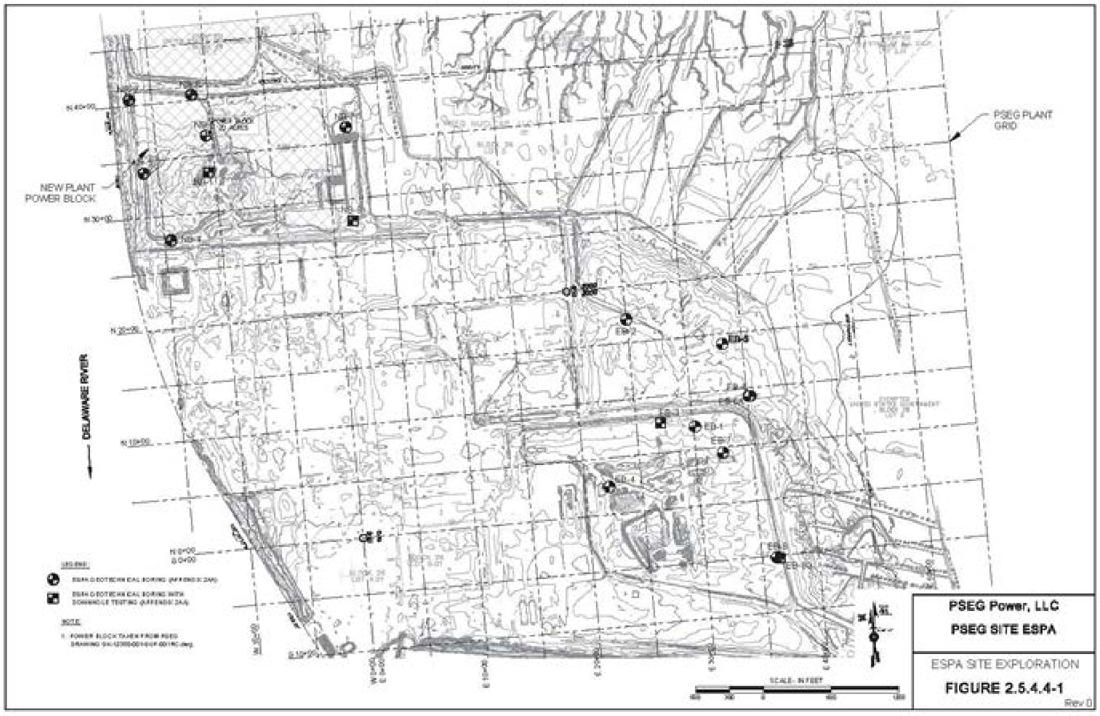


Figure 2.5.4-2 PSEG ESP Application site exploration (Reproduced from SSAR Figure 2.5.4.4-1)

2.5.4.2.4.2 <u>Crosshole Seismic Velocity Testing</u>.

The applicant used crosshole techniques at two locations (in the vicinity of borings NB-1 and NB-8) to complete seismic velocity measurement following the guidance in ASTM D 4428. The applicant recorded crosshole seismic velocity measurements to depths of about 61 m (200 ft). The applicant stated that the comparison of results obtained from suspension and crosshole velocity testing procedures, as presented in SSAR Figure 2.5.4.4-7, is in agreement.

2.5.4.2.4.3 <u>Downhole Seismic Velocity Testing</u>.

The applicant conducted downhole seismic velocity testing in borehole CH NB-1C to a depth of approximately 59 m (195 ft), following the GEOVision procedure. The applicant stated that the comparison of results obtained from downhole and suspension velocity measurements, as presented in SSAR Figure 2.5.4.4-8, is in good agreement for the foundation bearing soils and below.

2.5.4.2.5 Excavation and Backfill

SSAR Section 2.5.4.5 describes the excavation limits, sources and quantities of backfill, and dewatering and excavation methods that the applicant plans to implement at the PSEG Site.

2.5.4.2.5.1 <u>Extent of Excavations</u>.

SSAR Figure 2.5.4.5-1 presents a general layout of the limits of the excavation for the new plant location. The applicant stated that the lateral and vertical extent of the excavation for the

Seismic Category I structures depends on the specifications and requirements of the chosen plant technology. The PPE includes bounding conditions for the reactor building embedment depths ranging from 12 to 25.7 m (39 to 84.3 ft). Since the competent foundation layer at the PSEG Site is located at approximately elevation -20 m (-67 ft) NAVD, the vertical excavation for Seismic Category I structures will extend to approximately elevation -20 m (-67 ft) NAVD, regardless of the technology selected. The applicant will excavate approximately 23 m (75 ft) below present ground surface to reach the Vincentown Formation in the area of the safety-related structures. Figure 2.5.4-3 of this report shows a conceptual illustration for the excavation within the power block.

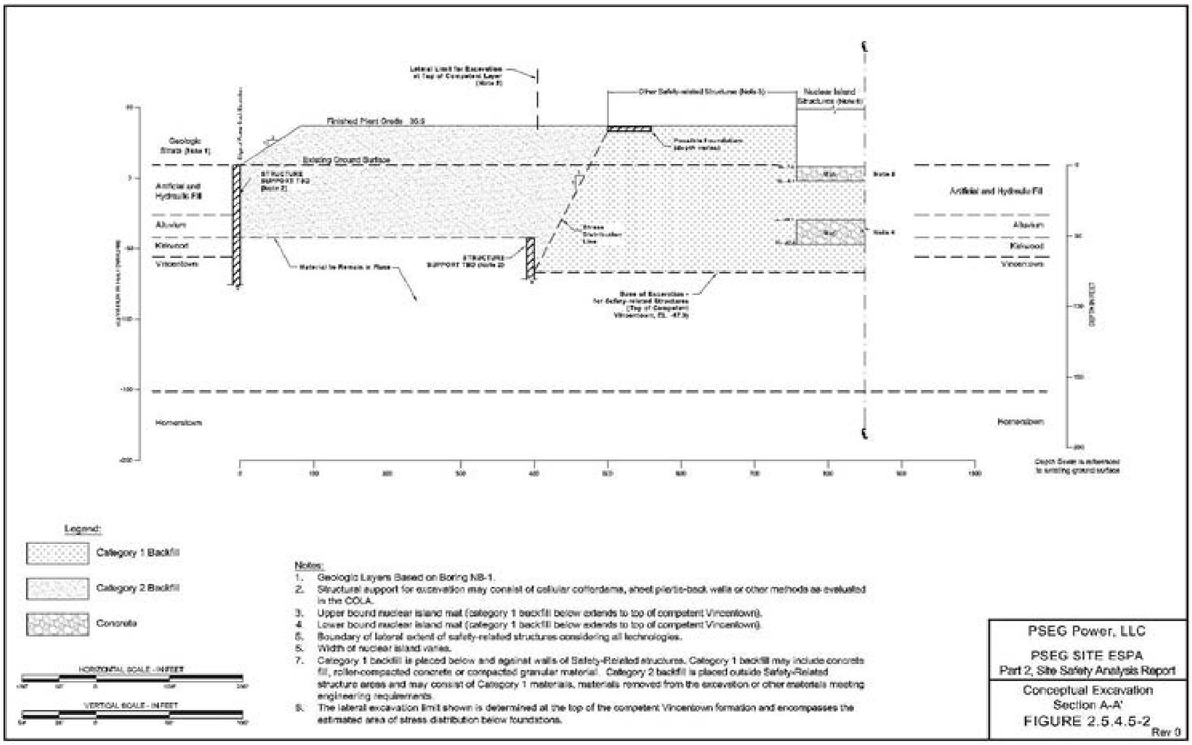


Figure 2.5.4-3 Conceptual Excavation Section A-A (Reproduced from SSAR Figure 2.5.4.5-2)

2.5.4.2.5.2 Excavation and Dewatering Methods.

In SSAR Section 2.5.4.5.2, the applicant stated that it will perform the site excavation in two stages. The first excavation will extend to the top of the Kirkwood Formation and the second excavation, which applies only to the area of the Seismic Category I structures, will extend to competent material within the Vincentown Formation. The applicant will decide the method of excavation support at the COL application stage. Some alternatives that the applicant is considering include: Cellular cofferdams, sheet pile walls, or other wall support systems.

Since the average groundwater level is at an approximate elevation of 0.2 m (0.8 ft) NAVD, dewatering is required during construction. The applicant plans to install wells around the outer and inner perimeters of the structural support system to accomplish dewatering and to maintain

the water level below the excavation bottom. The applicant does not expect that degradation or instability due to upward water seepage or piping will occur.

In SSAR Section 2.5.4.5.3.4, the applicant stated that after reaching the base of the excavation for Seismic Category I structures, it will inspect, map, and check for fill placement suitability in the subgrade. The applicant will inspect the subgrade using probing, cone penetrometer soundings, borings or heavy drivable equipment to look for conditions that need repair. The applicant plans to install geotechnical instrumentation prior to the excavation to monitor heave of the excavation bottom due to unloading from excavation.

2.5.4.2.5.3 Backfill Properties and Compaction Specifications.

In SSAR Section 2.5.4.5.3, the applicant stated that backfill is required from the base of the excavation to the bearing grade of the Seismic Category I structures, and between the walls of the nuclear island structures and the adjacent excavation support system. The applicant designated the backfill below the Seismic Category I structures that support safety-related structures as Category 1 fill. Otherwise, it will be designated as Category 2 fill. The applicant will discuss the details of the backfill quantities, types, sources, and compaction requirements during the COL application stage.

The applicant identified the following Category 1 backfill materials as possible: lean concrete, roller-compacted concrete, or structural granular material. The applicant plans to obtain granular materials locally and may consider using excavated material as Category 2 backfill. The material below the nuclear island or other safety-related structures must exhibit a V_s greater than 304.8 m/s (1,000 ft/s).

In SSAR Section 2.5.4.5.3.3, the applicant stated that it will apply the requirements of the American Concrete Institute (ACI) and the test methods described by ASTM to properly test during fill placement. The applicant will develop specifications for placement and compaction of backfill at the COL application stage. These specifications will include information regarding compaction density, moisture content, testing, and lift thickness. In the COL application, the applicant plans to include an inspection, test, analyses, and acceptance criteria (ITAAC) for the backfill to ensure a V_s of 304.8 m/s (1,000 ft/s), or higher.

2.5.4.2.5.4 Foundation Excavation Monitoring.

In SSAR Section 2.5.4.5.4, the applicant stated that it will observe and monitor foundation excavations during construction. The applicant will install geotechnical instrumentation for the nuclear island structures to monitor the heave of the excavation due to unloading from excavation. The applicant will include an instrumentation plan and monitoring schedule in the COL application. The applicant will document the initial mat foundation excavation to the top of the competent layer to confirm that the soils conform to those used in the design. The applicant plans to include the geologic mapping of the exposed soils, weathered zones, shear zones or fault zones.

2.5.4.2.6 Groundwater Conditions

SSAR Section 2.5.4.6 summarizes the groundwater conditions at the PSEG ESP Site. Additional details can be found in SSAR Section 2.4.12.

2.5.4.2.6.1 Site-Specific Groundwater Occurrence.

SSAR Section 2.5.4.6.1 notes that the applicant installed 16 well pairs (32 groundwater observation wells) as part of the ESP application investigation, located at or near the geotechnical boring locations. The applicant installed the deeper well in each well pair within the Vincentown or lower Kirkwood aquifer. SSAR Section 2.4.12 presents the complete data obtained from the monitoring wells.

The upper water-bearing zone, located above the upper unit of the Kirkwood Formation, consists of hydraulic fill and alluvium. The hydraulic fill acts as an aquitard, an impervious layer that prevents water penetration. The lower water-bearing zone consists of sands and gravel of the lower Kirkwood and Vincentown Formations. The average groundwater elevations observed in the upper and lower water-bearing zones at the ESP site are 0.25 and 0.24 m (0.82 and 0.80 ft) NAVD, respectively. The applicant also stated that groundwater flow modeling (discussed in SSAR Section 2.4.12.4) provides an estimate of the post-construction groundwater elevation ranging from 1.8 to 3.1 m (6 to 10 ft) NAVD. The applicant concluded that because the depth to groundwater at the new plant location after construction is more than 7.6 m (25 ft) below plant grade, there is no requirement for post-construction dewatering.

In SSAR Section 2.5.4.6.2, the applicant described the field testing conducted for hydraulic conductivity following the procedures described in ASTM D 4044, for the 16 observation wells installed at the new plant location. SSAR Table 2.5.4.6-2 summarizes the results of this testing. Additionally, the applicant conducted a tidal study, which is presented in SSAR Section 2.4.12.1.3.6. The applicant indicated that the water levels in the upper and lower water-bearing zones could have been tidally affected by up to 0.017 and 0.12 m (0.057 and 0.39 ft), during the slug tests. The applicant concluded that these potential tidal effects are negligible.

2.5.4.2.6.2 Dewatering Effects on Adjacent Structures.

In SSAR Section 2.5.4.6.3.1, the applicant stated that SSAR Figures 2.5.4.6-3 and 2.5.4.6-4 present the piezometric heads within the hydraulic fill and the Vincentown Formation of the site-specific groundwater model, after 1 year of dewatering. To consider dewatering effects, the applicant used the groundwater surface within the hydraulic fill to estimate the effects of groundwater table lowering for the layers above the Vincentown Formation, and used the piezometric drop within the Vincentown Formation for the Vincentown Formation and layers below. As a result, the applicant listed the structures that are within the projected zone of dewatering influence as follows:

- Independent Spent Fuel Storage Installation	- Fuel Oil Tank
- Hope Creek Generating Station (HCGS) Cooling Tower	- Water Treatment Plant
- Auxiliary Boiler Building	- Material Center
- HCGS Switchyard	- Low Level Radioactive Waste Building
- HCGS Intake Structure	- Salem Generating Station (SGS) Nuclear Island
- Learning and Development Center	- SGS intake Structure
- HCGS Nuclear Island	

The applicant explained that drawdown of the groundwater level at the centers of the structures listed above will cause an increase in vertical effective pressure and consequently can cause settlement of soils. In SSAR Sections 2.5.4.6.3.1.1 through 2.5.4.6.3.1.4, the applicant discussed the potential settlement due to dewatering drawdown and reported the following:

- HCGS and SGS Nuclear Islands – 0.76 and 0.254cm (0.3 and 0.1 in.), respectively
- HCGS Plant Area Buildings – 0.8 to 1.5 cm (0.3 to 0.6 in.)
- Independent Spent Fuel Storage Installation - 2.54 to 3.8 cm (1 to 1.5 in.)
- Buildings on Shallow Foundations – 3.30 to 4.8 cm (1.3 to 1.9 in.)

Since most structures outside of the nuclear island in the HCGS plant area are supported on piles, the applicant indicated that the settlements beneath HCGS plant area buildings will move the entire soil structure and overlying soil down as a unit and will result in minimal impacts. For buildings on shallow foundations, the applicant defined settlement as area settlement including pipes, roads, parking areas and other surrounding items. The applicant stated that, for buildings on shallow foundations, differential settlement is not expected between a building and adjacent areas. The applicant plans to further evaluate dewatering and potential impacts during the COL application stage.

2.5.4.2.7 Response of Soil and Rock to Dynamic Loading

SSAR Section 2.5.4.7 addresses the subsurface properties at the PSEG Site applicable to the evaluation of the ground motion site response. The applicant referred to SSAR Section 2.5.2.6 for a detailed description of the development of the GMRS. The applicant obtained the dynamic properties from field measurements (suspension P-S seismic velocity loggings, crosshole seismic velocity tests and down-hole seismic velocity tests) and laboratory testing (RCTS). Since the samples used for RCTS testing were susceptible to disturbance due to the presence of dense soils with cemented layers, the applicant developed the site velocity profile using the P-S suspension logging results. The applicant stated that the results of the crosshole and down-hole velocity tests are in agreement with the P-S suspension logging results.

2.5.4.2.7.1 Calculation of Dynamic Soil Property Profiles.

The applicant divided the dynamic profile into two portions: The shallow profile and the deep profile. The applicant used an elevation of -20 m (-67 ft) NAVD with an expected variation of plus or minus 1.2 m (4 ft) as the top of the competent layer (Vincentown Formation) in its

analysis. The applicant calculated the Poisson's ratio using the compression wave velocities (V_p) and shear wave velocities (V_s) obtained from the P-S suspension logging tests. The applicant applied a coefficient of variation of 0.25 to measurements of layers above a depth of 51 m (300 ft) and a coefficient of variation of 0.3 for measurements below 51 m (300 ft).

In SSAR Section 2.5.4.7.4.2, the applicant stated that the deep portion of the dynamic profile begins at the top of the Potomac Formation, and extends to the crystalline basement rock. The applicant defined the crystalline basement rock as material with a V_s greater than 2,804 m/s (9,200 ft/s) based on seismic refraction measurements reported by the Delmarva Power Summit site. SSAR Figure 2.5.4.7-10 presents the Delmarva Summit site location map in reference to the PSEG Site location. The applicant estimated the top of basement rock directly beneath the PSEG Site at elevation -533 m (-1,750 ft) NAVD. The applicant's estimate is based on the PSEG well information (PSEG-6) and on the interpolation among the nearest contour lines shown in three basement surface contour maps that extend from Delaware across New Jersey (SSAR Figure 2.5.4.7-9). The applicant correlated information from two seismic refraction survey lines reported in the Preliminary Safety Analysis Report for the Delmarva Power Summit site and used the velocity layering to develop a representative velocity profile. Figure 2.5.4-4 of this report (SSAR Figure 2.5.4.7-8(a)) presents the shallow and deep layered V_s profile.

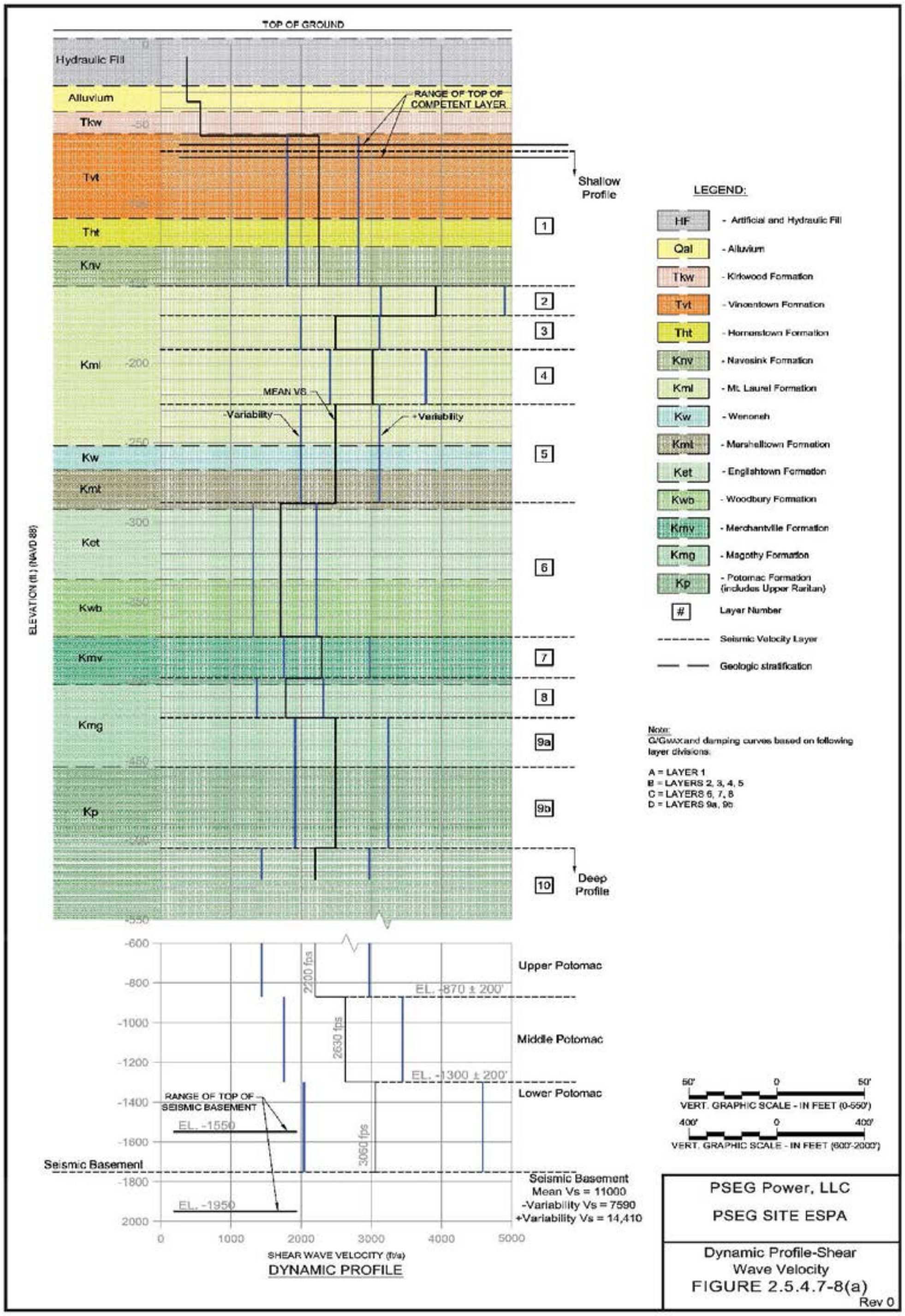


Figure 2.5.4-4 Dynamic Profile - Shear Wave Velocity (Reproduced from SSAR Figure 2.5.4.7-8(a))

Modulus Reduction and Damping Values. The applicant conducted RCTS testing in six intact samples that included the Vincentown, Hornerstown and Navesink formations. The applicant

did not consider one of the tests due to a high void ratio that was considered inconsistent with the character of the formation sampled.

The applicant did not use the RCTS test results to predict the modulus reduction and damping variation with shear strain because the RCTS test results are inconsistent with the EPRI generic curves. The applicant indicated that this inconsistency was due to the presence of the cemented layers within the formations which resulted in sample disturbance. The applicant determined that such results are not representative of the formation's behavior. Instead, the applicant used computational techniques for modeling modulus reduction and damping variation with shear strain based on results of RCTS test analyses developed at the University of Texas. The equation used to determine the modulus reduction and damping variation was developed by Darandeli (2001) and uses the confining pressure, plasticity index and overconsolidation ratio as inputs. The applicant divided the soils below the Vincentown and above the Potomac Formation into four layers, as summarized in SSAR Table 2.5.4.7-5. The resulting curves were used to develop the GMRS for the ESP site as discussed in SSAR Section 2.5.2.5.

2.5.4.2.8 Liquefaction Potential

SSAR Section 2.5.4.8 describes the liquefaction potential for the soils at the PSEG Site. The applicant performed geologically-based screening and also SPT-based liquefaction analyses in accordance with RG 1.198. Based on these analyses, the applicant stated that the soils below elevation -20 m (-67 ft) NAVD, or approximately 23 m (75 ft) below the present ground surface, are not susceptible to liquefaction. The applicant stated in SSAR Section 2.5.4.7.3 that the site has no evidence of liquefaction features based on aerial photographs and that no earthquakes larger than estimated body wave magnitude (Em_b) of 4.45 were recorded within the site vicinity.

2.5.4.2.8.1 <u>Geologically-based Liquefaction Assessment</u>.

In SSAR Section 2.5.4.8.2, the applicant performed a geologically-based liquefaction screening evaluation based on the composition of each formation, on the age of the formations and on the average corrected field SPT N value. The applicant stated that based on the granular composition (more than 50 percent sand) and the position below the water table; the Vincentown, Hornerstown, Navesink, Mount Laurel, Wenonah, Marshalltown, Englishtown, Magothy and Potomac Formations are potentially liquefiable. The applicant indicated that resistance of soils to liquefaction increases with age and that based on their ages, the formations below the top of the Vincentown Formation are not likely to liquefy. For the assessment based on the average corrected field SPT N value, the applicant indicated that because formations with an average corrected field SPT N value of less than 30 blows per foot are considered liquefiable, the Hornerstown, Wenonah and Englishtown formations are potentially liquefiable.

2.5.4.2.8.2 <u>SPT- based Liquefaction Assessment</u>.

In SSAR Section 2.5.4.8.3, the applicant described the SPT-based liquefaction assessment performed for the PSEG Site. The applicant calculated a factor of safety as the ratio of the cyclic resistance ratio (CRR) to the cyclic stress ratio (CSR). The CRR is based on SPT N-values corrected for sampling methods, overburden pressure, and fines content of the soil ($(N_1)_{60}$ values). The applicant computed this ratio based on an earthquake of magnitude 6. The CSR is a function of the maximum acceleration at the foundation level, total and effective

overburden pressures at the sample depth, and a stress reduction factor. The applicant used a maximum acceleration of 0.225g based on the GMRS calculation.

The applicant analyzed 257 SPT N-values from soil samples obtained from borings NB-1 through NB-8. Seventeen liquefaction factors of safety are less than 1.1, 15 factors of safety are between 1.1 and 1.4, and 225 are greater than 1.4. Based on the results of the calculation of factors of safety, the applicant stated that the potentially liquefiable soils are isolated pockets surrounded by dense material and not a continuous layer. The applicant stated that liquefaction below the top of the competent layer is not likely to occur.

The applicant stated that the nuclear island structures and other safety-related structures would not be impacted by liquefaction effects on soils outside of the excavation support structures. The applicant also stated that it will evaluate non-seismic liquefaction (erosion, floods, wind loads, etc.) during the COL application stage.

2.5.4.2.9 Earthquake Site Characteristics

SSAR Section 2.5.4.9 summarizes the derivation of the site-specific GMRS and SSE. The applicant developed the site-specific GMRS in accordance with the performance-based methodology provided in RG 1.208. The PSEG Site is located in the CEUS, which is a stable continental region. The applicant referred to SSAR Section 2.5.2.6 for detailed information on the development of the site-specific GMRS.

2.5.4.2.10 Static Stability

SSAR Section 2.5.4.10 describes the analysis of the stability of safety-related facilities (nuclear island) for static loading conditions. The applicant considered the following four technologies in its analysis: ABWR, AP1000, U.S. EPR, and US-APWR. SSAR Table 2.5.4.5-1 presents the plan dimensions and embedment depths for each plant technology. The applicant used the following design parameters in its stability analysis, based on the Design Control Document technologies cited above: foundation plan dimensions, upper and lower bound embedment depths of the foundation, and a static bearing pressure of 716 kN/m^2 (15,000 psf).

2.5.4.2.10.1 Bearing Capacity.

In SSAR Section 2.5.4.10.2, the applicant stated that it used three methodologies for the bearing capacity evaluation: Meyerhof, Terzaghi, and Vesic described by Bowles (1988). In the evaluation, the applicant assumed a granular structural backfill with properties similar to the fill used in the Hope Creek UFSAR: Compacted maximum dry unit weight of 20.1 kN/m^3 (128 lb/ft^3) and an angle of friction of 35 degrees. The applicant stated that the layers contributing to the bearing capacity are the Vincentown, Hornerstown, Navesink, and Mount Laurel Formations. The applicant used an average in-situ wet unit weight of 19.6 kN/m^3 (125 lb/ft^3) and an average angle of internal friction of 37 degrees to represent these layers. The applicant selected this angle of internal friction based on sample tests from the Vincentown Formation, in conjunction with calculation checks that are based on standard penetration resistance tests ($(N_1)_{60}$ values) for deeper formations. The applicant used a groundwater level at the existing ground surface, which is elevation 3 m (10 ft) NAVD in its analysis. The applicant calculated the ultimate bearing capacity as 20,100 kN/m^2 (420,000 psf).

2.5.4.2.10.2 Settlement Evaluation

In SSAR Section 2.5.4.10.3, the applicant stated that it has not established the criteria for total and differential settlement at the ESP application stage. The applicant calculated an example of possible settlement at the site using the technology with the largest mat foundation (U.S. EPR) combined with a representative static bearing pressure of 716 kN/m^2 (15,000 psf). The applicant indicated that the soils in the Vincentown and below are over-consolidated and that these soils will deform elastically because of the sandy composition of the soil and the over-consolidation of the hard clay zones. The applicant used two methods to calculate the settlement for the reactor building: Timoshenko and Goodier method, and the Janbu method described by Bowles (1988). The Timoshenko and Goodier method uses a single layer of material subject to compression (assumed to be twice the mat width in the ESP analysis) and a weighted average modulus of elasticity over this thickness. The Janbu method uses a layered subsurface model with the average vertical stress at the midpoint of each layer computed by stress distribution methods. SSAR Table 2.5.4.10-1 summarizes the layers, top elevations, unit weights, average shear wave velocities, shear modulus, Poisson's ratio, and elastic modulus used in the settlement analysis.

The applicant stated that the Janbu analysis method resulted in slightly greater estimated settlement than the Timoshenko and Goodier analysis method. The estimated settlement from the Janbu analysis, described above, was 4.1 cm (1.6 in.) for the center of the mat, and 2.54 cm (1 in.) for a side of the mat.

The applicant indicated that the subsurface layers are subhorizontal and have similar thicknesses and properties across the site. The applicant also indicated that the difference in applied stress conditions under the mat corner and the center is the only contributor to differential settlement.

2.5.4.2.11 Design Criteria

SSAR Section 2.5.4.11 summarizes the geotechnical design criteria discussed in the previous sections of the SSAR.

The applicant will provide additional settlement and construction groundwater control information at the COL application stage. SSAR Section 2.5.4.5 presents information regarding backfill material requirements. In SSAR Section 2.5.4.11, the applicant stated that the COL application will include an ITAAC for Operational Programs report to include the inspection, testing and acceptance criteria for backfill. However, in SSAR Section 2.5.4.5.3.3.2, the applicant stated that the backfill ITAAC will be part of a COL application. The staff notes that ITAAC for Operational Programs that do not relate to emergency planning are normally against Commission policy. The staff communicated this inconsistency to the applicant via a telephone call on June 17, 2014. In order to correct this inconsistency, on June 24, 2014, the applicant submitted supplemental information with SSAR markup for Section 2.5.4.11. The staff reviewed the applicant's information and determined that the applicant has appropriately corrected the inconsistency. The applicant committed to incorporate the SSAR changes in the next revision of the ESP application. The staff identified this as Confirmatory Item 2.5.4-1. The staff verified that in Revision 4 to the PSEG Site ESP application (June 5, 2015), the applicant incorporated the committed changes. Therefore, the staff considers Confirmatory Item 2.5.4-1 closed.

2.5.4.2.12 Techniques to Improve Subsurface Conditions

SSAR Section 2.5.4.12 discusses the soil improvement techniques in the foundation areas of the safety-related structures. As described in SSAR Section 2.5.4.5, the plant grade elevation is 11.2 m (36.9 ft). The materials above the stated base mat elevation are soft clays (hydraulic fill), loose sands (alluvium) and firm to soft clays (Kirkwood Formation). These materials are not adequate as bearing layers and the applicant described its plans to remove and replace them with backfill down to the competent material within the Vincentown Formation. To prepare the foundation-bearing soil, improvement techniques including over-excavation and replacement with backfill, and bearing surface compaction, will be necessary. The applicant stated that there is no need for deep soil improvement based on its preliminary static stability analysis.

2.5.4.3 Regulatory Basis

The applicable regulatory requirements for the stability of subsurface materials and foundations are as follows:

- 10 CFR Part 52, Subpart A, "Early Site Permit," as it relates to the requirements and procedures applicable to issuance of an early site permit for approval of a site for one or more power facilities.

- 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," as it relates to the design of nuclear power plant structures, systems, and components important to safety to withstand the effects of earthquakes.

- 10 CFR 100.23, "Geologic and Seismic Siting Criteria," as it relates to 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.

- 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plant," as it relates to the requirements of the quality assurance program to be applied to the design, fabrication, construction, and testing of the structures, systems, and components of the facility.

The related acceptance criteria from NUREG-0800, Section 2.5.4 are as follows. Many of these acceptance criteria are not evaluated for an Early Site Permit, and are deferred to the COL stage. These are indicated within the Technical Evaluation section of this report:

- Geologic Features: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 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 that are sufficiently detailed to obtain an unambiguous representation of the geology.

- Properties of Subsurface Materials: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 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.

- Foundation Interfaces: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 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.

- Geophysical Surveys: To meet 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 are presented in detail.

- Excavation and Backfill: To meet the requirements of 10 CFR Part 50 and 10 CFR Part 52, 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 Seismic 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 (QA) program described and referenced; (6) control of groundwater during excavation to preclude degradation of foundation materials and properties is described and referenced.

- Groundwater Conditions: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100, the analysis of groundwater conditions is acceptable if the following are included in this subsection or cross-referenced to the appropriate subsections in Section 2.4: (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.

- Response of Soil and Rock to Dynamic Loading: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 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 hysteretic damping properties of the soils and the results included.

- Liquefaction Potential: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100, if the foundation materials at the site adjacent to and under Seismic 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.

- Earthquake Design Basis: To meet the requirements of 10 CFR Part 50, the earthquake design basis analysis is acceptable if a brief summary of the derivation of the site-specific Ground Motion Response Spectrum is presented and references are included to Subsection 2.5.2.6. The staff's evaluation of the amplification characteristics of specific soils and rocks beneath the site as determined by procedures discussed in that section and in Subsections 2.5.4.2, 2.5.4.4, and 2.5.4.7 are summarized and cross-referenced herein. The review of Subsection 2.5.4.9 concentrates on determining its consistency or inconsistency with other subsections. Cross-referencing with other sections is expected.

- Static Stability: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 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.

- Design Criteria: To meet the requirements of 10 CFR Part 50, and 10 CFR Part 52, 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.

- Techniques to Improve Subsurface Conditions: To meet the requirements of 10 CFR Part 50, and 10 CFR Part 52, 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: RG 1.28, “Quality Assurance Program Requirements (Design and Construction)”; RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants”; RG 1.132, “Site Investigations for Foundations of Nuclear Power Plants”; RG 1.138, “Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants”; and RG 1.198, “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites.”

2.5.4.4 Technical Evaluation

The staff reviewed SSAR Section 2.5.4 and verified that the information contained in the ESP application addresses the required information relating to the stability of subsurface materials and foundations. This section provides the staff's evaluation of the geophysical and geotechnical investigations conducted by the applicant to determine the static and dynamic engineering properties of the materials that underlie the PSEG Site. The applicant presented technical information in SSAR Section 2.5.4 resulting from field and laboratory investigations. The applicant used the subsurface material properties from its field and laboratory investigations to evaluate the site geotechnical conditions including liquefaction potential. The applicant performed a preliminary static stability assessment and deferred the final determination of static stability to the COL stage.

Through its review of SSAR Section 2.5.4, the staff determined whether the applicant adequately sampled the subsurface materials underlying the ESP site in order to characterize the engineering properties as well as the response of the site to dynamic and static loading. The staff also determined if the applicant complied with the applicable regulations and conducted its investigations at an appropriate level of detail. The staff reviewed the applicant's field and laboratory investigation data and associated assumptions and calculations used to determine the geotechnical properties of the soil underlying the ESP site. The staff reviewed the responses to the RAIs, calculation packages supplementing these responses and the information provided in the SSAR.

On September 29 and 30, 2011, the staff conducted a site audit to observe some of the applicant's onsite borings logs and field explorations, conduct visual inspections of soil samples and review the geology, seismology and geotechnical modeling and calculations, as well as analyses and results of selected soil samples. This audit allowed the staff to better understand the modeling results in order to make accurate safety conclusions concerning the site characteristics. Further, the audit assisted the staff in identifying additional information that the staff needs for its further review of the PSEG ESP application.

2.5.4.4.1 Description of Site Geologic Features

SSAR Section 2.5.4.1 refers to SSAR Section 2.5.1.1 and 2.5.1.2 for a description of the regional and site geology. Section 2.5.1.4 of this report presents the staff evaluation regarding the regional and site geology. The staff reviewed the summary of the description and characterization of the site geology provided in SSAR Section 2.5.4.1 including the site-specific stratigraphy, and foundation stability conditions such as: (1) Zones of weathering; (2) subsurface structural weakness; (3) and groundwater conditions.

The staff focused its review particularly on the stability of the Vincentown and Hornerstown formations, which will be the foundation bearing layers for the safety-related structures for the PSEG Site. The staff examined boring logs taken from these locations and noticed considerable low SPT field N values measured from the upper portion of the Vincentown formation. In RAI 41, Question 02.05.04-4, the staff requested that the applicant describe the extent of the weathered zones, the possible impact on Seismic Category I foundations and what measures will be taken to ensure foundation bearing quality as described in the SSAR Section 2.5.4.10.

In a January 6, 2012, response to RAI 41, Question 02.05.04-4, the applicant confirmed that weathering has affected the top of the Vincentown formation. The applicant referred to SSAR Figures 2.5.4.3-3 and 2.5.4.3-4 to justify that oxidized zones, caused by weathering, in the upper part of the Vincentown Formation were not indicative of low V_s or SPT N-values and stated that oxidation may not necessarily influence geotechnical engineering properties. The applicant also stated that the Vincentown formation conditions encountered as part of the ESP investigation were very similar to the ones described in the Hope Creek FSAR. The applicant indicated that only four field SPT N-values were found to be less than 10 bpf in the Vincentown Formation and those occurred within the top 3 m (10 ft) of the formation. The applicant indicated that regardless of the technology selected, the vertical excavation for Seismic Category I structures will extend approximately to elevation -20 m (-67 ft) NAVD, where the Vincentown Formation is located. The applicant committed to perform additional investigations during the COL phase in order to provide additional information on the extent, thickness and nature of the oxidized material in the Vincentown Formation beneath the area of

Seismic Category I structures for the selected technology. The applicant also committed to remove softer soils with considerably lower SPT N-values during construction. Consistent with the applicant's stated commitment, the staff identified the following COL action item:

COL Action Item 2.5-1

> An applicant for a COL or CP referencing this early site permit should perform additional investigations in order to provide additional information on the extent, thickness, and nature of the oxidized material in the Vincentown Formation beneath the area of Seismic Category I structures for the selected reactor technology. The applicant should also remove less dense soils with considerably lower SPT N-values in order to meet the soil condition requirements.

The staff reviewed SSAR Figures 2.5.4.1-11A through 2.5.4.1-14B, which correlates V_s values with SPT N-values. These figures correlated P-S velocities, SPT field N values and geophysical logging information for NB-1, NB-8, EB-3 and EB-8/EB-8G. The staff also reviewed the location of oxidized zones in the Vincentown Formation shown in SSAR Figures 2.5.4.3-3 and 2.5.4.3-4. The staff noticed small variations in SPT field N or V_s values. V_s increased with depth despite areas with lower than average SPT values. Accordingly, the staff concurs with the applicant in that the oxidized zones are not indicative of low V_s or SPT field N-values. To confirm the applicant's assessment that only four SPT measurements were lower than 10 bpf (SSAR Figure 2.5.4.1-10), the staff reviewed most of the boring logs provided as part of SSAR Appendix 2AA. The staff confirmed that these low values occur in samples above approximately elevation -20 m (-67 ft) NAVD, which will be removed during construction. In addition, the staff noted that most field SPT N-values encountered at the site were within the range of 11 to 30 bpf for the Vincentown Formation. According to Table G-1, "Soil Density or Consistency from Standard Penetration Test Data," in the U.S. Army Corps of Engineers Geotechnical Investigation Manual (EM 1110-1-1804), these values represent medium dense soils.

The staff also verified the HCGS subsurface investigation (PSEG, 2008) to validate the applicant's assessment that subsurface conditions were similar to the PSEG Site. Based on Hope Creek's 230s series boring logs (SSAR Figure 2.5.4.1-2), which were closer to the PSEG Site, the staff noted similarities in the subsurface stratigraphy for both sites. For example, the field SPT N-values followed very similar patterns in both sites.

After reviewing foundation soil V_s measurements, field SPT N-values and boring logs, the staff agrees with the applicant that low field SPT N-values in the upper portion of the Vincentown Formation will be removed during construction and oxidized zones were not indicative of low V_s. The staff confirmed that the SSAR was revised to reflect graphical errors on figures that present boring logs with geophysical information. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, the staff considers RAI 41, Question 02.05.04 4, resolved.

2.5.4.4.2 Properties of Subsurface Materials

The staff focused its review of SSAR Section 2.5.4.2 on the applicant's description of the static and dynamic engineering properties of the soil strata underlying the PSEG Site, and the methods used to determine the site static and dynamic soil engineering properties. The staff reviewed the applicant's field investigation methods and laboratory testing program as well as the assumptions used to determine the properties of the subsurface materials. The review was

carried out with respect to the guidance of RG 1.132, RG 1.138, RG 1.208, and NUREG-0800, Section 2.5.4.

Description of Subsurface Materials

The staff reviewed the subsurface profile and materials, which described the underlying strata, categorized into 14 different soil strata. The staff focused its review of the subsurface in the Vincentown Formation, which would be the foundation bearing layer and will support the Seismic Category I structures for the PSEG Site. The Vincentown Formation is mostly composed of silty sands with some zones of clayey sands including various cemented zones. Based on the subsurface exploratory investigations and as indicated in SSAR Table 2.5.4.2-8, the applicant estimated that the top of the Vincentown Formation beneath the PSEG Site ranges from elevation -10 to -21 m (-33 to -70 ft) NAVD. The foundation bearing layer at the PSEG Site will be elevation -20 m (-67 ft) NAVD with an expected variation of plus or minus 1.2 m (4 ft). For its seismic analyses, the applicant selected approximately elevation -20 m (-67 ft) NAVD as the top of the competent Vincentown Formation. The applicant has not decided if Seismic Category I foundation basemat will be placed either on structural fill or on concrete fill placed directly on top of the bearing layer within the Vincentown Formation.

Field Investigations

The applicant performed its subsurface investigations during field operations in accordance with RG 1.132. The applicant employed the following exploration activities to collect data: Exploratory borehole drilling and sampling, in-situ geophysical testing and observation well installation and testing. The applicant stated that it performed all fieldwork under an audited and approved quality assurance program and work procedures. The scope of the work included 16 borings, 32 observation wells, 2 cross-hole, 4 suspension P-S velocity logging seismic tests and 1 downhole seismic velocity measurement. In addition, borehole deviation, natural gamma, resistivity, and caliper logging was performed in four boreholes.

The staff reviewed the power block and adjacent boring location plans and logs, the site subsurface profiles, and the results of the applicant's site exploration tests. SPT data was widely used by the applicant to derive the soils' engineering properties which include the determination of shear strength properties which were used as part of the foundation stability analysis. SSAR Table 2.5.4.2-8 states that the N_{60} values were determined by correcting the field SPT-N values for field conditions, including hammer energy. Typically, $(N_1)_{60,}$ values, which also include correction for overburden pressures, are used to determine site-specific soil properties. To ensure the adequacy of SPT data, in RAI 41, Question 02.05.04-10, the staff requested that the applicant indicate if it applied overburden corrections to sandy layers, and thus, if $(N_1)_{60}$ values were calculated. In addition, the staff requested that the applicant clarify if N_{60} instead of $(N_1)_{60}$ were used in the calculation checks to determine the internal friction angle. If $(N_1)_{60}$ values were used, the staff requested that the applicant make the appropriate corrections in SSAR Table 2.5.4.2-8.

In a January 6, 2012, response to RAI 41, Question 02.05.04-10, the applicant stated that $(N_1)_{60}$ values were calculated for non-cohesive soils for both NB and EB series borings, and that $(N_1)_{60}$ values were used to evaluate the foundation's stability described in SSAR Section 2.5.4.10.2. In addition, the applicant agreed to update SSAR Table 2.5.4.2-8 showing design (average) $(N_1)_{60}$ values for each formation.

The staff reviewed the applicant's January 6, 2012, response to RAI 41, Question 02.05.04-10. The staff also reviewed the latest revision of the calculation package (ESP 798, Calculation 2251-ESP-GT-001, Revision 4, "Correction of field SPT N values for field variables and effective overburden pressures") to verify the corrections made to field SPT N-values account for effective overburden pressures. The staff determined that these $(N_1)_{60}$ better represent the in-situ conditions and were used as input into foundation stability analyses (e.g., bearing capacity and liquefaction assessments). Since the calculation package was corrected, and the design $(N_1)_{60}$ values were included in SSAR Table 2.5.4.2-8, the staff concludes that the applicant adequately addressed this issue and, therefore, the staff considers RAI 41, Question 02.05.04-10, resolved.

Laboratory Testing

The applicant conducted the laboratory testing program in accordance with an approved quality assurance program following the guidance presented in RG 1.138. The staff reviewed the types and number of tests performed by the applicant, the locations from where the samples were taken, and the results of the tests. SSAR Section 2.5.4.2.1.1 states that RCTS tests were performed on six soil samples, and the results for one of these tests were disregarded due to the high void ratio in the sample. To confirm if these samples were considered representative of the soils sampled, in RAI 41, Question 02.05.04-6, the staff requested that the applicant explain the origin of this high void ratio and to indicate if this was a localized condition or if it was encountered in other locations at the site.

In a January 6, 2012, response to RAI 41, Question 02.05.04-6, the applicant referenced EB-3UD-UD-31 as the specific sample that was disregarded due to high void ratio. The applicant obtained this sample from the Mount Laurel Formation at depths from 63.4 m to 64.2 m (208 to 210.5 ft) below grade. The applicant indicated that this high void ratio was inconsistent with the character of the formation. To justify this statement, the applicant referred to the field SPT N-values and V_s obtained from the EB-3 boring, located adjacent and at similar depths to the boring where the referenced sample was obtained. Based on the consistently high field SPT N-values and V_s measurements obtained throughout the formation, the Mount Laurel Formation was characterized as "very dense" therefore, the applicant concluded that the sample might have been disturbed during sampling, and therefore, was not determined to represent the entire formation.

To evaluate if it was a localized condition, the staff verified the adjacent boring EB-3, for samples above, within, and below the interval sample EB-3UD-31. The staff noted that the field SPT N values evaluated in the adjacent boring were greater than 50 bpf, and that the V_s ranged around 790 m/s (2,600 ft/s). In addition, the staff reviewed field SPT N values from EB-1 to verify uniformity between adjacent borings and noted field SPT N values over 100 bpf within the Mount Laurel Formation. In-situ P-S velocity logging was not perform for EB-1, therefore actual V_s measurements from EB-8G, within the depth range discussed above, were reviewed and values over 730 m/s (2,400 ft/s) were encountered. Since high field SPT N values and V_s were encountered consistently throughout these borings at depths from 63.4 m to 64.2 m (208 to 210.5 ft), the staff concurs with the applicant that the Mount Laurel Formation could be considered very dense and the high void ratio sample was inconsistent with the character of the Mount Laurel formation. Accordingly, the staff considers RAI 41, Question 02.05.04-6, resolved.

SSAR Section 2.5.4.2.1.3.4 states that a ratio of vertical to horizontal stress (K_o) of 0.5 was used to calculate horizontal effective stresses on samples for RCTS testing. The applicant

stated that K_o of 0.5 is a typical value for normally consolidated soils. In RAI 41, Question 02.05.04-7, the staff requested that the applicant provide additional details to justify selecting this value, especially when SSAR Section 2.5.4.10.3 states that the soils in the Vincentown Formation and below are considered to be over-consolidated.

In a January 20, 2012, response to RAI 41, Question 02.05.04-7, the applicant stated that it initially calculated the mean confining pressure (σ_m) using a K_o of 0.5 and considering isotropic conditions. Since consolidation tests were not performed and the K_o value may not be known for a particular sample, the applicant decided to estimate confining pressure values based on 0.25, 0.5, 1, 2, and 4 times the calculated mean confining pressure. The applicant stated that the purpose of doing this was to allow for variations in the estimated K_o value in order for the RCTS tests to represent soil behavior at a wide range of possible consolidation conditions.

The staff evaluated the applicant's response to RAI 41, Question 02.05.04-7, but was not convinced that the applicant's method to calculate horizontal effective stresses on samples for RCTS testing produced accurate results. Specifically, the staff was concerned with how the applicant estimated K_o and used it to calculate σ_m without laboratory data to confirm results. In SSAR Section 2.5.4.7.5, the applicant stated that because of the existence of cemented layers and the dense consistency of in-situ soils, the intact samples obtained were disturbed and the RCTS test results were not representative of the formation. The applicant encountered inconsistent RCTS test results when compared to EPRI generic curves. The applicant decided to use Darandeli (2001) equations to develop degradation curves used to calculate the GMRS. The applicant indicated that Darandeli equations were results of research work at the University of Texas under the direction of Dr. Ken Stokoe and that the validity of these equations is supported by comparison with data from the Savannah River Site (Stokoe 2005).

The staff reviewed calculation package ESP811_PSEG_CALC_2251_ESP_GT_006_REV_2, "Dynamic Soil Profile," and reviewed how the applicant derived Darendeli curves. Darandeli equations use the confining pressure, plasticity index and overconsolidation ratio as inputs. The staff reviewed how the applicant estimated K_o and confining pressures and used them in the Darendeli equations. The staff found no information about the assumptions taken to obtain K_o used to estimate confining pressures. As a follow-up to RAI 41, Question 02.05.04-7, the staff issued RAI 64, Question 02.05.04-22, requesting that the applicant explain how variations in the estimated K_o were accounted for when using the Darandeli equations. The staff also requested that the applicant justify the use of K_o of 0.5 as input to the equation.

In a September 20, 2012, response RAI 64, Question 02.05.04-22, the applicant indicated that the Darandeli equations were calculated using a single value of K_o for all the layers. As part of its response, the applicant performed calculations to explore the effect of different K_o values on the calculated modulus of reduction (G/G_{max}) and damping variation with shear strain. K_o is an input that affects the mean effective pressure parameter that is an input to the Darandeli equations. Since a K_o of 0.5 is commonly used for normally consolidated soils, and the degree of overconsolidation in the subsurface soils is unknown, the applicant assumed three values of overconsolidation ratio (OCR) equal to 2, 4 and 6 to compute G/G_{max} and damping variation with shear strain for comparison with the original values that used a K_o of 0.5. The staff reviewed RAI Figures 64-22-1 through 64-22-8, which show the results of the calculations by comparing plots of the G/G_{max} and damping variation with shear strain for each of the three OCR cases against the original values. The staff noted that these plots showed a slight increase in the G/G_{max} and damping values for the same shear strain. Accordingly, the staff concurs with the applicant that the degradation curves developed using different OCRs are similar. The staff

considers RAI 64, Question 02.05.04-22 resolved. Additional details regarding the staff's review of Darandeli's equations and how they were used to estimate settlement is provided as part of the evaluation of the response to RAI 64, Question 02.05.04-25 (which is a follow-up of RAI 41, Question 02.05.04-13) in Section 2.5.4.4.7 of this report.

SSAR Table 2.5.4.2-4 illustrates several consolidated undrained triaxial test results for several samples from the Vincentown and Hornerstown Formations. The applicant stated that these soils have the presence of cemented zones and thus, samples from such materials are susceptible to disturbance. In RAI 41, Question 02.05.04-8, the staff requested that the applicant explain how two tests located on the northern part of the site are considered reliable to assess the soil's shear strength properties for the entire PSEG Site.

In a January 6, 2012, response to RAI 41, Question 02.05.04-8, the applicant used the Unified Soil Classification System (USCS) designation, V_s and field SPT N values to demonstrate that soils of the Vincentown and Hornerstown Formations are similar laterally across the site. To further justify the limited lateral variability in these two formations, the applicant developed two tables summarizing the field SPT N-values from the NB and EB borings. The applicant stated that based on average field SPT N-values of 37 and 57 bpf for the NB and EB respectively, site foundation soils could be classified as dense to very dense soils. The applicant referred to SSAR Table 2.5.4.7-3, which shows the lateral variation in V_s within the same geologic formations. Specifically, the applicant mentioned that V_s in the Vincentown and Hornerstown ranged from approximately 610 to 790 m/s (2,000 to 2,600 ft/s). Based on similar V_s and field SPT N values, the applicant concluded that the Vincentown and Hornerstown Formations are consistent laterally across the site and, therefore, soil engineering properties are likely to be similar. Based on this comparison, the applicant considered the soil shear strength values, determined from CU tests from NB- and EB-series borings, reliable to assess soil shear strength of the Vincentown and Hornerstown Formations.

The staff evaluated the applicant's January 6, 2012, response to RAI 41, Question 02.05.04-8. Specifically, the staff verified V_s and SPT data from samples recovered from the NB and EB borings. The staff reviewed SSAR Table 2.5.4.7-3 showing the lateral variation in V_s within the Vincentown and Hornerstown Formations obtained from P-S logging analysis from NB and EB borings. The staff noted that similar V_s values were encountered throughout the site. The staff reviewed the summary tables provided showing the field SPT N values and noted that the average field SPT N values for EB borings was 57 bpf ,while for the NB borings (borings located within the footprint of safety-related NPP foundations) was 37 bpf. As a follow-up to RAI 41, Question 02.05.04-8, the staff issued RAI 64, Question 02.05.04-23, requesting that the applicant explain how these formations were considered to be laterally uniform when considerable variations in average field SPT N values exist between NB and EB borings.
In addition, the staff requested that the applicant explain why a design value of 47 bpf was used for the Vincentown and Hornerstown Formations and to justify how the selected single value statistically reflects the entire layer.

In a September 20, 2012, response to RAI 64, Question 02.05.04-23, the applicant clarified that the response to RAI 41, Question 02.05.04-8 describes the soils of the Vincentown and Hornerstown Formations in terms of similarities and do not present them as being laterally uniform. The applicant indicated that these soils will behave similarly because the average SPT values obtained from NB-series and EB-series borings represent dense sand. Since the field SPT N value of 47 bpf would provide higher soil shear strength properties than the average field SPT N value of 37 bpf for NB-series, the applicant decided to revise the design field

SPT N-value to 37 bpf for both formations. Consequently, the design corrected value, $(N_1)_{60}$, was revised from 35 bpf to 32 bpf. The applicant indicated that additional subsurface information will be obtained during the COLA phase to obtain more SPT data and further evaluate and fully characterize the engineering properties of the Vincentown and Hornerstown Formation, including their potential lateral and vertical variation.

The staff reviewed the September 20, 2012, response to RAI 64, Question 02.05.04-23, and along with the recommendation provided in the Federal Highway Administration FHWA (2002) regarding the estimation of the friction angle, the staff finds that field SPT N values ranging from 37 to 54 bpf are representative of dense to very dense sand. Since the design SPT $(N_1)_{60}$ is used to estimate the soil friction angle, the staff verified how the effective friction angle changes when calculated using design $(N_1)_{60}$ equal to 32 bpf. The staff noted that the effective friction angle calculated using the empirical equation with $(N_1)_{60}$ equal to 32 bpf is higher than the design effective friction angle of 37 degrees, selected by the applicant. Therefore, the staff finds that the applicant used an adequate and conservative field SPT N value and design friction angle value. Accordingly, the staff considers RAI 64, Question 02.05.04-23, resolved.

In response to RAI 64, Question 02.05.04-23, the applicant stated that it would conduct additional subsurface investigation during the COLA phase to evaluate and fully characterize the engineering properties of the Vincentown and Hornerstown Formations and their potential lateral and vertical variation. In addition, the applicant stated that it would perform additional strength tests to further evaluate the soil shear strength parameter for the Vincentown and Hornerstown Formations. Consistent with the applicant's stated intention, the staff identified the following COL action item:

COL Action Item 2.5-2

> An applicant for a COL or CP referencing this early site permit should conduct additional subsurface investigations to evaluate and fully characterize the engineering properties of the Vincentown and Hornerstown Formations and their potential lateral and vertical variation. The applicant should also perform additional strength tests to further evaluate the soil shear strength parameter for the Vincentown and Hornerstown Formations.

Engineering Properties of Soils

The staff reviewed SSAR Section 2.5.4.2.2 focusing on the static and dynamic engineering properties of each of the 14 layers derived from the applicant's field and laboratory testing programs.

<u>Static Engineering Properties for the Artificial Fill, Hydraulic Fill, Alluvium and Kirkwood Formation</u>

SSAR Sections 2.5.4.2.2.1.1 through 2.5.4.2.2.1.4 summarize the engineering properties for the top four soil layers encountered at the PSEG Site. The applicant provided the engineering properties of these for completeness, even though these layers will be removed beneath the nuclear island. The staff reviewed the information provided in the SSAR and concludes that the applicant provided sufficient information to characterize the geotechnical engineering properties of these soils and acknowledges that these units will be removed from beneath the planned PSEG safety-related foundation areas.

Static Engineering Properties for the Vincentown and Hornerstown Formations

SSAR Section 2.5.4.2.2.1.5 summarizes the engineering properties of the Vincentown and Hornerstown formations. The applicant performed 40 static laboratory index tests from 40 SPT samples and a series of shear strength tests, including CU triaxial compression tests. The applicant stated that, for engineering purposes, the Vincentown and Hornerstown Formations are combined into one engineering layer due to their similar engineering properties. The staff reviewed the assigned properties for these two layers and in RAI 41, Question 02.05.04-9, requested that the applicant provide additional details regarding properties from both layers and how overall properties were weighted. In addition, the staff requested that the applicant justify how both formations would behave similarly, especially when the Vincentown Formation is classified as mostly silty sand layer, while the Hornerstown Formation has a considerable increase in fine content.

In a January 20, 2012, response to RAI 41, Question 02.05.04-9, to justify similarities between Vincentown and Hornerstown Formations, the applicant developed Table RAI-41-9-1, which summarizes the engineering properties of these formations including data related to the USCS classification, percent fines, field SPT N values and V_s. The applicant determined the design values presented in SSAR Table 2.5.4.2-8 by considering data from each formation with no weighting. The staff reviewed Table RAI-41-9-1 and noted similarities in the engineering characteristics for both formations. The majority of the samples taken from the two formations are classified as poorly graded sand, silty sand and clayey sand with average percent of fines of 24. In addition, average V_s between 681 and 640 m/s (2,233 and 2,101 ft/s) and average field SPT N values between 45 and 52 bpf were noted for both formations. Based on these similarities, the staff concludes that it is appropriate to group the Vincentown and Hornerstown Formations for engineering purposes. The applicant committed to modify the SSAR to correct the references of SSAR Table 2.5.4.2-2. The staff confirmed that the SSAR was revised as committed in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 41, Question 02.05.04-9, resolved.

Static Engineering Properties for the Navesink, Mount Laurel, Wenonah and Marshalltown, Englishtown and Woodbury, Merchantville, Magothy and Potomac Formations

In SSAR Sections 2.5.4.2.2.1.6 through 2.5.4.2.2.1.12, the applicant summarized the engineering properties for the remaining formations. The applicant classified the Navesink, Mount Laurel, Wenonah and Marshalltown formations as granular material and the Englishtown Woodbury, Merchantville, Magothy and Potomac Formations as clay material.

SSAR Section 2.5.4.2.2.1.6 states that two intact soil samples were recovered from the Navesink Formation. The applicant used these samples solely to determine static laboratory indices. In RAI 41, Question 02.05.04-11, the staff requested that the applicant explain why soil strength tests or other types of evaluations using these intact soil samples were not performed for this formation given that it is located directly within the safety-related foundation zone of influence.

In a January 6, 2012, response to RAI 41, Question 02.05.01-11, the applicant stated that the Navesink Formation was classified as very dense sand with an average $(N_1)_{60}$ of 45 bpf. The applicant also stated that the friction angle for this formation was estimated from an empirical correlation based on field SPT N values from the Federal Highway Administration Geotechnical Engineering Circular No. 5 (2002). To assess deformation or settlement properties, the applicant derived elastic properties from V_s measurements. The applicant explained that

because this formation was composed mostly of sandy soils and low fine content, direct shear or triaxial tests were not considered to estimate shear strength properties.

In the applicant's January 6, 2012, response to RAI 41, Question 02.05.04-11, the staff evaluated field SPT N-values from boring logs from the Navesink Formation used in correlations to estimate the formation's frictions angle. The field SPT N values for this formation were in the range of 40 and 80 bpf, which is indicative of a dense to very dense sand. When reviewing the FHWA geotechnical engineering manual, the applicant used to estimate the friction angle, the staff noted that several correlations were provided. It was unclear to the staff exactly which correlation the applicant used to estimate the friction angle. As a follow-up RAI 41, Question 02.05.04-11, the staff issued RAI 64, Question 02.05.04-24, requesting that the applicant clarify which correlation was actually used and to explain why a friction angle design value was not included in SSAR Table 2.5.4.2-8 for this formation. In addition, the staff requested that the applicant justify the adequacy of the friction angle, given the absence of laboratory testing and the sole reliance on empirical correlations.

In a September 20, 2012, response to RAI 64, Question 02.05.04-24, the applicant referenced its January 20, 2012, response to RAI 41, Question 02.05.04-15 for the calculation and the empirical correlation used to determine the friction angle for the Navesink Formation. The applicant provided the formula used for the calculation of the friction angle. The applicant clarified that it only reported in SSAR Table 2.5.4.2-8 the strength properties determined from laboratory shear strength test; therefore, the friction angle that was determined based on empirical correlations was not included in this table. The staff reviewed the applicant's response focusing on the FHWA methodology used for calculating friction angle and Table RAI-41-15-1b, which summarizes the friction angle results for Vincentown and Hornerstown, Navesink, and Mount Laurel Formations. When reviewing the FHWA methodology for selecting the friction angle based on SPT, the staff noted that for field SPT N-values ranging between 30 to 50 bpf, the effective friction angles ranged between 40 to 45 degrees. The staff also noted in the FHWA manual that for field SPT N-values higher than 50 bpf the effective friction angle would be higher than 45 degrees. The calculated friction angle based on the FHWA empirical formula was 46.3 degrees. The staff finds that the selection of 37 degrees for the friction angle for the Navesink Formation is a reasonable value for bearing capacity calculations. In the response to RAI 64, Question 02.05.04-24, the applicant stated that it would perform additional borings during the COLA phase to provide information for further evaluation of the shear strength properties of the Navesink formation. Consistent with the applicant's stated intention, the staff identified the following COL action item:

COL Action Item 2.5-3

> An applicant for a COL or CP referencing this early site permit should perform additional borings to provide information for further evaluation of the shear strength properties of the Navesink formation.

SSAR Section 2.5.4.2.2.1.8 states that the unit weights of soils for formations below the Mount Laurel were not determined for the ESP application. In RAI 41, Question 02.05.04-12, the staff requested that the applicant explain why unit weights were not determined. The staff also requested that the applicant include these values in SSAR Table 2.5.4.2-8.

As part of the January 6, 2012, response to RAI 41, Question 02.05.04-12, the applicant stated that no undisturbed samples were recovered for soils below the Mount Laurel Formation. From published correlations of typical soils and based on USCS classification, SPT N-values and

particle size distribution, the applicant selected a unit weight of 19.6 kN/m^3 (125 lbs/ft^3) as a representative value for formations below the Mount Laurel.

The staff reviewed the work of Coduto (2001) and the FHWA Soil and Foundation publication (2006), which present typical unit weights for various soil types depending on the saturation condition. The staff concludes that, given the ranges provided in these references (for saturated CL between 12 to 20 kN/m^3 (75 to 130 lb/ft^3) and for saturated SM between 17.3 to 21.2 kN/m^3 (110 to 135 lb/ft^3), a value of 19.6 kN/m^3 (125 lbs/ft^3) is considered a typical and reasonable value for unit weights for both sandy and clay type site soils encountered below the Mount Laurel Formation.

In the response to RAI 41, Question 02.05.04-12, the applicant stated that it would perform additional borings and unit weight determinations during the COLA phase of the project, including for the materials underlying the Mount Laurel Formation. Consistent with the applicant's stated intention, the staff identified the following COL action item:

COL Action Item 2.5-4

> An applicant for a COL or CP referencing this early site permit should perform additional borings and unit weight determinations for the materials underlying the Mount Laurel Formation.

Dynamic Material Properties

In SSAR Section 2.5.4.2.2.2, the applicant described the rationale followed when evaluating dynamic material properties. The applicant stated that RCTS tests were performed on samples from the Vincentown, Hornerstown and Navesink Formations. Given the dense and cemented nature of recovered samples, the RCTS test results from such materials were susceptible to disturbance and were not used to develop design shear modulus reduction and damping curves. Instead, the applicant used Darandeli equations described in Section 2.5.4.4.7 of this report, to develop the site dynamic profiles.

The staff reviewed the applicant's explanation regarding dynamic material properties, including RCTS results provided in SSAR Table 2.5.4.2-9 and Figures 2.5.4.2-4 through 2.5.4.2-7. The staff noted that the RCTS data range of shear strain is generally limited to strain less than 10^{-2} percent and does not cover the full range of shear strain presented by EPRI curves. The staff also noted that the pattern of the plotted data followed the shape of the EPRI curve, but with a more linear pattern, indicating the presence of cemented layers and dense consistency. The staff agrees with the applicant in that given the site soil condition, RCTS were unreliable and alternative methods should be considered. The staff's evaluation of these alternative methods and the processes followed to develop the site dynamic profile is provided in Section 2.5.4.4.7 of this report.

Conclusions Regarding the Properties of Subsurface Materials

Based on its review of SSAR Section 2.5.4.2 and the applicant's responses to the RAIs discussed above, the staff concludes that the applicant adequately determined the engineering properties of the soil underlying the ESP site following state of the art methodology for its field and laboratory investigations. The staff concludes that the applicant adequately characterized most of the layers by determining the extent, thickness, density, consistency, strength, and engineering and static design properties. However, the staff also concludes that the applicant

did not performed sufficient field investigation and laboratory testing to fully characterize the overall subsurface profile as well as the material properties underlying the ESP site.
The applicant committed to conduct additional subsurface investigation during the COLA phase to obtain additional SPT data, evaluate soil shear strength, perform additional unit weight determinations, thus evaluate and fully characterize the engineering properties of subsurface materials and their potential variation laterally and vertically.

Therefore, subject to COL Action Items 2.5-1 through 2.5-4 detailed above, the staff concludes that the applicant's description of the subsurface materials and properties at the PSEG Site forms an adequate basis to satisfy the criteria of 10 CFR Part 50 and 10 CFR Part 100.

2.5.4.4.3 Foundation Interfaces

In SSAR Section 2.5.4.3, the applicant described the foundation interface conditions at the PSEG Site based on a detailed geotechnical exploration and testing activity program, which include borehole drilling and sampling, in-situ geophysical testing and observation well installation and testing.

The staff's review focused on the relationship between the planned foundations for safety-related structures and the engineering properties of underlying materials. The applicant indicated that its PPE described in SSAR Section 1.3.3 shows the bounding condition for the reactor building/nuclear island base mat embedment depth as 12 m (39 ft) at its shallowest to 25.6 m (84.3 ft) at its deepest. The staff reviewed the position and properties of the subsurface stratigraphy relative to the bounding conditions of foundation embedment depths for safety-related structures. The staff noted that for an external plant grade of elevation 11.2 m (36.9 ft) NAVD, the range of vertical limit for the technologies, by elevation, is -0.6 to -14 m (-2.1 to -47 ft) NAVD, therefore, the proposed reactor building/nuclear island base mat embedment depths are bounded by the vertical limit of excavation at approximately elevation -20 m (-67 ft) NAVD. The staff reviewed the cross sections provided in SSAR Figures 2.5.4.3-3 and 2.5.4.3-4 in detail with the results of all subsurface investigations conducted at the site to ascertain that there has been sufficient exploration. The applicant stated that it would perform additional subsurface investigations in the COLA phase in order to ensure safety-related structures will be placed on competent foundation bearing materials. While the staff's COL Action Item 2.5-1 in Section 2.5.4.4.1 of this report addresses the need to perform additional subsurface investigations at the COL application stage, the staff's following COL action item includes additional specifics regarding these investigations:

COL Action Item 2.5-5

> An applicant for a COL or CP referencing this early site permit should perform additional subsurface investigations and correlate the plot plans and profiles of each Seismic Category I structure with the subsurface profile and material properties, and ensure placement of safety-related structures on competent foundation bearing material.

Conclusions Regarding Foundation Interfaces

The staff concludes that subject to COL Action Item 2.5-5, the applicant's description of the relationship between foundations and underlying materials, based on geotechnical exploration and testing, is consistent with state-of-the-art standards and common practice and is, therefore, acceptable.

2.5.4.4.4 Geophysical Surveys

The staff focused the review of SSAR Section 2.5.4.4 on the adequacy of the applicant's geophysical investigations to determine soil dynamic properties. The applicant relied primarily on the suspension P-S velocity logging method to determine the site stratigraphy and develop the site's V_s and V_p profiles. The applicant also obtained V_s and V_p profiles from crosshole seismic and downhole seismic velocity testing and compared the profiles to those obtained using P-S velocity logging. In addition, the staff considered the downhole geophysical testing results for additional information on the site's lithology and stratigraphy, location of low density zones, presence of clay, and variations in moisture content.

The staff reviewed the results of the geophysical surveys, specifically the profiles of V_s and V_p. The staff reviewed SSAR Figures 2.5.4.4-2 through 2.5.4.4-6, which show the V_s and V_p profiles developed from the downhole geophysical testing, suspension velocity logging and crosshole seismic velocity testing. The staff noted similar results between V_s and V_p along the profiles logged. Based on the applicant's site investigation program and results, the staff concludes that the applicant performed a complete and thorough geophysical survey of the PSEG Site using a variety of geophysical testing methods.

Conclusions Regarding Geophysical Surveys

Based on its review of SSAR Section 2.5.4.4, the staff concludes that the applicant adequately determined the soil dynamic properties through its geophysical survey of the ESP site and that the geophysical tests and methods form an adequate basis for the geophysical surveys of the site and meet the requirements of 10 CFR 100.23.

2.5.4.4.5 Excavation and Backfill

The staff reviewed SSAR Section 2.5.4.5, focusing on the earthwork for the proposed placement of safety-related structures, which includes the following activities: limits of excavation, construction excavation and dewatering, foundation excavation monitoring, backfill, compaction specifications and quality control testing. The applicant plans to raise the current ground surface elevation of 1.5 to 4.6 m (5 to 15 ft) to reach the proposed external plant grade of 11.2 m (36.9 ft) NAVD. The applicant also described plans to remove unsuitable materials at the power block area and below Seismic Category I structures and replace it with suitable backfill materials.

Extent of Excavations

The applicant indicated that the lateral and vertical extent of the excavation for Seismic Category I structures will depend on the plant technology chosen. The applicant defined the bearing layer at approximately elevation -20 m (-67 ft) NAVD based on shear wave velocities of 304.8 m/s (1,000 ft/s) or higher, therefore, the vertical limits of excavation for Seismic Category I structures will extend to approximately elevation -20 m (-67 ft) NAVD to reach the Vincentown formation. The staff reviewed boring logs presented in SSAR Appendix 2AA and noted that at elevation -20 m (-67 ft) NAVD, the V_s were 304.8 m/s (1,000 ft/s) or higher. SSAR Table 2.5.4-1 shows the plant dimensions for the four technologies assessed by the applicant. In SSAR Section 2.5.4.5, the applicant committed to provide specific details regarding the lateral and vertical extent of the excavation for the plant design technology selected in the COL application stage. Consistent with the applicant's stated commitment, the staff identified the following COL action item:

COL Action Item 2.5-6

> An applicant for a COL or CP referencing this early site permit should provide specific details regarding the lateral and vertical extent of the excavation consistent with the selected reactor technology.

Construction Excavation and Dewatering Methods

The staff reviewed the applicant's description of its dewatering methodology. The applicant plans to lower the water table to facilitate excavation work.

In SSAR Section 2.5.4.5.2.1, the applicant committed to evaluate the method of excavation support and the stability of temporary excavation slopes or support in the COLA stage. Consistent with the applicant's commitment, the staff identified the following COL action item:

COL Action Item 2.5-7

> An applicant for a COL or CP referencing this early site permit should evaluate the method of excavation support and the stability of temporary excavation slopes or support.

Backfill Properties and Compaction Specifications

The applicant mentioned several potential Category 1 backfill materials including: Lean concrete; roller compacted concrete (RCC) or structural granular material. The applicant indicated that the material removed from the excavation that meets the engineering requirements may be considered for use as Category 2 fill. The applicant stated that the lean concrete or RCC for backfill beneath and around the mat foundations will meet the requirements to support Seismic Category I structures. In addition, the applicant stated that the properties of the Category 1 granular materials are expected to be similar to the backfill used for the HCGS facility; however, the applicant deferred the determination of final granular backfill material properties to the COLA stage. The applicant committed to include specifications for placement and compaction of lean concrete, RCC and soil backfill at the COLA stage. In addition, in SSAR Section 2.5.4.5.3.3.2, the applicant committed to include in the COLA stage an ITAAC for the soil backfill, with specifications to ensure a V_s of 304.8 m/s (1,000 ft/s) or higher below Seismic Category I structures. Consistent with the applicant's commitment, the staff identified the following COL action item:

COL Action Item 2.5-8

> An applicant for a COL or CP referencing this early site permit should include in the COL application, an ITAAC for the soil backfill, with specifications to ensure a V_s of 304.8 m/s (1,000 ft/s) or higher below Seismic Category I structures.

The applicant indicated that the lateral loading conditions are not included as part of the ESP because information on the type and characteristics of these backfill materials is not available and the reactor technology, and its corresponding foundation depth, has not been selected. In SSAR Section 2.5.4.5.3, the applicant committed to evaluate lateral pressure from backfill materials and to discuss the details for the backfill quantities, types and sources during the COLA stage. Consistent with the applicant's stated commitment, the staff identified the following COL action item:

COL Action Item 2.5-9

> An applicant for a COL or CP referencing this early site permit should provide, consistent with the selected reactor technology, (i) details for the backfill quantities, types and sources; (ii) lateral loading conditions; (iii) information on the type and characteristics of backfill materials; and (iv) lateral pressure evaluation from backfill materials.

Foundation Excavation Monitoring

The staff reviewed SSAR Section 2.5.4.5.4. The applicant indicated that it will install geotechnical instrumentation for the nuclear island structures to monitor possible heave caused by removing soils during the excavation. The applicant stated that it will document the initial mat foundation excavation to the top of the competent layer to confirm that the soils conform to those used in the design. In SSAR Section 2.5.4.5.4.1, the applicant recognized the need to perform geologic mapping for documenting the presence or absence of faults and shear zones in plant foundation materials. Section 2.5.3.5, "Geologic Mapping Permit Condition," of this report identifies Permit Condition 3 as the COL or CP applicant's responsibility to perform detailed geologic mapping of excavations for nuclear island structures; and examine and evaluate geologic features discovered in those excavations.

In SSAR Section 2.5.4.5.4.2, the applicant committed to include the geotechnical instrumentation plan and monitoring schedule in the COL application. Consistent with the applicant's stated commitment, the staff identified the following COL action item:

COL Action Item 2.5-10

> An applicant for a COL or CP referencing this early site permit should include the geotechnical instrumentation plan and heave monitoring schedule in the COL application.

Conclusions Regarding Excavation and Backfill

Since the applicant has not selected a reactor technology design for the ESP site, it deferred to the COLA stage the specific details regarding excavation and backfill. However, regardless of the technology selected, the applicant defined the bearing layer at approximately elevation -20 m (-67 ft) NAVD, based on shear wave velocities of 304.8 m/s (1,000 ft/s) or higher. The applicant committed to provide specific details during the COLA stage regarding the lateral and vertical extent of the excavation for the plant design technology selected**;** the method of excavation support and the stability of temporary excavation slopes or support; the specification for placement and compaction of Category 1 backfill; ITAAC for the soil backfill and V_s; details for the backfill quantities, types and sources; lateral loading conditions; evaluation of the lateral pressure from backfill materials; and the instrumentation plan and monitoring schedule. Therefore, the staff defers its evaluation of the applicant's excavation and backfill plans until these plans are submitted as part of a COL or CP application.

2.5.4.4.6 Groundwater Conditions

The applicant described the installation of 16 well pairs in the site to characterize groundwater conditions. Eight of the well pairs were located in the north portion of the site within the new plant location. The applicant described the groundwater model it used to characterize

dewatering during construction and presented the dewatering effects on adjacent structures. SSAR Section 2.4.12 presents the applicant's full descriptions and results of the groundwater flow models during construction and subsequent plant operations. The staff's evaluation of this model is provided in Section 2.4.12.4 of this report.

The staff reviewed SSAR Section 2.5.4.6 focusing on the groundwater conditions relative to foundation stability for the safety-related structures. The staff noted that the average groundwater elevation of 0.2 m (0.6 ft) NAVD was calculated from groundwater monitoring data collected between January 2009 and July 2009 instead of the complete data range from January to December 2009. Since the position of the water table can affect the potential for liquefaction by changing the effective vertical stresses in the soil profile, in RAI 30, Question 02.05.04-2, the staff requested that the applicant discuss why the complete data range was not selected to calculate the average groundwater elevation. The staff also requested that the applicant discuss any potential impacts to the liquefaction assessment if the complete date range of monitoring data had been used.

In a June 29, 2011, response to RAI 30, Question 02.05.04-2, the applicant indicated that the depth to the groundwater table at each boring location used in the liquefaction evaluation was selected from water level measurements made in April 2009 in the shallow-depth observation wells installed adjacent to the geotechnical borings. In Table RAI-30-1, as part of the RAI response, the applicant summarized the groundwater elevations used for the liquefaction evaluation for each boring and the groundwater elevations from January through April at the observation wells near each boring. The applicant referenced SSAR Table 2.5.4.6-1 to indicate that the largest fluctuation in the shallow water table observation wells over the period from January 2009 to December 2009 was noted at 0.8 m (2.67 ft) in observation well NOW-2U. The maximum water table elevation for the observation well NOW-2U was at elevation 0.7 m (2.19 ft), which corresponds to a depth to water from the ground surface of 2 m (6 ft). As a consequence, the applicant prepared Table RAI 30-2, as part of the RAI response, to compare the factor of safety (FS) against liquefaction assuming a depth to the water table of 2 m (6 ft) instead of the original 2.6 m (8.4 ft) that was calculated based on groundwater data between January and July 2009.

The staff reviewed the liquefaction evaluation results after it considered the complete groundwater monitoring data, including the seasonal high water table. The staff reviewed the applicant's comparisons in calculated FS based on a different depth to the water table, as provided in Table RAI 30-2. The staff noted no changes for the factors of safety that were less than 1.4 and no additional samples with factors of safety less than 1.4. In the June 29, 2011, response to RAI 30, Question 02.05.04-2, the applicant committed to modify SSAR Table 2.5.4.8-2, update liquefaction factor of safety results and include additional information regarding this RAI. The staff confirmed that the revised SSAR includes the additional information as committed to in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 30, Question 02.05.04-2, resolved.

The applicant also discussed its groundwater investigation in SSAR Section 2.4.12. SSAR Section 2.4.12.1.2.5 discusses the groundwater conditions for the bearing layer. The applicant stated that groundwater in the Vincentown Formation beneath the PSEG Site has relatively high concentrations of chloride and is not suitable for use as a water supply. Since high concentrations of chloride content have the potential to increase the risk of corrosion of steel reinforcement in concrete foundations, in RAI 41, Question 02.05.04-5, the staff requested that

the applicant indicate any measures that will be taken to mitigate these effects and to provide chemical analyses for groundwater and soils, specifically for sulfate and chloride concentrations and pH values.

In a January 6, 2012, response to RAI 41, Question 02.05.04-5, the applicant indicated that chemical analysis of groundwater was not conducted as part of this SSAR site investigation. To provide appropriate protection against corrosion of below grade steel and concrete structures, the applicant stated in the RAI 41, Question 02.05.04-5 response, that it would evaluate and implement, during the COLA stage, design measures appropriate for the chemical characteristics of the Category 1 fill, site soils and site groundwater. Consistent with the applicant's stated intention, the staff identified the following COL action item:

COL Action Item 2.5-11

> An applicant for a COL or CP referencing this early site permit should evaluate and implement, during the COL application stage, design measures appropriate for the chemical characteristics of the Category 1 fill, site soils and site groundwater.

In SSAR Section 2.5.4.6.3.1, the applicant described construction dewatering effects on adjacent structures. The applicant plans to conduct construction dewatering to facilitate excavation and allow proper fill placement. The staff reviewed SSAR Table 2.5.4.6-3, which shows a summary of groundwater drawdowns at existing structures within the Vincentown Formation after one year of dewatering. The staff reviewed Calculation Package PSEG 2251-ESP-GT-009, Revision 2, "Evaluation of ground settlement in the area of existing structures due to temporary dewatering," and Figure 2251-ESP-GT-009, which shows contour maps depicting these drawdowns overlaid onto a general layout plan of the existing HCGS and SGS plants. The staff noted different groundwater levels across the existing HCGS's and SGS's safety-related structure foundations and, in RAI 41, Question 02.05.04-18, the staff requested that the applicant discuss possible impacts on differential settlement and the stability of these safety-related structures due to these different groundwater levels.

In a January 20, 2012, response to RAI 41, Question 02.05.04-18, the applicant estimated possible differential elastic settlement under the HCGS and SGS safety-related structures resulting from the dewatering activities described above. The applicant indicated that because the soil properties of the Vincentown Formation and underlying formations were considered to be the same under all structures, the settlement is proportional to the drawdown and varies linearly with it. The staff reviewed Table RAI 41-18-1 as part of the RAI response, which summarizes the estimated future drawdown and vertical settlement under the HCGS and SGS safety-related structures after 1 year of dewatering during the excavations for PSEG structures. U.S. Army Corps of Engineers Manual (1990) establishes that the differential settlements should not exceed 1.3 cm (0.5 in.) in buildings, otherwise cracking and structural damage may occur. Following the Army Corps of Engineers technical manual for settlement, the staff concludes that the future elastic differential settlement calculated by the applicant (0.25 cm (≤ 0.1 in.)) is not anticipated to negatively impact existing HCGS and SGS safety-related structures. Accordingly, the staff considers RAI 41, Question 02.05.04-18, resolved.

Conclusions Regarding Groundwater Conditions

The applicant described the groundwater measurements and elevations, construction dewatering plans and dewatering effects on existing safety-related structures located adjacent

to the PSEG Site. Based on the information above, the staff concludes that the applicant conducted an appropriate preliminary evaluation of the groundwater conditions. However, the applicant did not select a reactor design nor provide a final evaluation of groundwater conditions as they affect foundation stability or detailed dewatering plans. Therefore, the staff could not evaluate in detail the groundwater conditions as they affect the loading and stability of foundation materials, as well as groundwater control throughout the life of the plant. As such, the staff defers these evaluations and plans until the information is submitted as part of the COL or CP application. In SSAR Section 2.5.4.6.3.1, the applicant committed to further evaluate dewatering and potential impacts during the COLA stage. Consistent with the applicant's stated commitment, the staff identified the following COL action item:

COL Action Item 2.5-12

> An applicant for a COL or CP referencing this early site permit should perform, consistent with the selected reactor technology, evaluation of groundwater conditions as they affect the loading and stability of foundation materials, and also provide detailed dewatering and groundwater control plans.

2.5.4.4.7 Response of Soil and Rock to Dynamic Loading

The staff reviewed SSAR Section 2.5.4.7, focusing on subsurface properties and the rationale used by the applicant when developing: seismic wave velocity profiles, modulus reduction and damping curves and Poisson's ratio, which were ultimately used as input to develop the site response analyses. The applicant provided detailed information on its site response analysis and development of the GMRS in SSAR Section 2.5.2.5.2.

The applicant indicated in SSAR Section 2.5.4.7.4.1 that the site shallow dynamic profile was based on four P-S suspension logged boreholes. The staff reviewed the V_s profiles shown in SSAR Figures 2.5.4.4-1 through 2.5.4.4-4, and noted that out of the four boreholes in which P-S suspension was used to measure V_s, two were used to record V_s measurements in deeper layers (between 90 to 180 m (300 and 600 ft)), and out of these two, just one measures V_s within the northern portion of the site or proposed location of Seismic Category I buildings. Therefore, in RAI 41, Question 02.05.04-17, the staff requested that the applicant indicate how variations in V_s were estimated based on only one P-S suspension reading over the deeper portion of the profile.

In a January 6, 2012, response to RAI 41, Question 02.05.04-17, the applicant indicated that, geologically, the materials are consistent across the entire area, and V_s values are similar between borings NB-1, located on the north and EB-3, located east of the PSEG Site. The staff reviewed geologic cross-section provided in SSAR Figure 2.5.4.1-4 and concurs with the applicant that, in the deeper portions across the site, similar V_s measurements were noted. In addition, the staff revisited SSAR Figures 2.5.4.7-1B, 2.5.4.7-1C, 2.5.4.7-3B, 2.5.4.7-3C, which show boring profiles with SPT and V_s data. The staff also noted, based on the review of SSAR Figure 2.5.4.7-7, similar V_s values in the deeper portions of the profile for borings NB-1 and EB-3. As detailed in Section 2.5.4.4.2 of this report, the applicant committed to perform additional geotechnical investigations during the COLA stage. The staff concludes that this additional geotechnical investigation will provide further insights regarding the site's potential V_s variability's in the deeper portions of the soil profile. Accordingly, the staff considers RAI 41, Question 02.05.04-17, resolved.

SSAR Section 2.5.4.7.5 states that the applicant used Darendeli equations instead of RCTS test results to characterize the degradation properties of foundation bearing soils because of sample disturbances of the cemented soil layers. In RAI 41, Question 02.05.04-13, the staff requested that the applicant justify the validity of Darandeli equations and discuss how they represent actual degradation properties of the soils at the site and whether it is a conservative approach when used in site seismic response analysis.

In a January 20, 2012, response to RAI 41, Question 02.05.04-13, the applicant stated that the validity of Darandeli equations to characterize the PSEG Site's dynamic properties was supported by a comparison with data from the U.S. Department of Energy (DOE) Savannah River Site, indicating that the subsurface conditions of the Savannah River Site were similar to PSEG Site. In addition, the applicant used the elastic modulus derived from the Darandeli equations to calculate the settlement estimates.

The staff reviewed Figures RAI-41-13-5 through RAI-41-13-8, which show the degradation curves derived using Darendeli equations and used to calculate the elastic modulus for the settlement analysis. As a follow-up to RAI 41, Question 02.05.04-13, in RAI 64, Question 02.05.04-25, the staff requested that the applicant (i) provide additional details on the similarities between the PSEG and Savannah soils and (ii) explain how the use of these curves was considered appropriate and conservative to estimate site-specific settlements and to justify using dynamic instead of static properties for this analysis.

In a September 20, 2012, response to RAI 64, Question 02.05.04-25, part (i), the applicant stated that the response to RAI 41, Question 02.05.04-13 was not intended to imply that the use of Darandeli equations was contingent upon soils at the PSEG Site being similar to those at the Savannah River site; but to show that the modulus reduction and the material damping for the Savannah River site calculated using Darandeli equations compared favorably with the results based on RCTS testing for the same site. The staff reviewed the applicant's September 20, 2012, response to RAI 64, Question 02.05.04-25, and noted that the Darandeli equations were the result of research work at the University of Texas under the direction of Dr. Ken Stokoe and the validity of Darandeli equations is supported by comparison with data from the Savannah River Site. The staff concludes that the Darandeli equations are appropriate to calculate the modulus reduction and material damping for the PSEG Site. Therefore, the staff considers RAI 64, Question 02.05.04-25, part (i), resolved. The staff also noted that the degradation curves were used for the GMRS analysis and for the calculation of the elastic modulus for the settlement preliminary analysis. Section 2.5.4.4.10 of this report provides the staff's evaluation of the applicant's response related to RAI 64, Question 02.05.04-25, part (ii), the estimation of site-specific settlements, and Section 2.5.2.4.6 of this report provides the evaluation related to the GMRS analysis.

Conclusion Regarding Response of Soil and Rock to Dynamic Loading

The staff reviewed SSAR Section 2.5.4.7, and concludes that the applicant provided adequate information on the subsurface properties and the rationale used when developing the V_s profiles and modulus reduction and damping curves used to perform the dynamic response analyses. Section 2.5.2.4.5 of this report contains the staff's evaluation of the applicant's site response analyses, and Section 2.5.4.4.2 of this report provides additional details of the staff's evaluation of the ESP site dynamic soil properties. In SSAR Sections 2.5.2 and 2.5.4.7, the applicant indicated that it developed the GMRS at the top of a competent layer as a result of the dynamic analyses and that the development of foundation input response spectra (FIRS) and the Soil

Structure Interaction (SSI) analysis will be performed during the COLA stage. Consistent with the applicant's stated intention, the staff identified the following COL action item:

COL Action Item 2.5-13

> An applicant for a COL or CP referencing this early site permit should develop the foundation input response spectra (FIRS) and the Soil Structure Interaction (SSI) analysis at the COL application stage.

2.5.4.4.8 Liquefaction Potential

In its review of SSAR Section 2.5.4.8, the staff evaluated the applicant's description of liquefaction potential, including the geological based screening and SPT based liquefaction analyses at the PSEG Site. The staff focused its review on the input parameters, assumptions and processes used in the SPT based liquefaction analysis. The staff reviewed the calculation package DCN ESP-750, calculation 2251-ESP-GT-008, Revision 5, "Potential Liquefaction Evaluation," to verify that the applicant used the method recommended by RG 1.198 for determining the FS against liquefaction. The applicant used the procedure described by Youd et al. (2001), which evaluates soil strength against liquefaction based on SPT blowcount values and the induced cyclic stresses based on earthquake PGA and magnitude values.

To conduct a confirmatory analysis, in RAI 8, Question 02.05.04-1, the staff requested that the applicant provide additional information regarding the following site-specific input parameters used for the liquefaction evaluation; SPT N_{60}, V_s, shear modulus, effective overburden pressures and total stresses values. In addition, in RAI 30, Question 02.05.04-3, the staff requested that the applicant provide the methods and equations used to calculate $(N_1)_{60,}$ Cyclic Stress Ratio ($CRR_{7.5}$), Magnitude Scaling Factor (MSF), correction factor for overburden stress (k_s) and to justify the selected values.

In a March 21, 2011, response to RAI 8, Question 02.05.04-1, and a June 29, 2011, response to RAI 30, Question 02.05.04-3, the applicant provided the requested information regarding the input parameters used for the staff's confirmatory liquefaction analysis. In the March 21, 2011, response to RAI 8, Question 02.05.04-1, the applicant committed to modify associated text in SSAR Sections 2.5.4.2 and 2.5.4.8. While preparing the response, the applicant found a discrepancy in the assignment of stratigraphy to the split spoon samples. The applicant included corrections for the samples above the competent layer and committed to incorporate changes in the next scheduled update to the SSAR. The staff confirmed that Revision 1 of the ESP application, dated May 21, 2012, contains the SSAR changes committed in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 8, Question 02.05.04-1, resolved.

The staff was able to conduct the liquefaction confirmatory analysis using the methods described in RG 1.198. When performing the confirmatory analysis, the staff noted some variations between the FS calculated by the staff and the FS provided by the applicant. Therefore, the staff revisited the applicant submittal and noted that in the June 29, 2011, response to RAI 30, Question 02.05.04-3, the applicant indicated that the equation for relative density was developed based on Tokimatsu and Seed (1987), Figure 3 and stated that the value used for the calculation of the relative density was the field corrected value $(N_1)_{60cs}$, which includes correction for fines content. The staff reviewed Tokimatsu and Seed (1987) and noted that the equation from Figure 3 does not use SPT $(N_1)_{60cs}$ values. The relative density is used to calculate the overburden correction factor (K_σ), which was, in turn, used to adjust the calculated

liquefaction FS to account for high stresses. Therefore, as a follow-up to RAI 30, Question 02.05.04-3, in RAI 45, Questions 02.05.04-20, and 02.05.04-21, the staff requested that the applicant elaborate about how the relative density equation was derived, given the discrepancy noted above between different SPT N values used in the RAI responses and in Tokimatsu and Seed (1987).

In a December 19, 2011, response to RAI 45, Questions 02.05.04-20, and 02.05.04-21, the applicant elaborated on the development of the relative density equation. Figure RAI-45-21-1 shows a relationship curve representing the relative density equation using SPT N-values measured by Japanese standards. From this curve, the applicant derived an equation relating $(N_1)_{60}$ to the relative density as follows:

$$D_r = k\,[(N_1)_{60}]^{0.5}$$

where

D_r= relative density

k= constant

$(N_1)_{60}$= Field SPT N value corrected for overburden stress, energy, borehole diameter, rod length and sampler liner

The applicant selected D_r and $(N_1)_{60}$ values from Figure RAI-45-21-1 and calculated a value of 15 for k. Furthermore, the applicant indicated that the inclusion of $(N_1)_{60cs}$ was a typographical error as fines content is not part of the equation to determined relative density. The applicant indicated that the correct equation includes $(N_1)_{60}$, which is the field SPT N-value corrected for overburden stress, energy, borehole diameter, rod length and sample liner. The staff reviewed the derivation of the formula, including the calculation of the k value and noted that the applicant employed a reasonable approach for determining the values of relative density. In accordance with the method of Youd and others (2001) referenced in RG 1.198, the staff agrees that $(N_1)_{60}$ is the correct value to use for the K_σ value, ultimately used to adjust the calculated liquefaction factor of safety to account for high stresses. In its June 29, 2011, response to RAI 30, Question 02.05.04-3, the applicant committed to modify the SSAR to include the appropriate markups for this response. The staff confirmed that the Revision 1 of the ESP application, dated May 21, 2012, contains the SSAR changes committed in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 30, Question 02.05.04-3, and RAI 45, Questions 02.05.04-20 and 02.05.04-21 resolved.

In addition, when reviewing PSEG calculation package DCN ESP-750, calculation 2251-ESP-GT-008, Revision 5, "Potential Liquefaction Evaluation," the staff noted that for the calculation of the Cyclic Stress Ratio, the stress reduction factor (rd) was calculated starting at elevation -20 m (-67 ft) NAVD, and the total overburden stress and the effective overburden stress were calculated from the ground surface elevations at the boring locations at the time the borings were drilled. In RAI 41, Question 02.05.04-19, the staff requested that the applicant justify the difference in the chosen depth for the calculation of the stress reduction factor, overburden stresses and effective overburden stresses and to discuss how the difference in the chosen depth affects the factors of safety against liquefaction.

In a January 6, 2012, response to RAI 41, Question 02.05.04-19, the applicant prepared additional calculations using boring NB-1 data to illustrate the effect on FS based liquefaction of using rd computed with the ground surface as the reference point (3.9 m (12.8 ft)), instead of at

the top of the competent material, at elevation -20 m (-67 ft) NAVD. Based on this new calculation, the FS calculated using an rd referenced at elevation -20 m (-67 ft) NAVD were lower than the FS calculated using an elevation 3.9 m (12.8 ft). Therefore, the applicant concluded that rd will be calculated from elevation -20 m (-67 ft) NAVD, since it will provide more conservative results.

The staff reviewed Table RAI-41-19-1 as part of the RAI response, which compares the results from the additional calculation. The staff noted that the factors of safety when the rd is computed at the existing ground elevation, are greater than if rd is computed at -20 m (-67 ft) NAVD. The staff agrees that to compute rd at elevation -20 m (-67 ft) NAVD produces conservative FS values. This explains the variations between the FS calculated in the staff's confirmatory analysis and the FS calculated by the applicant. However, given that input parameters were calculated using different references within the soil profile, the staff issued RAI 69, Question 02.05.04-27, as a follow-up to RAI 41, Question 02.05.04-19, requesting that the applicant justify in the SSAR the deviation from the formula and explain the appropriateness of the results, or correct the liquefaction analysis and include the changes in the SSAR.

In an April 4, 2013, response to RAI 69, Question 02.05.04-27, the applicant referenced its December 20, 2012, response to RAI 61, Question 02.05.02-10, to support its conclusion. As a result of RAI 61, Question 02.05.02-10, in which the staff requested that the applicant re-evaluate the site seismicity using the CEUS-SSC model, the applicant revised its liquefaction analysis using a PGA equal to 0.225g. To support its response, the applicant selected the result of condition 1 in Table RAI-69-1 as part of the response to RAI 69, which computes liquefaction FS using rd computed at the top of the competent material at elevation -20 m (-67 ft) NAVD. In Table RAI-69-2, as part of the response to RAI 69, the applicant reported a total of 17 liquefaction safety factors less than or equal to 1.1, 15 of which are in the Vincentown Formation. The applicant characterized these specific samples as isolated pockets surrounded by denser materials, not a continuous layer. The applicant concluded that liquefaction of granular soils below the top of the Vincentown Formation is not likely to occur. The applicant committed to revise SSAR Section 2.5.4.8 and SSAR Table 2.5.4.8-2 to incorporate changes in response to RAI 69, Question 02.05.04-27. The staff confirmed that Revision 3 of the ESP application, dated March 31, 2014, contains the SSAR changes committed in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 69, Question 02.05.04-27 resolved. However, the staff noted that results from the updated liquefaction analysis, based on a higher input PGA, indicate a considerable increase in the number of samples with FS less than or equal to 1.1. Table RAI-69-1, shows that most of the points with FS equal to or less than 1.1 are located within the Vincentown Formation and are from samples taken from borings NB-1, NB-2, NB-3 and NB-4. In the first 15 m (50 ft) evaluated by the applicant, a total of 17 values of FS were equal to or lower than 1.1. The staff notes a consistent pattern in the FSs that might indicate a potentially weak liquefiable zone. Given the considerable number of samples with FS equal to or lower than 1.1 encountered at the site, and the limited extent of field investigation performed at the site, as a follow-up to RAI 69, Question 02.05.04-27, the staff issued RAI 70, Question 02.05.04-28, requesting that the applicant justify its conclusion.

In a July 17, 2013, response to RAI 70, Question 02.05.04-28, the applicant provided site information and references regarding geologic aging, historical information from the HCGS's and SGS's licensing studies and a discussion of the evaluation of liquefaction potential using a V_s screening method proposed by Andrus, Stokoe II and Juang (2004). The applicant indicated that according to literature, the Vincentown Formation is considered generally immune to

liquefaction because of its pre-Pleistocene age. However, RG 1.198 indicates that cases of liquefaction have been observed in Pleistocene and pre-Pleistocene deposits, especially those deposits dealing with dune sands, talus and loess. The applicant stated that Vincentown Formation consists of marine sediments and does not contain dune sands, talus or loess.

The staff reviewed the references associated with the V_s screening used by the applicant to support its conclusion. Particularly, the staff focused in the reference by Andrus, Stokoe II and Juang (2004), which provides guidance to evaluate liquefaction potential based on V_s data. The paper proposes an approach to extend V_s screening to deeper depths and to older geologic formations. Andrus, Stokoe II and Juang (2004) based its calculation of the CSR on Youd et al., (2001), but proposed the calculation of the CRR based on stress correction of V_s and the application of an age correction factor to the CRR. Although the case study presented in Andrus, Stokoe II and Juang (2004) demonstrates that cyclic strengths could increase with age, it also indicates that a high degree of uncertainty is present in the results due to assumptions made and limited case history data. Furthermore, Andrus, Stokoe II and Juang (2004) acknowledge that additional work is needed to better quantify the influence of age on V_s and liquefaction resistance of soils. Since there is no professional consensus on a quantitative correction factor to account for the age of the deposit, the staff concludes that, for the use of age correction factor in the liquefaction assessment, additional investigation is needed to better quantify the influence of age on V_s and liquefaction resistance of soils.

In addition, the staff reviewed information provided by the applicant regarding borings logs performed at HCGS and SGS. Based on the review of these borings, the applicant indicated that the low values for FS against liquefaction do not indicate a continuous liquefiable layer across the PSEG Site. The staff reviewed the URS Corporation Independent Spent Fuel Storage Installation (ISFSI) Geotechnical Investigation borings report detailing borings performed directly south of the south boundary of the PSEG Site and confirmed that only two instances of lower blow count were found below elevation -20 m (-67 ft) NAVD of the 11 borings performed. Although this supports the applicant's conclusion regarding not having a continuous liquefiable layer across the PSEG Site, it is not located in the area of interest enclosed by PSEG borings NB-1, NB-2, NB-3 and NB-4. In its response, the applicant referred to 10 borings from HCGS located in the area between NB-4 and NB-8 and extending approximately 240 m (800 ft) south of these borings to indicate that PSEG borings with lower blow counts are an isolated condition. However, these 10 borings are not located within the area enclosed by borings NB-1, NB-2, NB-3 and NB-4. Moreover, the applicant provided information regarding boring 30 of the SGS site investigation, which is located in the area enclosed by borings NB-1, NB-2, NB-3 and NB-4. The staff reviewed the boring log and found five instances of low blow counts (less than 30 bpf) in the Vincentown Formation, between elevation -20 m (-67 ft) and -27 m (-90 ft) NAVD. The field investigation data presented by the applicant from past licensing studies and current field investigation data in the PSEG Site area indicates that the Vincentown Formation does have instances where looser soils are encountered which are associated with low liquefaction FSs, which might indicate a potentially weak liquefiable zone in the area enclosed by borings NB-1, NB-2, NB-3 and NB-4. Therefore, the staff notes that additional geotechnical investigation is needed for a complete seismic liquefaction assessment at the COL stage. In addition, as part of its response to RAI 70, Question 02.05.04-28, the applicant acknowledged that additional borings will be conducted during the COL stage, and analyzed to determine if zones of lower blow counts are present underneath the competent layer. If the additional borings and analyses performed during COLA development identify areas where the potential for liquefaction may be present, the applicant stated that it would remove the unsuitable material

and replace it with competent material. Consistent with the applicant's stated intention, the staff identified the following COL action item to address liquefaction potential:

COL Action Item 2.5-14

> An applicant for a COL or CP referencing this early site permit should perform additional geotechnical investigation, consistent with RG 1.132, including the performance of additional borings and a detailed liquefaction assessment to determine if zones of lower blow counts, which might indicate a potentially weak liquefiable zone, are present underneath the competent layer. If the additional borings and analyses identify areas where potential for liquefaction may be present, the applicant should remove unsuitable materials and either replace it with competent material or improve it to eliminate liquefaction potential.

NUREG-0800 suggests that non-seismic liquefaction, such as that induced by erosion, floods, wind loads on structures and wave action should be analyzed using state-of-the-art principles of soil mechanics. In SSAR Section 2.5.4.8.5, the applicant committed to evaluate non-seismic liquefaction during the COLA stage. Consistent with the applicant's stated commitment, the staff identified the following COL action item to address non-seismic liquefaction:

COL Action Item 2.5-15

> An applicant for a COL or CP referencing this early site permit should evaluate non-seismic liquefaction.

In SSAR Section 2.5.4.7.4.1, the applicant stated that the soils above the Vincentown Formation present unsuitable engineering characteristics with shear wave velocities less than 304.8 m/s (1,000 ft/s). The applicant stated that they will remove these soils from the area of safety-related structures to reach the competent material and replace it with a suitable backfill. The applicant stated that the top of the competent layer is located, in the Vincentown Formation, at approximately elevation -67 ft NAVD.

Consistent with the applicant's commitments described above, the staff identified Permit Condition 4, described in Section 2.5.4.5 of this report.

Conclusions Regarding Liquefaction Potential

The staff concludes that based on the information and findings above, the applicant used an acceptable methodology to determine the liquefaction potential of the soil underlying the ESP site. Because soils above the Vincentown Formation present unsuitable engineering characteristics, the applicant stated that it will remove and replace these soils from the area of safety-related structures. Subject to Permit Condition 4 described in Section 2.5.4.5 of this report, and COL Action Items 2.5-14 and 2.5-15, the staff concludes that the information provided in the ESP is consistent with the guidelines in NUREG-0800.

2.5.4.4.9 Earthquake Design Basis

SSAR Section 2.5.4.9 summarizes the applicant's approach to derive the site-specific GMRS and SSE. This derivation is detailed by the applicant in SSAR Section 2.5.2.6. The applicant indicated that the GMRS satisfies the requirements of 10 CFR 100.23 for the development of

the site-specific SSE ground motion. Section 2.5.2.4.6 of this report provides the staff's evaluation for the GMRS and SSE.

2.5.4.4.10 Static Stability

The staff reviewed SSAR Section 2.5.4.10 focusing on the applicant's evaluation of bearing capacity and settlement of the bearing strata at the ESP site. For its analyses, the applicant used the reactor foundation design parameters included in the reactor technology Design Control Documents (DCD) for four reactor technologies: ABWR; AP1000; U.S. EPR; and US-APWR.

Bearing Capacity

The applicant evaluated the bearing capacity under static and dynamic conditions using three methodologies that included: Meyerhof, Terzaghi and Vesic described by Bowles (1988). Based on the evaluation of bearing capacity for the technologies stated above, the applicant determined that the PPE value for the ultimate bearing capacity was 20,100 kN/m^2 (420,000 psf) under static conditions. The ultimate bearing capacity is defined as the bearing pressure required to produce a bearing capacity failure. The staff performed a confirmatory analysis using the design foundation parameters for each technology and the PSEG soil properties. The staff used 37 degrees as the effective angle of friction and a unit weight of 19.6 kN/m^3 (125 lb/ft^3), the foundation dimension and embedment depth for each design technology, and a groundwater depth of 3 m (10 ft) NAVD. The staff used the Terzaghi and Vesic methodologies and concluded that the PPE value for the ultimate bearing capacity is appropriate for the four reactor technologies considered by the applicant. The staff's confirmatory analysis for each of the technologies produced values for the ultimate bearing capacity of approximately 20,100 kN/m^2 (420,000 psf) or higher.

The applicant stated in SSAR Section 2.5.4.10.2 that for the bearing capacity calculations, a friction angle of 37 degrees was selected based on N_{60} values and a unit weight of 19.6 kN/m^3 (125 lb/ft^3) based on a weighted average of unit weights from the Vincentown, Hornerstown, Navesink and Mount Laurel Formations. In Section 2.5.4.4.2 of this report, the staff discussed RAI 41, Question 02.05.04-15, related to the selection of the internal friction angle. Also in RAI 41, Question 02.05.04-15, the staff requested that the applicant justify selecting 19.6 kN/m^3 (125 lb/ft^3) for the bearing capacity calculation, when the referenced values given in SSAR Table 2.5.4.2-9 were lower.

In a January 20, 2012, response to RAI 41, Question 02.05.04-15, the applicant indicated that it used the weighted average of the unit weight for the combined Vincentown and Hornerstown, Navesink, and Mount Laurel Formations, instead of using its design values. The applicant presented details in Table RAI-41-15-2 as part of the RAI response. The applicant indicated that the unit weight values given in SSAR Table 2.5.4.2-8 for these formations were used to calculate the average unit weight for use in the bearing capacity analysis. The staff reviewed Table RAI-41-15-2 and considers that the use of weighted unit weights is a simplification that provides a reasonable approximation of the bearing capacity. Accordingly, the staff considers RAI 41, Question 02.05.04-15, resolved. However, the staff identified the following COL action item to address recalculations of the bearing capacity:

COL Action Item 2.5-16

An applicant for a COL or CP referencing this early site permit should analyze the stability of all planned safety-related facilities, including static and dynamic bearing capacity, rebound, settlement, and differential settlements under dead loads of fills and plant facilities, as well as lateral loading conditions.

Settlement

In SSAR Section 2.5.4.10.3, the applicant stated that it has not established the criteria to estimate the site-specific total and differential settlement because the settlement is dependent on the position of the applied load relative to the subsurface layer and the size of the mat. This information has not yet been determined. The staff reviewed SSAR Section 2.5.4.10.3, which includes a preliminary evaluation of possible settlement at the site using the technology with the largest mat foundation, U.S. EPR.

As stated in Section 2.5.4.4.7, of this report, the staff reviewed Figures RAI-41-13-5 through RAI-41-13-8, as part of the response to RAI 41, which show the degradation curves derived using Darendeli (2001) equations, and which the applicant used to calculate the elastic modulus for the settlement analysis. As a follow-up to RAI 41, Question 02.05.04-13, the staff issued RAI 64, Question 02.05.04-25, part (ii), requesting that the applicant explain how the use of these curves was considered appropriate and conservative to estimate site-specific settlements and to justify them using dynamic, instead of static, properties for this analysis.

In a September 20, 2012, response to RAI 64, Question 02.05.04-25**,** part (ii), the applicant indicated that it used the V_s to estimate the elastic modulus of a soil using the method described in FHWA Geotechnical Engineering Circular (2002). The applicant estimated the elastic modulus as follows:

$E/E_0 = 1 – (q/q_{ult})^{0.3}$ where

E= reduced modulus for higher shear strain

E_o= modulus at low shear strain

q= applied bearing pressure

q_{ult}= ultimate bearing pressure

The applicant stated that the ratio E/E_o is the same as G/G_{max}, because E and E_o are related to G and G_{max} by the same factor. The applicant calculated E/E_o of 0.63 using a typical bearing pressure for reactor technologies of 15,000 psf (716 kN/m^2) and q_{ult} of 20,100 kN/m^2 (420,000 psf). While reviewing the applicant’s response, the staff noted that the applicant used a conservative ratio to estimate the settlement, because the G/G_{max} listed in SSAR Table 2.5.4.10-1 is lower than that calculated using its PPE parameters for bearing pressure. In addition, the applicant compared the estimated settlement using reduction values of 0.4 and 0.5 with the estimated settlement using modulus reduction curves at 10^{-3} and concluded that the results show an increase of approximately 10 percent in the estimated settlement using reduction values. The staff concludes that the reduction values of 0.4 for materials above elevation -90 m (-300 ft) and 0.5 for materials below that elevation are appropriate with respect to the FHWA methodology, and when compared with the reduction values using modulus reduction curves at 10^{-3} at the foundation level because the use of a smaller reduction factor results in a decrease in the modulus value and produces higher settlements; therefore it is a

conservative approach. Accordingly, the staff considers RAI 64, Question 02.05.04-25, part (ii), resolved.

While describing its settlement analysis, the applicant stated that the Vincentown Formation and soils below will deform elastically because of the sandy composition of soils and over-consolidated nature of clays. In RAI 41, Question 02.05.04-14, the staff requested that the applicant provide additional information to support this statement, especially when the pre-consolidation pressures were not obtained from one dimensional consolidation test for these clay type soils. In addition, the staff requested that the applicant clarify if they calculated drained elastic modulus values for clay-type soils to assess the long term conditions.

In a January 20, 2012, response to RAI 41, Question 02.05.04-14, the applicant indicated that it relied on the area's geologic history (erosion and sea level changes) to justify describing site soils as overconsolidated. The staff noted that laboratory testing was not performed to obtain consolidation data. Therefore, as a follow-up to RAI 41, Question 02.05.04-14, the staff issued RAI 64, Question 02.05.04-26, requesting that the applicant indicate if laboratory tests were planned to be performed on site subsurface soils to assess consolidation properties during the COLA phase, and explain why the liquidity indices from the Atterberg limits test on these soils are unreliable to assess consolidation properties to support the statement that foundation soils will behave as over-consolidated soils.

In a September 20, 2012, response to RAI 64, Question 02.05.04-26, the applicant indicated that the reason for not using the Atterberg limits to support its conclusion was because the results interpreted during the ESP work to further assess consolidation properties were not considered reliable. The applicant provided Table RAI-64-26-1 as part of the RAI response, which shows a comparison of liquidity index values and the estimated consolidated pressures. Based on this table, the applicant stated that the estimated existing overburden pressures are greater than the estimated preconsolidation pressures developed from the United Facilities Criteria Soil Mechanics chart (UFC-3-220-10N). The staff reviewed Table RAI-64-26-1, and the United Facilities Criteria Soil Mechanics chart (UFC-3-220-10N), which provides the relation between the liquid index and preconsolidation pressures. The staff concurs with the applicant that the effective overburden pressures were greater than the preconsolidated pressures. Since a soil is considered to be overconsolidated when the preconsolidation pressures are equal or larger than the present overburden pressures and because the applicant described the soils as overconsoildated, the staff further concurs with the applicant that the liquidity limits from the Atterberg limits test are unreliable to further assess consolidation properties.

In the response to RAI 64, Question 02.05.04-26, the applicant stated that during the COLA exploration, additional borings will be drilled, intact samples will be obtained, and laboratory testing will be conducted, including the consolidation testing for materials having a high percentage of fine-grained particles. Consistent with the applicant's stated intention, the staff identified the following COL action item:

COL Action Item 2.5-17

> An applicant for a COL or CP referencing this early site permit should conduct laboratory testing on intact samples and conduct consolidation testing for materials having a high percentage of fine-grained particles.

Lateral Earth Pressures

In SSAR Section 2.5.4.10, the applicant did not include information for lateral loading conditions as suggested in RS-002. To study the stability of all planned safety-related facilities, lateral loading conditions and their effects on Seismic Category I structures should be analyzed. Therefore, in RAI 41, Question 02.05.04-16, the staff requested that the applicant explain why lateral loading conditions were not included as part of the ESP, and indicate when the lateral earth pressure evaluation will be performed.

In a January 6, 2012, response to RAI 41, Question 02.05.04-16, the applicant indicated that lateral loading conditions were not evaluated as part of the ESP because information on the types and characteristics of the backfill were not available at this stage. In addition, the applicant indicated that it has not selected the reactor technology and its foundation depth. In SSAR Section 2.5.4.5.3, the applicant committed to evaluate lateral earth pressures as part of the COLA stage. The staff addressed this in COL Action Item 2.5-9. In its January 6, 2012, response to RAI 41, Question 02.05.04-16, the applicant also committed to modify SSAR Section 2.5.4.5.3 to describe the reason for not performing the lateral pressure evaluation as part of the ESP application, and to state its plan to perform it as part of the COLA stage. The staff confirmed that the Revision 1 of the ESP application, dated May 21, 2012, contains the SSAR changes committed in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 41, Question 02.05.04-16, resolved.

Conclusions Regarding Static Stability

Based on its review of SSAR Section 2.5.4.10, the staff concludes that the applicant provided an adequate preliminary assessment of the static stability of the ESP site. However, for the staff to perform a complete review of site static stability, the COL or CP applicant referencing this ESP will need to analyze the stability of all planned safety-related facilities once the locations and technology of the plant structures are specified. This analysis should include bearing capacity, rebound, settlement, and differential settlements, as well as lateral loading conditions for all safety-related facilities. Therefore, the staff concludes that the applicant's description of the static stability is adequate to provide assurance of the stability of the ESP site, but the staff needs additional information to support any finding regarding detailed structure-specific stability. The staff identified COL Action Item 2.5-16 in Section 2.5.4.4.10 of this report to address the need for analyzing the stability of all planned safety-related facilities, including static and dynamic bearing capacity, rebound, settlement, and differential settlements under dead loads of fills and plant facilities, as well as lateral loading conditions.

2.5.4.4.11 Design Criteria

In SSAR Section 2.5.4.11, the applicant referenced the geotechnical characteristics discussed in the previous sections of the SSAR. The staff reviewed the general PSEG geotechnical site characteristics as described in the previous sections of this report.

In SSAR Section 2.5.4.5.3.3.2, the applicant committed to include, as part of the COLA submittal, an ITAAC to address the inspection, testing and acceptance criteria for backfill. In addition, the applicant stated that the complete settlement evaluation and construction groundwater control will be addressed at the COL application stage. The staff's COL Action Item 2.5-8 identified in Section 2.5.4.4.5 addresses the backfill ITAAC.

Since the applicant has not selected a reactor design technology and, therefore, did not describe the design criteria for the PSEG Site, the staff identified the following COL action item:

COL Action Item 2.5-18

> An applicant for a COL or CP referencing this early site permit should describe the design criteria and methods, including the factors of safety (FSs) from the design foundation stability analyses consistent with the selected reactor technology.

2.5.4.4.12 Techniques to Improve Subsurface Conditions

The staff reviewed the techniques for soil improvement for the foundation areas of the safety-related structures. Given Permit Condition 4, the COL or CP applicant may need to apply improvement techniques to eliminate any liquefaction potential found during its COL or CP investigation.

In SSAR Section 2.5.4.12, the applicant stated that removal of the unsuitable materials will extend to competent materials present in the Vincentown Formation. In the area of safety-related structures, the applicant plans to excavate down to the competent foundation layer, the Vincentown Formation. The applicant further stated that in the preparation of the foundation bearing surfaces, the applicant will use shallow depth soil improvement techniques, including over-excavation and replacement, and bearing surface compaction. The applicant plans to use dewatering systems to allow construction under dry conditions. Consistent with the applicant's stated intention, the staff identified the following COL action item:

COL Action Item 2.5-19

> An applicant for a COL or CP referencing this early site permit should improve subsurface conditions in cases where foundation soils do not provide adequate bearing capacity for safety-related structures.

2.5.4.5 Permit Conditions

In SSAR Section 2.5.4.5.4.1, the applicant acknowledged the need to perform geologic mapping for documenting the presence or absence of faults and shear zones in plant foundation materials. Therefore, in Section 2.5.3.5, "Geologic Mapping Permit Condition," of this report, the staff identified Permit Condition 3 related to detailed geologic mapping of safety-related excavations at the PSEG Site as the responsibility of the COL or CP applicant.

For evaluation of suitability of a proposed site, requirements in 10 CFR 100.23, "Geologic and Seismic Siting Criteria," specifically 10 CFR 100.23(c), indicate that the engineering characteristics of a site and its environs must be investigated in sufficient scope and detail to permit an adequate evaluation of the proposed site. Several siting factors are discussed in 10 CFR 100.23(d) that must be evaluated, including the potential for soil liquefaction, in addition to several other geologic and seismic factors. In addition, guidance in RG 1.198 indicates that if evaluations of the site investigations indicate the presence of potentially liquefiable soils, the resistance of these soils to liquefaction must be evaluated, and it must also be determined whether the potentially liquefiable soils should be removed, whether remedial action should be undertaken, whether further field and laboratory investigations are needed, or whether detailed stability and deformation analysis could demonstrate that an acceptable margin of safety is

maintained for the design structures even if liquefaction is assumed to occur. In SSAR Section 2.5.4.7.4.1, the applicant stated that the soils above the Vincentown Formation present unsuitable engineering characteristics with shear wave velocities less than 304.8 m/s (1,000 ft/s). The applicant stated that it will remove these soils from the area of safety-related structures to reach the competent material and replace it with suitable backfill. The applicant stated that the top of the competent layer is located, in the Vincentown Formation, at approximately elevation -20 m (-67 ft) NAVD. This activity is Permit Condition 4, the required actions for which are as follows:

Permit Condition 4

> An applicant for a COL or CP referencing this early site permit shall remove and replace the soils directly above the Vincentown Formation for soils under or adjacent to Seismic Category I structures to minimize any liquefaction potential.

2.5.4.6 Conclusion

Based on its review of SSAR Section 2.5.4, and the applicant's responses to the associated RAIs, the staff concludes that the applicant adequately determined the site-specific engineering properties of the soil underlying the ESP site following state-of the art methodology for its field and laboratory methods and in accordance with RG 1.132, RG 1.138, and RG 1.198. However, the staff also concludes that the applicant did not perform sufficient field investigations and laboratory testing to fully characterize the overall subsurface profile. The staff notes that the applicant committed to perform additional field investigations, once it has selected the reactor technology at the COL stage. The applicant addressed the response of the soil to dynamic loading in SSAR Section 2.5.2.

In SSAR Sections 2.5.4.5, 2.5.4.6, 2.5.4.10, 2.5.4.11, and 2.5.4.12, the applicant did not provide sufficient information for the staff to perform a complete evaluation. Each of these topics depends on specific information related to building location and design, and will be needed as part of any COL or CP application referencing this ESP.

In SSAR Table 2.0-1, the applicant identified three subsurface material properties as PSEG Site characteristic values. The first site characteristic specifies that "soils below the competent layer are not susceptible to liquefaction." The applicant used an acceptable methodology, to determine the liquefaction potential of the soil underlying the ESP site; however, in consideration of instances of lower blow counts encountered in the widely spaced and limited numbers of ESP borings performed during the investigation, the staff identified Permit Condition 4, which addresses the need for additional geotechnical investigations and liquefaction assessments for a COL or CP. The second site characteristic value specifies a minimum ultimate bearing capacity of 20,100 kN/m^2 (420,000 psf). The staff reviewed the site characteristic value and found that the PPE value for the ultimate bearing capacity is appropriate for the four reactor technologies considered by the applicant. However, for the staff to perform a complete review of site static stability, including the bearing capacity, the staff will need a COL or CP applicant to analyze the stability of all planned safety-related facilities when the locations and technology for the plant structures are specified. Finally, the third design parameter specifies the minimum V_s through the foundation materials as 492 m/s (1,613 ft/s). The minimum V_s value is based on the applicant's field geophysical surveys. The staff reviewed the applicant's suggested site characteristics related to SSAR Section 2.5.4 for inclusion in an ESP. For the reasons discussed above, the staff concurs with the applicant that the site characteristics values are reasonable.

Subject to Permit Condition 4 and COL Action Items 2.5-1 through 2.5-19, the staff concludes that the applicant meets the requirements of 10 CFR Part 52, Subpart A, applicable to "Stability of Subsurface Materials and Foundations," for an early site permit.

2.5.5 Stability of Slopes

2.5.5.1 Introduction

SSAR Section 2.5.5, "Stability of Slopes," addresses the stability of both natural and manmade (cuts, fill, embankments, dams, etc.) earth slopes whose failure could affect safety-related structures. The staff evaluated this section based on the data provided by the applicant in the SSAR. In SSAR Section 2.5.5.3, the applicant indicated that boring logs for slopes were not performed because the locations of slopes are not known at the ESP stage. The applicant plans to conduct exploration for the design and analysis of slopes at the COL stage.

2.5.5.2 Summary of Application

SSAR Section 2.5.5 discusses stability of earth slopes whose failure could affect safety-related structures. SSAR Table 2.0-1, "PSEG Site Characteristics," contains the site characteristics related to stability of slopes. The pertinent information related to stability of slopes includes: capable tectonic structures, maximum flood, maximum groundwater level, and liquefaction. The applicant deferred the specifics for slope stability design until the COL application stage with a selected reactor technology.

2.5.5.2.1 Slope Characteristics

In SSAR Section 2.5.5.1, "Slope Characteristics," the applicant stated that it plans to perform temporary excavations to remove unsuitable soils above the competent layer and replace these soils with compacted granular fill, lean concrete, or roller-compacted concrete. The applicant stated that the edges of the new fill will be sloped at 3 (horizontal): 1 (vertical) or flatter. Figure 2.5.5-1, "Section A-A′ Slope Configuration," in this report (Reproduced from SSAR Figure 2.5.5-2) presents the approximated slopes configuration corresponding to Section A-A′ located in the power block area.

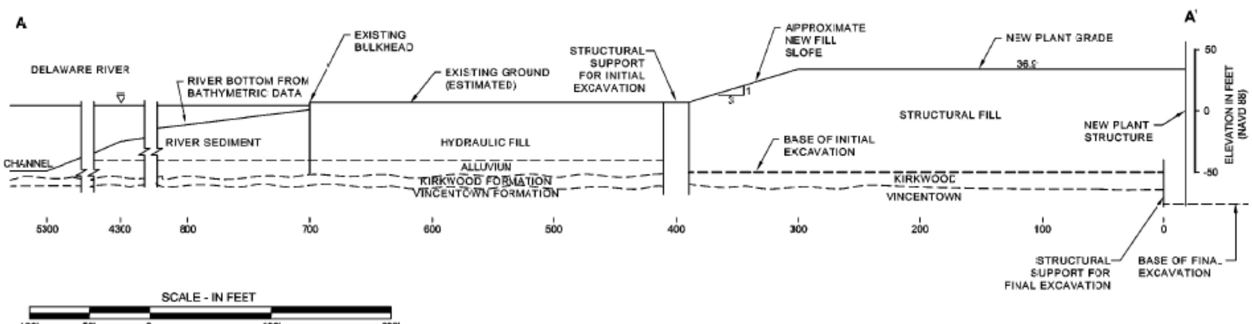


Figure 2.5.5-1 Section A-A' Slope Configuration (Reproduced from SSAR Figure 2.5.5-2)

The applicant stated that one of the four technologies included in the PPE may require an ultimate heat sink, and that the slope stability analysis of the ultimate heat sink will be completed during the COL application stage. Slope stability for the selected technology will

include evaluation of deep slope failure surfaces that may extend into the Delaware River and will also be performed during the COL application stage.

The applicant indicated that there are no existing slopes on the site at this time, either natural or manmade, that could affect the stability of the site.

2.5.5.2.2 Design Criteria and Analysis

In SSAR Section 2.5.5.2, "Design Criteria and Analysis," the applicant stated that the stability of slopes will be assessed during the COL application stage. The applicant will use limit equilibrium methods for their analysis, such as Bishop's simplified method, Janbu's simplified method, and the Spencer method. The stability analysis will evaluate the following loading conditions: end of construction, steady state, rapid drawdown, and seismic events.

2.5.5.2.3 Boring Logs

In SSAR Section 2.5.5.3, "Boring Logs," the applicant stated that because the locations of the new slopes, resulting from the fill material to be placed to reach the new plant grade and the possible construction of an ultimate heat sink pond, are unknown at the ESP stage, the borings for slopes were not performed. In SSAR Section 2.5.5.3, the applicant indicated that it will conduct further exploration for design and analysis of slopes for the COL application, including the evaluation of the required bearing elevation for fill material placement.

2.5.5.2.4 Compacted Fill

In SSAR Section 2.5.5.4, "Compacted Fill," the applicant stated that fill material will be from on-site and off-site sources, but specific characteristics are not identified during the ESP stage. The applicant mentioned that it will protect the exterior slopes of the fill above the existing ground level against scour and erosion using rock riprap, concrete blocks or mats. The applicant will present details of slope protection at the COL application stage.

2.5.5.3 Regulatory Basis

The applicable regulatory requirements for the stability of slopes are as follows:

- 10 CFR Part 52, Subpart A, "Early Site Permit," as it relates to the requirements and procedures applicable to issuance of an early site permit for approval of a site for one or more power facilities.

- 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," as it relates to the design of nuclear power plant structures, systems, and components important to safety to withstand the effects of earthquakes.

- 10 CFR 100.23, "Geologic and Seismic Criteria," as it relates to 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 from NUREG-0800, Section 2.5 are summarized as follows:

- Slope Characteristics: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100, the discussion of slope characteristics is acceptable if the subsection includes: (1) Cross sections and profiles of the slope in sufficient quantity and detail to represent the slope and foundation conditions; (2) a summary and description of static and dynamic properties of the soil and rock comprised by Seismic Category I embankment dams and their foundations, natural and cut slopes, and all soil or rock slopes whose stability would directly or indirectly affect safety-related and Seismic Category I facilities; and (3) a summary and description of groundwater, seepage, and high and low groundwater conditions.

- Design Criteria and Analyses: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100, the discussion of design criteria and analyses is acceptable if the criteria for the stability and design of all Seismic Category I slopes are described and valid static and dynamic analyses have been presented to demonstrate that there is an adequate margin of safety.

- Boring Logs: To meet the requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100, the applicant should describe the borings and soil testing carried out for slope stability studies and dam and dike analyses.

- Compacted Fill: To meet the requirements of 10 CFR Part 50, and 10 CFR Part 52, the applicant should describe the excavation, backfill, and borrow material planned for any dams, dikes, and embankment slopes.

- In addition, the geologic characteristics should be consistent with appropriate sections from: RG 1.27; RG 1.28; RG 1.132; RG 1.138; and RG 1.198.

2.5.5.4 Technical Evaluation

The staff reviewed SSAR Section 2.5.5, which provides the applicant's general description of its plan for future slope stability analysis at the COL stage. The staff reviewed SSAR Figures 2.5.4.3-3 and 2.5.4.3-4, which show PSEG geologic cross sections, and has determined that there are no existing slopes at this time that could affect the stability of the site. The staff's determination is consistent with the applicant's information. While the general description was useful to the staff in performing the ESP application review, the staff identified the following COL action item to address the need for slope stability analyses:

COL Action Item 2.5-20

> An applicant for a COL or CP referencing this early site permit should perform a slope stability analysis consistent with the selected reactor technology. Slope stability analysis will include the evaluation of deep slope failure surfaces that may extend into the Delaware River and various water level considerations.

2.5.5.5 Conclusion

The applicant's information regarding the stability of slopes analysis is incomplete at this time. In SSAR Section 2.5.5, the applicant stated that during the COL application stage, it would present details of slope protection, and complete the slope stability analysis for the selected reactor technology. As such, at this time the staff is unable to reach any conclusion regarding the stability of slopes that have not been designed or constructed due to absence of a reactor

technology. The staff evaluation of slope stability will be performed as part of its review of the COL or CP application.

When referenced by a COL applicant pursuant to 10 CFR 52.73, "Relationship to Subparts A and B," this ESP is subject to these COL action Items and permit conditions:

COL Action Items 2.5-1 through 2.5-20

2.5-1 An applicant for a COL or CP referencing this early site permit should perform additional investigations in order to provide additional information on the extent, thickness, and nature of the oxidized material in the Vincentown Formation beneath the area of Seismic Category I structures for the selected reactor technology. The applicant should also remove less dense soils with considerably lower SPT N-values in order to meet the soil condition requirements. (See Section 2.5.4.4.1 of this report.)

2.5-2 An applicant for a COL or CP referencing this early site permit should conduct additional subsurface investigations to evaluate and fully characterize the engineering properties of the Vincentown and Hornerstown Formations and their potential lateral and vertical variation. The applicant should also perform additional strength tests to further evaluate the soil shear strength parameter for the Vincentown and Hornerstown Formations. (See Section 2.5.4.4.2 of this report.)

2.5-3 An applicant for a COL or CP referencing this early site permit should perform additional borings to provide information for further evaluation of the shear strength properties of the Navesink formation. (See Section 2.5.4.4.2 of this report.)

2.5-4 An applicant for a COL or CP referencing this early site permit should perform additional borings and unit weight determinations for the materials underlying the Mount Laurel Formation. (See Section 2.5.4.4.2 of this report.)

2.5-5 An applicant for a COL or CP referencing this early site permit should perform additional subsurface investigations and correlate the plot plans and profiles of each Seismic Category I structure with the subsurface profile and material properties, and ensure placement of safety-related structures on competent foundation bearing material. (See Section 2.5.4.4.3 of this report.)

2.5-6 An applicant for a COL or CP referencing this early site permit should provide specific details regarding the lateral and vertical extent of the excavation consistent with the selected reactor technology. (See Section 2.5.4.4.5 of this report.)

2.5-7 An applicant for a COL or CP referencing this early site permit should evaluate the method of excavation support and the stability of temporary excavation slopes or support. (See Section 2.5.4.4.5 of this report.)

2.5-8 An applicant for a COL or CP referencing this early site permit should include in the COL application, an ITAAC for the soil backfill, with specifications to ensure a V_s of 304.8 m/s (1,000 ft/s) or higher below Seismic Category I structures. (See Section 2.5.4.4.5 of this report.)

2.5-9 An applicant for a COL or CP referencing this early site permit should provide, consistent with the selected reactor technology, (i) details for the backfill quantities,

types and sources; (ii) lateral loading conditions; (iii) information on the type and characteristics of backfill materials; and (iv) lateral pressure evaluation from backfill materials. (See Section 2.5.4.4.5 of this report.)

2.5-10 An applicant for a COL or CP referencing this early site permit should include the geotechnical instrumentation plan and heave monitoring schedule in the COL application. (See Section 2.5.4.4.5 of this report.)

2.5-11 An applicant for a COL or CP referencing this early site permit should evaluate and implement, during the COL application stage, design measures appropriate for the chemical characteristics of the Category 1 fill, site soils and site groundwater. (See Section 2.5.4.4.6 of this report.)

2.5-12 An applicant for a COL or CP referencing this early site permit should perform, consistent with the selected reactor technology, evaluation of groundwater conditions as they affect the loading and stability of foundation materials, and also provide detailed dewatering and groundwater control plans. (See Section 2.5.4.4.6 of this report.)

2.5-13 An applicant for a COL or CP referencing this early site permit should develop the foundation input response spectra (FIRS) and the Soil Structure Interaction (SSI) analysis at the COL application stage. (See Section 2.5.4.4.7 of this report.)

2.5-14 An applicant for a COL or CP referencing this early site permit should perform additional geotechnical investigation, consistent with RG 1.132, including the performance of additional borings and a detailed liquefaction assessment to determine if zones of lower blow counts, which might indicate a potentially weak liquefiable zone, are present underneath the competent layer. If the additional borings and analyses identify areas where potential for liquefaction may be present, the applicant should remove unsuitable materials and either replace it with competent material or improve it to eliminate liquefaction potential. (See Section 2.5.4.4.8 of this report.)

2.5-15 An applicant for a COL or CP referencing this early site permit should evaluate non-seismic liquefaction. (See Section 2.5.4.4.8 of this report.)

2.5-16 An applicant for a COL or CP referencing this early site permit should analyze the stability of all planned safety-related facilities, including static and dynamic bearing capacity, rebound, settlement, and differential settlements under dead loads of fills and plant facilities, as well as lateral loading conditions. (See Section 2.5.4.4.10 of this report.)

2.5-17 An applicant for a COL or CP referencing this early site permit should conduct laboratory testing on intact samples and conduct consolidation testing for materials having a high percentage of fine-grained particles. (See Section 2.5.4.4.10 of this report.)

2.5-18 An applicant for a COL or CP referencing this early site permit should describe the design criteria and methods, including the factors of safety (FSs) from the design foundation stability analyses consistent with the selected reactor technology. (See Section 2.5.4.4.11 of this report.)

2.5-19 An applicant for a COL or CP referencing this early site permit should improve subsurface conditions in cases where foundation soils do not provide adequate bearing capacity for safety-related structures. (See Section 2.5.4.4.12 of this report.)

2.5-20 An applicant for a COL or CP referencing this early site permit should perform a slope stability analysis consistent with the selected reactor technology. Slope stability analysis will include the evaluation of deep slope failure surfaces that may extend into the Delaware River and various water level considerations. (See Section 2.5.5.4 of this report.)

Permit Conditions 3 and 4

3. An applicant for a COL or CP referencing this early site permit shall perform detailed geologic mapping of excavations for safety-related structures; examine and evaluate geologic features discovered in those excavations; and notify the Director of the Office of New Reactors, or the Director's designee, once excavations for safety-related structures are open for examination by NRC staff. (See Section 2.5.3.5 of this report.)

4. An applicant for a COL or CP referencing this early site permit shall remove and replace the soils directly above the Vincentown Formation for soils under or adjacent to Seismic Category I structures to minimize any liquefaction potential. (See Section 2.5.4.5 of this report.)

3.0 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT, AND SYSTEMS

3.5.1.6 Aircraft Hazards

3.5.1.6.1 Introduction

For the early site permit (ESP) application, PSEG Power, LLC and PSEG Nuclear, LLC (the applicant) provided information evaluating the potential hazards associated with aircraft. The U.S. Nuclear Regulatory Commission (NRC) staff reviewed these evaluations to ensure that the risks associated with potential aircraft hazards are sufficiently low.

3.5.1.6.2 Summary of Application

In Site Safety Analysis Report (SSAR), Section 2.2.2.7, "Airports, Airways, and Military Training Routes," the applicant presented information concerning the airports, airways and military training routes in the vicinity of the site to evaluate potential hazards with respect to nuclear units that might be constructed on the proposed PSEG ESP Site.

The applicant stated that the helipad for Salem Generating Station (SGS) and Hope Creek Generating Station (HCGS) is the only heliport or airport within 8 kilometers (km) (5 miles (mi)) of the PSEG Site. Additionally, there are seven airports and one heliport located within 8 to 16.1 km (5 to 10 mi) of the PSEG Site. Pertinent information and data on all airports within 16.1 km (10 mi), and other nearby public airports beyond 16.1 km (10 mi) is presented in SSAR Table 2.2-11, "Airport Operations within the PSEG Site Region," along with the annual number of operations for each of the airports.

There are four Federal airways (V123-312, V29, V157, and V213 within 16.1 km (10 mi) of the PSEG Site. There are also two high altitude routes J42-150 and J191. The closest military routes are six (SR800, SR805, SR844, SR845, SR846 and SR847) slow speed low-altitude military training routes as indicated in SSAR Figure 2.2-2, "Airports and Airways within 10 miles of the PSEG Site." The nearest edges of the military training routes are located within 8 km (5 statute mi) of the PSEG Site.

There are no military facilities within 16.1 km (10 mi) of the PSEG Site. New Castle County Airport is the closest facility with military operations (Air National Guard) and it is located 23 km (14.5 mi) northeast of the site. The closest dedicated military facility is Dover Air Force Base, in Delaware, which is located 38.3 km (23.8 mi) south of the site. The operations at Dover Air Force Base are 100 percent military and the numbers appear in SSAR Table 2.2-11.

3.5.1.6.3 Regulatory Basis

The acceptance criteria for aircraft hazards are based on meeting the relevant requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 52.17, "Contents of Applications, Technical Information," and 10 CFR Part 100, "Reactor Site Criteria." The staff considered the following regulatory requirements and guidance in reviewing the site location and area description.

- 10 CFR 52.17, as it relates to the requirement that the applicant provide the location and description of any nearby military or transportation facilities and routes.

- 10 CFR Part 100, as it relates to the following:
  - o 10 CFR 100.20(b), as it relates to the requirement that the nature and proximity of man-related hazards (e.g., airports, transportation routes, and military facilities) must be evaluated to establish site characteristics for use to determine whether a plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.
  - o 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 characteristics 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. Review Standard, (RS)-002, Section 3.5.1.6, "Guidance for Processing Applications for Early Site Permits," Regulatory Guide (RG) 1.206, "Regulatory Guide for Combined License Applications for Nuclear Power Plants," and NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," specify that the above regulatory requirements are met if the probability of aircraft accidents 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 the following criteria:
    - ➢ 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 mi, and the projected annual number of operations is less than 1000 $D^{2.}$
    - ➢ 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 1,000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation.
    - ➢ 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. The guidance on the performance of such reviews appears in RS-002, Section 3.5.1.6, RG.1.206, and NUREG-0800.

3.5.1.6.4 Technical Evaluation

In SSAR Section 3.5.1.6, the applicant addressed the aircraft hazards evaluations. There are seven airports and a helipad between 8 and 16.1 km (5 and 10 mi) of the location of the proposed plant at the PSEG Site. The airports have a very small infrequent number (sporadic) of flights annually that would not contribute to exceeding the acceptable aircraft hazards probability of 10^{-7} per year, and therefore are not considered a safety hazard. Based on the review of the information provided by the applicant and the information obtained from sources available in the public domain, the staff considers the applicant's conclusion acceptable.

There are six airports within 16.1 to 48.3 km (10 to 30 mi) having projected number of flights from each of the airports much less than the respective plant-to-distance criterion of 1000 D^2, where D is the distance in miles from the site to the airport. Therefore, the aircraft crash

probability is considered to be acceptable as less than about 10^{-7} per year. Based on the review of the flight data information, the staff considers the applicant's approach and conclusion acceptable as it meets the acceptance criteria.

The applicant addressed military airports and routes considering New Castle County Airport located 23.3 km (14.5 mi) northeast of the site, with military operations (Air National Guard) and Dover Air Force Base located 38.3 km (23.8 mi) south from the site. The applicant identified the closest military training route to be VR1709 located 59.5 km (37 mi) from the PSEG Site, and screened the route out from evaluation based on the distance. However, based on independent review of the information, the staff identified several potential military training routes within close proximity of the site. These are SR800, SR805, SR844, SR845, SR846, and SR847. Therefore, in Request for Additional Information (RAI) 40, Question 03.05.01.06-1, the staff requested that the applicant provide additional information in the SSAR pertaining to these routes, to address and include these routes in aircraft hazards evaluation.

In a December 14, 2011, response to RAI 40, Question 03.05.01.06-1, the applicant provided confirmation of the identified military training routes within 8 km (5 mi) of the PSEG Site. The applicant provided pertinent information used in aircraft hazard probability determination and committed to revise the aircraft probability determination to include these identified military training routes. In a March 13, 2012, supplemental response to RAI 40, Question 03.05.01.06-1, the applicant provided additional probability calculations that reflect the inclusion of the identified military training routes. The applicant determined that since only large military aircrafts are flown on these military training routes, only the large aircraft crash probability is affected in the revised calculations, and still the large aircraft crash probability remains below the 10^{-7} per year acceptance criteria. The applicant provided the revisions to SSAR application Sections 2.2.2.7.2, 3.5.1.6.2, and Figure 2.2-2. The staff confirmed that per commitment in the response to RAI 40, Question 03.05.01.06-1, the applicant has incorporated the changes in SSAR Revision 1, dated May 21, 2012, specifically in Sections 2.2.2.7.2 and 3.5.1.6.2. However, the staff identified that the applicant did not include revised SSAR Figure 2.2-2. Subsequently, the applicant included, and the staff verified, that revised SSAR Figure 2.2-2, "Airports and Airways Within 10-Miles of the PSEG Site, Rev 1," was included in SSAR Revision 2, and, therefore, the staff considers RAI 40, Question 03.05.01.06-1 resolved.

The applicant addressed and evaluated the airways for the aircraft hazards probability. The applicant identified three airways (V123-312, V29, and J42-150) that are within 3.2 km (2 mi) of the site. The applicant performed aircraft hazard probability for each of the four reactor design technologies separately, using the U.S. Department of Energy's (DOE's) four-factor formula that uses crash rates for non-airport operations referenced in DOE-STD-3014-96, "Accident Analysis for Aircraft Crash into Hazardous Facilities." The staff considers the applicant's approach and methodology reasonable and acceptable in determining the aircraft hazard calculations, as it conforms to the staff review guidance. The applicant used calculated effective areas for each aircraft type and reactor design considered. Since the details are not provided in the SSAR, in RAI 40, Question 03.05.01.06-1, the staff requested that the applicant provide detailed calculations of these site-specific effective areas for each of the reactor designs and aircraft type. In a December 14, 2011, response, the applicant provided information pertaining to the effective area calculations. The staff considers this acceptable as the methodology satisfies the requirements and guidance.

The applicant determined the probability of aircraft crash per year for a large aircraft and a small aircraft, for each of the reactor designs considered. The large aircraft crash probability for each of the reactor designs is less than the acceptable probability of 10^{-7} per year. However, the

small aircraft crash probability for each of the reactor designs exceeded the aircraft crash probability of 10^{-7} per year, thereby posing a threat that the resulting dose due to radioactive release could exceed the 10 CFR Part 100 exposure criteria. The radiological consequences of 10 CFR Part 100 exposure criteria are considered met if it is demonstrated that the probability of radiological release or core damage frequency (CDF) is less than 10^{-7} per year. Therefore, the applicant applied the respective conditional core damage probability (CCDP) of each reactor design to the calculated small aircraft crash probability of the respective design to calculate the CDF. Based on the calculated CDF values, the applicant concluded that the resultant CDFs for each of the reactor design technologies is less than the acceptance criteria of 10^{-7} per year. The staff considers that the applicant's approach and methodology of the CDF determination is reasonable and acceptable, as it is in accordance with guidance. However, the applicant did not provide the CCDP values. Therefore, in RAI 40, Question 03.05.01.06-1, the staff requested that the applicant provide CCDP values for each reactor design with references. In a December 14, 2011, response to RAI 40, Question 03.05.01.06-1, the applicant provided CCDP values for each of the reactor designs considered. CCDP is determined based on design-specific Probabilistic Risk Assessment (PRA), and it is addressed under the "Severe Accidents" section of a combined license (COL) application to determine whether or not the aircraft accident is a design-basis event. The technical review of the information involving CCDP determination is conducted in conjunction with a COL application review. Therefore, the staff has identified this as COL Action Item 3.5.1.6-1 as described below:

COL Action Item 3.5.1.6-1

> An applicant for a COL or CP referencing this early site permit (ESP), should evaluate and demonstrate compliance with the design-basis aircraft accident probability acceptance criterion of 1×10^{-7} per year or less, in accordance with the probabilistic risk assessment (PRA) guidance provided in NUREG-0800, Chapter 19 ("Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors"), and should provide the determined core damage frequency (CDF) baesd on the design selected.

The staff reviewed the applicant's assumptions and calculations and finds them reasonable, consistent and acceptable, as they comply with the requirements of 10 CFR 52.17, 10 CFR 100.20(b), and conform to the guidance in RS-002, RG 1.206, and NUREG-0800. The staff performed independent confirmatory aircraft crash probability calculations, using the highest of most recent 5-year (2006-2010) Federal Aviation Administration (FAA) supplied flight operations data within 5 miles of the site. The crash probability calculated by the staff using conservative crash rates per mile is comparable to the highest probability determined by the applicant. Based on the independent estimation of the probability of a potential aircraft crash, the staff confirms that the probability of aircraft accidents, resulting in radiological consequences greater than 10 CFR Part 100 exposure guidelines, is less than an order of magnitude of 10^{-7} per year for the PSEG Site.

3.5.1.6.5 Conclusion

The staff reviewed the applicant's aircraft hazard analysis using the guidelines in RS-002, Section 3.5.1.6, RG 1.206, and NUREG-0800. As discussed above, the staff independently verified the applicant's assessment of aircraft hazards at the PSEG Site and concludes that the estimated probability of an accident having the potential for radiological consequences in excess of the exposure criteria contained in 10 CFR Part 100 is less than an order of magnitude of 10^{-7} per year.

Based on these considerations, and also including COL Action Item 3.5.1.6-1, the staff concludes that aircraft hazards do not present an undue risk to the safe operation of nuclear units at the PSEG Site, and finds the PSEG Site acceptable for one or two nuclear units as proposed. The staff also concludes that the PSEG Site meets the relevant requirements related to aircraft hazards of 10 CFR Part 52 and 10 CFR Part 100 for compliance with respect to determining the acceptability of the site.

11.0 RADIOACTIVE WASTE MANAGEMENT - RADIOLOGICAL EFFLUENT RELEASE DOSE CONSEQUENCES FROM NORMAL OPERATIONS

11.1 Introduction

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the information provided in Chapter 11, “Radioactive Waste Management,” of the Site Safety Analysis Report (SSAR) contained in Part 2 of the PSEG Site Early Site Permit (ESP) application. The information in Chapter 11 provides the analysis for the liquid and gaseous radioactive effluents to determine whether site characteristics are such that the radiation effluent doses to members of the public would be within regulatory guidelines. The SSAR must comply with the applicable requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) 52.17(a)(1) and 10 CFR 100.21(c)(1).

11.2 Summary of Application

The applicant provided information on the radioactive liquid and gaseous effluents that would be generated as a normal byproduct of nuclear power operations. These radioactive materials will be collected, processed, stored, and discharged in a controlled manner to the local environment. The proposed facility will have the ability to handle these radiological effluents in a manner that minimizes radioactive releases to the environment and maintains exposure to the public during normal plant operation, anticipated operational occurrences (AOO), and maintenance at levels that are as low as is reasonably achievable (ALARA).

11.3 Regulatory Basis

The acceptance criteria for addressing radiological doses to a member of the public from radiological effluents due to postulated normal plant operations are based on meeting the relevant requirements of 10 CFR 52.17, 10 CFR Part 100, 10 CFR Part 20, “Standards for Protection Against Radiation,” 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations,” and 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” 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.” The staff considered the following regulations 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:

1. 10 CFR Part 20, as it relates to the requirement that annual effluents concentrations would not exceed the radionuclide concentration limits of Appendix B (Table 2, Columns 1 and 2, under the unity rule) for liquid and gaseous discharges into unrestricted areas.

2. 10 CFR Part 50, Appendix I, as it relates to the requirement to provide numerical guidance on design objectives to meet the requirements that radiation doses caused by radioactive materials in effluents released to unrestricted areas be kept ALARA.

3. 10 CFR 52.17(a), as it relates to the requirement that the application contain a description of the anticipated maximum levels of radiological and thermal effluents each proposed facility will produce.

4. 10 CFR 100.21(c), as it relates to the requirement 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.

5. 40 CFR Part 190, as applicable U.S. Environmental Protection Agency (EPA) environmental radiation standards implemented under 10 CFR 20.1301(e) for all radioactive liquid and gaseous effluents discharged from the proposed facility.

The information assembled in compliance with the above regulatory requirements would be necessary, at the Combined License (COL) or Construction Permit (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 environmental radiation standards in 40 CFR Part 190) specified in 10 CFR Part 20, as well as maintain radiological effluents at ALARA levels in accordance with the dose objectives of 10 CFR Part 50, Appendix I. Table 11.3-1 of this report provides a quantitative summary of the standards above.

To the extent applicable for an ESP application under the regulatory requirements cited above, the applicant applied the NRC-endorsed analytical methodologies and parameters found in both Regulatory Guide (RG) 1.109, Revision 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," October 1977, and RG 1.111, Revision 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," July 1977. When independently assessing the accuracy of the information the applicant presented in SSAR Chapter 11, the staff confirmed and applied the same analytical methodologies and parameters cited above as those of the applicant's.

Table 11.3-1 Staff Summary of 10 CFR Part 50, Appendix I, Dose Objectives and 40 CFR Part 190, Environmental Standards

Regulation	Type of Effluent	Pathway	Organ	Dose Limit
10 CFR Part 50, Appendix I *	Liquid	All	Total Body	3.0E-2 (3.0E0) mSv/yr/unit (mrem/yr per unit)
		All	Any Organ	1.0E-1 (1.0E1) mSv/yr/unit (mrem/yr per unit)
	Gaseous	All	Total Body	5E-2 (5E0) mSv/yr/unit (mrem/yr per unit) #
		All	Skin	1.5E-1 (1.5E1) mSv/yr/unit (mrem/yr per unit)
	Radioiodines & Particulates	All	Any Organ	1.5E-1 (1.5E1) mSv/yr/unit (mrem/yr per unit)

Regulation	Type of Effluent	Pathway	Organ	Dose Limit
	Gaseous	Gamma Air Dose	N/A	1.0E-1 (1.0E1) mGy/yr/unit (mrad/yr per unit) ***
		Beta Air Dose	N/A	2.0E-1(2.0E1) mGy/yr/unit (mrad/yr per unit) ***
40 CFR Part 190**	All	All	Total Body	2.5E-1 (2.5E1) mSv/yr/unit (mrem/yr per unit) #
	All	All	Thyroid	7.5E-1 (7.5E1) mSv/yr/unit (mrem/yr per unit) #
	All	All	Any Other Organ	2.5E-1 (2.5E1) mSv/yr/unit (mrem/yr per unit) #

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 mGy/year (mrad/year) instead of mSv/year (mrem/year).

\# See 40 CFR Part 190. Dose limits are for the entire site and apply to all operating units.

11.4 Technical Evaluation

11.4.1 Compliance with 10 CFR Part 20 and 10 CFR Part 50, Appendix I – Liquid Effluents

Liquid Effluent Source Term Analysis

The applicant provided estimates of radiological effects on members of the public from the annual liquid effluents that would be generated as a normal byproduct of nuclear power operations. The estimated bounding annual average quantity of radioactivity projected to be released was indicated in SSAR Table 1.3-8, "Single Unit Composite Average Annual Normal Liquid Release." The highest liquid effluent quantity per year for each of the individual radionuclides represents the highest activity from the four reactor designs presented in SSAR Section 1.3, "Plant Parameters Envelope (PPE)." SSAR Table 1.3-8 would bound the liquid effluent quantity of each radionuclide for any selected reactor design to the highest quantity of liquid effluent expected from any of the four reactor designs. The four reactor designs being considered by the applicant are: (1) Single Unit U.S. EPR; (2) Single Unit Advanced Boiling Water Reactor (ABWR); (3) Single Unit U.S. Advanced Pressurized-Water Reactor (US-APWR); and (4) Dual Unit Advanced Passive 1000 (AP1000). By reviewing the source terms for these

four reactor designs, the staff evaluated and confirmed that the bounding annual average liquid effluent source term release values listed in SSAR Table 1.3-8 were consistent.

SSAR Table 11.2-1, "Liquid Release Source Terms," indicates by footnote (a) that the values listed are from SSAR Table 1.3-8. However, the staff noted inconsistencies between the values in these two tables. Therefore, in request for additional information (RAI) 7, Question 11.02-1, the staff requested that the applicant provide information for SSAR Table 1.3-8 indicating the bounding release rate for each radionuclide, in order to rectify the above-mentioned inconsistencies. The staff also noted that the values for four radionuclides (Rh-103m, Rh-106, Ag-110, and Ba-137m) appeared to be missing, without explanation.

In a March 10, 2011, response, to RAI 7, Question 11.02-1, the applicant stated that these are short-lived daughter products of long-lived parents, and that these short-lived daughter products do not have any dose factors in the dose-factor library. The applicant included a footnote at the end of SSAR Table 11.2-1 stating why these radionuclides are not included. Therefore, the staff finds the applicant's response acceptable because the applicant addressed the staff's concern. The staff verified that Revision 2 of the application, dated March 27, 2013, included this information. Accordingly, the staff considers RAI 7, Question 11.02-1, resolved.

<u>10 CFR Part 20 Liquid Compliance</u>

The applicant provided SSAR Table 11.2-2, "Site Concentrations Comparison to 10 CFR 20, Appendix B, Table 2, Column 2, Effluent Concentration Limits (ECLs)," to demonstrate compliance with the annual average liquid release concentrations to meet the 10 CFR Part 20, Column 2, Appendix B, Table 2, "unity rule," concentration limit identified in Note 4 of 10 CFR Part 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage." The applicant's tabulation included site concentrations that encompassed liquid effluent releases from a new dual unit plant as well as the nearby operating Salem Generating Station (SGS) and Hope Creek Generating Station (HCGS). The staff notes that the liquid effluent site concentrations are below the limits in 10 CFR Part 20, Appendix B, Column 2, Table 2, and the unity calculation described in Note 4.

The staff performed an independent confirmatory assessment of the results presented in SSAR Table 11.2-2 and all associated calculations. The staff finds that, based on the total liquid estimated to be discharged from the site, the concentrations of radioactive materials present in liquid effluents and discharged in unrestricted areas, listed in SSAR Table 11.2-2, comply with the limits specified in 10 CFR Part 20, Appendix B, Table 2, Column 2, and the sum of the ratios meets the 10 CFR Part 20, Appendix B, "unity rule."

<u>10 CFR Part 50, Appendix I Liquid Dose Compliance</u>

The staff identified that sufficient information, input parameters, and resulting doses due to annual liquid effluent releases from the proposed PSEG Site were not included in the ESP application to confirm compliance with 10 CFR Part 50, Appendix I, design objectives.

Therefore, in RAI 23, Question 11.02-3, the staff requested that the applicant provide details of the liquid effluent data and associated effluent dose information, and that supporting details on effluent releases and basis of dose modeling be incorporated into the SSAR. In a June 3, 2011, response to RAI 23, Question 11.02-3, the applicant provided the requested information concerning the liquid effluent data and associated liquid effluent doses. The applicant's

response included a description of the required model assumptions and input parameters needed to run LADTAP II computer codes (the NRC technical report designation and contractor report NUREG/CR-4013, “LADTAP II - Technical Reference and User Guide,” April 1986), with justification for excluding potential exposure pathways. Using radiological exposure models in RG 1.109, and the LADTAP II computer program, the applicant calculated the estimated public doses to a hypothetical Maximally Exposed Individual (MEI) and to the population within 80 kilometers (km) (50 miles (mi)) from the postulated liquid effluent discharge point.

Table 11.4.1-1 below lists the parameters the staff used for the LADTAP II computer code in conducting its independent calculations. The staff considered a direct liquid release to the environment, as the applicant did, into the brackish water of the Delaware River. The drinking water pathway is not considered an exposure pathway due to the brackish water and the Delaware River is not a potable water supply in the vicinity of the site. The staff used a combination of the values listed in SSAR Table 11.2-1 and the applicant’s site-specific values in effluent dose estimation. The staff reviewed the calculated doses provided and concluded that the applicant’s response to RAI 23, Question 11.02-3, contained the required liquid effluent data and associated dose information. The staff finds this response acceptable and, therefore, considers RAI 23, Question 11.02-3, resolved.

Table 11.4.1-1 Important LADTAP Parameter Values Used by the Staff

Parameter	NRC Value*	Basis
Annual radionuclide release (Ci/yr)	PPE Values from PSEG SSAR	RG 1.112 and RG 1.109
Discharge Flow Rate (cfs)	4.5E1	Provided release rate for new unit: SSAR Section 11.2.3.1
Water Type	Salt (Brackish)	Delaware River: SSAR Section 2.4.11.3.3
Dilution Factors	2.0E1	Ratio of the discharge rates: SSAR Section 11.2.3.1

* The staff used the applicant and LADTAP II default values for parameters not listed in the table.

Table 11.4.1-2 below compares the applicant’s results to the staff’s and the 10 CFR Part 50, Appendix I, liquid dose design objectives. Table 11.4.1-2 below shows that the applicant’s results and the staff’s confirmatory results are below the 10 CFR Part 50, Appendix I, criteria. The staff performed independent confirmatory assessments and concluded that the applicant demonstrated compliance with the liquid effluent regulatory requirements in 10 CFR Part 20 and 10 CFR Part 50, Appendix I.

Table 11.4.1-2 Comparison of Liquid Maximum Doses, mSv/yr/unit (mrem/yr/unit)

Organ/Body	Application*	NRC Analysis	10 CFR Part 50 Appendix I, Section II.A
Total Body	1.57E-4 (1.57E-2)	1.57E-4 (1. 57E-2)	3.0E-2 (3.0E0)
GI-LLI** (Adult)	1.77E-3 (1.77E-1)	1.77E-3 (1.77E-1)	1.0E-1 (1.0E1)

*   SSAR Table 11.2-6.
** GI-LLI – Gastrointestinal Tract-Lower Large Intestine.

The applicant calculated a collective whole body liquid dose for the population of 8.1 million, within 80 km (50 mi) of the proposed PSEG Site. This included a description of the exposure pathways by which radiation and radioactive effluents could be transmitted to members of the public within the 80 km (50 mi) radius from the site. The applicant used the information for the fish and invertebrate ingestion, shoreline, swimming and boating pathways. The drinking water pathway was not considered since the Delaware River in the site vicinity is composed of brackish water.

<u>Population Dose Evaluation – Liquid Effluents</u>

Table 11.4.1-3 below lists population collective doses that the applicant calculated and compares them to the staff's independently calculated results. Normally, an ESP application does not include the review of the population dose section since a cost benefit analysis is not performed at this stage of the review. However, the staff has verified the population dose values provided by the applicant. The table below shows that the assumptions and parameters the applicant used resulted in approximately the same doses for the total body and thyroid when compared to the staff's bounding independent assessment. The annual population doses listed in SSAR Table 11.2-8, "Collective Annual Doses from a New Unit to Population within 50 Miles, Liquid Pathway," are 4.55E-1 person Sv (4.55E+01 person rem) to the total body, and 6.72E-1 person Sv (6.72E+01 person rem) to the thyroid. The cumulative population exposure is determined for annual liquid effluent releases and then utilized by the applicant during the COL application stage employing RG 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," methodology. This regulatory guidance assesses the potential reductions in the cumulative exposure to the population using augments to the proposed liquid radwaste systems applying a cost-benefit analysis calculation.

Table 11.4.1-3 Comparison of Liquid Population Doses Person Sv/yr (person rem/yr)

Organ/Body	Application*	NRC Analysis
Total Body	4.55E-1 (4.55E+01)	4.56E-1 (4.56E+01)
Thyroid	6.72E-1 (6.72E+01)	6.73E-1 (6.73E+01)

* SSAR Table 11.2-8

11.4.2 Compliance with 10 CFR Part 20 and 10 CFR Part 50, Appendix I – Gaseous Effluents

Gaseous Effluent Source Term Analysis

The applicant provided estimates of radiological impacts on members of the public from the annual gaseous effluent that would be generated as a normal byproduct of nuclear power operations. The estimated bounding annual average quantity of radioactivity projected to be released was given in SSAR Table 1.3-7, "Single Unit Composite Average Annual Normal Gaseous Release." The gaseous effluent quantity represents the highest activity of the individual radionuclides from the four reactor designs, namely, U.S. EPR, ABWR, US-APWR, and dual unit AP1000, presented in SSAR Section 1.3, "Plant Parameters Envelope (PPE)," and would bound the gaseous effluent quantity of each radionuclide for any selected reactor design to the highest quantity of gaseous effluent expected from any of these four reactor designs.

In addition to the information provided in SSAR Chapter 11, it is necessary to use those results found in SSAR Chapter 2, Section 2.3.5, "Long-Term (Routine) Diffusion Estimates," for the proposed site's long-term (routine) atmospheric diffusion parameters. Through review of SSAR Section 2.3.5, the staff finds that the parameters necessary for input into the GASPAR II computer code are acceptable. The staff's review of the proposed site's long-term (routine) atmospheric diffusion parameters is found in Section 2.3.5 of this report.

By reviewing the referenced source terms for the four reactor designs, the staff evaluated and confirmed that the bounding annual average gaseous effluent source term releases listed in SSAR Table 1.3-7 were consistent. The staff determined that SSAR Table 1.3-7, indicating the bounding release rate for each radionuclide, was not consistent with SSAR Table 11.3-5, "Gaseous Release Source Terms," that stated in footnote (a) that the values listed are from SSAR Table 1.3-7. The values for five radionuclides (Kr-90, Rh-103m, Rh-106, Ba-137m, and Xe-139) appeared to be missing without explanation. Therefore, in RAI 6, Question 11.03-1, the staff requested that the applicant clarify this apparent inconsistency. In a March 3, 2011, response to RAI 6, Question 11.03-1, the applicant stated that these are short-lived daughter products of long-lived parents which also do not have any dose factors in the dose-factor library. The applicant provided footnotes at the end of SSAR Table 11.3-5 explaining why these five radionuclides are not included. The staff verified that Revision 2 of the application, dated March 27, 2013, included this information. The staff finds this response acceptable and, therefore, considers RAI 6, Question 11.03-1, resolved.

10 CFR Part 20, Gaseous Compliance

The applicant initially provided SSAR Table 11.3-6, "Site Concentrations Comparison to 10 CFR Part 20, Appendix B, Table 2, Column 1 Effluent Concentration Limits (ECLs)," to demonstrate compliance with the annual average gaseous release concentrations identified in Note 4 of 10 CFR Part 20, Appendix B, Table 2, Column 1, "unity rule" concentration limit. The applicant's tabulation included site concentrations that encompassed gaseous effluent releases from the operating SGS, HCGS, and a potential new dual unit plant at the proposed PSEG Site. The gaseous effluent site concentrations in SSAR Table 11.3-6 indicated that the values are below the limits in 10 CFR Part 20, Appendix B, Column 1, Table 2, and the unity calculation in Note 4.

The staff reviewed the initial results in SSAR Table 11.3-6, and the associated calculations, and verified that these initial values indicated that the gaseous effluent site concentrations were below the 10 CFR Part 20, Appendix B, Column 1, Table 2 limits, and the unity calculation in Note 4. However, the staff issued RAI 18, Question 11.03-3, because the methodology utilized by the applicant to determine the MEI doses in SSAR Table 11.3-8, "Comparison of Maximally Exposed Individual Doses with 10 CFR 50, Appendix I Criteria," and the 10 CFR Part 50, Appendix I, gaseous effluent doses, also affected the gaseous effluent source term. Since the gaseous effluent source term was impacted, the 10 CFR Part 20, Appendix B, Column 1, Table 2 , and the unity calculation in Note 4, and the effluent doses calculated in accordance with 10 CFR Part 50 Appendix I were affected. Therefore, any table in the SSAR relating to the gaseous effluent source term must be re-evaluated. In an April 12, 2011, response to RAI 18 Question 11.03-3, the applicant updated the gaseous effluent source term in SSAR Table 1.3-7, "Single Unit Composite Average Annual Normal Gaseous Release." (Additional discussion of RAI 18 is in the section titled, "10 CFR Part 50, Appendix I, Gaseous Dose Compliance" below.)

In the April 12, 2011, response to RAI 18, Question 11.03-3, the applicant also revised SSAR Table 11.3-5 and SSAR Table 11.3-7, which had initially been verified to comply with 10 CFR Part 20, Appendix B, Column 1, Table 2, and the unity calculation in Note 4. In RAI 37, Question 11.03-7, the staff requested that the applicant use the information submitted to the staff in the April 12, 2011, response to RAI 18, Question 11.03-3 to re-evaluate the concentrations of all radionuclides in SSAR Table 11.3-6, and to determine if the recalculated gaseous concentrations are within the limits specified in 10 CFR Part 20, Appendix B, Column 1, Table 2, and the unity calculation in Note 4.

In a September 19, 2011, response to RAI 37, Question 11.03-7, the applicant re-evaluated the gaseous concentrations of all radionuclides in SSAR Table 11.3-6. The applicant determined that the modified gaseous effluent site concentrations in SSAR Table 11.3-6 indicated that the values are below the limits in 10 CFR Part 20, Appendix B, Column 1, Table 2, and the unity calculation in Note 4.

The staff reviewed the modified results in SSAR Table 11.3-6 and the associated revised calculations. The staff verified that the SSAR Table 11.3-6 values for the gaseous effluent site concentrations are below the 10 CFR Part 20, Appendix B, Column 1, Table 2 limits, and the unity calculation in Note 4 and, therefore, are acceptable. The staff verified that Revision 2 of the application, dated March 27, 2013, included this information. Accordingly, the staff considers RAI 37, Question 11.03-7, resolved.

10 CFR Part 50, Appendix I, Gaseous Dose Compliance

The staff identified that sufficient information, including input parameters to be used along with the derivation of the atmospheric dispersion parameters in Section 2.3.5 of the SSAR to calculate the resulting doses due to annual gaseous effluent releases, was not included in the ESP application to confirm compliance with 10 CFR Part 50, Appendix I, design objectives. Therefore, in RAI 24, Question 11.03-4, the staff requested that the applicant provide details of the gaseous effluent data, the associated effluent dose information, and then incorporate the effluent information into the SSAR. In a June 3, 2011, response to RAI 24, Question 11.03-4, the applicant provided the requested information concerning the gaseous effluent data and associated gaseous effluent doses. The applicant's response to RAI 24, Question 11.03-4, included a description of the required model assumptions and input parameters needed to run the GASPAR II computer codes along with the justifications for potential exposure pathways.

Using radiological exposure models in RG 1.109 and the GASPAR II computer program (NUREG/CR-4653, "GASPAR II - Technical Reference and User Guide"), the applicant calculated the estimated public doses to a hypothetical MEI and to the population within 80 km (50 mi) from postulated gaseous effluents discharge point. The staff reviewed the additional information and finds it acceptable for evaluation of the gaseous effluent doses for proposed PSEG site.

However, the staff determined that a disagreement existed between the information provided in the June 3, 2011, response to RAI 24, Question 11.03-4, and the data the applicant used in the GASPAR II calculations for population doses. "Table RAI 24-1" in the RAI response contained transposed sector and distance population distributions when compared to the data used in the GASPAR II calculation model. Therefore, in follow-up RAI 36, Question 11.03-6, the staff requested that the applicant clarify the information provided. In a September 19, 2011, response to RAI 36, Question 11.03-6, the applicant confirmed that the "Table RAI 24-1" provided in the response to RAI 24, Question 11.03-4, is correct and the error in transposed population distributions is a result of using a feature of GASPAR II to start inputting data from south instead of north. The staff finds the applicant's response acceptable. The response to RAI 36, Question 11.03-6, did not result in a revision to the SSAR. Accordingly, the staff considers RAI 36, Question 11.03-6, resolved.

In RAI 18, Question 11.03-3, the staff requested that the applicant justify the use of a partial occupancy factor from the site Offsite Dose Calculations Manual (ODCM) of 2000 hr/year to calculate the gaseous effluent dose in SSAR Section 11.3.3.2 to comply with 10 CFR Part 50, Appendix I. SSAR Table 11.3-8 used the assumption that a member of the public will work onsite for 2000 hr/yr as a basis for a 10 CFR Part 50, Appendix I dose to an MEI. In an April 12, 2011, response to RAI 18, Question 11.03-3, the applicant removed the use of 2000 hr/yr for the member of the public at the nearest site boundary to calculate the 10 CFR Part 50, Appendix I, gaseous effluent dose. The applicant provided a calculation of effluent MEI gaseous doses for the 10 CFR Part 50, Appendix I criteria based on a member of the public being located at the nearest site boundary for the full duration of the year. The staff reviewed the changes and verified that all gaseous effluent releases and dose calculations provided by the applicant meet NRC design criteria. The staff verified that Revision 2 of the application, dated March 27, 2013, included this information. Accordingly, the staff considers RAI 18, Question 11.03-3, resolved.

In RAI 46, Question 11.03-8, the staff requested that the applicant confirm its intention to use the Bell Bend Nuclear Power Plant (BBNPP) effluent release rate, given that BBNPP has sought a departure from the U.S. EPR Design Certification Document (DCD) source terms, and that the BBNPP COL application is not the reference COL application for this reactor design. The staff also stated in this question that there were standing RAIs to the BBNPP applicant to justify the approach to use their developed source terms.

In a February 3, 2012, response to RAI 46, Question 11.03-8, the applicant declined to provide the requested reference information concerning the liquid and gaseous effluent data in the SSAR. In review of other previous RAI responses from the applicant, the staff found the similar referenced information, as requested in RAI 46, Question 11.03-8, provided in response to RAI 13, Question 02.04.13-2. In a February 23, 2012, teleconference, the staff requested that the applicant provide the gaseous effluent reference data information in the same format as RAI 13, Question 02.04.13-2. In a March 29, 2012, supplemental response to RAI 46, the applicant included revised footnotes to SSAR Table 1.3-7 to describe the origin of the various gaseous source terms provided in the PPE approach used in the ESP application. The staff

determined that the markup notes were not acceptable because the applicant's response did not include what was requested. On October 24, 2012, the staff held a public teleconference meeting with the applicant to resolve the issue described above. In a January 11, 2013, supplemental response, the applicant included references for the source terms in SSAR Tables 1.3-7 and 1.3-8 used in the PPE determination. The staff confirmed that these references are consistent with those for SSAR Table 1.3-9 that were submitted with the original ESP application. The staff verified that Revision 2 of the application, dated March 27, 2013, included this information. The staff reviewed the changes to the SSAR tables and finds them acceptable and, therefore, considers RAI 46, Question 11.03-8, resolved.

In the June 3, 2011, response to RAI 24, Question 11.03-4, the applicant provided a description of the required model assumptions and input parameters needed to run the GASPAR II computer codes and justifications for potential exposure pathways using radiological exposure models in RG 1.109 and the GASPAR II computer program (NUREG/CR-4653, "GASPAR II - Technical Reference and User Guide"). In the response, the applicant calculated the estimated public doses to a hypothetical MEI and to the population within 80 km (50 mi) from postulated gaseous effluents discharges. Table 11.4.2-1 below lists the parameters used by staff for the GASPAR II computer code in conducting its verification calculations.

Table 11.4.2-1 Important GASPAR Parameter Values Used by the Staff

Parameter	NRC Value*	Basis
Annual Radionuclide Release (Ci/yr)	PPE Values from PSEG SSAR	RG 1.112, and RG 1.109 SSAR Table 11.3-5
Annual Average X/Q (with no decay)	1.00E-5 sec/m^3	SSAR Section 2.3.5.2
Production Rate	Population data multiplied by consumption rates	Population Data from SSAR Table 2.1-2 Consumptions provided in NUREG/CR-4653, also provided in SSAR Table 11.3-3

* The staff used the applicant and GASPAR II default values for parameters not listed in the table.

The applicant also provided justification for all potential gaseous effluent exposure pathways. The pathways that the applicant analyzed were based on information provided in the SSAR. In accordance with NRC guidelines, the staff evaluated the information provided by the applicant and independently verified the parameters used in gaseous effluent dose calculations and resulting doses. The staff verified that Revision 2 of the application, dated March 27, 2013, included this information. The staff finds the applicant's response adequate and acceptable and, therefore, considers RAI 24, Question 11.03-4, resolved.

The staff's independent gaseous effluent dose calculations were performed in accordance with the NRC guidance using the applicant's site-specific values and SSAR Table 11.3-5 source term. Annual gamma air doses at the site boundary were determined to be 0.061 mGy (6.1 millirad (mrad)), and the beta annual air dose is estimated to be 0.11 mGy (11.0 mrad). The annual total body and skin doses, at the location of highest offsite exposure (evaluated at a

location that is anticipated to be occupied during the lifetime of the plant or evaluated with respect to such potential land and water usage and food pathways), were estimated to be 0.046 mSv (4.6 mrem) and 0.122 mSv (12.2 mrem), respectively. The maximum annual organ dose (thyroid) to the nearest child was estimated to be 0.0722 mSv (7.22 mrem). The Total Body dose of 0.046 mSv (4.6 mrem) compared to the limit of 0.05 mSv is very close to the limit for two reasons: (1) The Total Body Dose is for the MEI, the nearest resident for the application data; the applicant chose to use the value for the Site Boundary to demonstrate compliance, which shows that at a closer distance to the plant it still meets the dose objectives of 10 CFR Part 50, Appendix I, and (2) in the GASPAR computer code, when the Undecayed, Undepleted and Decayed, Undepleted X/Q values are equal, the equation GASPAR II uses to solve for decay time sets time equal to zero. Without a decay time, the short-lived gaseous radionuclides increase the total dose. The staff's independent verification of the calculated gaseous effluent doses indicates that the applicant's results are acceptable and comply with 10 CFR Part 50, Appendix I design objectives. Therefore, the staff finds that SSAR effluent doses adequately address the design criteria in 10 CFR Part 50, Appendix I (see Table 11.4.2-2 of this report), and are acceptable.

Table 11.4.2-2 below, is a comparison of the applicant's results to the staff's verification calculations, specifically comparing those results to 10 CFR Part 50, Appendix I, objectives.

Table 11.4.2-2 Comparison of Gaseous Maximum Individual Doses, mSv/yr/unit (mrem/yr/per unit)

Description	Applicant Results	NRC Results	10 CFR Part 50, Appendix I, Section II.B and Section II.C Limits
Noble Gases			
Gamma Dose Site Boundary	6.1E-2 (6.1E0) *	6.1E-2 (6.1E0) *	1.0E-1 (1.0E1) *
Beta Dose Site Boundary	1.1E-1 (1.1E1) *	1.1E-1 (1.1E1) *	2.0E-1 (2.0E1) *
Total Body At MEI	4.6E-2 (4.6E0)	4.6E-2 (4.6E0)	5.0E-2 (5.0E0)
Skin At MEI	1.22E-1 (1.22E1)	1.22E-1 (1.22E1)	1.5E-1 (1.5E1)
Radioiodines and Particulates Maximum Organ Thyroid At MEI (Child)**	7.22E-2 (7.22E0)	7.23E-2 (7.23E0)	1.5E-1 (1.5E1)

* Units of mGy/yr (mrad/yr).
** The MEI here was calculated using the highest of each category, which included using the Goat Milk value for an infant and child for every other pathway.

Population Dose Evaluation—Gaseous Effluents

Table 11.4.2-3 of this report lists the population doses that the applicant calculated as compared to the staff's verification of the applicant's results. Normally, an ESP does not include the review of the population dose section since a related cost benefit analysis is not performed at this stage of the review. However, the staff has verified the population dose values that the applicant provided. The applicant's calculated gaseous annual population doses from the proposed unit(s) are 0.204 person Sv (20.4 person rem) to the total body and 0.91 person Sv (91 person rem) to the thyroid. Table 11.4.2-3 below shows the assumptions and parameters used by the applicant that resulted in the same dose for the total body and a slightly lower dose for the thyroid when compared to the staff's bounding independent assessment.

Table 11.4.2-3 Comparison of Gaseous Population Doses, Person Sv/yr (person rem/yr)*

Organ/Body	Application**	NRC Analysis **
Total Body	2.04E-1 (2.04E+01)	2.04E-1 (2.04E+01)
Thyroid	9.10E-1 (9.10E+01)	9.12E-1 (9.12E+01)

* SSAR Table 11.3-10, "Collective Annual Doses from a New Unit to Population within 50 miles, by Pathway."

** Population doses are per reactor.

10 CFR 20.1301(e), (40 CFR Part 190) Liquid and Gaseous Effluent Dose Compliance

10 CFR 20.1301(e) requires that NRC-licensed facilities comply with "the provisions of EPA's generally applicable environmental radiation standards in 40 CFR Part 190" for all facilities that are part of the fuel cycle. The EPA annual dose limits are 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other organ. Compliance with 10 CFR 20.1301(e) requires the consideration of all potential sources of external radiation and radioactivity, including liquid and gaseous effluents and external radiation exposures from buildings, storage tanks, radioactive waste storage areas, and radioactive Nitrogen-16 (N-16) sky shine (reflected radiation from a Boiling Water Reactor (BWR) site back to the ground) from BWR turbine buildings. The EPA standards apply to the entire site or facility, whether it has a single unit or multiple units.

The staff reviewed SSAR Chapter 11 for compliance with 10 CFR 20.1301(e) and EPA general radiation protection standard, 40 CFR Part 190.

The staff determined that the effluent dose information in SSAR Table 11.3-9, "Comparison of Maximally Exposed Individual Doses with 40 CFR Part 190 Criteria," was not transferred correctly from SSAR Table 11.2-7, "Liquid Contributions to Maximally Exposed Individual Doses with Regards to 40 CFR 190 Criteria," SSAR Table 11.3-7, "Doses to Maximally Exposed

Individual from Gaseous Effluent Releases," and SSAR Table 11.3-8, "Comparison of Maximally Exposed Individual Doses with 10 CFR Part 50, Appendix I Criteria."

In RAI 11, Question 11.03-2, the staff requested that the applicant provide the required dose information in accordance with 10 CFR 20.1301(e). In a March 10, 2011, response to RAI 11, Question 11.03-2, the applicant provided information concerning calculated liquid and gaseous effluent doses from anticipated planned discharges of radioactive materials to be transferred to SSAR Table 11.3-9 to indicate compliance with 40 CFR Part 190. The staff reviewed the response and determined that it was not consistent with the dose totals shown in SSAR Table 11.3-9.

Therefore, in follow-up RAI 28, Question 11.03-5, the staff requested that the applicant provide a consistent presentation of tabulated doses results. In a June 3, 2011, response to follow-up RAI 28, Question 11.03-5, the applicant supplied additional effluent data and doses in applicable SSAR tables. The staff performed a final review of the information in SSAR Table 11.3-9 and determined that direct doses from all fuel cycle facilities were not included in the applicant's response.

Therefore, in RAI 62, Question 11.03-9, the staff requested that the applicant account for the location and direct dose to the general environment from uranium fuel cycle operations and to consider radiation from these operations from all fuel cycle facilities in SSAR Table 11.3-9 to demonstrate compliance with 40 CFR Part 190 and 10 CFR 20.1301(e). In an August 7, 2012, response to RAI 62, 11.03-9, the applicant revised SSAR Table 11.3-9. The applicant's response included the sum of the actual current liquid and gaseous effluent doses from the three operating units at the site, plus the conservative direct dose from one new unit, considered an ABWR, from the PPE designs considered, and the liquid and gaseous effluent doses projected from a maximum of two potential new units. The bounding direct radiation dose at the proposed site is for the design that is based on a single ABWR unit. The direct dose based on a new single ABWR unit is more conservative and bounding than the direct dose based on any new dual unit designs. The staff concluded that all doses from all fuel cycle facilities were being accounted for in SSAR Table 11.3-9. For the total site dose, 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. The staff finds that the information submitted in the August 7, 2012, response to RAI 62, Question 11.03-9, meets the requirements of 40 CFR Part 190 and 10 CFR 20.1301(e), and is acceptable. The staff verified that Revision 2 of the application, dated March 27, 2013, included this information. Accordingly, the staff considers RAI 11, Question 11.03-2, RAI 28, Question 11.03-5, and RAI 62, Question 11.03-9, resolved.

Table 11.4.2-4 below compares the staff's independent calculations to those results obtained by the applicant. This table accounts for Liquid and Gaseous Effluent dose and Direct dose contributions.

Table 11.4.2-4 Comparison of Maximum Individual Doses to 10 CFR 20.1301(e)/40 CFR Part 190 mSv/yr (mrem/yr)

Dose Type	Gaseous Dual Unit	Liquid Dual Unit	Existing Units	Direct Radiation Dual Units	Total	10 CFR 20.1301 and 40 CFR Part 190, Limits
Total Body Applicant*	4.00E-3 (4.00E-1)	3.14E-4 (3.14E-2)	5.36E-5 (5.36E-3)	2.50E-2 (2.50E0)**	2.94E-2 (2.94E0)	2.5E-1 (2.5E1)
Organ/Body Applicant*	1.1E-2 (1.1E0)	3.54E-3 (3.54E-1)	2.04E-4 (2.04E-2)	2.50E-2 (2.50E0)**	3.97E-2 (3.97E0)	2.5E-1 (2.5E1)
Thyroid Applicant*	4.26E-2 (4.26E0)	8.30E-4 (8.30E-2)	2.04E-4 (2.04E-2)	2.50E-2 (2.50E0)**	6.86E-2 (6.86E0)	7.5E-1 (7.5E1)
Total Body NRC	4.00E-3 (4.00E-1)	3.14E-4 (3.14E-2)	5.36E-5 (5.36E-3)	2.50E-2 (2.50E0)**	2.94E-2 (2.94E0)	2.5E-1 (2.5E1)
Organ/Body NRC	1.1E-2 (1.1E0)	3.54E-3 (3.54E-1)	2.04E-4 (2.04E-2)	2.50E-2 (2.50E0)**	3.97E-2 (3.97E0)	2.5E-1 (2.5E1)
Thyroid NRC	4.26E-2 (4.26E0)	8.30E-4 (8.30E-2)	2.04E-4 (2.04E-2)	2.50E-2 (2.50E0)**	6.86E-2 (6.86E0)	7.5E-1 (7.5E1)

* Source: SSAR Table 11.3-9.

** The 2.5E-2 mSv (2.5 mrem) values used here are the direct dose contributions from one ABWR unit

The staff independently confirmed the adequacy of the applicant's dose consequence calculations from normal operations. The staff determined that since specific details on how the new facility will control, monitor, and maintain radioactive gaseous and liquid effluents are not known at the ESP stage, a COL applicant that references this ESP for the proposed PSEG Site will need to verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for one or more new units which may be built at the PSEG Site are bounded by the radiological doses included in the ESP application and reviewed by the staff, as described above, and address with justification any discrepancies. This includes any changes made to address differences in reactor design used to calculate radiological doses (e.g., basis of the liquid and gaseous radiological source terms, and liquid effluent discharge flow rates and site-specific dilution flow rates). In addition, detailed information on the solid waste management system used to process radioactive gaseous and liquid effluents will be necessary to reflect plant and site-specific COL design considerations. The staff identified these items collectively as COL Action Item 11-1.

COL Action Item 11-1

> An applicant for a COL or a CP referencing this early site permit should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for one or more new units which may be built at the PSEG Site are bounded by the radiological doses included in the ESP application, and must address and justify any discrepancies. This includes any changes made to address differences in reactor design used to calculate radiological doses (e.g., basis of the liquid and gaseous radiological source terms, and liquid effluent discharge flow rates and site-specific dilution flow rates). The COL or CP applicant should also provide detailed information, reflecting plant and site-specific COL design considerations, on the solid waste management system used to process radioactive gaseous and liquid effluents.

11.5 Conclusion

As set forth above, the applicant provided information adequate to provide reasonable assurance that it will control, monitor, and maintain radioactive gaseous and liquid effluents from the ESP site within the regulatory limits described in 10 CFR Part 20, Appendix B, Table 2, as well as maintain them at levels that are in accordance with the effluent design objectives contained in 10 CFR Part 50, Appendix I, Sections II.A, II.B, and II.C. Under the requirements of 10 CFR 20.1301 (e), the applicant also demonstrated compliance with the environmental radiation standards of the EPA under 40 CFR Part 190.

Based upon the above findings and considerations including COL Action Item 11-1, the staff concludes that radiological doses to members of the public from radioactive gaseous and liquid effluents resulting from the normal operation of one or two new nuclear power plants that might be constructed on the proposed site do not present an undue risk to the health and safety of the public. Therefore, with respect to radiological effluent releases and dose consequences from normal operations, the staff concludes that appropriate long-term atmospheric dispersion coefficients have been established for the proposed site, and are acceptable for constructing one or two units falling within the applicant's bounding site-specific PPE, and that the proposed site meets the relevant requirements of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria."

13.0 CONDUCT OF OPERATIONS

13.3 Emergency Planning

13.3.1 Introduction

This section addresses the plans, design features, facilities, functions, and equipment necessary for radiological emergency planning (EP) that must be considered in an early site permit (ESP) application (hereinafter referred to as "ESPA" or "application") that includes a complete and integrated emergency plan. This section includes both the applicant's onsite emergency plan and State and local (offsite) emergency plans, which the U.S. Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA) evaluated to determine whether the plans are adequate, and that there is reasonable assurance that they can be implemented. The emergency plans are an expression of the overall concept of operation and describe the essential elements of advance planning that have been considered, as well as the provisions that have been made to cope with radiological emergency situations.

PSEG Power, LLC, and PSEG Nuclear, LLC (hereinafter referred to as "PSEG Nuclear"), are the applicants for the ESP (hereinafter referred to as "PSEG" or "applicant"). PSEG submitted its ESPA on May 25, 2010, for approval of a site for construction of either a single or dual unit light-water reactor (LWR) plant (hereinafter referred to as "new unit" or "new plant"). The proposed site is located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, NJ. The NRC docketed the application on August 4, 2010 (Docket No. 52-043). PSEG submitted Revision 1 of its ESPA on May 21, 2012, and Revision 2 of its ESPA on March 27, 2013.

Designated by the applicant as the "PSEG Site," the site is approximately 29 kilometers (km) (18 miles (mi)) south of Wilmington, DE, and 48 km (30 mi) southwest of Philadelphia, PA. The PSEG Site is located adjacent to three existing reactors, Salem Generating Station (SGS), Units 1 & 2, and Hope Creek Generating Station (HCGS), Unit 1 (hereinafter referred to as "SGS/HCGS site"), and will consist of an 819-acre area north of HCGS. PSEG Nuclear is the licensee for SGS and HCGS. The ESPA takes advantage of the EP resources, capabilities, and organization that currently exist at the SGS and HCGS site. For purposes of EP, given the new plant's proximity to the existing reactors, little distinction exists between the existing reactor units and the new plant proposed to be located on the PSEG Site.

The applicant has submitted a complete and integrated emergency plan for the new plant under Title 10 of the *Code of Federal Regulations* (10 CFR) 52.17(b)(2)(ii), which consists of the PSEG Site Emergency Plan in Part 5 of the ESPA (hereinafter referred to as "emergency plan" or "ESP Plan"), and supplemental information that includes the offsite radiological emergency response plans (RERPs) for the States of New Jersey, Delaware, and Maryland, and the Commonwealth of Pennsylvania. The PSEG Site evacuation time estimate (ETE) report (hereinafter referred to as "ETE Report") is included as Attachment 11 to the ESP Plan. (The ETE Report is discussed in Sections 13.3.4.1 and 13.3.4.3.17 of this report.) Revisions 1 and 2 of this ESPA included Revisions 1 and 2 of the ESP Plan, respectively.

As described below, in consultation with FEMA, the staff reviewed the ESPA, the applicant's responses to requests for additional information (RAIs), and generally available reference materials in accordance with the guidance provided in the Standard Review Plan (SRP)

(i.e., NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Revision 3, March 2007), Section 13.3, “Emergency Planning,” and Section 14.3.10, “Emergency Planning – Inspections, Tests, Analyses, and Acceptance Criteria.” FEMA reviewed the offsite RERPs and on January 19, 2011, provided the NRC with its Interim Finding Report for Reasonable Assurance of the offsite emergency response plans for the PSEG Site. In a December 13, 2011, letter, the NRC provided FEMA with updated New Jersey and Delaware RERPs. In its March 21, 2012, response, FEMA stated that the FEMA Region II and Region III Radiological Emergency Preparedness Offices reviewed the updated New Jersey and Delaware RERPs for the PSEG Site, and confirmed that the January 19, 2011, findings are still valid. The staff reviewed the FEMA findings, and the overall FEMA conclusions are reflected below in Sections 13.3.4 and 13.3.5 of this report.

Since the specific reactor type for the PSEG Site has not been selected, technical information from various reactor designs is used to develop bounding parameters (i.e., a plant parameter envelope (PPE)) intended to envelop the proposed facility characterization necessary to evaluate the suitability of the site for future construction and operation of a nuclear power plant. The choice of reactor type will be made by a combined license (COL) applicant that uses the ESP as a reference for the PSEG Site.

13.3.2 Summary of Application

Site Safety Analysis Report (SSAR) (ESPA Part 2), Section 13.3, “Emergency Plan,” describes EP for the addition of a new plant at the PSEG Site, and addresses the submission of a complete and integrated emergency plan, which is contained in Part 5 of the ESPA. SSAR Section 13.3 addresses the physical characteristics of the PSEG Site, the emergency planning zones (EPZs) for the new plant, ETEs, and contacts and arrangements with local, State, Federal, and other organizations with supporting emergency responsibilities. In the ESPA, the applicant also provided the following emergency plan information.

Onsite Emergency Plan

As described in the SSAR, the ESPA emergency plan for a new plant at the PSEG Site is provided in ESPA Part 5, and consists of a Basic Plan and 11 attachments. The ESP Plan is based on the existing SGS and HCGS Emergency Plan,, and consists of a complete and integrated emergency plan. The Basic Plan is structured to follow the 16 planning standards in NUREG-0654/FEMA-REP-1, “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants,” Revision 1 (hereinafter referred to as “NUREG-0654). The 11 attachments (listed below) provide additional detailed information on specific aspects of EP.

- Attachment 1: Typical Contents to Emergency Documents
- Attachment 2: Certification Letters
- Attachment 3: Memoranda of Understanding
- Attachment 4: Radiological Assistance Program
- Attachment 5: Emergency Action Levels
- Attachment 6: AP1000 – Specific Information

- Attachment 7: ABWR – Specific Information
- Attachment 8: US-APWR – Specific Information
- Attachment 9: U.S. EPR – Specific Information
- Attachment 10: Emergency Planning – Inspections, Tests, Analyses, and Acceptance Criteria (EP-ITAAC)
- Attachment 11: PSEG Site – Development of Evacuation Time Estimates (ETE Report No. KLD TR-445)

Offsite Emergency Plans

The ESPA includes supplemental information consisting of the offsite RERPs for the States of New Jersey, Delaware, and Maryland, and the Commonwealth of Pennsylvania.

13.3.3 Regulatory Basis

The applicable regulatory requirements and guidance for evaluation of the emergency planning information submitted in an ESPA are:

- For an ESPA submitted pursuant to 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,” that includes a complete and integrated emergency plan, 10 CFR 52.17(b)(2)(ii) requires that the emergency plans meet the applicable standards of 10 CFR 50.47, “Emergency plans,” and the requirements of 10 CFR Part 50, Appendix E. The staff also considered the applicable requirements in 10 CFR 50.33(g), 10 CFR 52.17(b)(3), 10 CFR 52.17(b)(4), 10 CFR 50.72, “Immediate notification requirements for operating nuclear power reactors,” 10 CFR 52.18, “Standards for review of applications,” and 10 CFR 100.21, “Non-seismic siting criteria.”

- NUREG-0800 identifies NUREG-0654 and other related guidance that the staff should consider during its review. The related acceptance criteria are identified in Section II, “Acceptance Criteria,” NUREG-0800, Section 13.3, and the applicable regulatory guidance for reviewing emergency preparedness as an operational program is established in NUREG-0800, Section 13.4, “Operational Programs.” In addition, the staff considered Interim Staff Guidance (ISG) NSIR/DPR-ISG-01, Revision 0, “Emergency Planning for Nuclear Power Plants” (ADAMS Accession No. ML113010523). (NSIR/DPR-ISG-01, Revision 0, “Emergency Planning for Nuclear Power Plants,” November 2011, provides updated guidance based on changes to EP regulations in 10 CFR 50.47 and 10 CFR Part 50, Appendix E, which were published as a Final Rule in the *Federal Register* (*FR*) on November 23, 2011 (76 FR 72560)).

- 44 CFR Part 350, “Review and Approval of State and Local Radiological Emergency Plans and Preparedness,” and 44 CFR Part 352, “Commercial Nuclear Power Plants: Emergency Preparedness Planning,” provide procedures for the review and evaluation of the adequacy of offsite radiological emergency planning and preparedness. In addition, FEMA considered NUREG-0654 (FEMA-REP-1), the Radiological Emergency Preparedness (REP) Program Manual, current FEMA guidance documents, and established industry practices. Pursuant 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," Appendix A, "Memorandum of Understanding Between NRC and FEMA Relating to Radiological Emergency Planning and Preparedness" (58 FR 47996, September 14, 1993), FEMA provided its findings and determinations on offsite planning and preparedness to the NRC for its use in the licensing process.

13.3.4 Technical Evaluation

Pursuant to 10 CFR 52.17(b)(1), an ESPA must identify in the SSAR physical characteristics of 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. If such physical characteristics are identified, the application must identify measures that would, when implemented, mitigate or eliminate the significant impediment.

In addition, 10 CFR 52.17(b)(2) allows an ESP applicant to also propose either major features of emergency plans or a complete and integrated emergency plan, in accordance with the pertinent standards of 10 CFR 50.47 and 10 CFR Part 50, Appendix E. Major features of emergency plans are defined in 10 CFR 52.1, as aspects of those plans necessary to address in whole or part one or more of the 16 planning standards in 10 CFR 50.47(b), or a description of the EPZs as required by 10 CFR 50.33(g). (Before the amendment of 10 CFR Part 52 in 2007 (see 72 FR 49517, August 28, 2007), "major features" were defined in NUREG-0654, Supplement 2, "Criteria for Emergency Planning in an Early Site Permit Application," Section III Draft Report for Comment, published April 1996.) For a complete and integrated emergency plan, 10 CFR 52.17(b)(4) requires that the applicant make good-faith efforts to obtain certifications from local, State, and Federal governmental agencies with emergency planning responsibilities. In addition, 10 CFR 52.17(b)(3) requires that the emergency plans (i.e., the ESP Plan) include the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that will provide reasonable assurance that the facility has been constructed and will be operated in conformity with the emergency plans, the *Atomic Energy Act of 1954*, and NRC regulations. Additional guidance applicable to ESP applications is provided in NUREG-0654, Supplement 2.

PSEG proposed a complete and integrated emergency plan for the new plant pursuant to 10 CFR 52.17(b)(2)(ii). The SSAR states that PSEG has not selected a reactor technology to be built at the PSEG Site, or the number of proposed reactor units based on a selected design. Therefore, attachments to the emergency plan are developed to address information specific to these four technologies considered by the applicant.

- Single Unit U.S. Evolutionary Power Reactor (U.S. EPR)
- Single Unit Advanced Boiling Water Reactor (ABWR)
- Single Unit U.S. Advanced Pressurized Water Reactor (US-APWR)
- Dual Unit Advanced Passive 1000 (AP1000)

The new plant on the PSEG Site may be any of the reactor designs identified, or a different design that falls within the site characteristics and the range of the information developed to characterize the new plant. Until a reactor design is selected, the emergency plan for the new plant will use a generic PPE as a placeholder. The combination of PPE values and site characteristics that form the licensing basis for NRC issuance of the ESP are identified in the SSAR. The SSAR further states that the emergency plan will be revised after the selection of the reactor technology. The demonstration of the emergency plan performance cannot be

completed until portions of the facility have been constructed. To support demonstration, ITAAC are included as an attachment to the emergency plan.

The staff reviewed the information in the ESPA, including SSAR Section 13.3, "Emergency Plan," and the complete and integrated emergency plan (ESP Plan), for conformance with applicable standards and requirements identified in NUREG-0800, Sections 13.3 and 14.3.10, and confirmed that the ESPA addresses the required information relating to EP. The complete set of emergency planning ITAAC for the new plant is provided below in Table 13.3-1 of this report, and various ITAAC are discussed throughout this section of the report. In addition, the staff reviewed selected portions of the emergency response plans for the States of New Jersey, Delaware, Maryland, and the Commonwealth of Pennsylvania for understanding and content, in relation to consistency with various sections of the ESP Plan that address offsite support and response. The staff also conducted two site area visits to the PSEG Site on May 6 and 7, 2010, consisting of a review of the various areas within and beyond the 16-km (10-mi) plume exposure pathway EPZ.

The staff's and FEMA's technical reviews of the ESPA addressed all of the relevant evaluation criteria in the 16 planning standards (i.e., A through P) of NUREG-0654 in a way consistent with NUREG-0800, Section 13.3, which cites the applicable regulations. The proposed new plant is to be located adjacent to the existing SGS/HCGS site. Therefore, for purposes of EP, little distinction exists between the SGS/HCGS site (for the existing reactor units) and the new plant at the PSEG Site. The ESPA takes advantage of the emergency planning resources, capabilities, and organization that currently exist at the SGS/HCGS site. NUREG-0800, Section 13.3, "Emergency Planning," Subsection I, "Areas of Review," provides, in part, this guidance to the staff regarding the appropriate level of review.

> In general, if an application is for an additional reactor at an operating reactor site, and the application proposes to incorporate and extend elements of the existing emergency planning program to the new reactor (including by reference), those existing elements should be considered acceptable and adequate. The reviewer will generally focus the review on the extension of the existing program to the new reactor, and will determine whether the incorporated emergency planning program information from the existing reactor site (1) is applicable to the proposed reactor, (2) is up-to-date when the application is submitted, and (3) reflects use of the site for construction of a new reactor (or reactors) and appropriately incorporates the new reactor(s) into the existing plan.

To be consistent with this guidance, the staff focused its review on the extension of the existing SGS/HCGS site emergency preparedness program to the new unit(s), and considered those elements of the existing program that are unchanged in their applicability to the new unit(s), as acceptable and adequate.

13.3.4.1 Significant Impediments to the Development of Emergency Plans

As part of an ESPA review, 10 CFR 52.18 requires the NRC to determine, after consultation with FEMA, whether the information required of an ESP applicant by 10 CFR 52.17(b)(1) shows that there is no significant impediment to the development of emergency plans that cannot be mitigated or eliminated by measures proposed by the applicant. In a way consistent with 10 CFR 52.17(b)(1), NUREG-0654, Supplement 2, "Criteria for Emergency Planning in an Early Site Permit Application," addresses the identification of physical characteristics of the proposed site that could pose a significant impediment to the development of emergency plans.

NUREG-0654, Supplement 2, Section II states that an ESP application may identify unique physical characteristics of the site by performing a preliminary analysis of the time required to evacuate various sectors and distances within the 16-km (10-mi) EPZ for transient and permanent populations, noting major impediments to the evacuation or the taking of other protective actions. In addition, NUREG-0800, Section 13.3, Subsection II, "Acceptance Criteria," states this in Criterion 16 under "SRP Acceptance Criteria".

> For an ESP application, a preliminary analysis of evacuation times is one example of how some significant impediments to the development of emergency plans may be identified. Other factors, such as the availability of adequate shelter facilities, in consideration of 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) should also be addressed when identifying significant impediments to the development of emergency plans. Any ETE analysis or other identification of physical impediments should include the latest population census numbers and reflect the most recent local conditions. Appendix 4 to NUREG-0654/FEMA-REP-1, Rev. 1, and Supplement 2 to NUREG-0654/FEMA-REP-1, Rev. 1, provide guidance relating to performing an ETE analysis. NUREG/CR-6863 provides additional information on ETEs.

NUREG-0654, Supplement 2 further states that the ETE analysis is an emergency planning tool that can be used to assess the feasibility of developing emergency plans for a site, and will serve to demonstrate whether any physical characteristics (or combination of physical characteristics) of the site could pose impediments to the development of emergency plans. The staff notes that the value of the ETE analysis is in the methodology required to perform the analysis, rather than in the calculated ETE times. While lower ETEs might reflect favorable site characteristics from an emergency planning standpoint, there is no minimum required evacuation time that a licensee or an applicant has to meet. Accordingly, the ETE analysis should not focus on the numerical time estimates, but on the site factors that are considered to be impediments to emergency planning and preparedness.

In SSAR Section 13.3.1, the applicant described the population of the PSEG Site and the surrounding area, stating that the PSEG Site lies on the low coastal plain of New Jersey, surrounded by extensive marshlands and meadowlands, that the closest primary public road is NJ Highway 49 and that vehicle access to the site is from Alloway Creek Neck Road. The existing 734 acres of PSEG property (i.e., the SGS/HCGS site) is located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, NJ.

The applicant further stated that there are no physical characteristics unique to the PSEG Site, that pose a significant impediment to the development of the emergency plan, and that the ETE Report did not identify any impediments to the development of the emergency plan. More specifically, the ETE models the road network surrounding the PSEG Site, and shows it to be robust enough to handle the volume of traffic in the event of an emergency. (Section 13.3.4.3.17 of this report provides a detailed evaluation of the ETE Report.)

The staff reviewed the projected populations within the 16-km (10-mile) EPZ for the 20-year period of the ESP, focusing on the period between the years 2010 and 2031. SSAR

Section 2.1.3, “Population Distribution,” provides population projections for the area surrounding the PSEG Site through 2081. SSAR Tables 2.1-1 and 2.1-4 indicate the total projected resident and transient populations for 2010 to be 42,743 and 12,549, respectively, with a total of 55,292. The respective populations for 2031 are 47,772 and 14,057, with a total of 61,829. The staff calculated that this indicates an increase of 6537 over a 21-year period (i.e., 2010 to 2031), which is approximately 0.57 percent per year over that time period.

In addition, SSAR Section 2.2.2.9, “Projections of Industrial Growth,” states that for Salem County, NJ, the Salem County Utilities Authority identified areas of the county that are expected to undergo economic development, including a possible recycling center in the City of Salem, NJ, and a business/industrial park addition in Oldmans Township and Carneys Point, NJ. The projects identified in Salem County are more than 8 km (5 mi) from the PSEG Site. For New Castle County, DE, most of the land is expected to remain agricultural or open space. The closest zoned industrial plot is the Delaware City Industrial Complex, located on the northwest side of Delaware City, 14.3 km (8.9 mi) from the PSEG Site. A new wastewater treatment plant is planned at 9.5 km (5.9 mi) west of the site, situated along U.S. Route 13. The planned wastewater treatment plant chemical delivery is not expected to approach any closer than the existing facilities in New Castle County. Finally, a review of available Salem and New Castle County planning documents did not indicate any significant expansion of military or transportation facilities located within 8 km (5 mi) of the PSEG Site.

The staff also considered FEMA’s review of the offsite emergency plans, which did not identify any significant impediments to the development of emergency plans in support of a new plant at the PSEG Site. The staff finds that there is little distinction between the existing SGS/HCGS site Emergency Plan and the ESP Plan, and that the applicant has shown through use of the ETE, including consideration of other factors that currently support the existing SGS/HCGS site emergency plan, that there are no physical characteristics unique to the PSEG Site that could pose a significant impediment to the development of emergency plans.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Supplement 2 and NUREG-0800. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 52.17(b)(1) and 10 CFR 52.18, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situation.

13.3.4.2 Contacts and Arrangements with Local, State, and Federal Agencies

As part of the ESPA, PSEG submitted complete and integrated emergency plans pursuant to 10 CFR 52.17(b)(2)(ii). As such, 10 CFR 52.17(b)(4) requires, in part, that the applicant 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) the agencies are committed to participating in any further development of the plans, including any required field demonstrations; and (3) the agencies are committed to executing their responsibilities under the plans in the event of an emergency. This requirement is also reflected in NUREG-0654, Supplement 2, Section IV.B, and NUREG-0800, Section 13.3, Subsection II.

In addition, NUREG-0654, Supplement 2, Section II.B states that the ESP application must include a description of contacts and arrangements made with local, State, and Federal

agencies with emergency planning responsibilities. The descriptions should include the name and location of the organization contacted, the title and/or position of the person(s) contacted, and the role of the organization in EP. NUREG-0800, Section 13.3, Subsection II also addresses this requirement.

The contacts and arrangements with local, State, and Federal agencies, as well as other offsite support organizations, are addressed throughout the ESP Plan, and discussed in Section 13.3.4.3 of this report. In SSAR Section 13.3.5, “Contacts and Agreements,” the applicant stated that the surrounding emergency response organizations currently support SGS and HCGS, and that the addition of a new facility does not change the number of organizations or their level of support. In ESP Plan Attachment 2, “Certification Letters,” the applicant provided certification letters (dated between December 2009 and January 2010) from these offsite agencies in support of the new plant.

- New Jersey Office of Emergency Management
- Salem County Department of Emergency Services
- Cumberland County Office of Emergency Management
- Lower Alloways Creek Township Emergency Management
- Delaware Emergency Management Agency
- New Castle County Office of Emergency Management
- Kent County Emergency Management

In addition, in ESP Plan Attachment 3, “Memoranda of Understanding,” the applicant provided current memoranda of understanding with offsite support organizations that support SGS and HCGS. The applicant also stated that as PSEG moves forward with new plant development, the memoranda of understanding will be revised, as necessary, to include information to support the new plant, and the certification letters will be deleted. Pursuant to 10 CFR 52.39(b), an applicant for a COL that references this ESP shall update the emergency preparedness information that was provided under 10 CFR 52.17(b), and discuss whether the updated information materially changes the bases for compliance with applicable NRC requirements. As such, the staff identified the following COL action item to address necessary revisions of the agreements with offsite support organizations:

COL Action Item 13.3-1

> An applicant for a COL or CP referencing this early site permit should submit to the NRC updated letters of agreement or memoranda of understanding with offsite support organizations to reflect the chosen plant design.

The staff reviewed the certification letters and memoranda of understanding, including the FEMA findings related to the memoranda of understanding (letters of agreement) in ESP Plan Attachment 3. The staff finds that the certification letters are acceptable because they address the three criteria identified above from 10 CFR 52.17(b)(4) and NUREG-0654, Supplement 2, Section IV.B, and are consistent with NUREG-0800, Section 13.3, Subsection II. In addition, the memoranda of understanding are acceptable because they address the criteria in NUREG-0654, Supplement 2, Section II.B (i.e., they include the names and locations of the organizations contacted, the titles and/or positions of the persons contacted, and the roles of the organizations in emergency planning), and are consistent with NUREG-0800, Section 13.3, Subsection II.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Supplement 2, and NUREG-0800. A COL applicant will address COL Action Item 13.3-1. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 52.17(b)(4), insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3 Complete and Integrated Emergency Plan

In SSAR Section 13.3, the applicant stated that the ESPA Part 5 contains the complete and integrated emergency plan (i.e., the ESP Plan), which is based on the existing SGS and HCGS Emergency Plan, and complies with 10 CFR 50.47(b) and 10 CFR Part 50, Appendix E. In addition, SSAR Section 13.3.3, "Emergency Planning Zones," states that the EPZs for the new plant at the PSEG Site are based on the requirements contained in Appendix E. As shown in ESP Plan Figure 1-3, the plume exposure pathway EPZ for the PSEG Site is an area surrounding the plant within a radius of approximately 16 km (10 miles), and includes portions of Salem and Cumberland Counties in New Jersey and New Castle and Kent Counties in Delaware. ESP Plan Figure 1-4 shows the ingestion exposure pathway EPZ, which is an area surrounding the PSEG Site within a radius of approximately 80 km (50 mi). The existing 16-km and 80-km (10-mi and 50-mi) EPZs for the SGS and HCGS are used for the new plant.

Sections 13.3.4.3.1 through 13.3.4.3.17 describe the staff's technical evaluation of the information provided in the ESP Plan, and the review and findings in this SER apply only to the proposed new plant. Any changes to the operating SGS and HCGS units Emergency Plan would be addressed as separate licensing actions, in accordance with 10 CFR 50.54(q). The section designations of the ESP Plan generally correspond to the planning standard designations in NUREG-0654, Section II; specifically, ESP Plan Sections 2 through 17 addresses NUREG-0654, Planning Standards A through P, respectively. The format of the staff's review of the ESP Plan is patterned after these 16 planning standards, which reflect the requirements in 10 CFR 50.47(b)(1) through 10 CFR 50.47(b)(16). 10 CFR Part 50, Appendix E provides additional requirements that duplicate and supplement the evaluation criteria associated with the planning standards. The staff's evaluation of the various aspects of 10 CFR Part 50, Appendix E is included within the associated NUREG-0654 planning standards review.

13.3.4.3.1 Assignment of Responsibility (Organization Control)

As stated in NUREG-0654, Planning Standard A, "Assignment of Responsibility (Organization Control)," 10 CFR 50.47(b)(1) 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 addition, 10 CFR Part 50, Appendix E, Section III requires that the emergency plans incorporate information about the emergency response roles of supporting organizations and offsite agencies, and that the incorporated information shall be sufficient to provide assurance of coordination among the supporting groups and with the licensee. 10 CFR Part 50, Appendix E, Section IV.A requires a description of the local offsite services to be provided in support of the licensee's emergency organization; identification of, and a description of the assistance expected from, appropriate local, State, and Federal agencies with responsibilities for coping with emergencies, including

hostile action at the site; and identification of the State and/or local officials responsible for planning for, ordering, and controlling appropriate protective actions, including evacuations when necessary.

In ESP Plan Section 2, ”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 PSEG Site and might be needed to respond to an emergency at the PSEG 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 to evaluate the emergency plan against NUREG-0654, planning standard A, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(1).

ESP Plan Section 2.2.0, “Principal Government Jurisdictions in the EPZs,” describes the local and State response organizations that are intended to be part of the overall response organization for the EPZs. The interrelationships of PSEG and offsite organizations are illustrated in block diagrams in ESP Plan Figures 2-1 through 2-11 and 3-1 through 3-4. In addition, Federal agencies are discussed in ESP Plan Section 4 (see Section 13.3.4.3.3 of this report regarding emergency response support and resources).

The local response organizations include the Delaware Emergency Management Agency (DEMA), which serves as the lead agency for coordinating State emergency actions and implements the Delaware Radiological Emergency Preparedness (REP) Plan. As described in the Delaware REP Plan, the Delaware Department of Health and Social Services (DHSS) has the overall responsibility for protecting the health and safety of the general public. In addition, the Delaware Department of Natural Resources and Environmental Control (DNREC) is responsible for protecting the environment, and the Delaware Department of Agriculture (DDA) is responsible for protection of agriculture. The Technical Assessment Center (TAC) develops Delaware's accident assessment and protective action response and provides protective action recommendations to the DEMA Director. ESP Plan Figure 2-6 shows the Delaware response organization, and ESP Plan Figure 2-5 shows the outline of the development of protective actions (discussed in detail in ESP Plan Sections 10 and 11).

The resources and response organizations of the State of New Jersey are described in the New Jersey REP Plan. The Office of Emergency Management (OEM) of the New Jersey State Police (NJSP) has the authority to assist in supervising and coordinating State emergency response activities, including those of all of the political subdivisions. The Superintendent of the NJSP acts as the State emergency coordinator and is responsible for directing and coordinating all emergency response by State agencies. The New Jersey Department of Environmental Protection (DEP) is the lead agency for New Jersey's assessment of radiological emergencies, and has the authority to recommend and take radiological protective actions. The DEP Commissioner is the agency head responsible for the response of that organization, and actions taken by DEP are coordinated through (and parallel with) the actions of the NJSP. ESP Plan Figure 2-7 shows the New Jersey response organization.

Local response organizations include Salem and Cumberland Counties in New Jersey and New Castle and Kent Counties in Delaware. The local government representatives who act as the county emergency coordinators are the County Emergency Management Coordinators for

Salem and Cumberland Counties and the County Emergency Preparedness Coordinators for New Castle and Kent Counties. The response organizations for the counties are shown in ESP Plan Figures 2-8 through 2-11. Expected assistance associated with hostile action at the site is addressed in Section 13.3.4.3.3 of this report.

The States of Pennsylvania and Maryland are contiguous (ingestion pathway) states, and are shown in ESP Plan Figure 1-4, “50-Mile Emergency Planning Zone.” The State of New Jersey has a Memorandum of Understanding with Pennsylvania and Maryland, and has the primary responsibility for notification and communications with these contiguous states. The State of Delaware also has agreements with Pennsylvania and Maryland regarding notifications. If an accident causes conditions offsite that justify monitoring of the ingestion pathway, PSEG’s Emergency Coordinator will verify with the State of New Jersey that Pennsylvania and Maryland have been notified. The criterion for recommending ingestion pathway monitoring is that radionuclide concentrations in excess of 10 CFR Part 20, Appendix B limits could potentially exist or are verified to exist offsite.

ESP Plan Section 2.1.1, “Internal Responsibility,” states that PSEG has the primary responsibility for planning and implementing emergency measures within the site boundary. In addition to accident mitigation, this responsibility includes accident assessment and the evaluation of any real or potential risk to the public health and safety. Based on this evaluation, appropriate offsite agencies are promptly notified of the protective action recommendations (PARs) for the affected population areas. Additional information about the emergency response organization and resources is provided in ESP Plan Sections 3 and 4. ESP Plan Section 3.4.0, “Emergency Direction and Control,” states that the Emergency Coordinator has overall responsibility to direct and control the emergency response. (Emergency Coordinator responsibilities are also addressed in ESP Plan Sections 3, 4, and 14, and discussed in Sections 13.3.4.3.2, 13.3.4.3.3, and 13.3.4.3.13, respectively, of this report.)

The ESP Plan states that the PSEG Site maintains 24-hour emergency response capability. The normal on-shift complement provides the initial response to an emergency, and is trained to handle emergency situations until the augmented ERO arrives. Procedures for training and maintenance of the emergency organization are in place to provide the capability of continuous (24-hour) operations. ESP Plan Section 7, “Emergency Communications,” describes the communications plans for emergencies, and states that provisions are in place on a 24-hour basis for communications with the States of New Jersey and Delaware, counties, and the NRC. The Emergency Manager/Supervisor is responsible for maintaining and ensuring the continuity of personnel and resources. ITAAC 8.1.1.C.3 states that the licensee will demonstrate the ability to prepare for 24-hour staffing requirements during a full participation exercise.

ESP Plan Section 2.1.2, “External Agreements,” states that PSEG has entered into agreements with emergency response organizations that would provide onsite and offsite support in the event of an emergency at the PSEG Site. These agreements are provided in the ESP Plan Attachments 2 and 3, and are described in Section 13.3.4.2 of this report. The ESP Plan Attachment 3 includes copies of 16 memoranda of understanding/letters of agreement from various agencies and organizations that currently provide support during response to an emergency at the SGS/HCGS site, which describe the scope of services to be provided. The staff reviewed the memoranda of understanding, and confirmed that they adequately identify the emergency response measures to be provided, the mutually acceptable criteria for implementation, and the arrangements for exchange of information. PSEG identified two additional memoranda of understanding with AREVA and Mitsubishi (not included in ESP

Plan Attachment 3) that will be revised, as necessary, to include information to support the proposed new plant. (Also see COL Action Item 13.3-1 in Section 13.3.4.2 of this report.)

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant has adequately assigned primary responsibilities for emergency response, and the applicant has the staff to respond to and to augment its initial response on a continuous basis. The applicant is capable of providing 24-hour-per-day emergency response and staffing of communications links, including continuous (24-hour) operations for a protracted period. In addition, the applicant has identified the appropriate organizations that are intended to be part of the overall response organization, and has established the emergency responsibilities of the various supporting organizations, including providing adequate written agreements. The applicant has specified the concept of operations and its relationship to the total effort, illustrated the interrelationships in a block diagram, and has identified the individuals in charge of the emergency response and for ensuring continuity of resources.

In addition, the staff finds that the applicant has incorporated information about the emergency response roles of supporting organizations and offsite agencies, and that that information is sufficient to provide assurance of coordination among the supporting groups and with the licensee. Further, the applicant has described the local offsite services to be provided in support of the licensee's emergency organization, and has identified the assistance expected from appropriate local, State, and Federal agencies, including State and/or local officials responsible for planning for, ordering, and controlling appropriate protective actions.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard A. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(1) and 10 CFR Part 50, Appendix E, Sections III and IV.A, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations

13.3.4.3.2 Onsite Emergency Organization

As stated in NUREG-0654, Planning Standard B, "Onsite Emergency Organization," 10 CFR 50.47(b)(2) requires that on-shift facility licensee responsibilities for emergency response are unambiguously defined, that adequate staffing to provide initial facility accident response in key functional areas is maintained at all times, that timely augmentation of response capabilities is available, and that interfaces among various onsite response activities and offsite support and response activities are specified. In addition, 10 CFR Part 50, Appendix E, Section IV.A requires a description of the organization for coping with radiological emergencies, including definition of authorities, responsibilities, and duties of individuals assigned to the licensee's emergency organization, and the means for notification of such individuals in the event of an emergency. This shall include a description of the normal plant operating organization, onsite emergency response organization, headquarters personnel who will augment the onsite emergency organization, and local offsite services to be provided in support of the licensee's emergency organization. The emergency plan shall identify persons within the licensee organization who will be responsible for making offsite dose projections, and other

employees with special qualifications for coping with emergency conditions that might arise. Other persons with special qualifications, who are not licensee employees and who may be called on for assistance, shall also be identified, including a description of their special qualifications. 10 CFR Part 50, Appendix E, Section IV.A.9 requires a detailed analysis demonstrating that on-shift personnel assigned emergency plan implementation functions are not assigned responsibilities that would prevent the timely performance of their assigned functions, as specified in the emergency plan.

In ESP Plan Section 3, “Emergency Organization,” the applicant described the ERO and its key positions and associated responsibilities, including outlining the staffing requirements that provide initial emergency response actions and provisions for timely augmentation of on-shift personnel when required. 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 to evaluate the emergency plan against NUREG-0654, Planning Standard B, and NSIR/DPR-ISG-01, Section IV.C, which provide the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(2).

ESP Plan Section 3.2.0, “Normal Shift Organization,” describes the plant’s normal staff complement that comprises the onsite emergency organization, including various positions and station departments (e.g., operations, fire department and first aid team, maintenance, engineering, security, radiation protection, and chemistry). The emergency organization’s functional areas and detailed job descriptions are provided in ESP Plan Section 3.9. ESP Plan Figures 3-1 and 3-2 illustrate in block diagrams the relationship of the onsite ERO to the normal staff complement, as well as interfaces between the Control Room and Technical Support Center (TSC) with offsite agencies and organizations. In addition, ESP Plan Figures 3-3 and 3-4 illustrate the Emergency Operations Facility (EOF) and Emergency News Center/Joint Information Center (ENC/JIC) organizational structure and interfaces, respectively, as well as interfaces with external agencies and organizations.

The individual functioning in the position of Emergency Coordinator has overall responsibility to direct and control the emergency response. The Shift Manager initially assumes the Emergency Coordinator function and is responsible for initiating the necessary immediate actions to limit the consequences of an accident and bring the affected unit under control. The Shift Manager is normally the senior shift member of the station organization, and has the primary management responsibility for safe operation, including maintaining an overview of the unit’s condition, providing emergency direction and control, initiating emergency actions, and controlling operations by providing specific directions to shift personnel. While the Shift Manager is fulfilling the Emergency Coordinator function, the Control Room Supervisor takes operational control of the unit and has the authority and responsibility of the Shift Manager.

As the onsite emergency organization is augmented, the Emergency Coordinator function passes from the Shift Manager to the Emergency Duty Officer, and then to the Emergency Response Manager. ESP Plan Table 3-1 describes the respective duty positions and identifies at which emergency classification these positions may assume the Emergency Coordinator duties. The individual fulfilling the function of Emergency Coordinator has these non-delegable responsibilities:

- Provide direction, control, and coordination of PSEG’s emergency response

- Authorize the expenditure of company funds and commit corporate resources as necessary to implement emergency procedures and/or to mitigate the accident

- Classify emergencies in accordance with the PSEG Site Event Classification Guides

- Make decisions to notify and recommend protective actions to offsite agencies

(Emergency Coordinator responsibilities are also addressed in ESP Plan Sections 2, 4, and 14, and discussed in Sections 13.3.4.3.1, 13.3.4.3.3, and 13.3.4.3.13, respectively, of this report.) Upon determination by the Shift Manager of an emergency classified as an Alert or higher, the Operations Support Center (OSC) is activated. For short-term staff augmentation, the OSC Coordinator takes control of the corrective action and support function from the Shift Manager, and is the interface between the Shift Manager and OSC support teams. The OSC Coordinator assumes responsibility for directing support of repair, corrective actions, fire fighting, search and rescue teams, and is responsible for supplementing the OSC staff as needed. Long-term staff augmentation includes necessary additional support staff, including contractual assistance.

The staff finds that the applicant has adequately designated an individual as the Emergency Coordinator who has the authority and responsibility to initiate emergency actions, including recommending protective actions to the authorities responsible for implementing offsite emergency measures. The staff also finds that the applicant clearly specified which responsibilities may not be delegated to other elements of the emergency organization, and has identified an adequate line of succession for the Emergency Coordinator position.

In ESP Plan Section 3.10, “Staffing Commitments,” the applicant stated that the commitment for minimum staffing will be in accordance with NUREG-0654, Table B-1, “Minimum Staffing Requirements for NRC Licensees for Nuclear Power Plant Emergencies.” Specifically, ESP Plan Table 3-2 provides a correlation between major functional areas, major tasks, and position title or expertise (as described in NUREG-0654, Table B-1) and the similar tasks and titles in the ERO. The staff reviewed ESP Plan Table 3-2, and finds that the required minimum on-shift and augmentation staffing in support of the new plant is acceptable because it is consistent with NUREG-0654, Table B-1.

Fukushima Dai-ichi – NTTF Recommendation 9.3

In RAI 65, Question 13.03-29, the staff requested that the applicant address staffing and communications provisions to enhance emergency preparedness, as addressed in NRC Near-Term Task Force (NTTF), Recommendation 9.3, “Emergency Preparedness” review of the accident at the Fukushima Dai-ichi nuclear facility (also discussed in “Recommendations for Enhancing Reactor Safety in the 21st Century”, July 12, 2011, and the NRC’s subsequent letter to licensees, “Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident,” March 12, 2012). With regard to staffing, the accident at Fukushima highlighted the need to determine and implement the required staff to fill all necessary positions responding to a multi-unit event. Specifically, NTTF Recommendation 9.3 requests that all power reactor licensees and holders of construction permits (in active or deferred status) assess their current staffing levels and determine the appropriate staff to fill all necessary positions for responding to a multi-unit event during a beyond-design-basis natural event, and determine if any enhancements are appropriate. Single-unit sites should provide the requested information, as it pertains to an extended loss of

all alternating current (ac) power and impeded access to the site. (Emergency communications are addressed in Section 13.3.4.3.6 of this report.)

In a September 10, 2012, response to RAI 65, Question 13.03-29, the applicant included the statement below, which addresses both the staffing and communications areas addressed in NTTF Recommendation 9.3.

> The detailed designs of on-site and off-site communication systems, including their power supplies, are not yet complete. The designs will be completed after the selection of the reactor technology. After PSEG selects a reactor technology, an assessment of on-site and off-site communication systems and equipment used during an emergency, including their power supplies and the emergency organization staffing levels, will be conducted to identify possible enhancements to ensure communications are maintained during a large scale natural event as requested in *Recommendation 9.3* . . ..

Consistent with the applicant's stated intention, the staff identified the following permit conditions, which address enhanced staffing and communications capabilities. The permit conditions include the use of Nuclear Energy Institute (NEI) technical report NEI 12-01, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," which the NRC has endorsed as an acceptable method for licensees to employ when addressing NTTF Recommendation 9.3.[1]

Permit Conditions 5 and 6

5. An applicant for a COL or CP referencing this early site permit shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an assessment of on-site and augmented staffing capability for responding to a multi-unit event. The staffing assessment shall be performed in accordance with the latest NRC-endorsed revision of NEI 12-01, "Guidance for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," (ii) At least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall complete implementation of corrective actions identified in the staffing assessment described above and identify how the augmented staff will be notified given degraded communications capabilities, including any related emergency plan and implementing procedure changes and associated training.

6. An applicant for a COL or CP referencing this early site permit shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for

[1] See (1) NRC May 15, 2012, letter, 'U.S. Nuclear Regulatory Commission Review of NEI 12-01, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," Revision 0, dated May 2012' (ADAMS Accession No. ML12131A043); (2) NEI May 3, 2012, letter, 'Transmittal of NEI 12-01, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," Revision 0, dated May 2012' (ADAMS Accession No. ML12125A411); and (3) NEI Report No. 12-01, Revision 0, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," May 2012 (ADAMS Accession No. ML12125A412).

completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an assessment of on-site and off-site communications systems and equipment relied upon during an emergency event to ensure communications capabilities can be maintained during an extended loss of ac power. The communications capability assessment shall be performed in accordance with the latest NRC-endorsed revision of NEI 12-01, "Guidance for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," (ii) At least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall complete implementation of corrective actions identified in the communications capability assessment described above, including any related emergency plan and implementing procedure changes and associated training.

Subject to Permit Conditions 5 and 6, the staff finds the applicant's response to RAI 65, Question 13.03-29, acceptable. Accordingly, the staff considers RAI 65, Question 13.03-29, resolved.

Enhancements to Emergency Preparedness Regulations

In addition to appropriate staffing levels associated with multi-unit events (discussed above), on November 23, 2011, the NRC published a Final Rule, "Enhancements to Emergency Preparedness Regulations," (76 *FR* 72560) (hereinafter referred to as "Final Rule"), which included a new requirement in 10 CFR Part 50, Appendix E, Section IV.A associated with on-shift ERO personnel. Specifically, 10 CFR Part 50, Appendix E, Section IV.A.9 requires that for nuclear power reactor licensees, by December 24, 2012, a detailed analysis demonstrating that on-shift personnel assigned emergency plan implementation functions are not assigned responsibilities that would prevent the timely performance of their assigned functions, as specified in the emergency plan.

In an August 29, 2012, letter to the NRC, PSEG described the implementation approach for the 11 amendments (enhancements) to the emergency preparedness regulations addressed in the Final Rule (76 *FR* 72560). With regard to the on-shift staffing analysis requirement in 10 CFR Part 50, Appendix E, Section IV.A.9, at the COL application phase, PSEG will validate the existing on-shift staffing in the ESP Plan when a reactor technology selection has been made and plant procedures are available. PSEG will make a COL application commitment to perform the validation analysis in accordance with the requirements of the Final Rule and submit the results to the NRC 180 days prior to fuel load. In addition, validation will be performed using Nuclear Energy Institute (NEI) 10-05, "Assessment of On-Shift Emergency Response Organization Staffing and Capabilities," Revision 0, June 2011, which has been endorsed by the NRC as a process for performing the analysis.

The staff finds this approach acceptable because it is consistent with the Final Rule and Interim Staff Guidance NSIR/DPR-ISG-01. The NRC endorsement of NEI 10-05 is addressed in NSIR/DPR-ISG-01, Section IV.C, "On-Shift Staffing Analysis," which states, in part, that NEI 10-05 establishes a standard methodology for a licensee to perform the required staffing analysis, and that the NRC has reviewed NEI 10-05 and finds it an acceptable methodology for this purpose. Consistent with the applicant's stated intention, the staff identified the following permit condition, which addresses the actions that will be taken to analyze on-shift personnel assigned emergency plan implementation function.

Permit Condition 7

7. An applicant for a COL or CP referencing this early site permit shall revise the emergency plan to describe on-shift personnel assigned emergency plan implementing functions associated with the chosen reactor technology and the number of proposed reactor units. In addition, the COL or CP applicant shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an on-shift staffing analysis in accordance with the latest NRC-endorsed revision of NEI 10-05, “Assessment of On-Shift Emergency Response Organization Staffing and Capabilities,” (ii) At least one hundred eighty (180) days before the date schedule for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall incorporate any changes to the emergency plan needed to bring staffing to the required levels.

Subject to Permit Conditions 5, 6, and 7, the staff finds that the applicant unambiguously defined its responsibilities for emergency response, has adequate staffing to provide and maintain at all times initial facility accident response in key functional areas, and is capable of timely augmentation of the response capabilities. In addition, the applicant adequately specified the interfaces among various onsite and offsite support and response activities. In addition, the applicant described the organization for coping with radiological emergencies, including the authorities, responsibilities, and duties of individuals assigned to the licensee’s emergency organization and the means for their notification in the event of an emergency. The applicant also described the normal plant operating organization, the onsite ERO, and the headquarters and local offsite personnel and services that will augment and support the onsite organization. Further, licensee employees who are responsible for making offsite dose projections, and licensee and other persons with special qualifications for coping with emergency conditions, are also identified. An analysis of on-shift staffing personnel responsibilities is addressed in Permit Condition 7.

<u>Conclusion</u>

Subject to Permit Conditions 5, 6, and 7, the staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard B and NSIR/DPR-ISG-01, Section IV.C. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(2) and 10 CFR Part 50, Appendix E, Section IV.A, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.3 Emergency Response Support and Resources

As stated in NUREG-0654, Planning Standard C, “Emergency Response Support and Resources,” 10 CFR 50.47(b)(3) requires that arrangements for requesting and effectively using assistance resources have been made, arrangements to accommodate State and local staff at the licensee EOF have been made, and other organizations capable of augmenting the planned response have been identified. In addition, 10 CFR Part 50, Appendix E, Section III requires that the emergency plans incorporate information about the emergency response roles of supporting organizations and offsite agencies, and that that information shall be sufficient to provide assurance of coordination among the supporting groups and with the licensee. 10 CFR Part 50, Appendix E, Section IV.A.7 requires identification of, and a description of the

assistance expected from, appropriate local, State, and Federal agencies with responsibilities for coping with emergencies, including hostile action at the site.

In ESP Plan Section 4, "Emergency Response Support and Resources," the applicant described the provisions for requesting and effectively using support resources and for accommodating offsite officials at the emergency response facilities. 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 to evaluate the emergency plan against NUREG-0654, Planning Standard C, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirement in 10 CFR 50.47(b)(3).

ESP Plan Section 4 describes the Federal emergency resource, including the roles of the NRC, FEMA, U.S. Department of Energy (DOE), and U.S. Coast Guard (USCG). The resources of the Federal Government—through the implementation of the National Response Framework (NRF), Nuclear/Radiological Incident Annex—may be used to supplement the onsite radiological surveys or relieve PSEG offsite radiological survey teams. The Emergency Coordinator is authorized to request NRF resources. (Emergency Coordinator responsibilities are also addressed in ESP Plan Sections 2, 3, and 14, and discussed in Sections 13.3.4.3.1, 13.3.4.3.2, and 13.3.4.3.13, respectively, of this report.) The Federal response (other than by the NRC) is primarily related to offsite protective actions and radiological assessment, and is implemented at the request of the States of New Jersey and/or Delaware. FEMA acts as coordinator of the Federal response, and emergency management from New Jersey and Delaware provides information and assistance to FEMA.

PSEG provides appropriate space and facilities to the principal State and Federal response organizations at the EOF, from where Federal response coordination will be conducted. ESP Plan Section 7 describes dedicated and commercial communication systems that are available to support the Federal response. PSEG also assigns a person to assist the States, which allows State response personnel to have immediate access to all station radiological and operational data. Upon request, PSEG will send representatives to the State emergency operations centers (EOCs) to provide assistance and coordination. ESP Plan Figure 4-1, "PSEG Site Access from Area Airports," provides directions to the EOF and PSEG Site from Dulles International Airport, Philadelphia International Airport, and New Castle County Airport.

The applicant also identified radiological laboratories that can provide radiological monitoring and analysis services in an emergency. These include the PSEG Maplewood Testing Services in Maplewood, NJ, which provides extensive facilities and equipment for analysis of materials, environmental radioactivity analysis, and radiation surveys. In addition, manpower is available to assist in sample collection in the aftermath of an incident involving the release of radioactive materials. Other organizations that can be relied on in an emergency, including the identification of specific assistance, are identified in memoranda of understanding in ESP Plan Attachment 3. These include General Electric Company, Institute of Nuclear Power Operations (INPO), Westinghouse Electric Company, Haz/Med Consultants, Wilmington Fire Department, AREVA, Mitsubishi, and the Memorial Hospital of Salem County. ESP Plan Figures 2-3 through 2-11 and 3-1 through 3-3 illustrate the interrelationships of the offsite agencies and organizations with the overall emergency response organization.

In an August 29, 2012, letter, PSEG described the implementation approach for the 11 amendments (enhancements) to the emergency preparedness regulations addressed in the Final Rule. With regard to assistance expected from offsite response organizations (OROs) during emergencies including a hostile-action-based (HAB) event, the applicant stated that additional detail of ORO response capabilities and resources for a HAB event is maintained by PSEG Nuclear and may contain Safeguards Information. These same resources would be available to the new unit(s) at the PSEG Site during a HAB event, as stated in the certification letters (in ESP Plan Attachment 2). In addition, the PSEG Site emergency plan implementing procedures (EPIPs) will identify the ORO resources available and their integration into site activities during an emergency event at the PSEG Site (see ITAAC 9.1).

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant has made arrangements for requesting and effectively using assistance resources, including arrangements to accommodate State and local staff at the EOF, and has identified other organizations capable of augmenting the planned response. In addition, the applicant has made adequate provisions for incorporating the Federal response capability into its operation plan, and has identified radiological laboratories and other organizations that can be relied on in an emergency to provide assistance. The staff also finds that the emergency plans incorporate information about the emergency response roles of supporting organizations and offsite agencies, and that the information is sufficient to provide assurance of coordination among the supporting groups and the licensee. Finally, the applicant has identified appropriate local, State, and Federal agencies with responsibilities for coping with emergencies (including hostile action at the PSEG Site), as well as the expected assistance from each.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard C. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(3) and 10 CFR Part 50, Appendix E, Sections III and IV.A.7, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.4 Emergency Classification System

As stated in NUREG-0654, Planning Standard D, “Emergency Classification System,” 10 CFR 50.47(b)(4) 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 addition, 10 CFR Part 50, Appendix E, Section IV.B requires a description of the means to be used for determining the magnitude, and for continually assessing the impact, of the release of radioactive materials, including emergency action levels (EALs) that are to be used as criteria for determining the need for offsite agency notifications and participation, and when and what types of protective measures should be considered. The EALs must include hostile actions that might adversely affect the nuclear power plant. The initial EALs shall be discussed and agreed on by the applicant or licensee and State and local governmental authorities, and approved by the NRC. Thereafter, EALs shall be reviewed with State and local governmental authorities on

an annual basis. 10 CFR Part 50, Appendix E, Section IV.C requires a description of EALs and emergency conditions that involve alerting or activating the total emergency organization, including communication steps to be taken under each emergency class. The emergency classes defined shall include (1) notification of unusual event, (2) alert, (3) site area emergency, and (4) general emergency. 10 CFR Part 50, Appendix E, Section IV.C.2 requires the capability to assess, classify, and declare an emergency condition within 15 minutes after the availability of indications to plant operators that an EAL has been exceeded, and to promptly declare the emergency conditions as soon as possible after the identification of the appropriate emergency classification level.

In ESP Plan Section 5, "Emergency Classification System," the applicant described the emergency classification and action level scheme used to determine the minimum response to an abnormal event at the plant. 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 to evaluate the emergency plan against NUREG-0654, Planning Standard D, which provides detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(4).

In ESP Plan Attachment 5, "Emergency Action Levels," the applicant addressed the EAL scheme associated with the four proposed reactor technologies, consisting of the U.S. EPR, ABWR, US-APWR, and AP1000. The applicant stated that certain aspects of each reactor design's EALs cannot be completed at this time because actual setpoints cannot be derived until as-built information is available and certain technical specifications are finalized. PSEG's adoption of an EAL scheme following the selection of a reactor technology is also discussed in SSAR Section 13.3.

At the ESP application stage (with a proposed complete and integrated emergency plan), as well as the COL application stage, the requisite EAL information is limited and consists of four critical elements: (1) An overview of the EAL scheme, including a definition of the four emergency classification levels and general list of licensee actions; (2) a commitment to develop the remainder of the EAL scheme using a specified NRC-endorsed guidance document; (3) a proposed license condition that addresses EAL completion, agreement with State and local officials (as appropriate), and submission of the fully developed EALs to the NRC; and (4) maintaining the EALs in a document controlled by 10 CFR 50.54(q). The information associated with these critical elements, along with the permit conditions, provides a sufficient level of application detail to support the staff's reasonable assurance evaluation.

ESP Plan Section 5 provides an overview of the emergency action level scheme, including the definition of the four emergency classification levels (i.e., Unusual Event, Alert, Site Area Emergency, and General Emergency) and a general list of licensee actions for each emergency classification level. The staff finds this acceptable because it is consistent with 10 CFR Part 50, Appendix E, Section IV.C. In addition, the applicant stated that the emergency classification system is designed to provide a consistent method for categorizing possible events or accidents, and that a detailed description of the emergency classifications is provided in the Event Classification Guide (ECG).

The ECG lists the initiating conditions and associated action levels for all emergency and non-emergency reportable events (e.g., reportable action levels for Security/Emergency Response Capabilities), and guides the Emergency Coordinator to an immediate and

appropriate response specific to the event. (Security-based EALs are also discussed in NRC Bulletin 2005-02, "Emergency Preparedness and Response Actions for Security-Based Events," July 18, 2005, and in Section 13.3.4.3.10 of this report.) ESP Plan Attachment 1-1.3 provides the typical contents (example index) of an ECG for the PSEG Site. The ECG is considered an annex of the PSEG emergency plan, and like the emergency plan is subject to specific reviews and approvals. The staff finds this acceptable because the EALs are kept in a document that is controlled by 10 CFR 50.54(q). In addition, ESP Plan Section 17 states that the emergency plan and associated documents (including EALs) are reviewed by PSEG at least once each year. As part of the review, the ECG is reviewed with the State and local governments.

In an August 29, 2012, letter, PSEG described the implementation approach for the 11 amendments (enhancements) to the emergency preparedness regulations addressed in the Final Rule. With regard to the requirement in 10 CFR Part 50, Appendix E, Section IV.C.2 for the capability to assess, classify, and declare an emergency condition within 15 minutes after the availability of indications to plant operators that an EAL has been exceeded, the applicant stated that PSEG will implement this element of the Final Rule in the ECG, as is done in the current SGS and HCGS ECGs. Permit Conditions 8 and 9 (below) address submission of the (ECG) EALs. In addition, the requirement to make an emergency declaration within 15 minutes of the existence of the condition will be included in the EPIPs (see ITAAC 9.1). See ITAAC 8.1.1.A.1.a, which addresses accident assessment and classification (within 15 minutes) during a full-participation exercise.

In ESP Plan Attachment 5, the applicant stated that in the COL application, PSEG will make a commitment to adopt its EAL scheme by utilizing the guidance in the NRC-approved (template) version of either NEI 99-01, or NEI 07-01, as appropriate, at least 180 days prior to initial fuel load of the unit, and that any deviations or differences in the proposed EALs from the applicable template will be justified. In addition, the applicant stated that the development of EALs in accordance with the guidance presented in NEI 99-01 or NEI 07-01, including its submittal to the NRC at least 180 days prior to fuel load, is a proposed license condition. ESP Plan Section 5 further states that the EALs have been discussed and agreed on by PSEG and the State governments. Consistent with the applicant's stated intention, the staff identified the following permit conditions, which address the creation of a fully developed EAL scheme, interfaces with State and local officials, and submission to the NRC.

Permit Conditions 8 and 9

8. An applicant for a COL or CP referencing this early site permit and the AP1000 standard design shall propose a license condition for the licensee to develop an Emergency Action Level (EAL) scheme with fully developed site-specific EALs, in accordance with the latest NRC-endorsed revision of NEI 07-01, "Methodology for Development of Emergency Action Levels, Advanced Passive Light Water Reactors," with few or no deviations or differences. All deviations or differences from NEI 07-01 must be fully described in the COL application, including providing the initiating condition, operating modes, notes, EAL threshold(s), basis information, and developer guidance for how a particular setpoint is (or will be) determined. The EALs shall have been discussed and agreed upon with State and local officials. The fully developed site-specific EAL scheme shall be submitted to the NRC at least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a).

9. An applicant for a COL or CP referencing this early site permit and the U.S. EPR, ABWR, or US-APWR standard design shall propose a license condition for the licensee to develop an Emergency Action Level (EAL) scheme with fully developed site-specific EALs, in accordance with the latest NRC-endorsed revision of NEI 99-01, "Methodology for Development of Emergency Action Levels," with few or no deviations or differences, other than those attributable to the specific reactor design. All deviations or differences from NEI 99-01 must be fully described in the COL application, including providing the initiating condition, operating modes, notes, EAL threshold(s), basis information, and developer guidance for how a particular setpoint is (or will be) determined. The EALs shall have been discussed and agreed upon with State and local officials. The fully developed site-specific EAL scheme shall be submitted to the NRC at least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a).

For the reasons discussed above, the staff finds that the applicant adequately addressed the four critical elements (identified above) that comprise the required EAL information in the ESP application. EALs are also addressed in the various ITAAC in ESP Plan Attachment 10 and reflected in Table 13.3-1 of this report. These include ITAAC 1.1(a), which states that the parameters referenced in the Emergency Classification and EAL scheme are retrievable in the Control Room, TSC, and EOF. ITAAC 1.1(b) states that the ranges of the displays encompass the values specified in the Emergency Classification and EAL scheme. Finally, full-participation exercise ITAAC 8.1.1.A states that the licensee will demonstrate the ability to identify initiating conditions, determine EAL parameters, and correctly classify the emergency throughout the exercise.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

Subject to Permit Conditions 8 and 9, the staff finds that the applicant established a standard emergency classification and action level scheme, the bases of which include facility system and effluent parameters, which includes the four emergency classes identified above. The applicant described EALs and emergency conditions that involve ERO activation, including steps to be taken under each emergency class. The applicant also described the means to determine the magnitude of, and for continually assessing the impact of, the release of radioactive materials, and EALs (including those pertaining to hostile actions) that are used to determine the need for offsite notifications and protective measures. In addition, the applicant has the capability to assess, classify, and declare an emergency condition within 15 minutes after the availability of indications to plant operators that an EAL has been exceeded, and to promptly declare the emergency condition.

Conclusion

Subject to Permit Conditions 8 and 9, the staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard D. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(4) and 10 CFR Part 50, Appendix E, Sections IV.B and IV.C, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.5 Notification Methods and Procedures

As stated in NUREG-0654, Planning Standard E, “Notification Methods and Procedures,” 10 CFR 50.47(b)(5) 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; that the content of initial and follow-up messages to response organizations and the public has been established; and that the means to provide early notification and clear instruction to the populace within the 16-km (10-mi) plume exposure pathway EPZ have been established. In addition, 10 CFR Part 50, Appendix E, Section IV.A.4 requires a description of how offsite dose projections will be made and the results transmitted to State and local authorities, NRC, and other appropriate governmental entities. 10 CFR Part 50, Appendix E, Section IV.C requires a description of EALs and emergency conditions that involve alerting or activating the emergency organization, including communication steps to be taken under each class of emergency, and the existence of a message-authentication scheme. 10 CFR Part 50, Appendix E, Section IV.D.1 requires a description of administrative and physical means for notifying local, State, and Federal officials and agencies and agreements reached with these officials and agencies for the prompt notification of the public and for public evacuation or other protective measures. The description shall include identification of the appropriate officials, by title and agency, of the State and local government agencies within the EPZs. 10 CFR Part 50, Appendix E, Section IV.D.3 requires the licensee to have the capability to notify responsible State and local governmental agencies within 15 minutes after declaring an emergency. The licensee shall demonstrate that appropriate governmental authorities have the capability to make a public alerting and notification decision promptly on being informed by the licensee of an emergency condition, and that administrative and physical means have been established for alerting and providing prompt instructions to the public within the plume exposure pathway EPZ. The alerting and notification capability shall include a backup method. Finally, 10 CFR 50.72(a)(3) requires NRC notification no later than 1 hour after declaring an emergency.

In ESP Plan Section 6, “Notification Methods – Response Organizations,” the applicant described notification of ERO personnel; State, county, and Federal agencies; and the general public during a declared 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 to evaluate the emergency plan against NUREG-0654, Planning Standard E, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(5).

Notification actions taken by PSEG for each of the four emergency classification levels are described in ESP Plan Table 6-1, and Figure 6-1 provides a block diagram of notification method. ESP Plan Attachment 1-1.4 includes a listing of typical onsite EPIPs, which include EPIP 204P, “Emergency Response Callout/Personnel Recall.” Emergency communication systems are described in ESP Plan Section 7 and discussed in Section 13.3.4.3.6 of this report.

The station plant paging systems are used to notify onsite personnel of emergency conditions and whether activation of emergency response facilities might be required. An automated Emergency Outdial System computer is used to call out the balance of emergency response personnel for full organizational augmentation and activation of emergency response facilities. The system activates appropriate digital group pagers while simultaneously calling other personnel on the telephone. Additional PSEG telephone notifications, including to the NRC, are

made in accordance with applicable Event Classification Guide Attachments and EPIPs. ITAAC 2.2 states that a test of the primary and backup ERO notification system will be performed.

The initial notification to the States of an emergency or a change in emergency classification is made to the State Police Headquarters of New Jersey and Delaware. Upon completion of the initial message, each State Police Headquarters verifies the call by performing a callback check, and then makes the notifications indicated in ESP Plan Figures 6-2 and 6-3. The procedures for initial notifications to the States of New Jersey and Delaware are identical for all emergency classes. Once activated, the Delaware Emergency Management Agency will take initial notifications, rather than the Delaware State Police. This notification is made promptly following the declaration of the emergency (within 15 minutes). An example of the message format for this initial notification used in the emergency procedures is provided in ESP Plan Figure 6-4 and appropriate forms are utilized for each emergency classification. In addition, ESP Plan Section 4.3.1 states that the NRC is notified via a dedicated telephone line (i.e., the Emergency Notification System (ENS)) from the Control Room, TSC, or EOF to the NRC Rockville, MD, Operations Center within 1 hour after identifying the existence of an emergency condition. (See Section 13.3.4.3.10 of this report, which addresses NRC Bulletin 2005-02.)

ITAAC 2.1 states that the States of Delaware and New Jersey, and Kent, New Castle, Cumberland, and Salem Counties received notification within 15 minutes after the declaration of an emergency from the Control Room, TSC, or EOF. In addition, ITAAC 8.1.1.B.2 states that the licensee demonstrated the ability to notify responsible State agencies within 15 minutes and the NRC within 60 minutes after declaring an emergency.

For events classified as an unusual event, alert, or site area emergency, each State, after being notified by PSEG, initially notifies the local authorities. If, however, PSEG has not been able to contact a State, PSEG directly notifies the local (county) authorities. All initial notifications must be accomplished within 15 minutes. Accident assessment, protective action recommendations, and other information normally provided to the State are communicated to the local authorities (or other agencies, as provided in the memorandum of understanding with the State) until the State assessment agency assumes its communications and assessment responsibilities. ESP Plan Section 10, “Accident Assessment,” describes how offsite dose projections will be made, and is addressed in Section 13.3.4.3.9 of this report. ESP Plan Section 11, “Protective Response,” describes how offsite protective action recommendations will be made, and is addressed in Section 13.3.4.3.10 of this report.

For events classified as a general emergency, PSEG makes direct contact with the States of New Jersey and Delaware. If the States cannot be contacted within 15 minutes, PSEG notifies the local governments (counties) and the USCG. After this initial contact, the States (or counties) will be responsible for assessing the information provided, activating their response organization (as required), notifying appropriate local governments, and the public. After being contacted by the State (or PSEG), each county and the USCG are responsible for assessing the information provided and activating its response organizations.

After initial notification, the States make a determination on protective actions and activation of the prompt alerting and notification system. This system can be activated directly by Salem County in New Jersey and by the Delaware State Police in Delaware for a rapidly developing emergency. ITAAC 2.3 states that a full test of the Prompt Alerting and Notification System and the Emergency Alert System capabilities will be conducted, such that notification and clear

instructions to the public will be accomplished in accordance with the emergency plan requirements.

The procedures for follow-up communications with the States of New Jersey and Delaware are identical for all emergency classes. The follow-up communications with the States is initiated by a return call from the authorized State agency. For the State of Delaware, the Delaware Emergency Management Agency is responsible for follow-up communications. For the State of New Jersey, the Department of Environmental Protection, Bureau of Nuclear Engineering, and/or the New Jersey State Police Office of Emergency Management are responsible for follow-up communications. ESP Plan Figure 6-5 provides an example message format for follow-up communications used in the EPIPs. Follow-up communications with the local authorities are provided by the appropriate State agency for all emergency classifications. ITAAC 8.1.1.B.2.b addresses the transmission of follow-up notification information using the designated checklist.

The existing SGS/HCGS site's prompt alerting and notification system will be used by the PSEG Site. After initial notification, it is the responsibility of the States to make a determination regarding protective actions and to decide whether to activate the prompt alerting and notification system. The prompt alerting and notification system (shown in ESP Plan Figure 6-6), which is operated by the States and controlled from a location that is staffed continuously (24 hours), provides notification to the population within 8 km (5 mi) of the PSEG Site in 15 minutes or less after a protective action decision requiring notification, and notification to the population within 8 to 16 km (5 to 10 mi) in 45 minutes or less after a protective action decision requiring notification. The system includes both a siren and public-address system. Siren coverage is provided to population centers throughout the plume exposure EPZ and selected areas known to have recreational or transient populations (see ESP Plan Figure 6-7). The public-address system, which is used for waterborne transient boaters within the plume exposure EPZ, consists of a radio alert and notification system that is coordinated by the USCG and supplemented by broadcasts via the Emergency Alert System (EAS) and National Oceanographic and Atmospheric Administration (NOAA) weather radio. The USCG and States also dispatch boats and helicopters to make direct contact with boaters.

Land use within the PSEG Site plume exposure EPZ is principally rural. The area within 8 km (5 mi) of the PSEG Site is largely water and marshland. This area attracts only a limited number of hunters and trappers, most of whom are local residents. The agencies in charge of parks and recreation, the Delaware National Guard, the marine police, and State police assist in the notification of transients within their jurisdictions. These agencies may use motor vehicles, aircraft, boats, and roadblocks to alert and notify transients. The methods used to inform and educate the transient population of the prompt alerting system, and their required response is provided in ESP Plan Section 8.0. As a backup alerting and notification capability that augments the prompt alerting subsystems, public-address systems can be used by police and fire personnel for route alerting.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

As described above, the staff finds that procedures for notification of State and local response organizations and emergency personnel by all organizations have been established, and the licensee has the capability to notify offsite officials and agencies, including State and local

governmental agencies within 15 minutes, and the NRC no later than 1 hour, after declaring an emergency. The appropriate officials of the State and local government agencies within the EPZs have been identified. The licensee has described the entire spectrum of emergency conditions that involve alerting or activating the total emergency response organization, including EALs for offsite agency notification and communication steps to be taken under each class of emergency. Message authentication is described in the State and local emergency plans. The applicant has also described how appropriate governmental authorities have the capability to make a public alerting and notification decision promptly following notification of an emergency by the licensee, and administrative and physical means have been established for alerting and providing prompt instruction to the public within the plume exposure pathway EPZ (including a backup method to alert populations), and for public evacuation and other protective measures. In addition, the applicant has described how offsite dose projections will be made and the results transmitted to State and local authorities, the NRC, and other appropriate governmental entities.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard E. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(5), 10 CFR 50.72(a)(3), and 10 CFR Part 50, Appendix E, Sections IV.A.4, IV.C, IV.D.1, and IV.D.3, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.6 Emergency Communications

As stated in NUREG-0654, Planning Standard F, “Emergency Communications,” 10 CFR 50.47(b)(6) requires that provisions exist for prompt communications among principal response organizations, to emergency personnel, and to the public. In addition, 10 CFR Part 50, Appendix E, Section IV.E.9 requires onsite and offsite communication systems with backup power sources, including provisions for communications with State and local governments within the plume exposure EPZ, and Federal emergency response organizations and the NRC. Also required are provisions for communications among the Control Room, TSC, EOF, principal State and local EOCs, and field assessment teams. Communication systems shall be tested at designated frequencies.

In ESP Plan Section 7, “Emergency Communications,” the applicant described the provisions used for communications between the PSEG Site and principal response organizations, as well as between the emergency response facilities. (Notification to, and communications with, the public is described in ESP Plan Sections 6 and 8, and addressed in Sections 13.3.4.3.5 and 13.3.4.3.7, respectively, of this report. 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 to evaluate the emergency plan against NUREG-0654, Planning Standard F, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(6).

The station’s plant paging systems are used to notify onsite personnel that emergency conditions exist and that activation of emergency response facilities might be required. This includes the PSEG Site public-address system, which is a voice-communication system located throughout the plant. PSEG also maintains multiple radio systems that support station

operations, fire protection, security, and onsite and offsite field monitoring teams. ITAAC 3.1(b) states that a test will be performed to demonstrate (both primary and secondary methods/systems) the ability to communicate from the TSC and the EOF to PSEG field monitoring teams. ESP Plan Table 7-1 summarizes the dedicated and commercial communications services maintained in emergency response facilities onsite and offsite. ESP Plan Section 15, “Exercises and Drills,” addresses communication systems testing.

To assure that external notifications and communications are available during an emergency, PSEG maintains both dedicated and commercial communication systems as part of its emergency response capabilities. The existing SGS and HCGS emergency communication systems will be used by the PSEG Site. Provisions are in place for establishing and maintaining (on a 24-hour basis) communications with the States of New Jersey and Delaware, the 16-km (10-mi) EPZ counties, Lower Alloways Creek Township, and the NRC. Organizational titles associated with communications are identified in ESP Plan Section 3, “Emergency Organization,” and initial and follow-up notification is addressed in ESP Plan Section 6, “Notification Methods – Response Organizations.” The available communication systems include the Nuclear Emergency Telecommunications System (NETS), Centrex/Electronic Switch System Exchange (Centrex/ESSX 1), and Direct Inward Dial (DID) system.

NETS, which is a privately controlled and self-contained telephone exchange that operates as a closed system, is dedicated to emergency response use and is the primary communication system between the PSEG Site, the States, and counties. NETS telephones are located in onsite and offsite PSEG emergency response facilities, as well as the EOC facilities of the States and counties. The system is used to notify the States for all EALs and provide emergency communications with the counties, and may use PSEG microwave, commercial telephone-system microwave, fiber optics, or buried cable transmission. As an independent system with an uninterruptible power supply, NETS can operate with or without local phone service or external power.

The secondary communications to the States and counties are provided by both the Centrex/ESSX 1 and DID systems, which are strategically placed throughout emergency facilities. Centrix/ESSX 1 is a privately controlled exchange, which PSEG operates with its own microwave signal system, and is considered the primary backup for NETS. This system is also independent of local phone service, because each circuit is independently wired. DID is the principal telephone system used for normal business at the site. DID is also a backup system for emergency response, and allows station telephones to be extensions or tied lines of the same systems. These exchanges can take advantage of backup power supplies provided to the station, and may use PSEG microwave, commercial telephone-system microwave, or buried cable-transmission systems to maintain external communications.

Additional methods for State and county contacts include Emergency Radio (EMRAD) and the National Attack Warning and Alert System (NAWAS). The Federal Telecommunications System (FTS) provides a dedicated communication system with the NRC and is installed in the Control Room, TSC, and EOF. ITAAC 3.1(a) states that a test will be performed to demonstrate (both primary and secondary methods/systems) the ability to communicate from the Control Room, TSC, and the EOF to responsible State and local government agencies.

In RAI 22, Question 13.03-13, the staff requested that the applicant describe the components and availability of FTS. In a July 21, 2011, response to RAI 22, Question 13.03-13, the applicant stated that the Control Room and TSC designs are not complete because a reactor

technology has not been selected, and that the PSEG Site FTS design will be developed following the selection of a reactor technology. Pursuant to 10 CFR 52.39(b), an applicant for a COL that references this ESP shall update the emergency preparedness information that was provided under 10 CFR 52.17(b), and discuss whether the updated information materially changes the bases for compliance with applicable NRC requirements. As such, the staff identified the following COL action item to address the selection of a reactor technology to be built at the PSEG Site, including the description of the FTS.

COL Action Item 13.3-2

> An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the components, availability, and power supplies for the Federal Telecommunications System (FTS), including all required communications and data links associated with the chosen reactor technology.

As described above, the staff finds the applicant's response to RAI 22, Question 13.03-3, acceptable and, therefore, considers RAI 22, Question 13.03-13, resolved.

In RAI 47, Question 13.03-26, the staff requested that the applicant discuss the availability of the Reactor Safety Counterpart Link (RSCL), Protective Measures Counterpart Link (PMCL), Management Counterpart Link (MCL), and Local Area Network (LAN). In a March 7, 2012, response to RAI 47, Question 13.03-26, the applicant stated that emergency plan supporting documentation (e.g., Communication Checklist Procedures EP-AA-124-1001-F12, -F13, and -F14) identifies specific FTS lines, including RSCL lines, PMCL lines, Health Physics Network (HPN) lines, ENS lines, an MCL line, and a LAN line. ITAAC 3.2 addresses establishment of communications associated with the ENS, HPN, and the Emergency Response Data System (ERDS). ERDS supplements the existing voice transmission over the ENS, and is discussed in Section 13.3.4.3.8 of this report. The staff finds the applicant's response to RAI 47, Question 13.03-26, acceptable and, therefore, considers RAI 47, Question 13.03-26, resolved.

Fukushima Dai-ichi – NTTF Recommendation 9.3

In RAI 65, Question 13.03-29, the staff requested that the applicant address staffing and communications provisions for enhancing emergency preparedness, as addressed in Recommendation 9.3 of the NRC NTTF review of the accident at the Fukushima Dai-ichi nuclear facility. With regard to communications, the accident at Fukushima highlighted the need to ensure that the communications equipment relied on to coordinate the event response during a prolonged station blackout can be powered. Specifically, NTTF Recommendation 9.3 requests that all power reactor licensees and holders of construction permits (in active or deferred status) assess their current communications systems and equipment used during an emergency event, including consideration of any enhancements that might be appropriate for the emergency plan with respect to the communications requirements of 10 CFR 50.47, 10 CFR Part 50, Appendix E, and NUREG-0696, "Functional Criteria for Emergency Response Facilities." In addition, the means necessary to power the new and existing communications equipment during a prolonged station blackout should be considered. (Onsite emergency organization and staffing is addressed above in Section 13.3.4.3.2 of this report.)

The applicant's September 10, 2012, response to RAI 65, Question 13.03-29, addressed both enhanced staffing and communications capabilities. The resolution of this RAI, including the

staff's proposed Permit Condition 6, associated with emergency communications, is addressed above in Section 13.3.4.3.2 of this report.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

Subject to Permit Condition 6, the staff finds that provisions exist for prompt communications among principal response organizations, to emergency personnel, and to the public. Specifically, the applicant established a reliable primary and backup means of communications for alerting and activating the response organizations and personnel, including 24-hour manning of communications links. Provisions also exist for communications among the Control Room, TSC, EOF, State and local governments within the EPZs, and field assessment teams. In addition, the applicant provided a coordinated communication link for fixed and mobile medical support facilities. Onsite and offsite communication systems have backup power sources and are tested at designated frequencies.

Conclusion

Subject to Permit Condition 6, the staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard F. A COL applicant will address COL Action Item 13.3-2. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(6) and 10 CFR Part 50, Appendix E, Section IV.E.9, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.7 Public Education and Information

As stated in NUREG-0654, Planning Standard G, "Public Education and Information," 10 CFR 50.47(b)(7) requires that information be made available periodically to the public concerning notification methods and initial actions the public 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 addition, 10 CFR Part 50, Appendix E, Section IV.D.2 requires a description of provisions for yearly dissemination to the public within the plume exposure EPZ of basic emergency planning information, such as methods for public notifications and protective actions planned if an accident occurs, general information as to the nature and effects of radiation, and a listing of local broadcast stations that will be used for dissemination of information during an emergency. Signs or other measures shall also be used to disseminate information to any transient population within the plume exposure pathway (16-km (10-mi)) EPZ.

In ESP Plan Section 8, "Public Information," the applicant described the PSEG public education and information program, including the process for keeping the public in the 16-km (10-mi) EPZ informed in the event 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 to evaluate the emergency plan against NUREG-0654, Planning Standard G, which provides the detailed evaluation criteria that the staff should consider to determine

whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(7).

The public information program consists of general information regarding nuclear energy, radiation, and emergency planning, which is provided at least annually as an insert in local publications. This includes educational information on radiation, contacts for additional information, public-response options of sheltering or evacuation, evacuation routes, relocation centers, and special considerations for the handicapped. This information is provided to the transient population and permanent residents of the 16-km (10-mi) EPZ in the form of pamphlets, advertisements in locally distributed newspapers or telephone books, placards, or postings at recreational facilities. Annually, selected information is either updated and redistributed or verified to be in place at appropriate locations. PSEG provides an information program for the media and the general public, which includes distributing training information along with an invitation to annually observe a training drill. During the May 6 and 7, 2010, site area visits, the staff observed several emergency siren signs within the 16-km (10-mi) EPZ, which provided instructions to tune to specific radio stations for emergency information if the siren sounds for 3 to 5 minutes.

ESP Plan Section 9.6, "Emergency News Center/Joint Information Center (ENC/JIC)," states that the ENC/JIC facilities are at the Salem County 911 Center. The facility can support use by 100 or more media personnel, including space for media briefings, and separate work areas are maintained for PSEG, NRC, State, and county personnel. ESP Plan Section 8.2.0, "Public Information During an Emergency," states that upon activation of the ENC/JIC, all information provided to the news media is approved by the Company Spokesperson (or ENC Manager) and State of New Jersey. ENC/JIC communications equipment is addressed in ESP Plan Section 7 and summarized in ESP Plan Table 7-1. ITAAC 4.1 states that the ENC/JIC included equipment to support the ENC/JIC operations, including communications with the TSC, EOF, principal State and local EOCs, and the news media. In addition, ITAAC 8.1.1.F states that the licensee will demonstrate the capability to develop and disseminate information to the news media, and establish rumor control.

In RAI 66, Question 14.03.10-1, the staff requested that the applicant make various minor revisions to the EP-ITAAC table in the ESP Plan, Revision 1, Attachment 10 to be consistent with the generic ITAAC in NUREG-0800, Section 14.3.10, Table 14.3.10-1, and to provide clear and objective ITAAC. (Affected EP-ITAAC include ITAAC 4.1, 6.1, 6.3, 6.5, 6.6, 6.8, 8.1.1.E.2.b, 8.1.3, and 10. The revised versions of these ITAAC are reflected in the respective sections, as well as Table 13.3-1 of this report, except for ITAAC 10 which was deleted.) In an October 19, 2012, response to RAI 66, Question 14.03.10-1, the applicant proposed changes to ESP Plan, Revision 1, Attachment 10 that are consistent with the staff's identified revisions, and included the changes in ESP Plan, Revision 2. The staff finds the applicant's response to RAI 66, Question 14.03.10-1, acceptable and, therefore, considers RAI 66, Question 14.03.10-1, resolved.

The Public Information Liaison, located in the EOF, will ensure that the necessary information is provided to the ENC/JIC by the emergency response organization. A timely exchange of information is ensured among the designated spokespersons for PSEG and representatives of the States of New Jersey and Delaware by systematically recording the receipt of news bulletins. ESP Plan Section 3.9.7.G, "Public Information," describes the various ENC/JIC staff positions and associated duties. This includes the Emergency News Center Manager, who is responsible for the overall operation of the ENC/JIC, including the dissemination of information

and media monitoring. The Company Spokesperson is a senior management representative responsible for representing the applicant in news-media briefings, and acts as the official Company Spokesperson. The Public Information Manager is responsible for representing PSEG as Company Spokesperson until activation of the ENC/JIC, and has the authority to release information provided by the Emergency Coordinator concerning any event at the PSEG Site that might be of interest to the media and the public.

In ESP Plan Section 8.4.0, "Rumor Control (Public Inquiry)," the applicant stated that rumor control is accomplished by providing information to other public information sources simultaneously and by providing public information officers with access to the PSEG public information source. Additionally, telephone access numbers are listed in the annual public information brochure so the public can contact officials who can quickly confirm or deny the accuracy of a given report or rumor. The Rumor Control Coordinator is responsible for coordinating the media monitoring effort and the dissemination of information about the emergency using PSEG's Rumor Control Network.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant provided for a coordinated and periodic dissemination of information to the public, including the permanent and transient adult population within the plume exposure (16-km (10-mi)) EPZ, regarding how they will be notified and what their actions should be in an emergency. The applicant also established the principal points of contact with the news media for dissemination of information during an emergency, and procedures for coordinated dissemination of information to the public. In addition, the applicant described the provisions for yearly dissemination to the public within the plume exposure EPZ of basic emergency planning information, including the use of signs or other measures to disseminate information to any transient population within the plume exposure EPZ.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard G. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(7) and 10 CFR Part 50, Appendix E, Section IV.D.2, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.8 Emergency Facilities and Equipment

As stated in NUREG-0654, Planning Standard H, "Emergency Facilities and Equipment," 10 CFR 50.47(b)(8) requires that adequate emergency facilities and equipment to support the emergency response be provided and maintained. In addition, 10 CFR Part 50, Appendix E, Section IV.E.8 requires that adequate provision be made and described for emergency facilities and equipment, including a licensee's onsite OSC and TSC, as well as an EOF from which effective direction can be given and effective control can be exercised during an emergency. 10 CFR Part 50, Appendix E, Section IV.E.8.b addresses various requirements associated with EOF locations and required provisions, which are not applicable to an existing EOF pursuant to 10 CFR Part 50, Appendix E, Section IV.E.8.e. 10 CFR Part 50, Appendix E, Section IV.E.8.c requires various EOF capabilities, which include supporting response to multiple reactors/sites and simultaneous events, as applicable. 10 CFR Part 50,

Appendix E, Section IV.E.8.d requires an alternative facility (for use when onsite emergency facilities cannot be safely accessed during hostile actions) that would be accessible and could function as a staging area for augmentation of emergency response staff. 10 CFR Part 50, Appendix E, Section IV.G requires a description of provisions to be employed to ensure that the emergency plan, its implementing procedures, and emergency equipment and supplies are maintained up to date. 10 CFR Part 50, Appendix E, Section VI.1 requires an ERDS data link between the licensee's onsite computer system and the NRC Operations Center, through which a limited data set of selected parameters can be automatically transmitted.

In ESP Plan Section 9, "Emergency Facilities and Equipment," the applicant described the functions and locations of the emergency response facilities and equipment that will be used and maintained by PSEG in coordinating and performing emergency response activities. 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 to evaluate the emergency plan against NUREG-0654, Planning Standard H, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(8).

Emergency facilities and equipment are maintained both onsite and offsite, and were developed to meet the intent of NUREG-0737, Supplement 1, "Requirements for Emergency Response Capability;" except as indicated otherwise in the emergency plan. Emergency preparedness inventory procedures include detailed equipment listings, and the equipment is inventoried and operationally checked quarterly and after each use. The instrument calibration frequency has been established in accordance with appropriate technical guidance, and allowance is made for replacement in the event of normal servicing and calibration. ESP Plan Table 9-1 lists typical equipment that is maintained both onsite and offsite. ESP Plan Attachments 6 through 9 provide information relating to the location, design, habitability, and monitoring capabilities of the PSEG Site Control Room, TSC, OSC, onsite laboratories, and decontamination facilities.

The onsite radiation monitoring capability for the four respective technologies considered includes an installed process, effluent, and area Radiation Monitoring System (RMS); portable survey instrumentation; counting equipment for radiochemical analysis; and a personnel dosimetry program to record integrated exposure. The area monitoring system provides information on radiation levels in various areas of the plant and has Control Room and local readout and audible alarms. In addition, a wide range of gas monitors are installed at normal effluent release points, and provide readout and alarm functions to the Control Room. ESP Plan Section 10 describes equipment and instrumentation (including the RMS and Safety Parameter Display System (SPDS)) that supports monitoring and assessment of operational, radiological, and geophysical events. Section 13.3.4.3.9 of this report documents the staff review of ESP Plan Section 10 and includes COL Action Item 13.3-4, which addresses radiation monitoring and other systems and equipment associated with the chosen reactor technology.

Initial monitoring and decontamination is performed onsite in the decontamination area at each Control Point or other suitable location. During normal operations, the Control Point serves PSEG Site as the access control point for personnel entering or leaving the Radiological Controlled Area. Radiation Protection/Chemistry personnel also support onsite corrective actions, access control, personnel monitoring, dosimetry, search and rescue, and first aid. Personnel monitoring and decontamination are addressed in ESP Plan Sections 11 and 12 and discussed in Sections 13.3.4.3.10 and 13.3.4.3.11 of this report, respectively. Arrangements for

medical services are also addressed in ESP Plan Section 13, and discussed in Section 13.3.4.3.12 of this report.

ESP Plan Table 7-1 summarizes the dedicated and commercial communications services maintained in emergency response facilities onsite and offsite. Supplementing the existing voice transmission over the ENS is the ERDS, which is a direct (near-realtime) electronic data link between the licensee's onsite computer system and the NRC Operations Center through which a limited data set of selected parameters can be automatically transmitted. In ESP Plan Attachment 1-1.8, the applicant listed typical emergency preparedness administrative procedures, including emergency support equipment procedure PC.EP-FT.ZZ-0006(Q), "Emergency Response Data System (ERDS) Test with NRC." In RAI 22, Question 13.03-18, the staff requested that the applicant address whether ERDS is tested quarterly. In a July 21, 2011, response to RAI 22, Question 13.03-18, the applicant stated that ERDS will be tested quarterly in accordance with NRC Inspection [Information] Notice 2008-15, "ERDS Test Schedule Revised," and that the requirement to test ERDS will be included in the emergency plan's functional test procedure for the new plant, in a way similar to ERDS testing at both SGS and HCGS. ITAAC 3.2 addresses establishment of communications associated with the ENS, HPN, and ERDS. The staff finds the applicant's response to RAI 22, Question 13.03-18, acceptable and, therefore, considers RAI 22, Question 13.03-18, resolved.

The offsite environmental radiological monitoring program includes thermoluminescent dosimeters (TLDs) in neighboring towns and cities, at schools and public assembly points, and at numerous locations close to the station. Additional resources and capabilities for offsite environmental monitoring and analysis, including meteorological consultation, are identified in ESP Plan Section 4 and discussed in Section 13.3.4.3.3 of this report. Meteorological monitoring capabilities are also addressed in ESP Plan Section 10 and discussed in Section 13.3.4.3.9 of this report. ITAAC 8.1.1.D.2 addresses the adequacy of equipment, security provisions, and habitability precautions for the TSC, OSC, EOF, and ENC/JIC.

Control Room

The Control Room continues its control functions during emergency response. The classification and notification responsibilities are met from the Control Room until other emergency facilities are activated. The PSEG Site Control Room is designed to meet the habitability requirements of 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 19. ESP Plan Table 9-1 lists typical radiological protection emergency equipment that is available to the Control Room personnel. Control Room communication systems are addressed in ESP Plan Section 7 and discussed in Section 13.3.4.3.6 of this report. Table 13.3-1 of this report includes various ITAAC associated with the Control Room. ITAAC 1.1 addresses the ability to retrieve EAL scheme parameters; ITAAC 6.4 addresses the availability of meteorological information; and ITAAC 3.1, 3.2, and 5.2.1 address communication systems.

Technical Support Center

The TSC provides an onsite location to support plant management during an emergency, and functions as an augmented communication/analysis center of technical data to supplement the Control Room staff's technical analysis and support plant operations personnel. The TSC is used by members of the ERO to relieve Control Room operators of any plant specific duties not directly related to the direct handling of plant controls. Such duties include directing analysis and assessment of the emergency conditions and performing functions associated with the EOF (when the EOF is not activated). The TSC is used as the assembly point for PSEG personnel,

onsite vendor support, the NRC, and personnel who are directly involved in accident assessment and mitigation.

The location of the TSC depends on the reactor technology and is addressed in the respective design control documents (DCDs) for the AP1000, ABWR, US-APWR, and U.S. EPR (cited in ESP Plan Attachments 6, 7, 8, and 9, respectively). ESP Plan Attachments 6 through 9 also state that the TSC is located within the Protected Area for each design, and address various TSC characteristics, such as size, habitability, power supply, and plant parameter displays. The TSC's location, size, and habitability for each reactor design are evaluated as part of the separate DCD reviews.

The TSC can be staffed and activated within 90 minutes of an Alert or higher emergency classification, although this staffing and activation time could vary if severe weather conditions or acts of nature or terrorism are experienced at the same time as the ERO callout. (ESP Plan Section 3 addresses TSC activation and staffing, which is discussed in Section 13.3.4.3.2 of this report.) (Refer to the June 26, 2008, Safety Evaluation, which addresses approval of the 90-minute personnel response and activation time goal for the emergency response facilities supporting SGS and HCGS for additional discussion (ADAMS Accession No. ML081690552)). When activated, the TSC becomes the primary onsite communications center during an emergency, and provides reliable voice communications to the Control Room OSC, EOF, NRC, and other offsite agencies. If the TSC becomes uninhabitable for any reason, TSC personnel will transfer to an unaffected station TSC.

Analytical and assessment capabilities assigned to the TSC include plant engineering support, computerized dose assessment, and the SPDS. ESP Plan Table 9-1 lists typical radiological-protection emergency equipment that is available to the TSC personnel. TSC communication systems are addressed in ESP Plan Section 7 and discussed in Section 13.3.4.3.6 of this report. Documentation available within the TSC supports emergency assessments, classification, and procedures. ESP Plan Attachment 1-1.4 includes these TSC-related EPIPs:

- PC.EP-EP.ZZ-0201(Q), "TSC – Integrated Engineering Response"
- PC.EP-EP.ZZ-0203(Q), "Administrative Support/Communication Team Response - TSC"
- PC.EP-EP.ZZ-0205(Q), "TSC – Post Accident Core Damage Assessment"

In RAI 47, Question 13.03-27, the staff requested that the applicant describe the availability in the TSC of the RMS and SPDS plant parameter variables, including those identified in RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants." In a March 7, 2012, response to RAI 47, Question 13.03-27, the applicant stated that the identification of specific plant parameter variables is dependent on the type of reactor selected for the site. At the COL stage, the specific post-accident parameters for the selected technology will be fully defined, and PSEG will update the emergency plan to identify the specific monitoring capability for the radiological parameters identified in RG 1.97. As discussed above, emergency facilities and equipment (including those that display available plant parameters and meteorological variables) were developed to meet the intent of NUREG-0737, Supplement 1, which references RG 1.97, Revision 2. This action at the COL stage is discussed in Section 13.3.4.3.9 of this report and is reflected in COL Action Item 13.3-4. The staff finds the applicant's response to RAI 47, Question 13.03-27, acceptable and, therefore, considers RAI 47, Question 13.03-27, resolved.

ITAAC 5.1 states that an inspection of the as-built TSC and OSC will be performed, including a test of their capabilities. The associated acceptance criteria address TSC size, habitability, communication, and backup power, as well as the availability of plant and environmental information, and the capability to conduct emergency assessment. ITAAC 8.1.1.D addressed TSC activation, operation, and the adequacy of equipment. ITAAC 8.1.1.C.1 addresses the capability of the TSC to direct and control emergency operations.

Operations Support Center

The OSC is an onsite area, separate from the Control Room and TSC, where licensee operations support personnel will assemble in an emergency. The location of the OSC depends on the reactor technology and is addressed in ESP Plan Attachments 6 through 9. ITAAC 5.1.6 states that there is an OSC located inside the Protected Area. The design control documents (DCDs) for the AP1000, ABWR, and U.S. EPR identify the specific OSC location. The US-APWR DCD does not include an OSC as part of the standard design; therefore, the OSC location will be determined at a later time. Pursuant to 10 CFR 52.39(b), an applicant for a COL that references this ESP shall update the emergency preparedness information that was provided under 10 CFR 52.17(b), and discuss whether the updated information materially changes the bases for compliance with applicable NRC requirements. As such, the staff identified the following COL action item to address the OSC location for the US-APWR reactor design.

COL Action Item 13.3-3

> An applicant for a COL or CP referencing this early site permit and the US-APWR standard design should revise the emergency plan to describe the location and capabilities of the Operations Support Center (OSC).

The PSEG Site OSC functions as an information relay station, dispatching office, assembly and assignment point, and accountability station for teams assigned from the OSC. In the event of an emergency, operations personnel not on duty and other support personnel report to the OSC to form repair and corrective action teams. ESP Plan Section 3 addresses OSC activation and staffing, and ESP Plan Attachment 1-1.4 includes these OSC-related EPIPs.

- PC.EP-EP.ZZ-0202(Q), “Operations Support Center (OSC) Activation and Operations”
- PC.EP-EP.ZZ-0304(Q), “Operations Support Center (OSC) Radiation Protection Response”

The TSC will serve as a backup OSC, if required. ESP Plan Table 9-1 lists typical radiological-protection emergency equipment that is available to the OSC personnel. OSC communication systems are addressed in ESP Plan Section 7 and discussed in Section 13.3.4.3.6 of this report. ITAAC 5.1.2 states that communication equipment is installed in the TSC and OSC, and voice transmission and reception are accomplished. ITAAC 8.1.1.D addresses OSC activation, operation, and the adequacy of equipment.

Emergency Operations Facility

The EOF is a licensee-controlled and -operated offsite support center, which serves as the near-site support center for management of the aggregate response to a radiological emergency at SGS, HCGS, and the proposed new plant at the PSEG Site. The EOF is located in the PSEG Energy and Environmental Resource Center (EERC) in Salem, NJ, approximately

12 km (7.5 mi) from the TSC.[2] This site is judged by the applicant to provide operational and logistical benefits with regard to its relationship to the area's transportation system, which makes the EOF readily accessible by road and air to designated personnel of all agencies and activities assigned an emergency response role by the emergency plan. The location makes possible rapid movement of personnel between the station and the EOF, as well as collection and assessment of offsite radiological monitoring information from the survey teams. In addition, an alternate near-site location at the EERC has been identified and equipped by the applicant, in the event that a security or other event prevents the ERO from reporting to the primary onsite emergency response facilities.

Approximately 487 m^2 (5240 ft^2) of floor space in the EERC is designated for use as the EOF, which provides approximately 7 m^2 (75 ft^2) of workspace per person for a staff of up to 70 persons and 60 m^2 (650 ft^2) for conference rooms. Additional space is available in the building for another 100 persons. The functional layout of the EOF depicts designated workspace for emergency response activities, equipment, functional displays, and storage of plant records. The EOF provides facilities and equipment to support staff performance of these major functions:

- Management of overall emergency response activities
- Coordination of radiological and environmental assessment
- Development of recommendations for protective actions for the public
- Coordination of emergency response operations with Federal, State, and local agencies

The EOF is staffed by PSEG and other emergency personnel designated by the PSEG emergency plan. Facilities are provided in the EOF for NRC, FEMA, New Jersey, Delaware, and local emergency response agency personnel responsible for implementing emergency response actions for protection of the general public. The EOF can be staffed and activated, or ready to activate, within 90 minutes of an Alert or higher emergency classification, although this time could vary if severe weather or acts of nature or terrorism are experienced at the same time as the ERO callout. (See the June 26, 2008, Safety Evaluation, cited above for TSC activation within 90 minutes.) To ensure EOF activation readiness, PSEG provides normal industrial security for the EOF complex. When activated, EOF access is restricted to authorized personnel by the industrial security system.

Equipment is provided in the EOF for the acquisition, recording, display and evaluation of containment and operational conditions, radiological releases, and meteorological data. The data is analyzed and evaluated to determine the nature and scope of any protective measures, which may be recommended to State and local officials for protection of the public health and safety, if the magnitude and potential effects of a radioactive release dictate. The equipment includes a display of information collected by the RMS. In addition, radiological monitoring equipment in the facility has the capability to monitor EOF airborne radioactivity, in order to ensure that personnel are not subjected to adverse radiological conditions. All equipment, displays, and instrumentation to be used to perform essential EOF functions are located in the EOF, and ESP Plan Table 9-1 lists typical radiological protection emergency equipment that is

[2] In SECY-84-63, "Backup Emergency Operations Facility for the Salem Generating Station, Units 1 and 2," February 6, 1984, the staff proposed that the NRC approve the Public Service Electric and Gas Company's (PSE&G's) request for an exception from the requirement for a backup EOF for SGS Units 1 and 2 (Docket Nos. 50-272 and 50-311), April 20, 1981. On February 23, 1984, the NRC found the exception request acceptable, and PSE&G was notified of the approval in a letter (D. Eisenhut to E. Liden), March 5, 1984.

maintained at the EOF, including EOF field team kits. Backup power is provided to the EOF by a diesel generator to supply facility lighting, the telephone system, and all EOF data and communications systems.

ITAAC 5.2 states that an inspection of the EOF will be performed, including a test of the capabilities. The associated acceptance criteria address EOF communications, the availability of EAL parameters, and the capability to handle events at two or more reactors on the site. ITAAC 8.1.1.D addresses EOF activation, operation, and the adequacy of equipment.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant described, provided, and maintains adequate emergency facilities and equipment to support the emergency response, including a licensee onsite OSC and TSC, and an EOF from which effective direction can be given and effective control can be exercised during an emergency. This includes onsite and offsite radiological and meteorological monitoring systems. The applicant also described provisions to be employed to ensure that the emergency plan, its implementing procedures, and emergency equipment and supplies are kept up-to-date. In addition, the applicant provided for an ERDS data link between the onsite computer system and the NRC Operations Center.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard H. A COL applicant will address COL Action Items 13.3-3 and 13.3-4. Therefore, staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(8) and 10 CFR Part 50, Appendix E, Sections IV.E.8, IV.G, and VI.1, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.9 Accident Assessment

As stated in NUREG-0654, Planning Standard I, "Accident Assessment," 10 CFR 50.47(b)(9) 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 addition, 10 CFR Part 50, Appendix E, Section IV.A.4 requires the identification of persons within the licensee organization who will be responsible for making offsite dose projections, and a description of how these projections will be made and the results transmitted to State and local authorities, the NRC, and other appropriate governmental entities. 10 CFR Part 50, Appendix E, Section IV.B requires a description of the means to be used for determining the magnitude of, and for continually assessing the impact of, the release of radioactive materials. 10 CFR Part 50, Appendix E, Section IV.E.2 requires that adequate provisions shall be made and described for emergency facilities and equipment, including equipment for determining the magnitude of, and for continuously assessing the impact of, the release of radioactive materials to the environment.

In ESP Plan Section 10, "Accident Assessment," the applicant described the methods, systems, and equipment available for assessing and monitoring the 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 to evaluate the emergency plan against NUREG-0654, Planning Standard I, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(9).

In ESP Plan Section 10.1.1, "Emergency Action Level Determination," the applicant stated that plant parameter and instrument values used to identify an emergency class are provided in ESP Plan Attachment 5, which addresses EALs for the four proposed reactor technologies. As discussed in ESP Plan Section 5, a detailed description of the emergency classifications is provided in the ECG, which lists the initiating conditions and associated action levels for all emergency and non-emergency reportable events. (See Section 13.3.4.3.4 of this report, above, for a discussion of the emergency classification and action level scheme.) ITAAC 1.1(a) states that the parameters referenced in the emergency classification and EAL scheme are retrievable in the Control Room, TSC, and EOF.

ESP Plan Section 10 states that there are several monitoring systems used to support emergency planning activities at the PSEG Site. The primary systems utilized include the RMS, SPDS, and Reactor Coolant Sampling System. The radiological monitors consist of process, effluent, and area radiation monitors, which continuously display and/or record the radiation levels in key areas. To provide the operators with essential information on plant conditions during an emergency, various plant processes are continuously monitored.

The RMS includes process radiation monitors, effluent radiation monitors, and area monitors and will comply with the recommendations of NUREG-0578.[3] In addition to the main plant vent, other potential major release points from the plant will be identified upon selection of the reactor technology for the PSEG Site. Procedures are utilized to monitor these potential release pathways and perform the necessary dose assessment. Reactor coolant and containment gaseous activity sampling are performed using station procedures and normal day-to-day sampling systems. The plant vent, which is the final release point, is continuously monitored by the RMS for noble gases. The iodine cartridge is physically removed and taken into a laboratory for analysis by a multi-channel analyzer available at the PSEG Site. There are also provisions provided in the plant vent to extract a grab sample. Analysis of reactor coolant and containment air samples provides detailed information on the status of the reactor core. These samples are used to provide confirmation of a loss of the fission product barriers. The applicant also stated that river water-level monitoring requirements will be determined when the reactor technology is selected.

Plume dose calculation procedures use plant effluent monitor data to project offsite doses caused by noble gases and iodines. The actual isotopic mix of the releases is used if the releases have been sampled and analyzed. Computer applications calculate offsite doses, including ingestion pathway exposures, which are compared to the protective action guides (PAGs) in the U.S. Environmental Protection Agency (EPA) guidance document, "Manual of

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[3] NUREG-0578, "TMI [Three Mile Island]-2 Lessons Learned Task Force Status Report and Short-Term Recommendations," July 1979, recommended improvements in post-accident radiation monitoring capability following the TMI-2 accident in 1979. The recommended improvements in NUREG-0578 were later ordered for licensees, incorporated in revisions to RG 1.97, and superseded by NUREG-0737, "Clarification of TMI Action Plan Requirements," November 1980, and NUREG-0737, Supplement 1, "Clarification of TMI Action Plan Requirements – Requirements for Emergency Response Capabilities (Generic Letter No. 82-33), January 1983.

Protective Action Guides and Protective Actions for Nuclear Incidents" (EPA 400-R-92-001)[4]. The results determine whether a protective action recommendation (PAR) is needed. When a general emergency is declared, a predetermined PAR is provided to the State governments in New Jersey and Delaware. (The transmittal of offsite dose projection results to State and local authorities is addressed in ESP Plan Section 6, and also addressed in Section 13.3.4.3.5 of this report.) Predetermined PARs are incorporated in both the ECG and EPIPs. The procedures and calculation capabilities are available at the PSEG Site Control Room, Control Point, TSC, and EOF. Relevant EPIPs include two onsite procedures listed in Attachment 1-1.4 and an EOF procedure listed in ESP Plan Attachment 1-1.5:

- PC.EP-EP.ZZ-0205(Q), "TSC – Post Accident Core Damage Assessment"
- PC.EP-EP.ZZ-0313(Q), "Advanced Dose Assessment (MIDAS) Instructions"
- NC.EP-EP.ZZ-0602(Q), "EOF Radiological Dose Assessment"

The RMS and SPDS provide an early indication of abnormal radiological conditions from both process and area monitors. The RMS provides radiological release rate information, and computer systems provide meteorological data acquisition for the PSEG Site. A computerized dose assessment program provides redundant emergency dose assessment modeling capability. The computer systems provide monitoring capability for the radiological parameters

identified in RG 1.97, including high range monitoring capability for effluent release paths. This data is input to the dose assessment computers at the PSEG Site. In SSAR Section 13.3, the applicant stated that following the selection of the reactor technology at the COL stage, PSEG will update the emergency plan to identify the specific monitoring capability for the radiological parameters identified in RG 1.97.

Pursuant to 10 CFR 52.39(b), an applicant for a COL that references this ESP shall update the emergency preparedness information that was provided under 10 CFR 52.17(b), and discuss whether the updated information materially changes the bases for compliance with applicable NRC requirements. As such, the staff identified the following COL action item to address the description of radiation monitoring and other systems and equipment associated with the chosen reactor technology that support accident assessment activities, as well as specific monitoring and dose-assessment and -projection modeling capabilities. Section 13.3.4.3.8 of this report also discusses the availability of plant parameter and meteorological variables in the TSC.

COL Action Item 13.3-4

> An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the radiation monitoring and other systems and equipment, including potential major release points from the plant and river water level monitoring requirements, associated with the chosen reactor technology that support accident assessment activities. The emergency plan should also identify the specific monitoring capability for the radiological parameters identified in NRC Regulatory Guide 1.97, Revision 2, and dose assessment and projection modeling system.

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[4] In March 2013, the EPA updated EPA 400-R-92-001 with "PAG manual – Protective Action Guides and Planning Guidance for Radiological Incidents," Draft for Interim Use and Public Comment.

Dose assessment or projection represents the calculation of an accumulated dose at some time in the future, if current or projected conditions continue. During an accident, the plant parameter display system and personal computers provide the ERO with the timely information required to make decisions. Radiological and meteorological instrumentation readings are used to project dose rates at predetermined distances from the plant, and to determine the integrated dose received. A computerized dose assessment program is used, which utilizes various analysis and sampling methods, including monitored release points, containment leakage/failure, release point samples, and field monitoring team data.

ITAAC 6.1 states, in part, that, using selected monitoring parameters, simulated degraded plant conditions are assessed and protective actions are initiated in accordance with the listed criteria. ITAAC 6.2 states that EPIPs provide direction to accurately calculate the source terms and the magnitude of the releases of postulated accident scenario releases. ITAAC 6.3 states that the means exist to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitoring readings, and onsite and offsite exposure and contamination for various meteorological conditions.

In ESP Plan Attachments 6 through 9, the applicant stated that the PSEG Site uses the existing SGS/HCGS site's meteorological monitoring program. PSEG has established a meteorological monitoring program that measures wind speed and direction and temperature difference to provide air stability estimates. SSAR Section 2.3.3, "On-Site Meteorological Measurements Program," states that PSEG maintains a backup meteorological tower 118 m (386 ft) south of the primary tower. Primary and backup meteorological information is available in the PSEG Site Control Room, TSC, and EOF. A system to provide alternate remote interrogation of the meteorological system is available by way of direct telephone dial-up capability, and the meteorological monitoring system is provided with a dedicated battery backup power supply. EPIPs provide for meteorological support from the closest NOAA National Weather Service station, including monthly communication checks. ITAAC 6.4 states that meteorological data necessary to implement the EPIPs is retrievable in the Control Room, TSC, and EOF.

EPIPs describe in detail how projected dose calculations are made if radiation monitors normally used for monitoring plant release points or containment radiation are off-scale or inoperable. The procedures call for determining the type of accident and classifying it according to a set of default classes that depend on the reactor technology. ITAAC 6.5 states that the licensee will demonstrate that EPIPs provide direction to determine release rate and projected dose rates when instruments are off-scale or inoperable.

The PSEG Site Offsite Dose Calculation Manual summarizes environmental radiological monitoring. Field monitoring within the plume exposure pathway (16-km (10-mi)) EPZ takes place whenever the radiological emergency response organization is fully activated, and field teams take direction from the radiological support personnel in the TSC and/or EOF. Survey-team deployment times range from 30 to 60 minutes, and meteorological information is used to direct onsite and offsite teams. The teams communicate using emergency radios and cellular phones. In RAI 22, Question 13.03-15 [RAI J-5], the staff requested that the applicant provide a map that identifies preselected radiological sampling and monitoring points. In a July 21, 2011, response to RAI 22, Question 13.03-15 [RAI J-5], the applicant stated that this information will be part of the EPIPs similar to those that currently exist for the SGS/HCGS site. ESP Plan Attachments 1-1.4 and 1-1.5 list these onsite and EOF EPIPs associated with field monitoring:

- PC.EP-EP.ZZ-0310(Q), "Radiation Protection Supervisor – Offsite and Field Monitoring Team Response"

- NC.EP-EP.ZZ-0603(Q), "Field Monitoring"

- NC.EP-EP.ZZ-0604(Q), "Helicopter Plume Tracking"

The staff finds the applicant's July 21, 2011, response to RAI 22, Question 13.03-15 [RAI J-5] acceptable and, therefore, considers RAI 22, Question 13.03-15 [RAI J-5] resolved. EPIPs also describe onsite instrumentation that can be used to initiate emergency measurements, including equipment required for a field survey team. This equipment provides the means to directly measure dose rates, or relate measured field contamination levels to dose rates. Radioactive plume and contamination dose rates are obtained directly from the dose rate meter. PSEG Site survey instruments are able to detect radioiodine concentrations as low as 1×10^{-7} μCi/cc (microcuries per cubic centimeter), provided that noble gases and background radiation (which can adversely affect the minimum detectable activity) are minimized. ITAAC 6.8 states that a field monitoring team demonstrated, in accordance with the appropriate EPIP(s), the use of sampling and detection equipment for air concentrations in the plume exposure pathway EPZ during a radioactive release scenario as low as 10^{-7} μCi/cc.

Since the Delaware River is not a source of potable water in the vicinity of the PSEG Site, the major critical pathways by which a population would receive a radiation exposure from liquid effluent releases are swimming and boating activities. In the event of a radioactive release to the Delaware River, water samples are taken and counted. ESP Plan Section 3 addresses ERO job description, including those associated with licensee radiological accident assessment and offsite survey teams.

ITAAC 6.6 states that the field monitoring teams were dispatched and able to locate and monitor a radiological release within the plume exposure pathway EPZ during a radioactive release scenario. ITAAC 6.9 states that personnel demonstrated the ability to estimate integrated dose from the dose assessment program and the field monitoring team reading during a radioactive release scenario; the results were successfully compared with the EPA PAGs. ITAAC 6.1.g states that the licensee will demonstrate the ability to develop appropriate protective action recommendations (PARs), and notify appropriate authorities within 15 minutes of development.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant described and provided adequate facilities, systems, equipment, and means for assessing and monitoring the actual or potential offsite consequences of a radiological emergency condition, including determining the magnitude of, and continually assessing the impact of, the release of radioactive materials. The applicant also described the capability and resources for field monitoring within the 16-km (10-mile) plume exposure pathway EPZ, and has the methods, equipment, and expertise to rapidly assess actual or potential radiological hazards. This includes the capability to detect and measure radioiodine airborne concentrations within the plume exposure pathway EPZ as low as 1×10^{-7} μCi/cc under field conditions, and to relate the various measured parameters to dose rates for key isotopes and gross radioactivity measurements. In addition, the applicant identified, by position and function to be performed, persons within the licensee organization who will be responsible for making offsite dose projections, and has described how these

projections will be made and the results transmitted to State and local authorities, the NRC, and other appropriate governmental entities.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard I. A COL applicant will address COL Action Item 13.3-4. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(9) and 10 CFR Part 50, Appendix E, Sections IV.A.4, IV.B, and IV.E.2, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.10 Protective Response

As stated in NUREG-0654, Planning Standard J, “Protective Response,” 10 CFR 50.47(b)(10) 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 potassium iodide (KI). ETEs have been developed by applicants and licensees, and licensees shall update the ETEs on a periodic basis. Guidelines for the choice of protective actions during an emergency are developed and in place, and protective actions for the ingestion exposure pathway EPZ appropriate to the locale have been developed. In addition, 10 CFR 50.47(c)(2) and 10 CFR Part 50, Appendix E, Section I require that the size and configuration of the EPZs be determined in relation to local emergency response needs and capabilities, as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries. 10 CFR Part 50, Appendix E, Section IV.I requires the development of a range of protective actions to protect onsite personnel during hostile action to ensure the continued ability of the licensee to safely shut down the reactor and perform the functions of the emergency plan.

In ESP Plan Section 11, “Protective Response,” the applicant described the range of protective actions that have been developed for PSEG emergency workers and the general public in the plume exposure pathway EPZ. 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 to evaluate the emergency plan against NUREG-0654, Planning Standard J, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(10).

SSAR Section 13.3, “Emergency Plan,” states that the existing EPZs for the SGS/HCGS site are used for the proposed new plant at the PSEG Site, which are based on the requirements in 10 CFR Part 50, Appendix E. As such, the size and configuration of the existing EPZs for the SGS/HCGS site were determined in relation to local emergency response needs and capabilities, as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries. ESP Plan Section 1 describes the plume exposure pathway EPZ and the ingestion exposure pathway EPZ, which are illustrated in Figures 1-3 and 1-4, respectively. The EPZs are the areas for which planning is performed to assure that prompt effective actions can be taken to protect the public in the event of an accident.

The plume exposure pathway EPZ is an area surrounding the plant out to a radius of approximately 16 km (10 mi), including portions of Salem and Cumberland Counties in New Jersey and New Castle and Kent Counties in Delaware. (See ESP Plan Attachment 11 regarding the ETE for evacuation of the 16-km (10-mi) EPZ, which is addressed in Sections 13.3.4.1 and 13.3.4.3.17 of this report.) The principal exposure sources from this pathway are whole body external exposure to gamma radiation from the plume and from deposited material, and inhalation exposure from the passing radioactive plume. The ingestion exposure pathway (80-km (50-mi)) EPZ is an area surrounding the plant out to a radius of approximately 80 km (50 mi). The principal exposure from this pathway is the ingestion of contaminated milk. The planning effort for this pathway involves the identification of potential sources of contaminated milk and associated control points and mechanisms that prevent it from entering the human food chain. Ingestion pathway exposures in general would represent a problem in the days or weeks after an accident, although some early protective actions to minimize subsequent contamination of milk are provided in the State plans.

The staff finds it appropriate (and necessary) for the PSEG Site to use the existing SGS/HCGS site EPZs, because of the location of the proposed new plant, and also because the size and configuration of the EPZs depend on the local (offsite) emergency response needs rather than the number of reactors on the combined and contiguous SGS/HCGS site and the PSEG Site.

ESP Plan Section 11 states that in the event of an emergency at the PSEG Site, methods are established for notifying personnel within the Protected Area and Owner Controlled Area. The primary means of notification within the onsite Protected Area are the plant’s public address system and evacuation alarms (described in ESP Plan Section 7, and discussed in Section 13.3.4.3.6 of this report). Announcements include the emergency classification and response actions to be taken by onsite personnel. PSEG maintains the ability to notify all individuals within the Protected Area, including high-noise areas and outbuildings. The SGS/HCGS site currently employs an onsite siren system to notify workers outside the Protected Area of the need to evacuate, and this system will be used for the PSEG Site. Individuals located outside the Protected Area, but inside the Owner Controlled Area, are informed by an onsite siren system. Other notification methods include public-address system announcements and security force activities (e.g., vehicle-mounted public-address systems).

In RAI 22, for the PSEG site ESP (ADAMS Accession No. ML11157A129), with Question 13.03-15 [RAI J-1], the staff requested that the applicant describe the time to warn or advise onsite individuals and individuals who may be in areas controlled by the operator. In a July 21, 2011, response to RAI 22, Question 13.03-15 [J-1], the applicant stated that the information will be provided in EPIPs similar to those that currently exist for the SGS/HCGS site (e.g., NC.EP-EP.ZZ-0102). ESP Plan Attachment 1-1.7 also lists EPIP NC.EP-EP.ZZ-0902(Q), “Accountability/Evacuation.” ITAAC 7.1 states that a test will be performed of the capabilities to warn and advise onsite individuals of an emergency, including those in the Owner Controlled Area and the immediate vicinity. The staff finds the applicant’s response to RAI 22, Question 13.03-15 [RAI J-1], acceptable and, therefore, considers RAI 22, Question 13.03-15 [RAI J-1] resolved.

ESP Plan Section 11.1.2, “Assembly and Accountability,” states that initial personnel accountability is completed 30 minutes after the accountability message has been announced over the station page, and includes all personnel who remain within the Protected Area. The accountability system is based in the security computer, which maintains normal logs of personnel entering and exiting the Protected Area, and uses the photo badge issued to each

person who accesses the site. After accountability is initiated, personnel pass their photo badge through dedicated accountability card readers installed at the various accountability stations. The security computer generates a report for the security supervisors, which indicates the names of unaccounted-for personnel, and the Shift Manager/Emergency Duty Officer is informed of the accountability results. Actions are taken to locate any missing persons, including use of search and rescue teams, if appropriate. ITAAC 8.1.1.C.4 states that during the full participation exercise, the licensee will demonstrate the ability to perform assembly and accountability for all personnel in the Protected Area within 30 minutes after the accountability message has been announced.

ESP Plan Section 11.1.3, “Protective Actions,” states that, once personnel accountability has been performed, specific instructions on appropriate protective actions to be taken by station personnel are issued over a public address system. Evacuation and sheltering options are combined with a consideration of the necessity for keeping specific technical or management personnel at the station for emergency plan implementation. Evacuation routes and transportation for nonessential onsite personnel are part of the evacuation study (i.e., the ETE) for the entire area around the PSEG Site, which is provided in ESP Plan Attachment 11. In addition, ETE Sections 3.3 and 3.6 address employees who work within the 16-km (10-mi) EPZ, which includes nonessential onsite personnel. The ETE also includes maps showing population distribution around the PSEG Site, evacuation areas and routes, and relocation centers. (The ETE is discussed in Section 13.3.4.3.17 of this report.)

ESP Plan Section 11.1.3 further states that evacuations are performed using the site evacuation procedures, which provide guidance to the Emergency Coordinator and security force on actions required for site evacuation. The access road to the PSEG Site is currently the only route to evacuate the site, although a proposed causeway might be available for use as an alternate route (see Proposed Plant Access Road shown on ESP Plan Section 1, Figures 1-1, 1-2, and 1-3). Affected individuals evacuate the site using personal vehicles. Persons without transportation are identified and provided transportation, as necessary. Appropriate sheltering is available if circumstances preclude evacuation of personnel by the access road. ESP Plan Section 11.2.0, “Personnel Monitoring and Decontamination,” states that for individuals remaining or arriving onsite during the emergency, respiratory protection, protective clothing, and thyroid-protecting drug KI are available. In RAI 22, Question 13.03-15 [RAI J-2], the staff requested that the applicant describe alternatives to the site access road that might be implemented in adverse weather conditions or when specific radiological conditions impact the evacuation route. In a July 21, 2011, response to RAI 22, Question 13.03-15 [RAI J-2], the applicant stated that alternatives to evacuation will be in EPIPs similar to those that currently exist for the SGS/HCGS site.

Pursuant to 10 CFR 52.39(b), an applicant for a COL that references this ESP shall update the emergency preparedness information that was provided under 10 CFR 52.17(b), and discuss whether the updated information materially changes the bases for compliance with applicable NRC requirements. As such, the staff identified the following COL action item to address the availability of a proposed causeway for use as an alternate site evacuation route.

COL Action Item 13.3-5

> An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the availability of a proposed causeway for use as an alternate route for evacuating the site. If appropriate, the applicant should update the

evacuation time estimate (ETE) analysis for the PSEG Site to reflect the causeway, and provide confirmation that the ETE update was provided to State and local governmental authorities for use in developing offsite protective action strategies.

The staff finds the applicant's July 21, 2011, response to RAI 22, Question 13.03-15 [RAI J-2], acceptable because the existing alternative to evacuation for the SGS/HCGS site are acceptable. Therefore, the staff considers RAI 22, Question 13.03-15 [RAI J-2], resolved.

With regard to a hostile action against the site, ESP Plan Section 11.1.2, "Assembly and Accountability," states that site protective actions during security-related events are taken in accordance with station abnormal operating procedures that deal with airborne threats and security events, and take priority ahead of the normal assembly/accountability process, as outlined in NRC Bulletin 2005-02. (See typical security procedures listed in ESP Plan Attachment 1-1.7.)

In addition, in an August 29, 2012, letter to the NRC, PSEG described the implementation approach for the 11 amendments (enhancements) to the emergency preparedness regulations in the Final Rule. With regard to the requirement in 10 CFR Part 50, Appendix E, Section IV.I for the development of a range of protective actions to protect onsite personnel during hostile action, the applicant identified the relevant language in ESP Plan Section 11.1.2 (discussed above), and added that "[a]dditional detail related to onsite protective actions for site personnel will be contained in site-specific Operations or Emergency Plan implementing procedures" (see ITAAC 9.1). ITAAC 8.1.1.D.2 also addresses (in part) demonstrating the adequacy of security provisions for the emergency response facilities (i.e., TSC, OSC, EOF, and ENC/JIC) during a full participation exercise.

Monitoring and decontamination of personnel is performed on individuals who have potentially been exposed to or come in contact with radioactive materials, and is performed onsite in the decontamination area at each Control Point or other suitable location within the controlled access areas of the station. Should an actual release of radioactive material occur, the source, wind direction, and survey results are used to determine whether general monitoring of station personnel is required. If general monitoring of personnel is determined to be required, the monitoring and decontamination are performed in accordance with EPIPs. The EOF serves as an offsite assembly area, and has facilities for personnel monitoring and decontamination. Methods of personnel decontamination are described in ESP Plan Section 12 and discussed below in Section 13.3.4.3.11 of this report.

With regard to offsite protective response, ESP Plan Section 11.3 states that the States of New Jersey and Delaware use similar bases for recommending protective actions within the 16-km (10-mi) EPZ. Consistent with action levels indicated in both State plans, which are adopted from EPA 400-R-92-001, PSEG determines what protective action, if any, should be recommended to the States. For a projected total effective dose equivalent (TEDE) plus 4-day dose of 1 rem (0.01 sievert) and thyroid committed dose equivalent (CDE) of 5 rem (0.05 sievert), PSEG may recommend that the affected population either seek shelter or evacuate, or a combination of both, depending on the distance and direction of the radioactive plume. The decision is based primarily on a comparison of the projected plume travel time, evacuation time estimates, ambient meteorology, anticipated duration of release, and degree of protection afforded by local residential units. ESP Plan Table 11-1 lists representative shielding factors provided by typical structures against direct exposure to the plume. If an evacuation can be completed before the plume passes over the affected population, an evacuation

recommendation may be made. A sheltering recommendation may be made if a "puff" radiological release occurs and it is not expected that evacuation can be completed before the plume reaches the affected population.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant developed a range of protective actions for the (16-km (10-mi)) plume exposure pathway EPZ for emergency workers and the public, including consideration of evacuation, sheltering, and the prophylactic use of KI. The staff finds that the applicant has developed guidelines for the choice of protective actions during an emergency that are consistent with Federal guidance, including protective actions for the (80-km (50-mi)) ingestion exposure pathway EPZ that are appropriate to the locale. The size and configuration of the EPZs have been determined in relation to local emergency response needs and capabilities, as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries. In addition, the staff finds that the applicant has developed a range of protective actions to protect onsite personnel during hostile action. Development of ETEs is addressed in Section 13.3.4.3.17 of this report.

<u>Conclusion</u>

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard J. A COL applicant will address COL Action Item 13.3-5. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(10), 10 CFR 50.47(c)(2), and 10 CFR Part 50, Appendix E, Sections I and IV.I, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.11 Radiological Exposure Control

As stated in NUREG-0654, Planning Standard K, "Radiological Exposure Control," 10 CFR 50.47(b)(11) requires that the 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 the EPA "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," EPA 400-R-92-001, May 1992. In addition, 10 CFR Part 50, Appendix E, Section IV.E.3 requires that adequate provisions shall be made and described for emergency facilities and equipment, including facilities and supplies at the site for decontamination of onsite individuals.

In ESP Plan Section 12, "Radiological Exposure Control," the applicant described the means to control emergency workers' radiological exposures during an emergency, including measures to provide assistance to persons injured by or exposed to radioactive materials. 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 to evaluate the emergency plan against NUREG-0654, Planning Standard K, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(11).

Onsite exposure guidelines are provided in EPIPs, which include site evacuation criteria, protective action recommendation guidance, exposure limits for emergency workers, and decontamination guidance. The radiation protection program has a goal of positive control of personnel exposure to radiation and radioactive material, and provides these emergency capabilities:

- 24-hour-per-day dose determination recording and record retention
- contamination control
- onsite and offsite decontamination of site personnel
- respiratory protection
- lifesaving dose risk assessment

The Radiation Protection Department is responsible for ensuring that internal and external radiation exposure at the worksite is kept as low as reasonably achievable (ALARA); this department will implement the dose determination capability for emergency personnel (including distribution of dosimeters and maintenance of dose records) and make available additional dosimetry to support additional personnel arriving onsite. ESP Plan Table 9-1 lists typical radiological protection emergency equipment available onsite and offsite. If it becomes necessary to evacuate during an emergency, necessary dosimetry equipment may be relocated to lower dose areas so that it remains available for exposure evaluation. ITAAC 8.1.1.E.2.b states that, during a full participation exercise, exposure records are available from the site database (primary), a personal computer database (backup), or a hard copy report (backup).

EPIPs address radiological exposure control, including any emergency exposures (i.e., planned exposures greater than regulatory limit in 10 CFR Part 20). Emergency exposures require approval by the Emergency Duty Officer. If the Emergency Duty Officer is not available, the Shift Manager, with advice from the Shift Radiation Protection Technician, makes the authorization decision. The upper limit for performing actions to save station equipment that is required to mitigate the emergency is 25 rems (0.25 sievert) and the upper limit for lifesaving actions is 75 rems (0.75 sievert). Lifesaving activities can include performing assessment or corrective actions, removing injured persons, providing first aid and medical treatment, performing personnel decontamination, and providing ambulance service. ITAAC 8.1.1.E.2.a states that, during a full participation exercise, emergency workers are issued self-reading dosimeters when radiation levels require, and exposures are controlled to 10 CFR Part 20 limits (unless emergency limits are authorized). The staff finds these dose guidelines for emergency workers consistent with EPA 400-R-92-001, Table 2-2, "Guidance on Dose Limits for Workers Performing Emergency Services."

Decontamination of personnel and vehicles is performed in accordance with EPIPs and/or Station Radiation Protection Procedures. ESP Plan Table 12-1 lists acceptable surface contamination levels, which are used as a guide for the release of equipment. ESP Plan Table 12-2 provides general guidance for the decontamination of personnel. The release of station personnel is performed using normal station operational limits, as incorporated into EPIPs, and the release values may be increased at the discretion of the Radiological Assessment Coordinator or Emergency Duty Officer. PSEG has established procedures for decontamination of relocated onsite personnel, including provisions for extra clothing and decontaminants. Relocated onsite personnel can be decontaminated at the Control Point or at the EOF, which serves as an offsite assembly area and has facilities for personnel monitoring and decontamination. Once evacuated from the Owner Controlled Area, non-emergency PSEG workers will normally be treated the same way as the general public where decontamination

processes are concerned; monitoring of personnel and vehicles will be performed by offsite officials at an appropriate reception center.

ESP Plan Attachments 6 through 9 each has a Section 1.e that describes decontamination facilities for one of the four proposed reactor technologies (AP1000, ABWR, US-APWR, and U.S. EPR, respectively). Except for the US-APWR, for which the DCD does not include a decontamination facility as part of the standard design, the location of the onsite personnel decontamination facility is identified. For the US-APWR, the applicant stated that the location of the decontamination facility will be determined at a later date. All four attachments state that the decontamination facility contains provisions for radiological decontamination of personnel, their wounds, supplies, instruments and equipment, and also contains extra clothing and decontaminants.

Pursuant to 10 CFR 52.39(b), an applicant for a COL that references this ESP shall update the emergency preparedness information that was provided under 10 CFR 52.17(b), and discuss whether the updated information materially changes the bases for compliance with applicable NRC requirements. As such, the staff identified the following COL action item to address the selection of the location of the decontamination facility for the US-APWR reactor technology.

COL Action Item 13.3-6

> An applicant for a COL or CP referencing this early site permit and the US-APWR design control document (DCD) should revise the emergency plan to identify the location of an onsite personnel decontamination facility.

PSEG maintains access control to the controlled areas of the station and assigns personnel to monitor anyone entering and leaving the controlled-access areas. Criteria for permitting the return of areas and items to normal use are established, with restoration levels and personnel exposure not exceeding 10 CFR Part 20 limits. Release values may be increased at the discretion of the Radiological Assessment Coordinator or Emergency Duty Officer. ESP Plan Table 12-1 is used as a guide for equipment release listing levels for loose contamination and combined (loose and fixed) contamination for gross beta/gamma and for gross alpha. Onsite drinking facilities with local groundwater as their source are considered contaminated until sampled and bottled drinking water and food supplies are shipped to the site from outside vendors.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant has established the means to control radiological exposures for emergency workers in a way consistent with the exposure guidelines in EPA 400-R-92-001. In addition, the applicant made and described adequate provisions for emergency facilities and equipment, including facilities and supplies for monitoring and decontamination of onsite and relocated personnel, vehicles, and other affected materials, and has established appropriate contamination control measures.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard K. A COL applicant will address COL Action Item 13.3-6.

Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(11) and 10 CFR Part 50, Appendix E, Section IV.E.3, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.12 Medical and Public Health Support

As stated in NUREG-0654, Planning Standard L, "Medical and Public Health Support," 10 CFR 50.47(b)(12) requires that arrangements be made for medical services for contaminated injured individuals. In addition, 10 CFR Part 50, Appendix E, Section IV.E requires facilities and medical supplies at the site for appropriate emergency first aid treatment, and arrangements for medical service providers qualified to handle radiation emergencies onsite. Arrangements are also required for transportation of contaminated injured individuals from the site to specifically identified treatment facilities outside the site boundary.

In ESP Plan Section 13, "Medical Support," the applicant described the arrangements for medical services for contaminated injured personnel at the PSEG 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 to evaluate the emergency plan against NUREG-0654, Planning Standard L, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(12).

The Memorial Hospital of Salem County (MHSC) provides emergency medical support and has agreed to accept contaminated patients for emergency medical and surgical treatment on a 24-hour basis. ESP Plan Attachment 3, "Memoranda of Understanding," provides a memorandum of understanding between PSEG and MHSC. MHSC is located near Salem, NJ, and all nuclear station and local ambulance drivers and support personnel are familiar with directions to the hospital. To handle contaminated patients safely without disturbing other hospital operations, MHSC has a designated Radiation Emergency Area. In addition, procedures for implementing the hospital's radiological medical emergency preparedness plan have been prepared and are known to the hospital personnel responsible for handling the treatment of radiological accident victims. Equipment and supplies are maintained at MHSC, and PSEG performs maintenance of the hospital's emergency preparedness plan and the equipment required to support the plan, including calibration of the radiological survey equipment.

The primary backup for MHSC is Southern Ocean County Hospital. If additional support is needed, both Christiana and Wilmington Hospitals in Delaware are capable of providing backup medical treatment of radioactively contaminated patients. In addition, an Emergency Medical Assistance Program is in effect with Radiation Emergency Assistance Center/Training Site (REAC/TS),[5] which provides backup medical treatment of radioactively contaminated patients.

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[5] U.S. Department of Energy REAC/TS staff is available 24 hours a day, 7 days a week, to deploy and provide emergency medical consultation for incidents involving radiation anywhere in the world. REAC/TS provides direct support for the National Nuclear Security Administration's Office of Emergency Response and the Federal Radiological Monitoring and Assessment Center (FRMAC). Source: http://orise.orau.gov/reacts/, visited May 3, 2012.

In RAI 22, Question 13.03-16, the staff requested that the applicant provide additional information regarding onsite access for physicians and other medical personnel that are qualified to handle radiation emergencies onsite. In a July 21, 2011, response to RAI 22, Question 13.03-16, the applicant stated that arrangements for the services of physicians and other medical personnel qualified to handle radiation emergencies onsite are discussed in ESP Plan Section 13.1.1, "Normal Operations – Onsite Medical Support," and will be part of the onsite Emergency Medical Team and Fire Brigade procedures, similar to those for SGS and HCGS (e.g., PSEG procedure SH.FP-EO.ZZ-0004, "Fire Department Medical Emergency Response")

ESP Plan Section 13 further states that the PSEG ambulance provides the equipment and capability to safely transport injured and/or contaminated personnel to an offsite medical facility. This ambulance is operated by members of the fire department who provide first aid during transport. A member of the station's radiation protection staff accompanies the patient to provide health physics coverage if required. Local ambulance squads provide secondary first aid and transportation support to the site. As indicated in the New Jersey Radiological Emergency Response Plans for Salem County and its municipalities, the Salem County Office of Emergency Services is responsible for the overall coordination of emergency medical units. ESP Plan Attachment 3 includes a memorandum of understanding between PSEG and the Salem County Department of Emergency Services, which states that Salem County shall provide notification to the Salem County Emergency Ambulance units to assist and cooperate with the PSEG Nuclear Emergency Medical Response units. The staff finds the applicant's July 21, 2011, response to RAI 22, Question 13.03-16, acceptable because the applicant has provided for onsite first aid capability. Accordingly, the staff considers RAI 22, Question 13.03-16, resolved.

The primary communication link between the onsite and offsite organizations responsible for medical support is by commercial telephone, and the telephone numbers are listed in the Emergency Telephone List. Communications directing or requesting an ambulance are made to the organization responsible for the ambulance, which maintains communications with the ambulance.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff reviewed the memoranda of understanding for the medical service providers described above and the additional information provided in ESP Plan Section 13. The staff finds that the applicant has made arrangements for hospital and medical service providers that have the capability to evaluate radiation exposure and uptake, and persons providing these services are adequately prepared to handle contaminated individuals. In addition, the applicant provided for appropriate emergency first aid treatment at the site, including qualified medical personnel to handle radiation emergencies, and arrangements for transporting victims of radiological accidents (i.e., contaminated injured individuals) to offsite medical support facilities.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard L. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(12) and 10 CFR Part 50,

Appendix E, Section IV.E, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.13 Recovery and Reentry Planning and Post-Accident Operations

As stated in NUREG-0654, Planning Standard M, “Recovery and Reentry Planning and Post-Accident Operations,” 10 CFR 50.47(b)(13) requires that general plans for recovery and reentry be developed. In addition, 10 CFR Part 50, Appendix E, Section IV.H requires a description of criteria to be used to determine when, following an accident, reentry of the facility would be appropriate or when operation could be resumed.

In ESP Plan Section 14, “Recovery and Reentry Planning,” the applicant described activities for reentry into the areas of the plant that have been evacuated as a result of an accident, as well as the recovery organization and its concepts of operation. 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 to evaluate the emergency plan against NUREG-0654, Planning Standard M, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(13).

Termination of an emergency and entry into recovery are determined based on the applicability of EALs in the Event Classification Guide (ECG) and consideration of various guidelines (described below). Reduction of an emergency classification level is based on improving conditions and the selection of the appropriate EAL in the ECG. ESP Plan Section 14.2.0, “Initiation of Recovery Operations,” states that the Emergency Coordinator determines if the emergency is under control prior to securing the emergency response and entering into recovery operations. Termination of the emergency and entry into recovery may be considered when these guidelines are met.

- Full-time operations of emergency response facilities may be curtailed.
- Radiation levels in all areas are either stable or decreasing with time.
- Releases of radioactive materials to the environment from the plant are within allowable Federal limits.
- Fire, flooding, or similar emergencies no longer present an emergency situation to plant operation.
- The plant is in a safe status and further degradation of a safety system is not expected.

ESP Plan Section 14.3.0, “Recovery Operations,” states that recovery operations will be under the direction of the Emergency Coordinator, and that entry into recovery operations for an alert or higher classification requires the concurrence of the Station Vice President (or, in his absence, the President and Chief Nuclear Officer PSEG Nuclear, or designee). Recovery operations consist of an orderly evaluation of the causes and effects of the emergency, measures necessary to place the plant back into operation, an analysis of exposure records, assembling of a Recovery Management Organization to implement Recovery Operations, coordination of additional assistance to offsite organizations, and reentry. The extent of these efforts will depend on the nature of the incident and its effect on plant systems.

Upon reduction of the emergency classification, the Emergency Coordinator may modify the emergency response organization, and will notify key emergency response managers and supervisors of the initiation of recovery actions through established communications methods, in accordance with EPIPs. ESP Plan Attachment 1-1.5 lists EOF EPIP NC.EP-EP.ZZ-0405(Q), “Emergency Termination/Reduction/Recovery.” All recovery operations that may have offsite consequences will be coordinated with appropriate offsite agencies, and the Emergency Coordinator will also notify State and local support agencies of the initiation of recovery action. (Emergency Coordinator responsibilities are also addressed in ESP Plan Sections 2, 3, and 4, and discussed in Sections 13.3.4.3.1, 13.3.4.3.2, and 13.3.4.3.3 of this report, respectively.)

ESP Plan Section 14.4.0, “Reentry,” discusses the various concepts of reentry associated with onsite recovery. Reentry consists of planned and deliberate access to areas of the plant that were evacuated, or were controlled as limited-access areas, as the result of an emergency. The Radiological Assessment Coordinator or Radiological Support Manager determines what is needed to reenter affected areas. Reentry activities may occur before the termination of the emergency, or they may be conducted as a part of recovery operations, and do not include the initial corrective or protective actions taken to establish control of the emergency. The primary function of reentry is to perform comprehensive radiological surveys of the plant or assessment of damaged plant equipment in order to establish detailed recovery plans. Planning considerations associated with reentry include contamination and ALARA controls, radiation dose rates and dose limits, decontamination requirements, posting of radiological areas, and site access. Offsite reentry activities are the responsibility of State and local authorities, in accordance with their plans and procedures.

In RAI 22, Question 13.03-17, the staff requested that the applicant provide information regarding the method used to periodically estimate total population exposure. In a July 21, 2011, response to RAI 22, Question 13.03-17, the applicant stated that atmospheric transport and diffusion for the new plant will be calculated using an approved dose assessment tool, and that a method for determining atmospheric transport and diffusion throughout the plume exposure EPZ during emergency conditions will be developed following the selection of a reactor technology. Pursuant to 10 CFR 52.39(b), an applicant for a COL that references this ESP shall update the emergency preparedness information that was provided under 10 CFR 52.17(b), and discuss whether the updated information materially changes the bases for compliance with applicable NRC requirements. As such, the staff identified the following COL action item to address the development of a method for determining atmospheric transport and diffusion.

COL Action Item 13.3-7

> An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the method for determining atmospheric transport and diffusion throughout the 10-mile plume exposure emergency planning zone during emergency conditions, including the ability to periodically estimate total population exposure.

As described above, the staff finds the applicant’s July 21, 2011, response to RAI 22, Question 13.03-17, acceptable and, therefore, considers RAI 22, Question 13.03-17, resolved.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant has developed general plans for recovery and reentry, including describing criteria to be used to determine when, following an accident, reentry of the facility is appropriate or operation can be resumed. In addition, the applicant designated the individuals who will fill key positions in the facility recovery organization. The staff finds that the plans adequately specify the means for informing members of the response organizations that a recovery operation is to be initiated, describe how decisions to relax protective measures are made, and include a method for periodically estimating total population exposure.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard M. A COL applicant will address COL Action Item 13.3-7. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(13) and 10 CFR Part 50, Appendix E, Section IV.H, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.14 Exercises and Drills

As stated in NUREG-0654, Planning Standard N, "Exercises and Drills," 10 CFR 50.47(b)(14) 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 addition, 10 CFR Part 50, Appendix E, Section IV.F requires a description of the program that provides for training of employees, exercising by periodic drills, and participation by other assisting persons. The exercises – including hostile action exercises of the onsite and offsite emergency plans – shall test the adequacy of timing and content of implementing procedures and methods, test emergency equipment and communications networks, test the public alert and notification system, and ensure that emergency organization personnel are familiar with their duties. 10 CFR Part 50, Appendix E, Section IV.F further describes the full participation exercise (including timing), participation by each offsite authority having a role under the radiological response plan, deficiencies identified during the exercise, remedial exercises, exercise scenarios, and 8-year exercise cycle.

In ESP Plan Section 15, "Exercises and Drills," the applicant described the program for drills and exercises conducted to practice, test, and evaluate the adequacy of the emergency preparedness program, including facilities, equipment, procedures, communication links, actions of ERO personnel, and coordination between PSEG 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 to evaluate the emergency plan against NUREG-0654, Planning Standard N, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(14).

An exercise tests the ability of personnel to assess simulated plant conditions and take appropriate actions. Actions are taken in accordance with the emergency plan and associated procedures and include such activities as staff notification and activation of emergency response facilities; conducting technical evaluation of plant condition and radiological surveys and assessment; notification, communication, and coordination with offsite response organizations (including providing protective action recommendations); and managing recovery

activities. Personnel training is addressed in ESP Plan Section 16 and discussed in Section 13.3.4.3.15 of this report.

Exercises are conducted in accordance with an exercise manual, and include (at a minimum) the elements listed in ESP Plan Section 15.1.2. These include such elements as exercise objectives, participating agencies, exercise conduct guidelines, operational and radiological data (including field radiation data), simulated events/action, and evaluation criteria. PSEG limits the scope and timing of the distribution of the exercise manual to protect the confidentiality of the exercise scenario. The exercise scenario is varied from year to year, so that all major elements of the plans and preparedness organizations are tested within a 6-year period. In addition, exercises are conducted under various weather conditions and once every 6 years start between 6:00 p.m. and 4:00 a.m. Federal observers/evaluators or drill referees/observers will evaluate the adequacy of the emergency response demonstrated for the exercise objectives.

In an August 29, 2012, letter to the NRC, PSEG described the implementation approach for the eleven amendments (enhancements) to the emergency preparedness regulations addressed in the Final Rule. With regard to drills and exercises, the applicant stated that the rule adds several requirements for exercises, including a hostile action based (HAB) exercise, 8-year exercise cycle, and NRC review of exercise scenarios. In addition, when PSEG selects a reactor technology and submits a COL application to the NRC, the COL application will include an ITAAC to submit EPIPs to the NRC 180 days prior to fuel load, and the EPIPs will require submittal of the exercise scenario to the NRC and conformance with the 8-year cycle scenario requirement.

In a December 18, 2013, letter to NRC, PSEG supplemented its August 29, 2012, response with regard to the conduct of HAB drills and the 8-year exercise drills. Specifically, PSEG committed to revise Section 15, “Exercises and Drills,” of the ESP Plan (in a future revision of the ESPA) by changing the drill cycle duration from six to eight years, and adding a requirement to conduct a HAB drill once during each eight year drill cycle. The staff reviewed the proposed revisions, and found them acceptable because they are consistent with 10 CFR Part 50, Appendix E, Section IV.F.2.i. Therefore, the staff identified these changes to the ESP Plan as Confirmatory Item 13.3-1. The staff verified that in Revision 4 to the PSEG Site ESP application (June 5, 2015), the applicant incorporated the committed changes. Therefore, the staff considers Confirmatory Item 13.3-1 closed.

Following an exercise, a critique is scheduled to evaluate the ability of the participants to respond to an emergency in accordance with the plan and procedures and to identify any deficiencies in training, facilities, equipment, or procedures. ITAAC 8.1.1.G.1 addresses the licensee conducting a post-exercise critique to determine areas requiring improvement and corrective action. The Manager – Emergency Preparedness reviews the deficiencies and ensures corrective actions are assigned appropriately, and NRC-evaluated exercise critiques are provided to senior management. Corrective actions are tracked for timely resolution or escalated to higher levels of management for action.

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, and ITAAC 8.1.1 lists onsite exercise objectives. In addition, ITAAC 8.1.2 addresses onsite personnel mobilization and performance of assigned responsibilities.

In addition to the exercises, the PSEG Site conducts drills for the purpose of testing, developing, and maintaining the proficiency of emergency responders. A drill is a supervised instruction

period used to develop and maintain skills in a particular operation. Drills are a training tool to develop and maintain the emergency response organization. ESP Plan Table 15-1 provides the schedule of exercises and drills, including participation of the various State and Federal response organizations. At a minimum, these activities will be conducted.

- Communication Drills—The monthly communications drill consists of a test of the primary and/or secondary communications links between the Control Rooms, TSCs and EOF, and the appropriate initial State and local government contact points. A communications drill to NRC Headquarters and the NRC Regional Office Operations Center from the Control Rooms, TSCs, and EOF is completed monthly. The quarterly communications drill consists of a test of the primary and/or secondary communications links between the Control Rooms, TSCs, and EOF and the appropriate Federal EROs and States within the ingestion pathway contact points. Annual communications drills test communications equipment used for notifications of Federal EROs and for communication among the nuclear facility, State and local EOCs, and field assessment teams.

- Notifications—The quarterly pager test consists of a test of the primary and/or secondary communications links between the callout computer and PSEG ERO members that carry pager.

- Fire Drills—Fire drills are performed at predetermined intervals, not to exceed three months, in accordance with the fire protection program.

- Medical Emergency Drills—The annual medical emergency drill consists of appropriate treatment of simulated contaminated person(s), use of appropriate contamination control measures, and transportation to the local medical facility by the station ambulance. The offsite portions of the medical drill may be performed as part of the required annual exercise.

- Radiological Monitoring Drills--The annual radiological monitoring drill consists of onsite and offsite surveys (to include environmental samples) and assessment of simulated survey results by the appropriate members of the ERO.

- Radiation Protection Drills--The semiannual radiation drill demonstrates the response of radiation protection personnel to simulated elevated radiation levels in airborne and liquid samples. It also simulates direct reading of radiation measurements in the environment.

- Accountability Drills—The annual accountability drill demonstrates the ability of personnel to report to their accountability stations and the accounting of Protected Area personnel during a simulated emergency. Additionally, security force personnel ensure that the accessible areas of the exclusion zone are simulated to be cleared of contractor personnel and/or members of the general public. A full accountability drill involves participation of all Protected Area personnel and shall be conducted at least once every 6 years.

- Augmentation Drills—Augmentation drills serve to demonstrate the capability of the process to augment the on-shift staff with a TSC, OSC, EOF, and ENC/JIC after declaration of an emergency. An unannounced augmentation drill shall be performed at least once every 6 years.

- EOF Consolidated Functions Drill—An EOF consolidated functions drill will demonstrate the capability of the EOF to support multiple units in an emergency, and shall be performed at least once every 6 years.

In its December 18, 2013, letter (discussed above), PSEG's commitment to revise Section 15 of the ESP Plan includes changing the above 6-year drill frequencies to eight years. These changes were included in Confirmatory Item 13.3-1, which has been closed (See earlier in this Section).

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654. In addition, FEMA stated that the adequacy of the PSEG Plan for offsite response organizations is also dependent on satisfactory demonstration of plan implementation during a joint exercise with the licensee and State and local governments, utilizing PSEG facilities. ITAAC 8.1.3 addresses offsite exercise objectives and the absence of uncorrected offsite exercise deficiencies prior to (reactor) operation above 5 percent of rated thermal power.

Consistent with the resolution of Confirmatory Item 13.3-1, the staff finds that the applicant has described provisions for conducting periodic exercises and drills to evaluate major portions of emergency response capabilities and to develop and maintain key skills. The exercises will test the adequacy of implementing procedures, emergency equipment and communications networks, and the public notification system, and will ensure that the ERO personnel are familiar with their duties. In addition, the staff finds that the applicant described the full participation exercise, participation by offsite authorities, and how exercise and drill deficiencies will be identified and corrected.

Conclusion

Consistent with the resolution of Confirmatory Item 13.3-1, the staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard N. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(14) and 10 CFR Part 50, Appendix E, Section IV.F, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.15 Radiological Emergency-Response Training

As stated in NUREG-0654, Planning Standard O, "Radiological Emergency Response Training," 10 CFR 50.47(b)(15), requires that radiological emergency response training be provided to those who may be called on to assist in an emergency. In addition, 10 CFR Part 50, Appendix E, Section IV.F.1 requires a description of the program that provides for training of employees, exercising by periodic drills, and participation by other assisting persons.

In ESP Plan Section 16, "Radiological Emergency Response Training," the applicant described the radiological emergency response training program which ensures the training, qualification, and requalification of individuals who will be required to provide assistance during an emergency at the PSEG 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 to evaluate the emergency plan against NUREG-0654, Planning Standard O, which provides the detailed

evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(15).

Emergency response training is a shared responsibility between Site Access Training and the Emergency Preparedness Group. Personnel badged for unescorted access to the Protected Area receive a basic emergency plan overview as part of General Employee Training (GET). All individuals entering the Protected Area who are not badged for unescorted access will be continuously escorted. Annual requalification is required to maintain unescorted access to the Protected Area. The Emergency Preparedness Group is responsible for administering the emergency plan training program, including conducting drills and exercises, and the Manager Emergency Preparedness ensures that GET lesson materials are maintained current and accurate.

All personnel assigned to emergency response positions receive annual emergency preparedness training, which is described in position-specific qualification guides. Training methods may include classroom instruction, computer-based instruction, drill training, individual knowledge discussions or evaluation, and are outlined in the position-specific qualification guides. Course content and qualification guides are created using position-specific job-task analysis, which describes the elements necessary to perform the job function. ESP Plan Table 16-1 identifies the training and qualification guide courses required for each ERO position, and ESP Plan Table 16-2 describes the content of each training course. The emergency planning administrative training procedure and Training & Reference Material describe the process for the development and presentation of the training material for emergency preparedness. Records are maintained in accordance with the PSEG training department procedures and guidance.

Periodic training is provided and staff members are assigned at least one training program, drill, conference, or similar training opportunity at least annually. Emergency plan drills are used as tools to practice, train, and demonstrate the skills learned in training and to exercise the interface between PSEG and offsite agencies. If deficiencies are identified during drills, corrective measures will include correction on the spot (or during post-drill critique sessions) by a qualified drill coach or controller. In addition, deficiencies identified in drills or exercises will be tracked in accordance with the PSEG Corrective Action Program. All drills and exercises will be conducted in accordance with ESP Plan Section 15, which is discussed above in Section 13.3.4.3.14 of this report.

PSEG also provides site-specific emergency response training for offsite emergency organizations that may be called on to provide assistance in the event of an emergency. This includes training associated with station response procedures and radiation protection techniques for offsite fire and rescue, ambulance, and hospital staff. Offsite ambulance-squad personnel are trained and qualified in courses equivalent (or superior) to the Red Cross Multimedia course. As discussed in ESP Plan Section 3, the on-shift fire department personnel have received firefighting and first aid training. The first-aid team is a collateral duty of the fire department and is staffed by personnel who are qualified emergency medical technicians (EMTs) in the State of New Jersey. All other training and retraining given to offsite State and municipal emergency response personnel will be provided in accordance with the appropriate State, county, or municipal emergency response plans.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant has provided for radiological emergency response training to those who may be called on to assist in an emergency. In addition, the applicant described the program that trains employees to ensure they are familiar with their specific emergency response duties, including exercising with periodic drills. The applicant also described the participation in training and drills by other persons whose assistance might be needed, including specialized initial training and periodic retraining.

Conclusion

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard O. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(15) and 10 CFR Part 50, Appendix E, Section IV.F.1 insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.16 Responsibility for the Planning Effort: Development, Periodic Review, and Distribution of Emergency Plans

As stated in NUREG-0654, Planning Standard P, "Responsibility for the Planning Effort: Development, Periodic Review and Distribution of Emergency Plans," 10 CFR 50.47(b)(16) requires that responsibilities for plan development and review and for distribution of emergency plans are established and that planners are properly trained. In addition, 10 CFR Part 50, Appendix E, Section IV.G requires a description of provisions to be employed to ensure that the emergency plan, its implementing procedures, and emergency equipment and supplies are maintained up to date.

In ESP Plan Section 17, "Emergency Plan Administration," the applicant described the responsibilities associated with maintaining the emergency preparedness program, including the development, review, and distribution of the emergency plan. 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 to evaluate the emergency plan compared to NUREG-0654, Planning Standard P, which provides the detailed evaluation criteria that the staff should consider to determine whether the emergency plan meets the applicable regulatory requirements in 10 CFR 50.47(b)(16).

The President and Chief Nuclear Officer – PSEG Nuclear has the overall responsibility to develop and update emergency planning and coordination of the plans with other response organizations. The Manager – Emergency Preparedness has the authority to approve EPIPs for adequacy and consistency, and is responsible for ensuring that the EPIPs are appropriately interfaced with the plans, procedures, and training of offsite support agencies. In addition, the Manager – Emergency Preparedness approves all revisions to emergency preparedness documents, and is responsible for the review and revision of training procedures and lesson plans in accordance with the licensee's Nuclear Emergency Preparedness Training Program. The training procedures and lesson plans are based on the approved emergency plan and procedures. ESP Plan Section 16 states that all personnel assigned to emergency response positions are to receive annual emergency preparedness training. ESP Plan Figure 17-1 shows

the organization for coordination and direction of emergency planning matters, and ESP Plan Table 17-1 shows how emergency plan documents are reviewed and approved.

Revisions to the emergency plan and EPIPs—including those based on training exercises and drills, and changes onsite or in the environs—are made when necessary in accordance with emergency preparedness administrative procedures (see ESP Plan Attachment 1-1.8). Telephone numbers are updated quarterly. Documents are mailed to copyholders and include instructions for replacing, deleting, and adding pages. Any holder of the emergency plan or EPIPs may prepare revisions to any plan section or procedure. The emergency plan and EPIPs include a list of the latest revision number and effective date, and all revisions are distributed in accordance with PSEG procedures. The ESP Plan includes a table of contents for the emergency documents, and a cross-reference to the evaluation criteria in NUREG-0654. The typical contents of the ECG and procedures (EPIPs) required to implement the emergency plan, some of which are discussed above, are listed in these ESP Plan attachments.

- Attachment 1-1.3 – PSEG Site Station Event Classification Guide
- Attachment 1-1.4 – Emergency Plan Onsite Implementing Procedures
- Attachment 1-1.5 – Emergency Operations Facility
- Attachment 1-1.6 – Emergency News Center
- Attachment 1-1.7 – Security Response
- Attachment 1-1.8 – Administrative Procedures

ITAAC 9.1 states that the licensee has submitted detailed EPIPs for the onsite emergency plan no less than 180 days prior to fuel load.

The emergency plan and associated documents are reviewed at least once each year and receive an independent review at least once every 12 months. Agreement letters from offsite agencies and local support groups are verified or updated biennially, or when plan revisions could affect their responsibilities. ESP Plan Table 1-2 provides a detailed listing of supporting plans and their sources. Supporting plans and associated responsibilities are also addressed in ESP Plan Section 2.0 and Attachments 2 and 3. Management directives address evaluation and correction of audit findings, training, readiness testing, and emergency equipment. Review results and actions taken are forwarded to PSEG senior management, and review records are retained for 5 years.

In its Interim Finding Report for Reasonable Assurance, FEMA found that the offsite emergency plans are adequate for this planning standard and the associated evaluation criteria in NUREG-0654.

The staff finds that the applicant has established the responsibilities for plan development and review, including distribution of the emergency plans to all appropriate organizations. In addition, the applicant established provisions to properly train the planners (i.e., the individuals responsible for the emergency planning effort) and described the provisions to be employed to ensure that the emergency plan, its implementing procedures, and emergency equipment and supplies are maintained up-to-date.

<u>Conclusion</u>

The staff concludes that the information provided in the ESPA is consistent with the guidelines in NUREG-0654, Planning Standard P. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(16) and 10 CFR Part 50,

Appendix E, Section IV.G, insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations.

13.3.4.3.17 Evacuation-Time Estimate Analysis

10 CFR 50.47(b)(10) requires, in part, that ETEs have been developed by applicants and licensees, and that licensees shall update the ETEs on a periodic basis. In addition, 10 CFR Part 50, Appendix E, Section IV requires that the applicant provide an analysis of the time required to evacuate various sectors and distances within the plume exposure pathway EPZ for transient and permanent populations, using the most recent U.S. Census Bureau data as of the application submission date. These requirements also apply to ESP applicants that propose complete and integrated emergency plans pursuant to 10 CFR 52.17(b)(2)(ii). NUREG-0654, Appendix 4, “Evacuation Time Estimates within the Plume Exposure Pathway Emergency Planning Zone,” contains the detailed guidance to be used by the staff to determine whether the ETE Report meets the applicable regulatory requirements in 10 CFR Part 50, Appendix E. ETEs are part of the required emergency planning basis and provide PSEG and State and local governments with site-specific information needed for protective action decision making.

SSAR Section 13.3.4, “Evacuation Time Estimates,” states that an independent ETE study has been performed to provide estimates of the time required to evacuate resident and transient populations surrounding the PSEG Site for various times of the year under favorable and adverse conditions. ESP Plan Attachment 11 consists of the ETE Report “PSEG Site: Development of Evacuation Time Estimates” (KLD TR-445, Revision 1, February 2012). The ETE Report was prepared by KLD Engineering, P.C., in coordination with PSEG personnel and emergency management personnel representing State and local governments. The ETE Report describes the analyses undertaken and the results obtained by a study to develop evacuation time estimates for the PSEG Site. The ETE Report consists of these 13 sections and includes detailed supporting information in Appendices A through N:

- Section 1: Introduction (basic description of the analysis process)
- Section 2: Study Estimates and Assumptions (methodology used)
- Section 3: Demand Estimation (population and vehicles)
- Section 4: Estimation of Highway Capacity (ability of road network to service demand)
- Section 5: Estimation of Trip Generation Time (activity/event time distributions)
- Section 6: Demand Estimation for Evacuation Scenarios (region and scenario evacuation cases)
- Section 7: General Population ETEs (results of computer analyses)
- Section 8: Transit-Dependent and Special Facility ETEs (analyses applied and results obtained)
- Section 9: Traffic Management Strategy (traffic control designed to expedite movement of evacuating traffic)

- Section 10: Evacuation Routes (major evacuation routes for the two counties within the plume exposure pathway EPZ)
- Section 11: Surveillance of Evacuation Operations (concurrent surveillance procedures)
- Section 12: Confirmation Time (suggested approach of stratified random sample and telephone survey to confirm that the evacuation process is effective)
- Section 13: Observations (suggestions to facilitate/improve the evacuation process)

The Executive Summary of the ETE Report includes a summary of the conclusions reached in the report. Specifically, the general population ETEs were computed for 255 unique cases, with the ETEs ranging from 2:00 (hr:min) to 2:55 at the 90th percentile. The ETEs for the 100th percentile are nearly double those for the 90th percentile as a result of the long tail of the evacuation curve caused by those evacuees who take longer to mobilize. Construction/ refueling activities add approximately 30 minutes, on average, to the ETE. PSEG is considering a proposed causeway connecting the new PSEG Site with local roads in Elsinboro Township, which will be used by construction workers and new plant personnel. The use of the proposed causeway reduces the ETEs for the 3.2-km (2-mi) Region R01 and 8-km (5-mi) Region R02 by 40 and 10 minutes, respectively. The ETE for the full EPZ (Region R03) is unaffected by the use of the proposed causeway.

Middletown, DE, and Salem, NJ, are the two most congested areas during an evacuation, and all congestion within the EPZ clears by 3 hours after the advisory to evacuate. Special population ETEs were computed for schools, medical facilities, transit-dependent persons, and homebound special needs persons. These ETEs are within a similar range as the general population ETEs, with the exception of the transit-dependent ETEs, which do exceed general population ETEs for some bus routes. The general population ETEs are not significantly impacted by the voluntary evacuation of vehicles from the Shadow Region. Finally, the ETE Report assumes that no Intelligent Transportation Systems (ITS) technologies and traffic management techniques are in place that might benefit the evacuation process and decrease ETEs. (Section 13.3.4.1 of this report addresses additional information in the ETE Report.)

The staff evaluated the ETE Report against the criteria set forth in NUREG-0654, Appendix 4. The evaluation included checking the ETE Report for internal consistency, consistency with other parts of the emergency plan, and consistency with other parts of the ESPA, including the SSAR. The staff verified the citations in the ETE Report by comparing it to the cited document text. General descriptions of the PSEG Site region, population, and highways were verified using internet searches and aerial photographs. The staff reviewed the general road condition, including shoulder and lane width, or the designated evacuation routes, and concluded that there were no impediments to evacuation.

In RAI 2, Questions 13.03-2 through 13.03-8, the staff requested that the applicant address various areas in an earlier version of the ETE Report, “PSEG Site: Development of Evacuation Time Estimates” (KLD TR-445, Revision 0, August 2009), included as ESP Plan Attachment 11, which contained information such as population data for transients and non-EPZ employees, schools and special events within the EPZ, the special needs population, comparison of various evacuation times, and engagement of affected State and local organizations. In a February 2, 2011, response to RAI 2, Questions 13.03-2 through 13.03-8, the applicant addressed the staff’s questions and proposed changes that would be added to a future revision of the ETE Report. In Revision 1 of the ESPA (May 21, 2012), PSEG included Revision 1 of the

ETE Report as ESP Plan Attachment 11. The staff reviewed the applicant's responses to RAI 2, Questions 13.03-2 through 13.03-8, and the updated ETE Report. The staff finds the responses acceptable because they adequately respond to the staff's questions in RAI 2, and that the proposed changes to the ETE Report have been reflected in Revision 1. Therefore, the staff considers RAI 2, Questions 13.03-2 through 13.03-8, resolved.

In an August 29, 2012, letter to the NRC, PSEG described the implementation approach for the 11 amendments (enhancements) to the emergency preparedness regulations addressed in the Final Rule. With regard to the requirement in 10 CFR 50.47(b)(10) and 10 CFR Part 50, Appendix E, Section IV for updating ETEs, the applicant stated that PSEG complies with this Final Rule element, as documented in ESP Plan Attachment 11 (i.e., the ETE Report), and that PSEG Nuclear is currently conducting an ETE to comply with this Final Rule element for the Salem and Hope Creek operating units. This ETE is not expected to reach different conclusions from the current ETE contained in the ESP Plan, and PSEG Nuclear will inform PSEG if any differences are identified. In addition, EPIPs will address protective action recommendations and will be consistent with the ETE conclusions (see ITAAC 9.1).

The timing associated with the applicant's submission of the ESPA and the effective date of the Final Rule enhancements to emergency preparedness regulations are relevant with regard to the status and acceptability of the ETE included in the ESPA. These dates, which are relevant to the staff's ETE review, reflect (1) ESPA submissions and revisions, (2) U.S. Census Bureau decennial updates, and (3) Final Rule implementation

- 2000—U.S. Census Bureau decennial update
- August 2009—ETE Report, Revision 0
- May 25, 2010—submission of ESPA, Revision 0
- 2010—U.S. Census Bureau decennial update
- November 23, 2011—Final Rule *Federal Register* Notice (76 *FR* 72560-72600)
- December 23, 2011—effective date of Final Rule, including use by the ETE of the most recent census data from the U.S. Census Bureau (see 10 CFR Part 50, Appendix E, Section IV.4)
- February 2012—ETE Report, Revision 1
- May 21, 2012 —submission of ESPA, Revision 1

In the Final Rule, 10 CFR Part 50, Appendix E, Section IV.2 requires that the ESP applicant's ETE use the most recent U.S. Census Bureau data as of the date the applicant submits its application to the NRC. In ESPA Revision 0, the applicant used the U.S. Census Bureau data files for the year 2000 to develop its ETE, which was the most recent U.S. Census Bureau data available as of the date of the initial submission of the ESPA (i.e., May 25, 2010).

Pursuant to 10 CFR 52.39(b), an applicant for a COL that references this ESP shall update the emergency preparedness information that was provided under 10 CFR 52.17(b), and discuss whether the updated information materially changes the bases for compliance with applicable NRC requirements. As such, the staff identified the following COL action item to assure that

available U.S. Census Bureau data is address by a COL applicant in updating the ETE Report, and that interfaces with the nearby operating plants are considered.

COL Action Item 13.3-8

> An applicant for a COL or CP referencing this early site permit should explain how any updated evacuation time estimate (ETE) information for the PSEG Site interfaces with any ETE updates that may have been provided for the nearby Salem and Hope Creek units.

As described above, the staff finds that the applicant has developed adequate ETEs for the plume exposure pathway EPZ for transient and permanent populations using the most recent U.S. Census Bureau data as of the application submission date, and that the ETEs are consistent with the guidance in NUREG-0654, Appendix 4.

<u>Conclusion</u>

The staff concludes that Revision 1 of the ETE Report is consistent with the guidelines in NUREG-0654, Appendix 4. A COL applicant will address COL Action Item 13.3-8. Therefore, the staff finds the information acceptable and meets the relevant requirements of 10 CFR 50.47(b)(10); 10 CFR Part 50, Appendix E, Section IV; and 10 CFR 52.17(b)(2)(ii), insofar as the information describes the essential elements of advanced planning and the provisions made to cope with emergency situations,

13.3.5 Conclusion

The staff reviewed the complete and integrated emergency plans provided in the PSEG ESP application for the proposed new unit(s) at the PSEG Site. The staff reviewed the onsite emergency plan against the relevant requirements of 10 CFR 50.33, "Contents of Applications: General Information"; 10 CFR 50.47; 10 CFR 50.72; 10 CFR Part 50, Appendix E; 10 CFR 52.17; 10 CFR 52.18; and 10 CFR 100.21, "Non-seismic Site Criteria," using the guidance criteria in NUREG-0654; NUREG-0737, Supplement 1; NUREG-0800; and NSIR/DPR-ISG-01. The staff concludes that, provided that the permit conditions identified below are adequately addressed and the enumerated ITAAC are performed and met, the PSEG 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 the proposed PSEG Site 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 staff concludes that, provided that the permit conditions identified below are adequately addressed and the enumerated ITAAC are performed and met, the PSEG Site 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 PSEG Site emergency plan includes the proposed inspections, tests, and analyses that the holder of a COL referencing the PSEG Site 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 new unit(s) at the PSEG Site has been constructed and will operate in conformity with the license, the provisions of the Atomic Energy Act of 1954, and NRC regulations.

Consistent with the resolution of Confirmatory Item 13.3-1, addressed in Section 13.3.4.3.14 of this report, 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(g); 10 CFR 50.47; 10 CFR 50.72(a)(3); 10 CFR Part 50, Appendix E; 10 CFR 52.17(b)(1); 10 CFR 52.17(b)(2)(ii); 10 CFR 52.17(b)(3); 10 CFR 52.17(b)(4); 10 CFR 52.18; and 10 CFR 100.21(g). 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 new unit(s), and that emergency preparedness at the PSEG Site 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 these COL action items and permit conditions (and to the ITAAC contained in Table 13.3-1 of this report):

COL Action Items 13.3-1 through 13.3-8

13.3-1 An applicant for a COL or CP referencing this early site permit should submit to the NRC updated letters of agreement or memoranda of understanding with offsite support organizations to reflect the chosen plant design. (See Section 13.3.4.2 of this report.)

13.3-2 An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the components, availability, and power supplies for the Federal Telecommunications System (FTS), including all required communications and data links associated with the chosen reactor technology. (See Section 13.3.4.3.6 of this report.)

13.3-3 An applicant for a COL or CP referencing this early site permit and the US-APWR standard design should revise the emergency plan to describe the location and capabilities of the Operations Support Center (OSC). (See Section 13.3.4.3.8 of this report.)

13.3-4 An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the radiation monitoring and other systems and equipment, including potential major release points from the plant and river water level monitoring requirements, associated with the chosen reactor technology that support accident assessment activities. The emergency plan should also identify the specific monitoring capability for the radiological parameters identified in NRC Regulatory Guide 1.97, Revision 2, and dose assessment and projection modeling system. (See Section 13.3.4.3.9 of this report.)

13.3-5 An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the availability of a proposed causeway for use as an

alternate route for evacuating the site. If appropriate, the applicant should update the evacuation time estimate (ETE) analysis for the PSEG Site to reflect the causeway, and provide confirmation that the ETE update was provided to State and local governmental authorities for use in developing offsite protective action strategies. (See Section 13.3.4.3.10 of this report.)

13.3-6 An applicant for a COL or CP referencing this early site permit and the US-APWR design control document (DCD) should revise the emergency plan to identify the location of the onsite personnel decontamination facility. (See Section 13.3.4.3.11 of this report.)

13.3-7 An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the method for determining atmospheric transport and diffusion throughout the 10-mile plume exposure emergency planning zone during emergency conditions, including the ability to periodically estimate total population exposure. (See Section 13.3.4.3.13 of this report.)

13.3-8 An applicant for a COL or CP referencing this early site permit should explain how any updated evacuation time estimate (ETE) information for the PSEG Site interfaces with any ETE updates that may have been provided for the nearby Salem and Hope Creek units. (See Section 13.3.4.3.17 of this report.)

Permit Conditions 5 through 9

5. An applicant for a COL or CP referencing this early site permit shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an assessment of on-site and augmented staffing capability for responding to a multi-unit event. The staffing assessment shall be performed in accordance with the latest NRC-endorsed revision of NEI 12-01, "Guidance for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," (ii) At least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall complete implementation of corrective actions identified in the staffing assessment described above and identify how the augmented staff will be notified given degraded communications capabilities, including any related emergency plan and implementing procedure changes and associated training. (See Section 13.3.4.3.2 of this report.)

6. An applicant for a COL or CP referencing this early site permit shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an assessment of on-site and off-site communications systems and equipment relied upon during an emergency event to ensure communications capabilities can be maintained during an extended loss of ac power. The communications capability assessment shall be performed in accordance with the latest NRC-endorsed revision of NEI 12-01, "Guidance for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," (ii) At least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall complete implementation of corrective actions

identified in the communications capability assessment described above, including any related emergency plan and implementing procedure changes and associated training. (See Section 13.3.4.3.2 of this report.)

7. An applicant for a COL or CP referencing this early site permit shall revise the emergency plan to describe on-shift personnel assigned emergency plan implementing functions associated with the chosen reactor technology and the number of proposed reactor units. In addition, the COL or CP applicant shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an on-shift staffing analysis in accordance with the latest NRC-endorsed revision of NEI 10-05, "Assessment of On-Shift Emergency Response Organization Staffing and Capabilities," (ii) At least one hundred eighty (180) days before the date schedule for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall incorporate any changes to the emergency plan needed to bring staffing to the required levels. (See Section 13.3.4.3.2 of this report.)

8. An applicant for a COL or CP referencing this early site permit and the AP1000 standard design shall propose a license condition for the licensee to develop an Emergency Action Level (EAL) scheme with fully developed site-specific EALs, in accordance with the latest NRC-endorsed revision of NEI 07-01, "Methodology for Development of Emergency Action Levels, Advanced Passive Light Water Reactors," with few or no deviations or differences. All deviations or differences from NEI 07-01 must be fully described in the COL application, including providing the initiating condition, operating modes, notes, EAL threshold(s), basis information, and developer guidance for how a particular setpoint is (or will be) determined. The EALs shall have been discussed and agreed upon with State and local officials. The fully developed site-specific EAL scheme shall be submitted to the NRC at least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a). (See Section 13.3.4.3.4 of this report.)

9. An applicant for a COL or CP referencing this early site permit and the U.S. EPR, ABWR, or US-APWR standard design shall propose a license condition for the licensee to develop an Emergency Action Level (EAL) scheme with fully developed site-specific EALs, in accordance with the latest NRC-endorsed revision of NEI 99-01, "Methodology for Development of Emergency Action Levels," with few or no deviations or differences, other than those attributable to the specific reactor design. All deviations or differences from NEI 99-01 must be fully described in the COL application, including providing the initiating condition, operating modes, notes, EAL threshold(s), basis information, and developer guidance for how a particular setpoint is (or will be) determined. The EALs shall have been discussed and agreed upon with State and local officials. The fully developed site-specific EAL scheme shall be submitted to the NRC at least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a). (See Section 13.3.4.3.4 of this report.)

Table 13.3-1 PSEG Site ITAAC

Planning Standard	EP Program Elements	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 response plans for reliance on information provided by facility licensees for determinations of minimum initial offsite response measures.	1.1 A standard emergency classification and emergency action level (EAL) scheme exists, and identifies facility system and effluent parameters constituting the bases for the classification scheme. [D.1**] [**D.1 corresponds to NUREG-0654/ FEMA-REP-1 evaluation criteria.]	1.1 An inspection of the Control Room, Technical Support Center (TSC), and Emergency Operations Facility (EOF) will be performed to verify that they have displays for retrieving facility system and effluent parameters as specified in the Emergency Classification and EAL scheme, and the displays are functional.	1.1(a) The parameters referenced in the Emergency Classification and EAL scheme are retrievable in the Control Room, TSC and EOF. 1.1(b) The ranges of the displays encompass the values specified in the Emergency Classification and EAL scheme.
2.0 Notification Methods and Procedures			
10 CFR 50.47(b)(5) – 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 means to provide early notification and clear instruction to the populace within the plume exposure pathway Emergency Planning Zone have been established.	2.1 The means exist to notify responsible State and local organizations within 15 minutes after the licensee declares an emergency. [E.1]	2.1 A test will be performed to demonstrate the capabilities for providing initial notification to the offsite authorities after a simulated emergency classification.	2.1 The States of Delaware and New Jersey, and Kent, New Castle, Cumberland, and Salem Counties received notification within 15 minutes after the declaration of an emergency from the Control Room, TSC, or EOF.
	2.2 The means exist to notify emergency response personnel. [E.2]	2.2 A test of the primary and backup emergency response organization (ERO)	2.2 A test of the primary and backup ERO notification system resulted in:

		notification systems will be performed	a. ERO personnel received the notification message; b. Mobilization communication validated by personnel response to the notification system or by telephone; c. Response to electronic notification and plant public address system demonstrated during normal working hours, and off hours
	2.3 The means exist to notify and provide instructions to the populace within the plume exposure emergency planning zone (EPZ). [E.6]	2.3 A full test of the Prompt Alerting and Notification System and the Emergency Alert System capabilities will be conducted.	2.3 Notification and clear instructions to the public accomplished in accordance with the emergency plan requirements.
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 exist for communications among the Control Room, TSC, EOF, principal State and local emergency operations centers (EOCs), and field monitoring teams. [F.1.d]	3.1(a) A test will be performed to demonstrate (both primary and secondary methods/systems) the ability to communicate from the Control Room, TSC and the EOF to responsible State and local government agencies. 3.1(b) A test will be performed to demonstrate (both primary and secondary methods/systems) the ability to communicate from the TSC and the EOF to PSEG field monitoring teams	3.1(a) Demonstrated (both primary and secondary methods/systems) the ability to communicate from the Control Room, TSC and the EOF to responsible State and local government agencies. 3.1(b) Demonstrated (both primary and secondary methods/systems) the ability to communicate from the TSC and the EOF to PSEG field monitoring teams.
	3.2 The means exist for communications from the Control Room, TSC, and EOF to the NRC headquarters and regional office EOCs (including	3.2 A test will be performed to demonstrate the ability to communicate from the Control Room, TSC and the EOF to the NRC Operations Center utilizing the	3.2 Communications are established between the Control Room, TSC and EOF to the NRC headquarters and regional office EOCs utilizing the ENS. The TSC and EOF demonstrated

	establishment of the Emergency Response Data System (ERDS) [or its successor system] between the onsite computer system and the NRC Operations Center.) [F.1.f]	Emergency Notification System (ENS). The Health Physics Network (HPN) is tested to ensure communications between the TSC and EOF with the NRC Operations Centers. ERDS is established [or its successor system] between the onsite computer systems and the NRC Operations Center.	communications with the NRC Operations Center using the HPN. The access port for ERDS [or its successor system] is provided and successfully completes a transfer of data from the Unit to the NRC Operations Center.
4.0 Public Education and Information			
10 CFR 50.47(b)(7) – Information is made available to the public on a periodic basis on how they will be notified and what their initial actions should be in an emergency (e.g., listening to a local broadcast station and remaining indoors), the principal points of contact with the news media for dissemination of information during an emergency (including the physical location or locations) are established in advance, and procedures for coordinated dissemination of information to the public are established.	4.1 The licensee has provided space which may be used for a limited number of the news media. [G.3.b]	4.1 An inspection of the as-built facility/area provided for the news media will be performed in the Emergency News Center/Joint Information Center (ENC/JIC).	4.1 The ENC/JIC included equipment to support the ENC/JIC operations, including communications with: a. TSC and EOF b. Principal State and local EOCs c. The news media Designated space is available for news media briefings.
5.0 Emergency Facilities and Equipment			
10 CFR 50.47(b)(8) – Adequate emergency facilities and equipment to support the emergency	5.1 The licensee has established a TSC and an onsite Operations Support Center (OSC). [H.1, H.9]	5.1 An inspection of the as-built TSC and OSC will be performed, including a test of their capabilities.	5.1.1 The TSC has at least 1875 ft^2 of floor space (75 ft^2 per person for a minimum of 25 persons).

response are provided and maintained.			
			5.1.2 Communication equipment is installed in the TSC and OSC, and voice transmission and reception are accomplished.
			5.1.3 The TSC ventilation system includes a high-efficiency particulate air (HEPA), and charcoal filter and radiation monitors are installed.
			5.1.4 The TSC has the means to receive, store, process, and display plant and environmental information, and enable the initiation of emergency measures and the conduct of emergency assessment. These capabilities are demonstrated during testing and acceptance activities.
			5.1.5 A reliable and backup electrical power supply is available for the TSC.
			5.1.6 There is an OSC located inside the Protected Area.
	5.2 The licensee has established an EOF. [H.2]	5.2 An inspection of the EOF will be performed, including a test of the capabilities.	5.2.1 Demonstrated communications between the Control Room, TSC, EOF, field monitoring teams, NRC, responsible State and county agencies, and the ENC/JIC.
			5.2.2 The parameters referenced in the Emergency Classification and EAL scheme are retrievable in the EOF.

			5.2.3 Demonstrated the capability of the EOF to respond to events at two or more reactors on the site in accordance with emergency plan implementing procedures (EPIPs), including the capabilities to discriminate plant data, staffing and operation of the facility.
6.0 Accident Assessment			
10 CFR 50.47(b)(9) – Adequate methods, systems and equipment for assessing and monitoring actual or potential off-site consequences of a radiological emergency condition are in use.	6.1 The means exist 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 or exercise to verify the capability to perform accident assessment.	6.1 Using selected monitoring parameters specified in the PSEG Site Emergency Plan, including EALs (ITAAC Acceptance Criteria 1.1), simulated degraded plant conditions are assessed and protective actions are initiated in accordance with the following criteria: a. Demonstrated the ability to obtain onsite radiological surveys and samples. b. Demonstrated the ability to continuously monitor and control radiation exposure to emergency workers. c. Demonstrated the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. d. Demonstrated the ability to satisfactorily collect and disseminate field team data. e. Demonstrated the ability to develop dose projections.

			f. Demonstrated the ability to make the decision whether to issue radioprotective drugs (KI) to onsite emergency workers. g. Demonstrated the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development.
	6.2 The means exist 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 A test will be performed to demonstrate that the means exist 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.	6.2 Demonstrated through training or drills that Emergency Plan Implementing Procedures (EPIPs) provide direction to accurately calculate the source terms and the magnitude of the release of postulated accident scenario releases.
	6.3 The means exist 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 A test will be performed that provides evidence that the impact of a radiological release to the environment can be assessed by using the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for various meteorological conditions.	6.3 Demonstrated through training or drills that EPIPs provide direction 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.
	6.4 The means exist to acquire and evaluate meteorological information. [I.5]	6.4 A test will be performed to acquire and evaluate meteorological data/ information.	6.4 Demonstrated that meteorological data necessary to implement the EPIPs is retrievable in the Control Room, TSC and EOF.
	6.5 The means exist to determine the	6.5 A test will be performed of the	6.5 Demonstrated through training or drills that EPIPs

	release rate and projected doses if the instrumentation used for assessment is off-scale or inoperable. [I.6]	capabilities to determine the release rate and projected doses if the instrumentation used for assessment if off-scale or inoperable.	provide direction to determine release rate and projected dose rates when instruments are off-scale or inoperable.
	6.6 The means exist for field monitoring within the plume exposure EPZ. [I.7]	6.6 A test will be performed of the capabilities for field monitoring within the plume exposure EPZ.	6.6 Demonstrated through training or drills that the field monitoring teams were dispatched and able to locate and monitor a radiological release within the plume exposure EPZ during a radioactive release scenario.
	6.7 The means exist to make rapid assessment of actual or potential magnitude and locations of 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]	6.7 A test will be performed of the capabilities to make rapid assessments of actual or potential magnitude and locations of radiological hazards through liquid or gaseous release pathways, including activation, notification means, field team composition, transportation, communication, monitoring equipment, and estimated deployment times.	6.7 Demonstrated through training or drills using EPIPs: a. A qualified field monitoring team was promptly notified, activated, briefed and dispatched from the EOF during a radiological release scenario. b. The team used monitoring equipment, transportation, communication from the field and located specific sampling locations. c. The team made rapid assessment of actual or potential magnitude and locations of any radiological hazards from simulated liquid or gaseous releases.
	6.8 The capability exists to detect and measure radioiodine concentrations in air in the plume exposure EPZ, as low as 10^{-7} µCi/cc (microcuries per cubic centimeter) under field conditions. [I.9]	6.8 A test will be performed of the capabilities to detect and measure radioiodine concentrations in air in the plume exposure EPZ, as low as 10^{-7} µCi/cc under field conditions.	6.8 A field monitoring team demonstrated, in accordance with the appropriate EPIP(s), the use of sampling and detection equipment for air concentrations in the plume exposure EPZ during a radioactive

			release scenario as low as 10^{-7} µCi/cc.
	6.9 The means exist to estimate integrated dose from the projected and actual dose rates, and for comparing these estimates with the Environmental Protection Agency (EPA) protective action guides (PAGs). [I.10]	6.9 A test will be performed of the capabilities to estimate integrated dose from the projected and actual dose rates, and for comparing these estimates with the EPA PAGs.	6.9 Personnel demonstrated the ability to estimate integrated dose from the dose assessment program and the field monitoring team reading during a radioactive release scenario. The results were successfully compared with the EPA PAGs.
7.0 Protective Response			
10 CFR 50.47(b)(10) – A range of protective actions has been developed for the plume exposure 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. Guide-lines 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 EPZ appropriate to the locale have been developed.	7.1 The means exist to warn and advise onsite individuals of an emergency, including those in areas controlled by the operator, including: [J.1] 1. Employees not having emergency assignments. 2. Visitors. 3. Contractor and construction personnel. 4. Other people who may be in the public access areas, on or passing through the site, or within the owner controlled area.	7.1 A test will be performed of the capabilities to warn and advise onsite individuals of an emergency, including those in the Owner Controlled Area and the immediate vicinity.	7.1 Demonstrated the ability to warn and advise onsite individuals including: 1. Non-essential employees. 2. Visitors. 3. Contractor and construction personnel. 4. Other personnel within the Owner Controlled Area and the immediate vicinity.
8.0 Exercises and Drills			
10 CFR 50.47(b)(14) – Periodic exercises are (will be) conducted to evaluate major portions of emergency	8.1 Licensee conducts a full participation exercise to evaluate major portions of	8.1 A full participation exercise (test) will be conducted within the specified time periods	8.1.1 The exercise is completed within the specified time periods of 10 CFR Part 50, Appendix E; onsite

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.	emergency response capabilities, which includes participation by the State and local agency within the plume exposure EPZ, and each State within the ingestion control EPZ. [N.1]	of 10 CFR Part 50, Appendix E.	exercise objectives have been met, and there are no uncorrected onsite exercise deficiencies.
			A. Accident Assessment and Classification 1. Demonstrated the ability to identify initiating conditions, determine EAL parameters, and correctly classify the emergency throughout the exercise. Standard Criteria: a. Determined 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. Demonstrated the ability to alert, notify and mobilize site emergency response personnel. Standard Criteria: a. Completed the designated checklist and performed the plant page announcement of the emergency classification.

			b. Activated the Emergency Outdial System following the initial event classification for an Alert or higher. 2. Demonstrated the ability to notify responsible State agencies within 15 minutes and the NRC within 60 minutes after declaring an emergency. Standard Criteria: a. Transmitted information using the designated checklist, in accordance with approved Emergency Plan documents within 15 minutes of event classification b. Transmitted follow-up notification information using the designated checklist, in accordance with approved Emergency Plan documents. c. Transmitted information using designated checklist within 60 minutes of event classification to the NRC. 3. Demonstrated the ability to warn or advise onsite individuals of emergency conditions. Standard Criteria: a. Initiated notification of onsite individuals (via public address, Owner Controlled Area sirens or telephone) using designated checklist.

			4. Demonstrated the capability of the Prompt Alerting System to operate properly for public notification when required. Standard Criteria: a. ≥90 percent of the sirens operate properly as indicated by the siren feedback system.
			C. Emergency Response 1. Demonstrated the capability to direct and control emergency operations. Standard Criteria: a. Overall emergency command and control demonstrated in the Control Room (simulator) in the early phase of the emergency and by the TSC within 90 minutes from initial event classification of Alert or higher. 2. Demonstrated the ability to transfer Emergency Coordinator function from the Shift Manager in the Control Room (simulator) to the Emergency Duty Officer in the TSC and later to the Emergency Response Manager in the EOF. Standard Criteria: a. Briefings were conducted prior to turnover responsibility. Personnel

			documented transfer of duties. 3. Demonstrated the ability to prepare for 24-hour staffing requirements. Standard Criteria: a. Completed 24-hour staff assignments. 4. Demonstrated the ability to perform assembly and accountability for all personnel in the Protected Area within 30 minutes of an emergency (after accountability message has been announced) requiring Protected Area accountability. Standard Criteria: a. Protected Area personnel accountability completed within 30 minutes of an emergency (after accountability message has been announced) requiring Protected Area accountability.
			D. Emergency Response Facilities 1. Demonstrated activation of the Operations Support Center (OSC) and full functional operation of the TSC and EOF within 90 minutes of event classification. Standard Criteria: a. The TSC and OSC activated within 90 minutes of the initial

			classification of an Alert or higher. b. The EOF activated within 90 minutes of the initial classification of Site Area Emergency or higher. 2. Demonstrated the adequacy of the equipment, security provisions, and habitability precautions for the TSC, OSC, EOF and ENC/JIC, as appropriate. Standard Criteria: a. Demonstrated the adequacy of the emergency equipment in the emergency response facilities including availability and general consistency with the EPIPs. b. Personnel assigned to the ERO implemented and followed applicable EPIPs. c. The Shift Radiation Protection Technician (on-shift), Radiological Assessment Coordinator (TSC), and Radiological Support Manager (EOF) implemented the designated checklist if an onsite/offsite release occurred. 3. Demonstrated the adequacy of communications for all emergency support resources. Standard Criteria:

			a. Emergency response communications listed in the EPIPs are available and operational. b. Communications systems are tested in accordance with the TSC, OSC and EOF activation checklists. c. Emergency response facility personnel are able to operate all specified communications systems. d. Clear primary and backup communications links are established and maintained for the duration of the exercise.
			E. Radiological Assessment and Control 1. Demonstrated the ability to obtain onsite radiological surveys and samples. Standard Criteria: a. Radiation Protection Technicians demonstrated the ability to obtain appropriate instruments (range and type) and perform surveys. b. Airborne samples taken when the conditions indicate the need for the information. 2. Demonstrated the ability to continuously monitor and control

			radiation exposure to emergency workers. Standard Criteria: a. Emergency workers issued self-reading dosimeters when radiation levels require, and exposures controlled to 10 CFR Part 20 limits (unless the Shift Manager or Emergency Duty Officer, or designee, authorizes emergency limits). b. Exposure records are available from the site database (primary), a personal computer database (backup), or a hard copy report (backup). 3. Demonstrated the ability to assemble and dispatch field monitoring teams. Standard Criteria: a. An onsite Field Monitoring Team is ready to be deployed within 60 minutes of being requested from the declaration of an Alert or higher. 4. Demonstrated 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. Radiological data disseminated from the Field Team to the Offsite Field Team Coordinator/ Communicator. 5. Demonstrated the ability to develop dose projections. Standard Criteria: a. The Shift Radiation Protection Technician performed timely and accurate dose projections, in accordance with the EPIPs. 6. Demonstrated the ability to develop appropriate protective action recommend-ations (PARs), and notified New Jersey and Delaware within 15 minutes of a General Emergency declaration or of an update of the previously issued PARs. Standard Criteria: a. Total Effective Dose Equivalent (TEDE) and Committed Dose Equivalent (CDE) dose projections from the dose assessment computer code, established in accordance with the EPIPs.

			b. PARs developed within 15 minutes of data availability. c. PARs transmitted via voice, fax, or electronically within 15 minutes, as required by the EPIPs.
			F. Public Information 1. Demonstrated the capability to develop and disseminate clear, accurate, and timely information to the news media. Standard Criteria: a. Media briefings provided within approximately 60 minutes of activation of the ENC/JIC. 2. Demonstrated the capability to establish and effectively operate rumor control in a coordinated fashion. Standard Criteria: a. Calls answered in a timely manner with the correct information. b. Calls returned or forwarded, as appropriate, to demonstrate responsiveness. c. Rumors identified and addressed.
			G. Evaluation 1. Demonstrated the ability to conduct a

			post-exercise critique, to determine areas requiring improvement and corrective action. Standard Criteria: a. Drill and Exercise objectives developed to allow for performance evaluation. b. Significant problems in achieving the objectives discussed to ensure understanding of why objectives were not fully achieved.

			8.1.2 Onsite emergency response personnel were mobilized in sufficient numbers to fill emergency response positions identified in Emergency Plan Section 3, Emergency Organization, and they successfully performed assigned responsibilities.
			8.1.3 The exercise was completed within the specified time periods of Appendix E to 10 CFR Part 50, offsite exercise objectives were met, and there were no uncorrected offsite exercise deficiencies; or a license condition requires offsite deficiencies to be corrected prior to operation above 5 percent of rated thermal power.

9.0 Implementing Procedures			
10 CFR Part 50, Appendix E.V - No less than 180 days before the scheduled issuance of an operating license for a nuclear power reactor or a license to possess nuclear material, the applicant's detailed implementation procedures for its emergency plan shall be submitted to the Commission.	9.1 The licensee has submitted detailed implementation procedures for its emergency plan no less than 180 days before fuel load.	9.1 An inspection of the submittal letter will be performed.	9.1 The licensee has submitted detailed EPIPs for the onsite emergency plan no less than 180 days before fuel load.

13.6 Physical Security

13.6.1 Introduction

The early site permit (ESP) application for the PSEG Site, submitted by PSEG Power, LLC, and PSEG Nuclear, LLC (the applicant), describes the site characteristics applicable to security and provides information to demonstrate that security plans and measures can be developed in accordance with the applicable requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 73.55, "Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors against Radiological Sabotage," and 10 CFR 100.21(f). Within Chapter 1, "Introduction and General Description," Chapter 2, "Site Characteristics and Site Parameters," and Chapter 13, "Conduct of Operations," Section 13.6, "Industrial Security," of the Site Safety Analysis Report (SSAR), contained in Part 2 of the PSEG ESP application, the applicant described the characteristics of the proposed site and the bounding parameters that establish the Plant Parameter Envelope (PPE) within which a reactor design will be selected before applying for a combined license (COL) for construction and operation of one or two units.

The applicant's proposed site (referred to as PSEG Site) is located in the Lower Alloways Creek Township, Salem County, NJ, on the southern part of Artificial Island on the eastern bank of the Delaware River, it is adjacent to and bordered on the west and south by the low coastal plain - tidal affected area of the Delaware River. The proposed site comprises a 734-acre PSEG property surrounded by extensive marshlands, and meadowlands. The layout of the PSEG Site is provided in SSAR Figure 1.2-3, "Site Utilization Plan," and in the aerial photograph in Figure 2.1-3, "View of PSEG Site," of the Environmental Report (ER) contained in Part 3 of the ESP application.

13.6.2 Summary of Application

SSAR Chapter 1, "Introduction and General Description," and SSAR Chapter 2, "Site Characteristics and Site Parameters," provide information on the specific site location, site description, various site maps and, PSEG Site aerial photographs that depict site topography. The application includes descriptions and depictions of the locations of existing industrial facilities, power generating stations, sewage treatment plants, pipelines, waterways, mining

operations, highways, railroads, airports, airways, and military facilities. The application also provides descriptions and evaluations of potential hazards within the vicinity of the site (explosions, flammable vapor clouds, toxic chemicals, fires, liquid spills, radiological hazards, dam failures, etc.) including natural hazards, such as floods, ice, and seismic activity. SSAR Section 13.6, "Industrial Security," describes site characteristics to address the applicable regulatory requirements for the PSEG Site to be such that adequate security plans and measures can be developed.

SSAR Chapters 1 and 2 and the ER include diagrams that provide (or identify) site layout depictions including a center-point reference to the proposed Power Block location inside a 70-acre land mass, and located at U.S. National Grid (NAD83); longitude: 75° 32′ 24.3316″; latitude: 39° 28′ 23.7436″. The diagrams also depict other features of interest such as an overall layout of the location of the site, which is north of Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS), and a proposed Exclusion Area Boundary (EAB) that will encompass the new plant. SSAR Chapters 1 and 2 and the ER also describe other manmade features such as a proposed barge slip, intake structures, and an existing Hope Creek fuel oil storage tank. The PSEG Site Utilization Plan map in SSAR Figure 1.2-3, coupled with the aerial photograph of ER Figure 2.1-3, provides information that can be used to assess additional manmade and natural features.

13.6.3 Regulatory Basis

The provisions of 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Subpart A, "Early Site Permits," establishes the requirements and procedures applicable to the U.S. Nuclear Regulatory Commission (NRC) issuance of an ESP for approval of a site for one or more nuclear power facilities separate from the filing of an application for a construction permit or a COL for the facility.

Provisions in 10 CFR 52.17, "Contents of Applications; Technical Information" set forth the requirements for the contents and technical information to be submitted in applications under this subpart:

- 10 CFR 52.17(a)(1)(x), as it relates to the requirement for submission of information to demonstrate that the site characteristics are such that adequate security plans and measures can be developed.

- 10 CFR 52.17(a)(1)(xii), as it relates to the requirement for submission of an evaluation of the site against applicable sections of the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application.

The provisions in 10 CFR 73.55, "Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage," set forth the requirements for power reactor licensees and applicants to establish and maintain a physical protection program, including a security organization, which will have as its objective to provide high assurance that activities involving special nuclear material are not harmful to the common defense and security and do not constitute an unreasonable risk to public health and safety.

The provisions in 10 CFR 100.21, "Non-seismic siting criteria," set forth the requirements regarding non-seismic siting criteria for proposed commercial power reactor sites.

- 10 CFR 100.21(f), as it relates to the requirement that site characteristics to be such that adequate security plans and measures can be developed.

Acceptance criteria adequate to meet the above requirements include those set forth in:

1. Regulatory Guide (RG) 4.7, “General Site Suitability Criteria for Nuclear Power Stations,” Revision 2, April 1998, as it relates to the suitability criteria for a proposed site.

2. NUREG 0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” Chapter 13, “Conduct of Operations,” Section 13.6.3, “Physical Security – Early Site Permit,” Revision 1; October 2010[6], as it relates to the review of physical security aspects of a permit application for a proposed site.

13.6.4 Technical Evaluation

In conducting the technical evaluation of the information contained in SSAR Chapter 13, “Conduct of Operations,” Section 13.6 “Industrial Security”, the staff also reviewed the pertinent information and figures contained in the following SSAR chapters and sections:

- Chapter 1, “Introduction and General Discussion”; Section 1.1, “Introduction”; Section 1.2, “General Plant Description”

- Chapter 2, “Site Characteristics and Site Parameters”; Section 2.0, “Site Characteristics”; Section 2.1, “Geography and Demography”; Section 2.2, “Identification of Potential Hazards in Site Vicinity”; and Section 2.4, “Hydrologic Engineering”

- Chapter 3, “Design of Structures, Components, Equipment and Systems”; Section 3.5.1.6, “Aircraft Hazards”; Section 3.5.1.6.1, “Airports”; Section 3.5.1.6.2, “Military Airports and Routes”; Section 3.5.1.6.3. “Airways”; and Section 3.5.1.6.4, “References”

In addition, the staff reviewed the pertinent information and figures contained in the ER, Chapters 1 and 2, to confirm information regarding the site characteristics, and to ensure information in the SSAR and ER, applicable to the review of physical security, is consistent.

The staff review focused on (1) whether the information in the application meets the requirements stated in 10 CFR 52.17(a)(1)(x) to demonstrate that the site is such that security plans and measures can be developed, (2) that the applicant has considered the applicable physical protection requirements stated in 10 CFR 73.55 in the selection of the site and its proposed layout, (3) that the information in the application related to the site characteristics and potential hazards provided sufficient technical basis to demonstrate that the site characteristics and potential hazards do not present impediments to preclude the development of adequate security plans and measures consistent with 10 CFR 100.21(f).

The staff review also included information the applicant submitted in response to Requests for Additional Information (RAI) 3, Questions 13.06.03-1, 13.06.03-2, 13.06.03-4, 13.06.03-5, and RAI 17, Question 13.06.03-6. These are discussed in the following sections of this report.

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[6] The staff utilized Revision 1 (October 2010) of NUREG-0800 (SRP), Section 13.6.3, for the ESP application physical security review. The changes between the 2007 and 2010 versions were addressed by means of RAIs; therefore, Revision 1 is the referenced SRP Section 13.6.3 revision for this ESP review.

13.6.4.1 Security Boundaries

In SSAR Section 13.6, the applicant stated: "The PSEG site is sufficiently large to provide adequate distances between structures and the probable location of security boundaries." The applicant also stated the following: "When a reactor technology selection is made and a combined license application is prepared, the specific design features to assure site security in compliance with 10 CFR 73.55, will be defined."

SSAR Figure 1.2-3 depicts the new PSEG property lines, EAB, plant parameters for the proposed new plant Power Block and related facilities, and water structures as well as the existing PSEG property lines, plant facilities and boundaries of Salem and Hope Creek Generating Stations. In addition, SSAR Figure 1.2-3 identifies the center-point reference to the proposed Power Block location inside a 70-acre land mass, and located at U.S. National Grid (NAD83); longitude: 75° 32′ 24.3316″; latitude: 39° 28′ 23.7436″. Along with the proposed Power Block location, SSAR Figure 1.2-3 depicts two large land masses directly adjacent to the Power Block land mass designated for the construction of plant support equipment, specifically a bounding 25-acre area adjoining the eastern boundary of the proposed Power Block location designated for the new plant switchyard and a bounding 50-acre area adjoining the northern boundary of the proposed Power Block area designated for new safety-related water sources (e.g., cooling towers).

On the basis of its review, the staff finds:

- The information contained in the application is consistent with the requirements of 10 CFR 52.17(a)(1)(x) and provides a sufficient basis to conclude that site characteristics regarding the establishment of security boundaries are such that adequate security plans and measures can be developed.

- Based on the information contained in the application, the postulated plant parameters, which consist of the new plant site center within the 70-acre proposed Power Block land mass enveloped within the PSEG proposed new property line and exclusion area, are sufficiently large enough to allow for the establishment of the security boundaries of the owner controlled area (OCA), protected area (PA), and protected area perimeter isolation zones, with sufficient distance between these security boundaries and vital areas, for the implementation of a physical protection program consistent with the requirements of 10 CFR 73.55.

13.6.4.2 Site Characteristics

In SSAR Chapters 1 and 2, the applicant describes and depicts the site characteristics and potential nearby hazards. Specifically, SSAR Figure 1.2-3 depicts and identifies features of the overall layout of the site, the proposed EAB as well as existing facilities and structures and other manmade features, such as, a proposed barge slip, intake structures, and industrial hazards. In addition, SSAR Figure 1.2-3 identifies the center-point reference to the proposed Power Block location inside a 70-acre land mass, and located at U.S. National Grid (NAD83); longitude: 75° 32′ 24.3316″; latitude: 39° 28′ 23.7436″. Along with the proposed Power Block location, SSAR Figure 1.2-3 depicts two large land masses directly adjacent to the Power Block land mass that are designated for the construction of plant support equipment. Specifically, the figure depicts a bounding 25-acre area adjoining the eastern boundary of the proposed Power Block location designated for the new plant switchyard and a bounding 50-acre area adjoining

the northern boundary of the proposed Power Block area designated for new water sources (e.g., cooling towers).

In SSAR Section 13.6, “Industrial Security,” the applicant stated, in part:

> The characteristics of the new plant footprint are such that the applicable requirements of the following are met: 10 CFR 73.55, Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage; NRC Regulatory Guide 4.7, General Site Suitability Criteria for Nuclear Stations; NEI 03-12, Template for Security Plan and Training and Qualification Plan; EA-03-086, Revised Design Basis Threat Order.

In RAI 3, Question 13.06.03-1, the staff requested that the applicant clarify the requirements referenced in the above quoted statement of the application. In a February 14, 2011, response to RAI 3, Question 13.06.03-1, the applicant clarified that the requirements referenced in SSAR Section 13.6 and as identified in the RAI, are the requirements stated in 10 CFR 73.55, “Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage.” The applicant identified that the remaining references listed in SSAR Section 13.6 are NRC and industry guidance to which PSEG will conform.

The staff finds the applicant’s February 14, 2011, response to RAI 3, Question 13.06.03-1 acceptable because the applicant clarified the statement identifying the requirements and guidance in SSAR Section 13.6. The applicant committed to revise SSAR Section 13.6 to incorporate clarifying changes in response to RAI 3, Question 13.06.03-1. The staff confirmed that SSAR Revision 1, dated May 21, 2012, was revised as committed in the RAI response. Accordingly, the staff finds the applicant adequately addressed this issue and, therefore, considers RAI 3, Question 13.06.03-1 resolved.

On the basis of its review, the staff finds:

- The information contained in the application is consistent with the requirements stated in 10 CFR 52.17(a)(1)(x), and along with the applicant’s response to RAI 3, Question 13.06.03-1, provides sufficient basis to conclude that site characteristics regarding the installation of physical protection equipment and the implementation of a physical protection program are such that adequate security plans and measures can be developed.

- Based on the information contained in the application, the characteristics and topographical features of the PSEG Site will not pose an impediment to the implementation of a physical protection program. The proposed Power Block location inside the 70-acre land mass is of sufficient size for the installation of intrusion detection and assessment equipment, physical barriers, vehicle checkpoints and search areas (sally ports), and will accommodate the implementation of a physical protection program consistent with the requirements of 10 CFR 73.55.

13.6.4.3 Approaches

In SSAR Section 2.2.2.5, “Highways,” the applicant described existing approaches or roadways to the PSEG Site. In SSAR Section 2.2.2.6, “Railroads,” the applicant addressed railroad lines that are in the vicinity of the site and identified that the closest railroad line is 13. 2 km (8.2 mi) to the northeast and there are no plans for expansion at this time.

SSAR Section 2.2.2.7, “Airports, Airways, and Military Training Routes,” identifies private airports, helipads, and heliports in the vicinity of the PSEG Site. An existing helipad is owned and operated by PSEG and is located 1172.87 m (3,848 ft) southeast of the proposed 70-acre Power Block location. Operations on the PSEG helipad are limited to medical emergencies and corporate use.

SSAR Chapter 3, “Design of Structures, Components, Equipment, and Systems,” Section 3.5.1.6.1, “Airports,” identifies eight airports and helipads within 8-16 km (5-10 mi) of the proposed plant location at the PSEG Site, and that the Salem/Hope Creek helipad is located within 8 km (5 mi) of the proposed plant location at the PSEG Site and exists for corporate and emergency use. SSAR Section 3.5.1.6.2, “Military Airports and Routes,” indicates that the New Castle County Airport is the closest facility with military operations (Air National Guard), and is located 23.3 km (14.5 mi) northeast of the site. The closest dedicated military facility is Dover Air Force Base, located 38.3 km (23.8 mi) from the PSEG Site.

In RAI 3, Question 13.06.03-2, the staff requested that the applicant address any proposed construction or planning of roadways or approaches to the proposed facility. In a February 14, 2011, response to RAI 3, Question 13.06.03-2, the applicant stated that a new second road in the form of a causeway is proposed for vehicular access to the site. The proposed causeway is conceptually designed as a 48-foot wide elevated structure that extends from the PSEG Site 7.6 km (4.7 mi) towards the northeast along, or adjacent to, the existing Red Lion 500 kV transmission right-of-way to the intersection of Money Island Road and Mason Point Road in Elsinboro Township. The proposed causeway's land approach to the PSEG Site is depicted in SSAR Figure 1.2-3.

The staff finds the applicant’s February 14, 2011, response to RAI 3, Question 13.06.03-2 acceptable because the applicant provided additional information regarding proposed roadways or approaches to the PSEG Site, thereby enabling evaluation of the site’s proposed roadways or approaches against the applicable requirements in 10 CFR 73.55. The applicant committed to revising SSAR Section 2.2.2.5, “Highways,” to incorporate clarifying changes in response to RAI 3, Question 13.06.03-2. The staff confirmed that the SSAR Revision 1, dated May 21, 2012, was revised as committed in the RAI response. Accordingly, the staff finds the applicant adequately addressed this issue and, therefore, considers RAI 3, Question 13.06.03-2, resolved.

SSAR Section 13.6 discusses a modification of current SGS and HCGS Coast Guard agreements to control the area of the Delaware River in the vicinity of these sites, which will address the inclusion of the new plant at the proposed PSEG Site.

In RAI 3, Question 13.06.03-4, the staff requested that the applicant provide information to address all primary and secondary waterways navigable or accessible that provide access to the PSEG Site. In a February 14, 2011, response to RAI 3, Question 13.06.03-4, the applicant stated that the only navigable waterway that provides water access to the PSEG Site is the Delaware River, which runs along the western border of the PSEG Site. SSAR Figure 2.5.1-30, “New Plant Location Aerial Photography,” depicts a coastal salt marsh complex comprised of small creeks and tributaries that border the northern and eastern edge of the PSEG Site. In addition, SSAR Figure 2.5.1-30 depicts approximately 11 defined creeks within the 0.96 km (0.6 mi) radius. The creeks generally decrease in width as they approach the vicinity of the proposed 70-acre Power Block area shown on SSAR Figure 1.2-3. The creeks range in width from approximately 9.14 m (30 ft) at the outer radius of SSAR Figure 2.5.1-30 to a width of

approximately 0.6-1.52 m (2-5 ft) for the streams closest to the vicinity of the proposed Power Block. All of these creeks are tidally influenced and most are less than 0.61-0.91 m (2-3 ft) deep at high tide, at low tide, they are essentially mudflats. The characteristics of these creeks and streams are such that traditional navigability is highly limited or nonexistent and accessibility to most of these disbursed channels and creeks would be tidally dependent.

The staff finds the applicant's February 14, 2011, response to RAI 3, Question 13.06.03-4, acceptable because the applicant provided additional detailed information about the navigability of surrounding primary or secondary waterways, thereby enabling evaluation of the site waterways against the applicable requirements of 10 CFR 73.55. Accordingly, the staff considers RAI 3, Question 13.06.03-4 resolved.

In SSAR Section 2.2, "Identification of Potential Hazards in Site Vicinity," the applicant described nearby existing road transportation routes and vehicular land approaches that pose potential risks or hazards to the proposed PSEG Site. The closest primary road providing paved access to the proposed site is New Jersey Highway 49, where sole endpoint access to the proposed PSEG Site will continue on the secondary Alloway Creek Neck Road. The only highway within 5 miles of the PSEG Site is Delaware Route 9, which at its closest point is 4.96 km (3.1 mi) west of the proposed Power Block area. SSAR Figure 1.2-3 and the aerial photograph in ER Figure 2.1-3 do not depict the existence of secondary routes or dirt roads.

Therefore, in RAI 17, Question 13.06.03-6, the staff requested that the applicant identify, characterize, and depict the location of secondary roads, trails and routes leading to the proposed site. In an April 5, 2011, response to RAI 17, Question 13.06.03-6, the applicant stated that SSAR Section 2.2 identifies, characterizes, and depicts the transportation routes within 16 km (10 mi) of the PSEG Site. The applicant also stated that SSAR Section 2.2.1 identifies all transportation routes within 8 km (5 mi) of the PSEG Site and references SSAR Figure 2.2-1, which visually depicts highways, roads, and railroads within 8-16 km (5-10 mi) of the PSEG Site. SSAR Figure 2.2-1 depicts the surrounding public roadways in close proximity to the PSEG Site including Alloway Creek Neck Road, which is the closest public road to the PSEG Site. SSAR Section 2.2.2.5 characterizes Alloway Creek Neck Road as a secondary road that eventually transitions into the dedicated plant access road leading to the PSEG Site. SSAR Figure 1.2-3 depicts onsite roadways designated for operating plant ingress/egress. The onsite roadways are also used by the U.S. Army Corp of Engineers to access the Confined Disposal Facilities north of the PSEG Site via a dirt road traversing the shoreline north of the PSEG Site. Additionally, the applicant stated that aside from the existing access road, there are currently no other secondary roads, trails or routes that provide pedestrian or vehicular access to the PSEG Site.

The staff finds the applicant's April 5, 2011, response to RAI 17, Question 13.06.03-6, acceptable because the applicant confirmed that there are no additional approaches, such as secondary roads, trails and routes, to be included in the evaluation of the site's land approaches other than those described and depicted in the above identified SSAR sections and figures. Accordingly, the staff considers RAI 17, Question 13.06.03-6 resolved.

On the basis of its review, the staff finds:

- The information contained in the application is consistent with the requirements stated in 10 CFR 52.17(a)(1)(x) and, along with the applicant's responses to RAI 3, Question 13.06.03-2; RAI 3, Question 13.06.03-4; and RAI 17, Question 13.06.03-6, provides a sufficient basis to conclude that site characteristics regarding the identification of

approaches to the site that may require security control measures are such that adequate security plans and measures can be developed.

- Based on the information contained in the application, the approaches to the proposed PSEG Site do not present impediments to the implementation of a physical protection program. The approaches to the proposed site (e.g., barge slips, main access road, transportation routes, cliffs, depressions, hills, mounds, open waterways, and trails, roadways or railways) can be addressed and managed through the implementation of a physical protection program consistent with the requirements of 10 CFR 73.55.

13.6.4.4 Industrial Hazards

As to nearby facilities and pipelines that may pose potential hazards to the PSEG Site development of adequate security plans and measures, the applicant states in SSAR Section 13.6, "Based on review of nearby facilities, there are no potential hazards in the vicinity of the PSEG Site."

In SSAR Section 2.2.2.2, "Pipelines," the applicant stated: "No natural gas or hazardous liquid pipelines are located within 5 miles of the proposed PSEG site." Additionally, the nearest gas transmission line runs parallel to U.S. Route 13, and is located 9.5 km (5.9 mi) west of the proposed Power Block area. In a June 17, 2010, teleconference with PSEG, the applicant stated that no new pipelines are currently being considered to be built in the area.

In SSAR Section 2.2, "Identification of Potential Hazards in Site Vicinity," Tables 2.2-1 through 2.2-22, the applicant provided information on potential hazards at and within 8-16 km (5-10 mi) of the PSEG Site. This includes potential hazards as industrial facilities, chemical storage locations, and transportation routes.

On the basis of its review, the staff finds:

- The information contained in the application is consistent with the requirements stated in 10 CFR 52.17(a)(1)(x), and provides a sufficient basis to conclude that site characteristics about potential industrial hazards to the site are such that adequate security plans and measures can be developed.

- The information contained in the application identifies there is sufficient spatial separation between the proposed PSEG Site and the potential industrial hazards within the vicinity of the site such that the potential industrial hazards do not present impediments that would preclude the implementation of a physical protection program consistent with the requirements of 10 CFR 73.55.

13.6.4.5 Unattended Openings

To evaluate the information about unattended openings that intersect security boundaries, the staff reviewed SSAR Section 2.1, "Geography and Demography"; SSAR Section 13.6, "Industrial Security"; and SSAR Figure 1.2-3 and the aerial photograph in ER Figure 2.1-3 that depict the 70-acre bounding location of the Power Block in which the PSEG Site's protected area will be established. The staff was unable to locate sufficient information in the SSAR or ER to address unattended openings that intersect a security boundary. Therefore, in RAI 3, Question 13.06.03-5, the staff requested that the applicant provide descriptions and locations of planned or existing culverts or unattended openings. In a February 14, 2011, response to

RAI 3, Question 13.06.03-5, the applicant stated that a reactor technology for the proposed plant at the PSEG Site had not yet been chosen, and that the location and design details on planned culverts and openings associated with the stormwater management systems have not been determined yet. The applicant also confirmed that upon selecting a reactor technology, detailed engineering associated with any designed culverts or openings as part of the site drainage plan will be developed and security attributes of these openings will be addressed in the formal Security Plan developed and submitted as part of the COL application.

Additionally, the applicant stated that the pre-existing culverts and openings relative to the PSEG Site delineated in SSAR Figure 1.2-3 and ER aerial photograph Figure 2.1-3 will be altered or eliminated as part of the excavation process for the new plant. A significant portion of the 70-acre Power Block area, delineated in the Site Utilization Plan shown on SSAR Figure 1.2-3, will be excavated to a depth of 18.29-22.86 m (60-75 ft). The depth of excavation will depend on the selected reactor technology and the final location of safety related structures within the Power Block boundary. This excavation will then be backfilled with structural fill or lean concrete. The scale of this excavation, which is described in SSAR Section 2.5.4.5 and depicted in SSAR Figures 2.5.4.5-1 and 2.5.4.5-2, will significantly alter or eliminate any pre-existing culverts or openings.

The staff finds the applicant's February 14, 2011, response to RAI 3, Question 13.06.03-5, acceptable because the applicant indicated that existing culverts would be altered or eliminated during site excavation. The applicant also confirmed that the security attributes of unattended openings that intersect security boundaries would be addressed within its COL application. The staff maintains that a COL action item is not warranted since the requirement of 10 CFR 73.55(i)(5)(iii) for the protection of unattended openings that intersect a security boundary will be addressed at the COL stage. Accordingly, the staff considers RAI 3, Question 13.06.03-5, resolved.

On the basis of its review, the staff finds:

- The information contained in the applicant's February 14, 2011, response to RAI 3, Question 13.06.03-5, is consistent with the requirements stated in 10 CFR 52.17(a)(1)(x), and provides a sufficient basis to conclude that site characteristics with the proposed alteration or elimination of the existing unattended openings that intersect a security boundary are such that adequate security plans and measures can be developed.

- Based on the information provided in the applicant's February 14, 2011. response to RAI 3, Question 13.06.03-5, in which the applicant confirmed that existing culverts or openings will be altered or eliminated during site excavation and that the security attributes of any planned and designed unattended openings that intersect a security boundary will be addressed in the COL application consistent with the requirements of 10 CFR 73.55, the existing unattended openings do not present an impediment to the implementation of a physical protection program.

13.6.5 Conclusion

As described above, the staff concludes that the applicant provided sufficient technical basis to demonstrate that the site characteristics and potential hazards do not present impediments that would preclude the development of adequate security plans and measures. The staff also concludes that the PSEG Site is such that adequate security plans and measures can be developed consistent with the requirements in 10 CFR 100.21(f).

15. TRANSIENT AND ACCIDENT ANALYSIS

15.0 <u>Accident Analysis</u>

15.0.3 Radiological Consequences of Design Basis Accidents

15.0.3.1 Introduction

This section of the report describes the U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of the information provided in Chapter 15, "Transient and Accident Analysis," of the Site Safety Analysis Report (SSAR), contained in Part 2 of the PSEG Site early site permit (ESP) application. The information in Chapter 15 describes the radiological consequences of design basis accidents (DBAs) for four standard reactor designs: (1) Single Unit U.S. EPR; (2) Single Unit Advanced Boiling Water Reactor (ABWR); (3) Dual Unit Advanced Passive 1000 (AP1000); and (4) Single Unit U.S. Advanced Pressurized-Water Reactor (US-APWR) to demonstrate that one or two 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 in Title 10 of the *Code of Federal Regulations* (10 CFR), Section 52.17, "Contents of Applications," and 10 CFR Part 100, "Reactor Site Criteria."

15.0.3.2 Summary of Application

As provided in the SSAR, the applicant used the design parameter source terms associated with each of the four chosen standard designs in conjunction with site characteristic atmospheric dispersion factors to demonstrate the suitability of the proposed ESP site. As part of the plant parameter envelope (PPE), the applicant used the source term developed for each of the following design-basis accidents (DBAs) for each of the standard designs (as applicable):

- Pressurized Water Reactor (PWR) steam system piping failures inside and outside of containment
    - o (AP1000, U.S. EPR, and US-APWR)
- Boiling Water Reactor (BWR) and PWR coolant pump shaft seizure (locked rotor)
    - o (ABWR, AP1000, U.S. EPR, and US-APWR)
- PWR rod ejection accident
    - o (AP1000, U.S. EPR, and US-APWR)
- BWR spectrum of rod drop accidents
    - o (ABWR)
- BWR and PWR failure of small lines carrying primary coolant outside containment
    - o (ABWR, AP1000, U.S. EPR, and US-APWR)
- PWR steam generator tube rupture
    - o (AP1000, U.S. EPR, and US-APWR)

- BWR main steam line break
    - (ABWR)
- BWR and PWR loss-of-coolant accident
    - (ABWR, AP1000, U.S. EPR, and US-APWR)
- BWR and PWR fuel handling accident
    - (ABWR, AP1000, U.S. EPR, and US-APWR)

In SSAR Chapter 15, the applicant addressed: (1) The selection of the above DBAs related to four standard designs; (2) the evaluation methodology for DBAs; (3) the source terms; and (4) the radiological consequences of each DBA pertaining to each standard design.

The applicant calculated and provided site characteristic short-term accident atmospheric dispersion factors (χ/Qs) at the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ), using methodology in Regulatory Guide (RG) 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," and site-specific meteorological data. The applicant also presented the dose assessment results for the postulated DBAs listed above at the proposed EAB and the LPZ in SSAR Tables 15.4-2 (US-APWR), 15.4-4 (ABWR), 15.4-10 (AP1000), and 15.4.-19 (U.S.EPR), which demonstrate that the potential doses would be within the radiological consequence evaluation factors set forth in 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1). In SSAR Tables 15.3-1 through 15.3-33, the applicant provided accident-specific source terms (release rates of radioactive materials to the environment for each DBA pertaining to each standard reactor design). The resulting site-specific dose consequences are also presented in the SSAR for each DBA and standard design.

15.0.3.3 Regulatory Basis

The applicable NRC regulatory requirements for the radiological dose consequences analyses of DBAs include the following:

- 10 CFR 52.17, "Contents of applications; technical information," as it relates to the assessment that must contain analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in paragraphs (a)(1)(ix)(A) and (a)(1)(ix)(B) of this section.
- 10 CFR Part 100, "Reactor Site Criteria," as it relates to considering evaluation factors for stationary power reactor Site Applications on or after January 10, 1997, to demonstrate that the radiological dose consequences of postulated accidents shall meet the criteria set forth in 10 CFR 50.34(a)(1) for type of facility proposed to be located at the PSEG Site.
- 10 CFR 50.34, "Contents of applications; technical information," as it relates to a description and safety assessment of the site and safety assessment of facility.

The acceptance criteria adequate to meet the above requirements are located in the following guidance and reference documents:

- RG 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,” as it relates to providing an acceptable methodology for determining site-specific relative concentrations (χ/Q) that include considerations of plume meander, directional dependence of dispersion conditions, and wind frequencies for various locations around actual exclusion area and LPZ boundaries.

- RG 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,” as it relates to providing guidance to licensees of operating power reactors’ acceptable applications of alternative source terms (AST); the scope, nature, and documentation of associated analyses and evaluations; considerations of impacts on analyzed risk; and content of submittals; and also identifies acceptable radiological analysis assumptions for use in conjunction with the accepted AST.

- Review Standard (RS)-002, “Guidance for Processing Applications for Early Site Permits,” as it relates to providing guidance on the staff’s process for reviewing an ESP application and developing the Safety Evaluation Report (SER) with specific technical and format guidance.

- RG 1.3, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors,” as it relates to providing guidance with acceptable assumptions that may be used in evaluating the radiological consequences of loss of coolant accident (LOCA) for a boiling water reactor.

- RG 1.25, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors,” as it relates to providing guidance with acceptable assumptions that may be used in evaluating the radiological consequences of a fuel handling accident in the fuel handling and storage facility resulting in damage to fuel cladding and subsequent release of radioactive material for boiling and pressurized water reactors.

- NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” as it relates to providing guidance to staff to perform safety reviews of applications to construct or operate nuclear power plants and the review of applications to approve standard designs and sites for nuclear power plants, to assure the quality and uniformity of staff safety review.

- Technical Information Document (TID)-14844, “Calculation of Distance Factors for Power and Test Reactor Sites” (March 23, 1962, Agencywide Documents Access and Management System (ADAMS) Accession number ML083380438), as it relates to providing guidance in siting evaluations and in using source terms in other design basis applications and being cited in 10 CFR Part 100 as a source of further guidance on siting analyses.

As required in 10 CFR 52.17(a)(1), ESP applications must contain an analysis and evaluation of the major systems, structures, and components (SSCs) of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in the requirements of 10 CFR 52.17(a)(1)(ix). In addition, the ESP site characteristics must comply with the requirements of 10 CFR 100.21, “Non-Seismic Siting Criteria,” which states that radiological dose consequences of postulated accidents shall meet the criteria set forth in

10 CFR 50.34(a)(1). The radiological dose reference values in 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1) for a postulated fission product release based on a major accident are as follows:

- 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 roentgen equivalent man (rem) total effective dose equivalent (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.

15.0.3.4 Technical Evaluation

Using the guidance listed above, the staff reviewed SSAR Chapter 15 for compliance with the applicable regulations. Although the applicant is using the PPE approach, for the DBA radiological consequence analyses source terms for DBAs from four standard reactor designs (i.e., U.S. EPR, ABWR, US APWR, and AP1000) were evaluated individually. The applicant evaluated the suitability of the site using reactor source terms and radiological consequences based on each of the reactor technology designs, as well as site characteristic atmospheric dispersion factor (χ/Q) values.

15.0.3.4.1 Selection of Design Basis Accidents

The applicant assessed each of the DBAs that are evaluated in the design control document for each of the standard reactor designs considered. These DBAs are categorized in Section 15.0.3.2 of this report. The staff finds that the applicant selected DBAs consistent with the DBAs listed in NUREG-0800, Chapter 15 for large light-water reactors. Therefore, the staff finds that the applicant provided an acceptable DBA selection for evaluating the compliance of the proposed ESP site with the dose consequence evaluation factors specified in 10 CFR 52.17(a)(1).

15.0.3.4.2 Site Characteristic Short-Term Atmospheric Dispersion Factors

Site characteristic short-term atmospheric dispersion factors are used in the radiological consequences analyses to characterize the effect of the site-specific meteorological conditions, topography, and distance to either EAB or LPZ on dose at the offsite receptors for purposes of siting. The applicant calculated short-term accident χ/Qs using RG 1.145 methodology and site-specific meteorological data. The staff's evaluation of the site characteristic short term χ/Q values is described in Section 2.3.4 of this report. Table 15.0.3.4.2-1 of this report lists the site characteristic short-term χ/Q values calculated by the applicant.

Table 15.0.3.4.2-1 Site Characteristic Short-Term χ/Q Values

Location	Time (hr)	Site Characteristic χ/Q (sec/m^3)
EAB	0-2	4.71×10^{-4}
LPZ	0-8	8.47×10^{-6}
LPZ	8-24	5.50×10^{-6}

Location	Time (hr)	Site Characteristic χ/Q (sec/m^3)
LPZ	24-96	2.15×10^{-6}
LPZ	96-720	5.60×10^{-7}

15.0.3.4.3 Radiological Consequences

The DBA radiological consequences analyses in the design control document (DCD) for each standard design used design reference values for the accident atmospheric dispersion factors in place of site specific values. The χ/Q values are the only input to the DBA radiological consequences analyses that are affected by the site characteristics. The estimated DBA dose calculated for a particular site is affected by the site characteristics through the calculated χ/Q input to the analysis; therefore, the resulting dose would be different than that calculated generically for the standard design in the DCD. All other inputs and assumptions in the radiological consequences analyses remain the same as in the DCD. Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses.

For each standard design considered, the applicant provided the postulated time-dependent release rate of radionuclides (source terms) to the environment during each DBA. Descriptions of these design-specific source terms are found in the design control document (DCD) for each standard design. The applicant incorporated these source terms into SSAR Tables 15.3-1 through 15.3-33. Different standard designs use different source terms and approaches to define the activity releases. The ABWR source terms, methodologies, and assumptions are based on the guidance in NUREG-0800, RG 1.3, and RG 1.25, and the AP1000, U.S. EPR, and US-APWR source terms are based on the alternative source term guidance outlined in RG 1.183. Because the applicant used DBA source terms derived from analyses from DCDs that are either from certified standard designs or from DCDs that are undergoing NRC review, the staff finds the PSEG SSAR DBA source terms to be not unreasonable as part of the PPE for showing compliance with requirements of 10 CFR 52.17(a)(1)(ix).

To determine the potential doses resulting from DBAs at the proposed site, the applicant used the site characteristic χ/Q values in conjunction with the DBA doses calculated using site parameter χ/Q values that were provided in each DCD. The estimated site characteristic χ/Q values for the proposed site are lower than the corresponding site parameter χ/Q values, as summarized in Tables 15.0.3.4.3-1 through 15.0.3.4.3-4 of this report.

Table 15.0.3.4.3-1 Site Parameter Short Term χ/Q Values for ABWR and Comparison to Site Characteristic χ/Qs

Location	Release Time (hr)	Site Parameter χ/Q (sec/m^3)	Site Characteristic χ/Q (sec/m^3)	χ/Q Ratio (Characteristic: Parameter)
EAB	0-2	1.37×10^{-3}	4.71×10^{-4}	0.344
LPZ	0-8	1.56×10^{-4}	8.47×10^{-6}	0.054
LPZ	8-24	9.61×10^{-5}	5.50×10^{-6}	0.057
LPZ	24-96	3.36×10^{-5}	2.15×10^{-6}	0.064
LPZ	96-720	7.42×10^{-6}	5.60×10^{-7}	0.075

Table 15.0.3.4.3-2 Site Parameter Short-Term χ/Q Values for AP1000 and Comparison to Site Characteristic χ/Qs

Location	Release Time (hr)	Site Parameter χ/Q (sec/m3)	Site Characteristic χ/Q (sec/m3)	χ/Q Ratio (Characteristic: Parameter)
EAB	0-2	5.1×10^{-4}	4.71×10^{-4}	0.924
LPZ	0-8	2.2×10^{-4}	8.47×10^{-6}	0.039
LPZ	8-24	1.6×10^{-4}	5.50×10^{-6}	0.034
LPZ	24-96	1.0×10^{-4}	2.15×10^{-6}	0.022
LPZ	96-720	8.0×10^{-5}	5.60×10^{-7}	0.007

Table 15.0.3.4.3-3 Site Parameter Short-Term χ/Q Values for U.S. EPR and Comparison to Site Characteristic χ/Qs

Location	Release Time (hr)	Site Parameter χ/Q (sec/m^3)	Site Characteristic χ/Q (sec/m^3)	χ/Q Ratio (Characteristic: Parameter)
EAB	0-2	1.00×10^{-3}	4.71×10^{-4}	0.471
LPZ	0-8	1.35×10^{-4}	8.47×10^{-6}	0.063
LPZ	8-24	1.00×10^{-4}	5.50×10^{-6}	0.055
LPZ	24-96	5.40×10^{-5}	2.15×10^{-6}	0.040
LPZ	96-720	2.20×10^{-5}	5.60×10^{-7}	0.025

Table 15.0.3.4.3-4 Site Parameter Short-Term X/Q Values for US-APWR and Comparison to Site Characteristic χ/Qs

Location	Release Time (hr)	Site Parameter χ/Q (sec/m^3)	Site Characteristic χ/Q (sec/m^3)	χ/Q Ratio (Characteristic: Parameter)
EAB	0-2	5.0×10^{-4}	4.71×10^{-4}	0.942
LPZ	0-8	2.1×10^{-4}	8.47×10^{-6}	0.040
LPZ	8-24	1.3×10^{-4}	5.50×10^{-6}	0.042
LPZ	24-96	6.9×10^{-5}	2.15×10^{-6}	0.031
LPZ	96-720	2.8×10^{-5}	5.60×10^{-7}	0.020

The applicant used the ratios of the site characteristic χ/Q values to the site parameter χ/Q values to demonstrate that the radiological consequences at the proposed site are within the calculated doses for each of the standard designs and, therefore, meet the requirements of 10 CFR 52.17. Site-specific DBA doses for the ABWR as given in SSAR were expressed as whole body and thyroid doses consistent with 10 CFR 100.11, which was applicable at the time of the certification of the ABWR design. Site-specific DBA doses for all other technologies evaluated are expressed in total effective dose equivalent (TEDE), consistent with 10 CFR 50.34 and 10 CFR 52.17.

The applicant provided the AP1000 site parameter χ/Q values for DBA accidents other than LOCA by referencing AP1000 DCD, Revision 17. The staff was unable to locate the site parameter χ/Q values for "All Other Accidents" accident in AP1000 DCD, Revision 17. Therefore, in RAI 4, Question 15.00.03-1, the staff requested that the applicant provide additional information about the source of "All Other Accidents" χ/Q values in SSAR Table 15.4-9. In a February 25, 2011, response to RAI 4, Question 15.00.03-1, the applicant stated that Westinghouse did provide "All Other Accidents" values in AP1000 DCD, Revision 18, including the 0-2 hour value for the EAB of 1.00E-3, instead of 8.00E-04. The applicant also stated that the larger EAB value in the AP1000 DCD will also bound the site characteristic χ/Q value for the PSEG Site. The staff finds that the site parameter χ/Q values for the AP1000 presented in SSAR Table 15.4-9 bound the more recent values in AP1000 DCD, Revision 19, and are acceptable. Therefore, the staff considers RAI 4, Question 15.00.03-1 resolved.

Currently, the U.S. EPR DCD uses two averaging periods (0-2 hours and 2-8 hours) to calculate atmospheric dispersion at the outer boundary of the LPZ, rather than the 0-8 hour value recommended in RG 1.70, "Standard Format and Content for Safety Analysis Reports for Nuclear Power Plants: LWR Edition," and RG 1.206, "Combined License Applications for Nuclear Power Plants." The applicant calculated a site characteristic χ/Q using a 0-8 hour period, as stated in RS-002. Due to the difference in time averaging values, the applicant decided to compare its site characteristic 0-8 hour LPZ χ/Q value to the U.S. EPR site parameter 2-8 hour LPZ χ/Q value. The result is a more conservative estimate of the ratio than if the applicant had compared its site characteristic 0-8 hour LPZ χ/Q value to the U.S. EPR site parameter 0-2 hour χ/Q value. The staff finds this comparison appropriate in this case, because it leads to a more conservative ratio.

For each of the DBAs for each of the standard designs considered, the site characteristic χ/Q values for each time averaging period are less than the design's comparable site parameter χ/Q values used in the referenced DCD radiological consequences analyses. Since the result of the radiological consequences analysis for a DBA during any time period of radioactive material release from the plant is directly proportional to the χ/Q for that time period, and because the PSEG site characteristic χ/Q values are less than the comparable DCD site parameter χ/Q values for all time periods and all accidents, then the PSEG site-specific estimated total dose for each DBA is, therefore, less than the estimated total dose for each DBA for all standard designs considered.

Since each of the AP1000, U.S. EPR and US-APWR DCD Chapter 15 DBA radiological consequences analyses show that the offsite radiological consequences meet the regulatory dose requirements of 10 CFR 52.47(a)(2), and since, by the logic above, the PSEG site-specific DBA radiological consequences are estimated to be less than those calculated in the referenced design DCDs, then the applicant has sufficiently shown that the DBA offsite radiological consequences meet the requirements of 10 CFR 52.17(a)(1).

Since the ABWR DCD Chapter 15 DBA radiological consequences analyses show that the offsite radiological consequences meet the regulatory dose requirements of 10 CFR 100.11, and since, by the logic above, the PSEG site-specific DBA radiological consequences are estimated to be less than those calculated in the referenced design DCDs, then the applicant has sufficiently shown that the DBA offsite radiological consequences meet the requirements of 10 CFR 52.17(a)(1).

Based on its evaluation of the applicant's DBA radiological consequences analysis methodology and the inputs to that analysis, the staff finds that the applicant correctly concluded that the

radiological consequences for each of the considered design technologies comply with the radiological dose reference values set forth in 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1).

15.0.3.5 Conclusion

As set forth above, the applicant presented the radiological consequence analyses using PPE values of source terms for each of four different standard designs (U.S. EPR, ABWR, US-APWR, and AP1000) and site characteristic χ/Q values; the applicant concluded that the proposed site meets the radiological dose reference values identified in 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1) for the PPE. Based on the technical evaluation presented in Section 15.0.3.4 of this report, the staff finds that the applicant's PPE values for source terms are not unreasonable. Furthermore, the staff finds the applicant's dose consequence evaluation methodology acceptable. In accordance with 10 CFR 52.79(b)(1), a combined license (COL) applicant referencing this ESP must either include or incorporate by reference the ESP SSAR, and the COL application must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the design of the facility falls within the site characteristics and design parameters specified in the ESP.

The staff further concludes that the applicant's determined site characteristic distances to the EAB and the LPZ outer (i.e., outermost) boundary of the proposed ESP site in SSAR Table 2.0-1, in conjunction with the PPE design parameter source terms, are adequate to provide reasonable assurance that the radiological consequences of postulated DBAs for a light-water reactor of design similar to those used as a basis for the PPE will be within the radiological dose reference values set forth in 10 CFR 50.34(a)(1) and 10 CFR 52.17(a)(1).

17. QUALITY ASSURANCE

17.5 Quality Assurance Program Description - Design Certification, Early Site Permit and New License Applicants

17.5.1 Introduction

PSEG Power, LLC and PSEG Nuclear, LLC (PSEG) submitted on May 25, 2010, an Early Site Permit (ESP) application for a site near Salem, NJ. Under a separate May 25, 2010, letter PSEG submitted the "Quality Assurance Program Description" (QAPD) as part of the ESP application.

PSEG QAPD incorporates the standard format and content of Revision 8 of the Nuclear Energy Institute's (NEI's) "Quality Assurance Program Description" (NEI-06-14A). Although the U.S. Nuclear Regulatory Commission (NRC) has not endorsed this specific revision of NEI-06-14A, the staff finds its use acceptable based on the approval of NEI-06-14A, Revision 7. The changes made in NEI-06-14A, Revision 8, are related to quality assurance programs (QAPs) for operating nuclear power plants (NPPs).

NEI-06-14A covers a variety of applications, including combined licenses (COL), construction, pre-operation, and operation activities. However, this evaluation covers only those activities described in the PSEG ESP application and QAPD.

17.5.2 Summary of Application

PSEG ESP Site Safety Analysis Report (SSAR), Revision 1, Section 17.1, identified the QAPD implemented during the development of the ESP application. The QAPD is a top-level policy document that defines the quality policy and assigns major functional responsibilities. The QAPD applies to safety-related Structures, Systems, and Components (SSCs) as well as to selected elements of non-safety-related SSCs that are nevertheless important to plant safety.

The PSEG QAPD addresses the activities associated with the ESP. These activities include designing, procuring, handling, testing, siting, inspecting, storing, training, and shipping. The QAPD is based on the applicable portions of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Pants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," and the American Society of Mechanical Engineers (ASME) NQA-1-1994, "Quality Assurance Requirements for Nuclear Facilities."

17.5.3 Regulatory Basis

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," establishes the NRC Quality Assurance (QA) requirements for the design, fabrication, construction, and testing of the facility SSCs. These requirements apply to all activities affecting the safety-related functions of those SSCs. This includes, but is not limited to, designing, procuring, handling, testing, siting, inspecting, storing, training, and shipping.

The technical information requirements for ESP applications are in 10 CFR 52.17, "Contents of Applications; Technical Information." 10 CFR 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.

17.5.4 Technical Evaluation

The staff used Standard Review Plan (SRP) (NUREG-0800), Chapter 17, “Quality Assurance,” Section 17.5, “Quality Assurance Program Description - Design Certification, Early Site Permit and New License Applicants,” to evaluate the applicant’s QAPD. To develop SRP Section 17.5, the staff used the American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA) Standard NQA-1-1994, “Quality Assurance Program Requirements for Nuclear Facilities,” as supplemented by regulatory and industry guidance for nuclear operating facilities.

The staff also conducted a QA implementation inspection of PSEG ESP activities for a proposed facility in Salem, NJ, from May 31 through June 3, 2011. The areas inspected included organization, programs, training and qualifications, procurement document control, internal and external audits, and other areas of interest. During the inspection, the inspectors identified one violation of NRC requirements. The violation was documented in NRC Inspection Report No. 05200043/2011-201 and Notice of Violation (NOV), July 27, 2011. The NOV was related to 10 CFR Part 50, Appendix B, Criterion II, “Quality Assurance Program,” which states, in part, that the QAP shall provide for indoctrination and training of personnel performing activities affecting quality as necessary to assure that suitable proficiency is achieved and maintained. The applicant’s implementing procedure, TQ-ND-101, “Nuclear Development Training and Indoctrination Procedure,” Revision 1, May 16, 2011, establishes the requirements to indoctrinate and train PSEG Nuclear Development (ND) personnel performing safety-related activities that affect the quality of the PSEG Site ESP application. TQ-ND-101, Step 4.1 states, in part, that “required indoctrination and training shall be accomplished prior to performing activity governed by the implementing procedures.”

Contrary to the above, the staff identified that PSEG ND personnel did not accomplish the required training before performing activities that are governed by the implementing procedures. Specifically, PSEG ND personnel who did not receive indoctrination training in accordance with TQ-ND-101 performed receipt inspections, an activity governed by PSEG implementing procedures, for safety-related calculations provided by Sargent and Lundy (Calculation Numbers 2011-03075 and 2009-10130). The staff did not identify any technical issues associated with the calculations.

In an August 24, 2011, response to the NOV, the applicant stated that each of the individuals assigned to perform the acceptance reviews of the vendor-generated calculations had more than 25 years of experience in the nuclear industry and each is considered a subject matter expert. In addition, the applicant stated that it entered this issue into its corrective action program on June 3, 2011, and developed corrective steps to prevent similar violations.

The inspection report concluded that the implementation of the PSEG QAP was consistent with the regulatory requirements of 10 CFR Part 50, Appendix B, and the provisions of the PSEG QAPD and associated implementing procedures with the resolution of the NOV.

17.5.4.1 Organization

The staff notes that the applicant’s QAPD follows the guidance of SRP Section 17.5, Paragraph II.A, which provides an organizational description that includes an organizational

structure, functional responsibilities, levels of authority, and interfaces to establish, execute, and verify QAPD implementation. The QAPD establishes independence between the organization responsible to check a function and the organization that performs the function. In addition, the QAPD allows management to size the QA 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.

17.5.4.2 Quality Assurance Program

The staff notes that 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 NPPs. The QAP comprises those planned and systematic actions necessary to provide confidence that SSCs will perform their intended safety function, as described in the applicant's SSAR.

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 QAPD also follows the guidance of SRP Section 17.5, Paragraphs II.S and II.T, in 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 its implementation.

The applicant commits to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 2 and Supplements 2S-1, 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 ASME Standard NQA-1-1994, Appendix 2A-1. The following alternatives may be applied to the implementation of this supplement and appendix.

  As an alternative to the requirement in ASME Standard NQA-1-1994, 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 skill level 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 the personnel that 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 ASME Standard NQA-1-1994, Supplement 2S-1, the organization must designate those activities that require qualified

inspectors and test personnel and establish written procedures for the qualification of these personnel. The staff finds the designation of a qualified engineer to plan inspections, evaluate inspectors, or evaluate the inspector qualification programs is acceptable. The staff finds this approach consistent with regulatory guidance, ASME Standard NQA-1-1994, or other industry guidance in this subject area.

- 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.

Based on the above, the staff finds the applicant's clarifications and exceptions acceptable.

17.5.4.3 Design Control

The staff notes that 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 set points) 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 who are knowledgeable in quality assurance principles to review design documents for the necessary quality assurance requirements (QAR).

The QAPD commits the applicant to conform to the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 3 and Supplement 3S-1, to establish the program for the subsurface investigation requirements contained in ASME Standard NQA-1-1994, Subpart 2.20 and for the standards for computer software QA controls contained in ASME Standard NQA-1-1994, Subpart 2.7.

17.5.4.4 Procurement Document Control

The staff notes that 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 QAP requirements. These requirements (such as specifications, codes, standards, tests, inspections, special processes, and 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 QAP that implements ASME

Standard NQA-1-1994, Part I. As an alternative, the QAPD proposes that suppliers have a documented QAP that meets 10 CFR Part 50, Appendix B as applicable to the circumstances of the procurement. 10 CFR Part 50, Appendix B, Criterion IV, "Procurement Document Control requires suppliers to have a QAP consistent with 10 CFR Part 50, 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 (instead of the supplier having its own QAP). 10 CFR Part 50, Appendix B, Criterion IV requires suppliers to have a QAP consistent with, 10 CFR Part 50, Appendix B. Therefore, the staff finds this clarification acceptable, 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 staff evaluated this proposed alternative and concluded that it provides adequate quality assurance review of procurement documents before awarding the contract and after any change. Therefore, the staff finds this alternative acceptable.

- 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 staff guidance in Generic Letter (GL) 89-02, "Actions to Improve the Detection of Counterfeit and Fraudulently Marked Products," March 21, 1989, and GL 91-05, "License Commercial-Grade Procurement and Dedication Programs," April 9, 1991, as delineated in SRP Section 17.5, Paragraphs II.U.1.d and II.U.1.e.

17.5.4.5 Instructions, Procedures and Drawings

The staff notes that the applicant's QAPD follows the guidance of SRP Section 17.5, Paragraph II.E, to establish 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.

To establish provisions for control of instructions, procedures and drawings, the applicant commits to comply with the quality standards described in ASME Standard NQA-1-1994, Basic Requirement 5.

17.5.4.6 Document Control

The staff notes that the applicant's QAPD follows the guidance of SRP Section 17.5, Paragraph II.F, to control the preparation, review, approval, issuance, and changes of documents that specify quality requirements or prescribe measures for controlling activities that affect 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 that identify the current approved revision or date is maintained so personnel can readily determine the appropriate document for use.

To establish 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.

17.5.4.7 Control of Purchased Material, Equipment, and Services

The staff notes that the applicant's QAPD follows the guidance of SRP Section 17.5, Paragraph II.G, to control the procurement of items and services to comply with requirements. The program provides measures for evaluating prospective suppliers and selecting only those that are qualified. In addition, the program provides guidelines for auditing and evaluating suppliers to ensure that qualified suppliers continue to provide acceptable products and services.

The staff notes that the program provides for acceptance actions (e.g., source verification, receipt inspection, pre- and post-installation tests) and review of documentation (e.g., conformance certificates) to ensure that the procurement, inspection, and test requirements have been satisfied before relying on the item to perform its intended safety function.

To establish 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 staff acknowledges that 10 CFR Part 50 licensees, authorized nuclear inspection agencies, National Institute of Standards and Technology (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 staff accepted a similar exception in a previous safety evaluation ("Approval of Relief Request RR-27," September 12, 2010), 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 any additional technical and administrative requirements, as necessary, to comply with the PSEG QA Program and technical provisions. At a minimum, the purchase document shall require that the calibration/report include identification of the laboratory equipment/standard used.

    - Purchase documents require reporting as-found calibration data when calibrated items are found to be out of tolerance.

- o 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 one of the following accrediting bodies, which are recognized by the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement:

        - ❖ National Voluntary Laboratory Accreditation Program, administered by the National Institute of Standards and Technology
        - ❖ American Association for Laboratory Accreditation
        - ❖ ACLASS Accreditation Services
        - ❖ International Accreditation Services
        - ❖ Laboratory Accreditation Bureau
        - ❖ Other NRC-approved laboratory accrediting body

    - ▪ The accreditation encompasses American Nuclear Society's ANS/ISO/IEC 17025, "General Requirements for the Competence of Testing and Calibration Laboratories."

    - ▪ 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 the documents 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 staff concluded that this alternative meets 10 CFR Part 50, Appendix B, "Control of Purchased Material, Equipment, and Services," Criterion VII, which requires documentary evidence that items conform to procurement documents to be available at the nuclear facility before installation or use. Therefore, the staff finds that this provision, which would allow for accessing and reviewing the necessary procurement documents at the site before installation and use, meets 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. PSEG will also use other appropriate approved regulatory means and controls to support PSEG commercial-grade dedication activities and will assume 10 CFR Part 21 reporting responsibility for all items that PSEG dedicates as safety-related.

- Consistent with the guidance mentioned above for commercial-grade items and services, the staff finds that 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 (GL 89-02 and GL 91-05) provide for

determining critical characteristics to ensure that an item is suitable for its intended use. The staff finds that the program also provides for technical evaluation of the item, receipt requirements, and quality evaluation of the item.

17.5.4.8 Identification and Control of Materials, Parts, and Components

The staff notes that 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.

To establish 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.

17.5.4.9 Control of Special Processes

The applicant's QAPD does not address special processes (e.g., welding, heat treating, chemical cleaning, and nondestructive examinations). In accordance with SRP Section 17.5, Paragraph II.I, control of special processes is not applicable to ESP applicants. Control of Special Processes will be addressed in the combined license application (COLA).

17.5.4.10 Inspection

The staff notes that 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.

To establish 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 (Std) 336-1985, "IEEE Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities." IEEE Std 336-1985 refers to IEEE Std 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 Std 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 Std 603-1980 but does not commit the applicant or holder to the balance of IEEE Std 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 Std 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 commits to the definition of safety systems equipment from IEEE Std 603-1980 to appropriately implement ASME Standard NQA-1-1994, Subpart 2.4. The clarification reinforces the fact that the QAPD is not committing to the entirety of IEEE Std 603-1980.

The staff finds the definition of safety systems equipment in the context of ASME Standard NQA-1-1994, Subpart 2.4, acceptable because it clarifies the definition.

17.5.4.11 Test Control

The staff notes that 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.

To establish 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.

To establish 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.

17.5.4.12 Control of Measuring and Test Equipment

The staff notes that 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.

To establish 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 ASME Standard NQA-1-1994, Supplement 12S-1, Paragraph 3.2, refer to cases in which the measuring and test equipment are found to be out of the required accuracy limits (i.e., out of tolerance) during calibration. The staff finds the clarification for the out-of-calibration conditions 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. The staff finds this alternative consistent with the guidance provided in SRP 17.5, Paragraph II.L.3.

17.5.4.13 Handling, Storage, and Shipping

The staff notes that the applicant's QAPD follows the guidance of SRP Section 17.5, Paragraph II.M, for controlling the handling, storage, packaging, shipping, cleaning, and preserving items to prevent inadvertent damage or loss and to minimize deterioration.

To establish 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.

17.5.4.14 Inspection, Test, and Operating Status

This element is not applicable to the PSEG ESP application. Inspection, Test, and Operating Status does not apply to PSEG or its suppliers related to the ESP because they are not constructing a nuclear power plant and therefore they are not responsible to determine the operability of SSCs. Therefore, this element has not been reviewed or approved by the NRC staff.

17.5.4.15 Nonconforming Materials, Parts, or Components

The staff notes that the QAPD follows the guidance of SRP Section 17.5, Paragraph II.O, to control items, including services that 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. The results are then documented and reported to upper management.

In addition, the QAPD provides for the establishment of 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)(1), "Definitions"; and/or 10 CFR Part 21," Reporting of Defects and Noncompliance."

To establish 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.

17.5.4.16 Corrective Action

The staff notes that 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 staff notes that the QAPD provides for establishing the necessary measures to implement a program to identify, evaluate, and report defects and non-compliances in accordance with the requirements of 10 CFR 50.55(e) and/or 10 CFR Part 21, as applicable.

To establish 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.

17.5.4.17 Quality Assurance Records

The staff notes that 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.

Regarding the use of electronic records storage and retrieval systems, the QAPD provides for compliance with NRC guidance given in Regulatory Issue Summary (RIS) 2000-18, "Guidance on Managing Quality Assurance Records in Electronic Media," October 23, 2000; and associated Nuclear Information and Records Management Association (NIRMA) guidelines TG 11-1998, "Authentication of Records and Media," TG 15-1998, "Management of Electronic Records," TG 16-1998, "Software Configuration Management and Quality Assurance," and TG 21-1998, "Electronic Records Protection and Restoration."

The staff notes that 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 ("Safety Evaluation by the Office of Nuclear Reactor Regulation Change to the Quality Assurance Program Duane Arnold Energy Center Monticello Nuclear Generating Plant Palisades Nuclear Plant Point Beach Nuclear Plant Units 1 and 2 Prairie Island Nuclear Generating Plant Units 1 and 2," September 15, 2005), the staff accepted a similar alternative. Therefore, the staff finds this alternative acceptable.

17.5.4.18 Quality Assurance Audits

The staff notes that 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 their compliance with the overall QAPD. Internal audits are performed with a frequency commensurate with safety significance. An audit of all applicable QAP 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 QAP. Audit results are documented and reviewed. Management responds to all audit findings and initiates corrective action. In addition, where corrective actions are indicated, documented follow-up of applicable areas through inspections, review, re-audits, or other means is conducted to verify corrective action.

To establish 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.

17.5.4.19 Non-Safety-Related SSC Quality Assurance Control

17.5.4.19.1 Non-Safety-Related SSCs Important to Plant Safety

The staff notes that the guidance of SRP Section 17.5, Paragraph II.V.1, to establish specific program controls applied to non-safety-related SSCs that are important to plant safety does not apply to ESP applicants. Non-safety-related SSC QA control will be addressed during the combined operating license process.

17.5.4.20 Regulatory Commitments

The staff notes that the QAPD follows the guidance of SRP Section 17.5, Paragraph II.U, to establish QAP commitments. The QAPD commits the applicant to comply with the following NRC regulatory guides (RG) and other QA standards to supplement and support the QAPD.

- Regulatory Guide (RG) 1.26, Revision 4, “Quality Group Classification and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” March 2007. This regulatory guide does not apply to ESP only applications using a plant parameter envelope.

- RG 1.28, Revision 3, “Quality Assurance Program Requirements (Design and Construction),” August 1985. The QAPD utilizes the NRC endorsed NQA-1-1994 Standards.

- RG 1.29, “Seismic Design Classification,” Revision 4, March 2007. The QAPD commits the applicant to comply with RG 1.29. Exceptions to this regulatory guide are addressed in SSAR Chapter 2, “Site Characteristics and Site Parameters.”

- ASME Standard NQA-1-1994, “Quality Assurance Requirements for Nuclear Facility Applications,” Parts I and II, as described in Sections 17.5.4.1 through 17.5.4.18 of this report.

- NIRMA technical guides, as described in Section 17.5.4.17 of this report.

17.5.5 Conclusion

The staff used the provisions of 10 CFR Part 50, Appendix B and the guidance of SRP Section 17.5 to evaluate the QAPD. The staff finds the following:

- The QAPD provides adequate guidance for an applicant to describe the authority and responsibility of management and supervisory personnel, performance and verification personnel, and self-assessment personnel.

- The QAPD gives 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 Section 17.5 and with the commitments to applicable regulatory guidance.

On the basis of its review, the staff concludes that the applicant's QAPD provides adequate guidance for establishing a QAP that complies with 10 CFR Part 50, Appendix B by following the guidance of ASME Standard NQA-1-1994, as supplemented by regulatory and industry guidance. Accordingly, the staff concludes that the applicant can use the QAPD for ESP activities.

20. REQUIREMENTS RESULTING FROM FUKUSHIMA NEAR-TERM TASK FORCE RECOMMENDATIONS

This chapter addresses the Fukushima Near-Term Task Force (NTTF) recommendations that are applicable to the PSEG Site early site permit (ESP) application. As discussed below, the staff considered the NTTF recommendations accordingly and found that most were outside the scope of site suitability requirements for the ESP review. In the case of the seismic and flooding reevaluation components of Recommendation 2.1, the staff determined that these issues were adequately addressed in the application and the staff's evaluation is documented in Chapter 2, Sections 2.5.2 (Vibratory Ground Motion), and 2.4.5 (Probable Maximum Surge and Seiche Flooding) and 2.4.6 (Probable Maximum Tsunami Hazards), respectively, of the staff's Final Safety Evaluation Report (FSER). The staff found the following recommendation topic was applicable to the PSEG Site ESP application: emergency preparedness (EP) staffing and communications (related to Recommendation 9.3).

Background

In response to the events at Fukushima resulting from the March 11, 2011, Great Tohoku earthquake and tsunami in Japan, the U.S. Nuclear Regulatory Commission (NRC) established the NTTF to conduct a systematic and methodical review of NRC processes and regulations (1) to determine whether the agency should make additional improvements to its regulatory system, and (2) to make recommendations to the Commission for policy directions. In July 2011, the NTTF issued a 90-day report, SECY-11-0093, "Near Term Report and Recommendations for Agency Actions Following the Events in Japan," (Agencywide Documents Access and Management System (ADAMS) Accession Number ML11186A950) identifying 12 recommendations. On September 9, 2011, in SECY-11-0124, "Recommended Actions to Be Taken without Delay from the NTTF Report" (ADAMS Accession No. ML11245A144), the staff submitted to the Commission for its consideration NTTF recommendations that can and—in the staff's judgment—should be partially or entirely initiated without delay. In SECY-11-0124, the staff identified and concluded that specific actions to address a subset of the NTTF recommendations would provide the greatest potential for improving safety in the near term:

1. Recommendation 2.1: Seismic and Flood Hazard Reevaluations

2. Recommendation 2.3: Seismic and Flood Walkdowns

3. Recommendation 4.1: Station Blackout Regulatory Actions

4. Recommendation 4.2: Equipment Covered under Title 10 of the *Code of Federal Regulations* (10 CFR) 50.54(hh)(2)

5. Recommendation 5.1: Reliable Hardened Vents for Mark I Containments

6. Recommendation 8: Strengthening and Integration of Emergency Operating Procedures, Severe Accidents Management Guidelines, and Extensive Damage Mitigation Guidelines

7. Recommendation 9.3: Emergency Preparedness Regulatory Actions (staffing and communications).

On October 3, 2011, in SECY-11-0137, "Prioritization of Recommended Actions to Be Taken in Response to Fukushima Lessons Learned" (ADAMS Accession No. ML11272A203), the staff

identified two actions in addition to the actions discussed in SECY-11-0124 that had the greatest potential for improving safety in the near term. The additional actions are as follows:

- Inclusion of Mark II containments in the staff's recommendation for reliable hardened vents associated with NTTF Recommendation 5.1
- The implementation of Spent Fuel Pool (SFP) instrumentation proposed in Recommendation 7.1

The staff also proposed to the Commission three tiers of prioritization for the NTTF recommendations. The first tier consists of those NTTF recommendations that the staff determined should be started without unnecessary delay and for which sufficient resource flexibility, including availability of critical skill sets, exists. The second tier consists of those NTTF recommendations that could not be initiated in the near term due to factors that include the need for further technical assessment and alignment, dependence on Tier 1 issues, or availability of critical skill sets. These actions do not require long-term study and can be initiated when sufficient technical information and applicable resources become available. The third tier consists of those NTTF recommendations that require further staff study to support a regulatory action, have an associated shorter-term action that needs to be completed to inform the longer-term action, are dependent on the availability of critical skill sets, or are dependent on the resolution of NTTF Recommendation 1 (See SECY-11-0093).

On February 17, 2012, in SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami" (ADAMS Accession No. ML12039A103), the staff provided the Commission with proposed orders and requests for information to be issued to all power reactor licensees and holders of construction permits.

On March 9, 2012, the Commission approved issuing the proposed orders with some modifications in the staff requirements memorandum (SRM) to SECY-12-0025. As set forth in SRM-SECY-12-0025, the proposed orders are needed for continued adequate protection or to provide a substantial increase in the protection of public health and safety. In accordance with its statutory authority under Section 161 of the Atomic Energy Act of 1954, as amended (the Act), the Commission may impose these requirements.

On March 12, 2012, the NRC issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events"; and Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation" (ADAMS Accession Nos. ML12054A735 and ML12054A679, respectively), to the appropriate licensees and permit holders, including the only holder at that time of a Combined License (COL) issued under 10 CFR Part 52, Southern Nuclear Operating Company, the licensee and operator of the Vogtle Electric Generating Plant Units 3 and 4. The staff also issued the requests for information pursuant to 10 CFR 50.54(f) regarding Recommendations 2.1, 2.3, and 9.3 to the appropriate licensees and construction permit holders in letters dated March 12, 2012 (ADAMS Accession No. ML12053A340).

The following Tier 1 recommendations from SECY-11-0137, as modified in SECY-12-0025, were considered in determining those that are applicable to the PSEG Site ESP application review:

1. Recommendation 2.1: Seismic and Flood Hazard Reevaluations

2. Recommendation 2.3: Seismic and Flood Walkdowns
3. Recommendation 4.1: Station Blackout Regulatory Actions
4. Recommendation 4.2: Equipment Covered under 10 CFR 50.54(hh)(2)
5. Recommendation 5.1: Reliable Hardened Vents for Mark I and Mark II Containments
6. Recommendation 7.1: Spent Fuel Pool Instrumentation
7. Recommendation 8: Strengthening and Integration of Emergency Operating Procedures, Severe Accidents Management Guidelines, and Extensive Damage Mitigation Guidelines
8. Recommendation 9.3: Emergency Preparedness Regulatory Actions (staffing and communications)

According to the "Applicability and Implementation Strategy for New Reactors," the Fukushima Task Force concluded that Recommendations 2.3, 4.1, 4.2, 5.1, 7.1, and 8 are applicable to design certification applications and/or combined license applications. The staff determined that within the scope of a site suitability determination, none of these recommendations would be applicable to the PSEG Site ESP application. However, since PSEG submitted a complete and integrated emergency plan, the staff determined that the following recommendation is applicable and should be addressed by the PSEG Site ESP applicant:

> Recommendation 9.3: Emergency preparedness regulatory actions (staffing and communications) - Order licensees to do the following until rulemaking is complete:
>
> - Determine and implement the required staff to fill all necessary positions for responding to a multi-unit event.
> - Provide a means to power communications equipment needed to communicate onsite (e.g., radios for response teams and between facilities) and offsite (e.g., cellular telephones and satellite telephones) during a prolonged station blackout.

The staff determined that the remaining Tier 1 recommendations did not need to be considered further in the PSEG Site ESP application review. The applicant evaluated the seismic and flood hazards using current guidance and methodologies. For the seismic hazard, consistent with guidance in Regulatory Guide 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," regarding the need to consider the latest information in the evaluation of seismic hazard, this included consideration of the NUREG–2115, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities," (CEUS-SSC) model as described in FSER Chapter 2, Section 2.5.2. For flood hazard, as evaluated in FSER Chapter 2, Sections 2.4.5 and 2.4.6, the applicant used Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," as supplemented by best current practices, as it relates to providing assurance that natural flooding phenomena that could potentially affect the site have been appropriately identified and characterized. Thus, the staff determined that the applicant has already addressed the seismic and flood hazard reevaluation portion of Recommendation 2.1. Therefore, there are no additional requirements left to be addressed in Recommendation 2.1 for seismic and flooding reevaluations applicable to the PSEG Site ESP application. Additionally, the staff determined that Recommendation 2.3 was not applicable to

the PSEG Site ESP application because construction is not part of the ESP application; Recommendation 4.2 can only be addressed at the design and operating stages, and Recommendation 7.1 is not applicable because the applicant has not selected a reactor technology, and instead used a plant parameter envelope (PPE) approach, and there is no spent fuel pool at the ESP stage. The staff also determined that Recommendation 5.1 is not applicable because it applies to boiling-water reactor plant designs with Mark I and Mark II containments, and the applicant has not selected a reactor technology at the ESP stage.

The staff noted that Recommendations 4.1 and 8 did not need to be considered further because SECY-11-0137 (and the associated SRM) directs that regulatory actions associated with these recommendations should be initiated through rulemaking.

The staff issued a request for additional information (RAI) related to the implementation of Fukushima NTTF recommendations pertaining to EP staffing and communications based on Recommendation 9.3, as modified by SRM-SECY-12-0025. In the following section, the staff provided an introduction and the regulatory basis for this recommendation. In addition, in the "Technical Evaluation and Conclusions" section below, the staff provided references to specific sections in the FSER where the staff's safety evaluation and conclusions for this recommendation is documented.

20.1 Recommendation 9.3, Emergency Preparedness

20.1.1 Introduction

The accident at Fukushima reinforced the need for effective emergency preparedness (EP). The objective of EP is to ensure that the capability exists for a licensee (or will exist for a COL applicant) to implement measures that mitigate the consequences of a radiological emergency and to provide for protective actions of the public. The accident at Fukushima highlighted the need to determine the staffing needed to respond to a multi-unit event. Additionally, there is a need to ensure that the communication equipment relied on has adequate power to coordinate the response to an event during an Extended Loss of A/C Power (ELAP).

20.1.2 Regulatory Basis

The requirements for EP for beyond-design-basis external events are established or described in the following:

- 10 CFR 50.47(b)(1) states, in part, "and each principal response organization has staff to respond and to augment its initial response on a continuous basis."
- 10 CFR 50.47(b)(2) states, in part, "adequate staffing to provide initial facility accident response in key functional areas is maintained at all times, timely augmentation of response capabilities is available.…"
- 10 CFR 50.47(b)(6) states that provisions exist for prompt communications among principal response organizations to emergency personnel and to the public.
- 10 CFR Part 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," Section IV. E.9 states, in part, that adequate provisions shall be made and described for emergency facilities and equipment including "at least one onsite and one offsite communications system; each system shall have a backup power source.

The guidance for EP for beyond-design-basis external events is established or described in the following:

- SECY-12-0025 states, in part, that the staff will also request all COL applicants to provide information required by the orders and request for information letters described in this paper, as applicable, through the review process.

- Nuclear Energy Institute (NEI) 12–01, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," Revision 0, May 2012 (ADAMS Accession No. ML12125A412).

- 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," Section B, "Onsite Emergency Organization," states, in part, the following:

  > 5. Each licensee shall specify the positions or title and major tasks to be performed by the persons to be assigned to the functional areas of emergency activity. . . .These assignments shall cover the emergency functions in Table B-1 entitled, "Minimum Staffing Requirements for Nuclear Power Plant Emergencies." The minimum on-shift staffing levels shall be as indicated in Table B-1. The licensee must be able to augment on-shift capabilities within a short period after declaration of an emergency. This capability shall be as indicated in Table B-1.

- NUREG–0696, "Functional Criteria for Emergency Response Facilities," offers guidance on how to meet the requirements of 10 CFR Part 50, Appendix E, and describes the onsite and offsite communications requirements for the licensee's emergency response facilities.

20.1.3 Technical Evaluation and Conclusion

Regarding NTTF Recommendation 9.3 (Emergency Preparedness), the NRC's request for information letter of March 12, 2012, requested that all power reactor licensees and holders of construction permits (in active or deferred status) assess their current staffing levels and determine the appropriate staff to fill all necessary positions for responding to a multi-unit event during a beyond-design-basis natural event, and determine if any enhancements are appropriate. Single-unit sites should provide the requested information, as it pertains to an extended loss of all alternating current (ac) power and impeded access to the site.

With regard to communications, NTTF Recommendation 9.3 requests that all power reactor licensees and holders of construction permits (in active or deferred status) assess their current communications systems and equipment used during an emergency event, including consideration of any enhancements that might be appropriate for the emergency plan with respect to the communications requirements of 10 CFR 50.47, 10 CFR Part 50, Appendix E, and NUREG-0696. In addition, the means necessary to power the new and existing communications equipment during a prolonged station blackout should be considered.

Accordingly, the staff requested that the PSEG Site ESP applicant address staffing and communications provisions to enhance emergency preparedness. The staff reviewed the applicant's submitted information and documented its evaluation and conclusions involving the staffing levels and communications in FSER Chapter 13, Sections 13.3.4.3.2 and 13.3.4.3.6, respectively.

21.0 REVIEW BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The Advisory Committee on Reactor Safeguards (ACRS) completed its review of the application submitted by PSEG Power, LLC and PSEG Nuclear, LLC (PSEG) for an early site permit (ESP) for the PSEG 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 PSEG and the staff on March 19, 2014, September 29 and 30, 2014, and June 9, 2015, to discuss all chapters of the PSEG ESP Site Safety Analysis Report (SSAR) and the NRC staff's advanced SER with no open items on all applicable chapters. The discussions during these meetings focused on the staff's site visits, conduct of inspections and audits, coordination with other Federal, State, and local agencies, use of methodology and the staff's independent confirmatory analyses where applicable, and the staff's safety findings and conclusions, including any proposed conditions and action items. This final safety evaluation report (FSER) documents the staff's findings and conclusions.

At the 625th meeting of the ACRS on June 10, 2015, the full committee considered the staff's advanced SER with no open items, as well as PSEG's ESP application, and issued its final letter report to the NRC Chairman on June 25, 2015. This letter report is included as Appendix E to this SER.

In its final letter report of June 25, 2015, the ACRS stated that the application for an ESP for the PSEG ESP site was adequate, and found that the NRC staff's review of the application was adequate. The ACRS concluded that the ESP should be granted.

22. 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 (NRC) reviewed the site safety analysis report (SSAR), and the emergency planning (EP) information included in the early site permit (ESP) application submitted by PSEG Power, LLC and PSEG Nuclear, LLC (PSEG) for an ESP for the PSEG 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 PSEG Site ESP application satisfies the applicable standards set out in 10 CFR Part 50 “Domestic Licensing of Production and Utilization Facilities” and its appendices and 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 applicable requirements of 10 CFR Part 50 and its appendices and 10 CFR Part 100, one or 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 inspections, tests, analyses, and acceptance criteria (ITAAC) for EP 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 PSEG Site ESP may be referenced in an application to construct and operate one or two nuclear power reactors with a maximum thermal power that does not exceed 4614 megawatts (thermal) (MWt) for a single unit or 6830 MWt for a dual unit at the ESP site, with a capability of producing up to approximately 2200 megawatts electric (MWe) net of electrical power, subject to the terms and conditions of the permit.

APPENDIX A

PERMIT CONDITIONS, COL ACTION ITEMS, SITE CHARACTERISTICS, BOUNDING DESIGN PARAMETERS, AND INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA

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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
2.1 & 2.2 – Geography and Demography & Nearby Industrial, Transportation, and Military Facilities		
1	2.1.2.4/2.1.2.5	An applicant for a combined license (COL) or construction permit (CP) referencing this early site permit shall notify the Nuclear Regulatory Commission staff when the COL applicant has acquired the required authority and control over the Exclusion Area (prior to issuance of any combined license that references this ESP) and shall provide confirmation that the basis for that conclusion includes the following: 1. The COL or CP applicant shall complete the acquisition of 0.34 km^2 (85 ac.) of land, including mineral rights, from the USACE that is currently part of the confined disposal facility north of the site. 2. The COL or CP applicant shall modify the existing PSEG Site Radiological Emergency Response Plan and the existing PSEG Site Security Plan, and reach agreements with the U.S. Coast Guard (USCG), to extend the protections for the Delaware River portion of the existing Salem and Hope Creek Exclusion Area to cover the Delaware River portion of the Exclusion Area related to the ESP. 3. The COL or CP applicant shall reach agreement with the USACE for any land within the EAB that will not be owned by the COL applicant to obtain legal authority from the U.S. Army Corps of Engineers (USACE) to either allow the COL applicant and its surrogates to determine all activities including exclusion or removal of personnel and property from the area or require that the USACE exercise that control in the manner specified by the COL or CP applicant.

Permit Condition No.	SER Section	Description
2	2.2.3.4.1/2.2.3.5	An applicant for a COL or CP referencing this early site permit shall demonstrate that the nearest structures, systems, and components (SSCs) important to safety of the selected plant design can withstand the effects of potential explosions associated with the relocated gasoline storage tank and the gasoline delivery tanker truck. The applicant shall demonstrate this by using the methodologies provided in RG 1.91 and RG 1.78 for direct explosion and vapor cloud explosion, respectively, to confirm that a minimum safe distance exists between the nearest plant SSCs important to safety and the relocated gasoline storage tank and the gasoline delivery tanker truck such that the SSCs would not experience an overpressure in excess of 1.0 psi in the event of an explosion.
2.5 – Geology, Seismology, and Geotechnical Engineering		
3	2.5.3.5	An applicant for a COL or CP referencing this early site permit shall perform detailed geologic mapping of excavations for safety-related structures; examine and evaluate geologic features discovered in those excavations; and notify the Director of the Office of New Reactors, or the Director's designee, once excavations for safety-related structures are open for examination by NRC staff.
4	2.5.4.5	An applicant for a COL or CP Referencing this early site permit shall remove and replace the soils directly above the Vincentown Formation for soils under or adjacent to Seismic Category I structures to minimize any liquefaction potential.

Permit Condition No.	SER Section	Description
13.3 – Emergency Planning		
5	13.3.4.3.2	An applicant for a COL or CP referencing this early site permit shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an assessment of on-site and augmented staffing capability for responding to a multi-unit event. The staffing assessment shall be performed in accordance with the latest NRC-endorsed revision of NEI 12-01, "Guidance for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," (ii) At least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall complete implementation of corrective actions identified in the staffing assessment described above and identify how the augmented staff will be notified given degraded communications capabilities, including any related emergency plan and implementing procedure changes and associated training.
6	13.3.4.3.2	An applicant for a COL or CP referencing this early site permit shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an assessment of on-site and off-site communications systems and equipment relied upon during an emergency event to ensure communications capabilities can be maintained during an extended loss of ac power. The communications capability assessment shall be performed in accordance with the latest NRC-endorsed revision of NEI 12-01, "Guidance for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities," (ii) At least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall complete implementation of corrective

Permit Condition No.	SER Section	Description
		actions identified in the communications capability assessment described above, including any related emergency plan and implementing procedure changes and associated training.
7	13.3.4.3.2	An applicant for a COL or CP referencing this early site permit shall revise the emergency plan to describe on-shift personnel assigned emergency plan implementing functions associated with the chosen reactor technology and the number of proposed reactor units. In addition, the COL or CP applicant shall propose a license condition for the licensee to perform the following: (i) No later than 18 months before the latest date set forth in the schedule submitted in accordance with 10 CFR 52.99(a) for completing the inspections, tests, and analyses in the ITAAC, the licensee shall have performed an on-shift staffing analysis in accordance with the latest NRC-endorsed revision of NEI 10-05, “Assessment of On-Shift Emergency Response Organization Staffing and Capabilities,” (ii) At least one hundred eighty (180) days before the date schedule for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a), the licensee shall incorporate any changes to the emergency plan needed to bring staffing to the required levels.
8	13.3.4.3.4	An applicant for a COL or CP referencing this early site permit and the AP1000 standard design shall propose a license condition for the licensee to develop an Emergency Action Level (EAL) scheme with fully developed site-specific EALs, in accordance with the latest NRC-endorsed revision of NEI 07-01, “Methodology for Development of Emergency Action Levels, Advanced Passive Light Water Reactors,” with few or no deviations or differences. All deviations or differences from NEI 07-01 must be fully described in the COL application, including providing the initiating condition, operating modes, notes, EAL threshold(s), basis information, and developer guidance for how a particular setpoint is (or will be) determined. The EALs shall have been discussed and agreed upon with State and local officials. The fully developed site-specific EAL scheme shall be submitted to the NRC at least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a).

Permit Condition No.	SER Section	Description
9	13.3.4.3.4	An applicant for a COL or CP referencing this early site permit and the U.S. EPR, ABWR, or US-APWR standard design shall propose a license condition for the licensee to develop an Emergency Action Level (EAL) scheme with fully developed site-specific EALs, in accordance with the latest NRC-endorsed revision of NEI 99-01, "Methodology for Development of Emergency Action Levels," with few or no deviations or differences, other than those attributable to the specific reactor design. All deviations or differences from NEI 99-01 must be fully described in the COL application, including providing the initiating condition, operating modes, notes, EAL threshold(s), basis information, and developer guidance for how a particular setpoint is (or will be) determined. The EALs shall have been discussed and agreed upon with State and local officials. The fully developed site-specific EAL scheme shall be submitted to the NRC at least one hundred eighty (180) days before the date scheduled for initial fuel loading, as set forth in the notification submitted in accordance with 10 CFR 52.103(a).

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 COL or CP who submits an application referencing the PSEG Site 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 PSEG Ste.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.2 – Nearby Industrial, Transportation, and Military Facilities			
2.2-1	2.2.3.4.2	An applicant for a COL or CP referencing this early site permit will, after selecting a reactor technology, evaluate the impact on the proposed plant at the PSEG Site of toxic chemicals processed, stored, used, or transported within the vicinity of the PSEG Site, to identify chemicals that lead to concentration above the Immediately Dangerous to Life and Health (IDLH) at the power block boundary, and provide a detailed control room habitability assessment.	The ESP applicant used Plant Parameter Envelope (PPE) instead of a specific plant design, and as such no control room is identified on site. Since the design of the control room at the proposed ESP site is not available, it is expected to be evaluated at the COL stage.
2.2-2	2.2.3.4.2	An applicant for a COL or CP referencing this early site permit will, after selecting a reactor technology, identify potentially toxic, flammable, or explosive hazardous materials to be stored onsite, and evaluate their possible impact on the proposed plant at the PSEG Site.	The ESP applicant used Plant Parameter Envelope (PPE) instead of a specific plant design, and as such no control room is identified on site. 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	2.3.5.4.2	An applicant for a COL or CP referencing this early site permit should verify specific release point characteristics and specific locations of receptors of interest used to generate the long-term (routine release) atmospheric dispersion site characteristics. Any	The ESP applicant screened out specific receptors of interest adjacent to the Delaware River, many of which contained the highest χ/Q values. A

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
		different exposure pathways and dose receptor locations, including those in sectors adjacent to the Delaware River, should be identified and discussed in order to demonstrate that long-term release atmospheric dispersion estimates fall within the site characteristic values in the ESP and to provide assurance of compliance with NRC dose requirements.	COL or CP applicant should ensure that any new potential exposure pathways are identified and considered in these sectors at the COL stage.
2.4 – Hydrologic Engineering			
2.4-1	2.4.2.4	An applicant for a COL or CP referencing this early site permit should design the site grading to provide flooding protection to safety-related structures at the ESP site based on a comprehensive flood water routing analysis for a local PMP event without relying on any active surface drainage systems that may be blocked during this event.	Detailed design of the site grading plan and storm water management system are beyond the scope of an ESP review. As such, final site drainage patterns are not yet known.
2.4-2	2.4.10.4	An applicant for a COL or CP referencing this early site permit should address whether the intake structure of the selected design is a safety-related SSC. If so, the applicant should address necessary flooding protection for a safety-related intake structure at the ESP site based on the design basis flooding event and associated effects.	Detailed site flooding protection requirements are beyond the scope of an ESP review as the ESP applicant has not selected a reactor technology.
2.4-3	2.4.12.4	An applicant for a COL or CP referencing this early site permit should refine hydrogeologic parameters and model estimates of dewatering rates and drawdowns beneath existing site structures	Additional groundwater characterization information, not yet known at the ESP stage, will be provided at the COL stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
		after determination of the final excavation geometry consistent with a selected reactor technology.	
2.5 – Geology, Seismology, and Geotechnical Engineering			
2.5-1	2.5.4.4.1	An applicant for a COL or CP referencing this early site permit should perform additional investigations in order to provide additional information on the extent, thickness, and nature of the oxidized material in the Vincentown Formation beneath the area of Seismic Category I structures for the selected reactor technology. The applicant should also remove less dense soils with considerably lower SPT N-values in order to meet the soil condition requirements.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-2	2.5.4.4.2	An applicant for a COL or CP referencing this early site permit should conduct additional subsurface investigations to evaluate and fully characterize the engineering properties of the Vincentown and Hornerstown Formations and their potential lateral and vertical variation. The applicant should also perform additional strength tests to further evaluate the soil shear strength parameter for the Vincentown and Hornerstown Formations.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
			corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-3	2.5.4.4.2	An applicant for a COL or CP referencing this early site permit should perform additional borings to provide information for further evaluation of the shear strength properties of the Navesink formation.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-4	2.5.4.4.2	An applicant for a COL or CP referencing this early site permit should perform additional borings and unit weight determinations for the materials underlying the Mount Laurel Formation.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
			will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-5	2.5.4.4.3	An applicant for a COL or CP referencing this early site permit should perform additional subsurface investigations and correlate the plot plans and profiles of each Seismic Category I structure with the subsurface profile and material properties, and ensure placement of safety-related structures on competent foundation bearing material.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.5-6	2.5.4.4.5	An applicant for a COL or CP referencing this early site permit should provide specific details regarding the lateral and vertical extent of the excavation consistent with the selected reactor technology.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.5-7	2.5.4.4.5	An applicant for a COL or CP referencing this early site permit should evaluate the method of excavation support and the stability of temporary excavation slopes or support.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-8	2.5.4.4.5	An applicant for a COL or CP referencing this early site permit should include in the COL application, an ITAAC for the soil backfill, with specifications to ensure a V_s of 304.8 m/s (1,000 ft/s) or higher below Seismic Category I structures.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.5-9	2.5.4.4.5	An applicant for a COL or CP referencing this early site permit should provide, consistent with the selected reactor technology, (i) details for the backfill quantities, types and sources; (ii) lateral loading conditions; (iii) information on the type and characteristics of backfill materials; and (iv) lateral pressure evaluation from backfill materials.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-10	2.5.4.4.5	An applicant for a COL or CP referencing this early site permit should include the geotechnical instrumentation plan and heave monitoring schedule in the COL application.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.5-11	2.5.4.4.6	An applicant for a COL or CP referencing this early site permit should evaluate and implement, during the COL application stage, design measures appropriate for the chemical characteristics of the Category 1 fill, site soils and site groundwater.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-12	2.5.4.4.6	An applicant for a COL or CP referencing this early site permit should perform, consistent with the selected reactor technology, evaluation of groundwater conditions as they affect the loading and stability of foundation materials, and also provide detailed dewatering and groundwater control plans.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.5-13	2.5.4.4.7	An applicant for a COL or CP referencing this early site permit should develop the foundation input response spectra (FIRS) and the Soil Structure Interaction (SSI) analysis at the COL application stage.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-14	2.5.4.4.8	An applicant for a COL or CP referencing this early site permit should perform additional geotechnical investigation, consistent with RG 1.132, including the performance of additional borings and a detailed liquefaction assessment to determine if zones of lower blow counts, which might indicate a potentially weak liquefiable zone, are present underneath the competent layer. If the additional borings and analyses identify areas where potential for liquefaction may be present, the applicant should remove unsuitable materials and either replace it with competent material or improve it to eliminate liquefaction potential.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.5-15	2.5.4.4.8	An applicant for a COL or CP referencing this early site permit should evaluate non-seismic liquefaction.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-16	2.5.4.4.10	An applicant for a COL or CP referencing this early site permit should analyze the stability of all planned safety-related facilities, including static and dynamic bearing capacity, rebound, settlement, and differential settlements under dead loads of fills and plant facilities, as well as lateral loading conditions.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.5-17	2.5.4.4.10	An applicant for a COL or CP referencing this early site permit should conduct laboratory testing on intact samples and conduct consolidation testing for materials having a high percentage of fine-grained particles.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-18	2.5.4.4.11	An applicant for a COL or CP referencing this early site permit should describe the design criteria and methods, including the factors of safety (FSs) from the design foundation stability analyses consistent with the selected reactor technology.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
2.5-19	2.5.4.4.12	An applicant for a COL or CP referencing this early site permit should improve subsurface conditions in cases where foundation soils do not provide adequate bearing capacity for safety-related structures.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.
2.5-20	2.5.5.4	An applicant for a COL or CP referencing this early site permit should perform a slope stability analysis consistent with the selected reactor technology. Slope stability analysis will include the evaluation of deep slope failure surfaces that may extend into the Delaware River and various water level considerations.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design, and as such, Seismic Category I structures for the proposed site are not identified and the location and extent of these structures is not known at the ESP stage. At the COL stage, additional subsurface investigations along with corresponding analyses and testing will be necessary for soils under these specific structures based on the selected reactor technology.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
3.5.1.6 – Aircraft Hazards			
3.5.1.6-1	3.5.1.6.4	An applicant for a COL or CP referencing this early site permit (ESP), should evaluate and demonstrate compliance with the design-basis aircraft accident probability acceptance criterion of 1 x 10^{-7} per year or less, in accordance with the probabilistic risk assessment (PRA) guidance provided in NUREG-0800, Chapter 19 ("Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors"), and should provide the determined core damage frequency (CDF) baesd on the design selected.	Conditional core damage probability (CCDP) is determined based on design-specific Probabilistic Risk Assessment (PRA), as part of the "Severe Accidents" section, the technical review of which is conducted in conjunction with a COL application review.
11.4 – Liquid and Gaseous Waste Management Systems			
11-1	11.4	An applicant for a COL or CP referencing this early site permit should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for one or more new units which may be built at the PSEG Site are bounded by the radiological doses included in the ESP application, and must address and justify any discrepancies. This includes any changes made to address differences in reactor design used to calculate radiological doses (e.g., basis of the liquid and gaseous radiological source terms, and liquid effluent discharge flow rates and site-specific dilution flow rates). The COL or CP applicant should also provide detailed information, reflecting plant and site-specific COL design considerations, on the solid waste management system used to process radioactive gaseous and liquid effluents.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design. Details on control, monitoring, and maintenance of radioactive gaseous and liquid effluents are not known at the ESP stage.

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
		13.3 – Emergency Planning	
13.3-1	13.3.4.2	An applicant for a COL or CP referencing this early site permit should submit to the NRC updated letters of agreement or memoranda of understanding with offsite support organizations to reflect the chosen plant design.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design.
13.3-2	13.3.4.3.6	An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the components, availability, and power supplies for the Federal Telecommunications System (FTS), including all required communications and data links associated with the chosen reactor technology.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design. Details associated with FTS are not known at the ESP stage.
13.3-3	13.3.4.3.8	An applicant for a COL or CP referencing this early site permit and the US-APWR standard design should revise the emergency plan to describe the location and capabilities of the Operations Support Center (OSC).	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design. Description of OSC cannot reflect US-APWR specific design at the ESP stage. A COL applicant will select a specific plant design in conjunction with the COL application.
13.3-4	13.3.4.3.9	An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the radiation monitoring and other systems and equipment, including potential major release points from the plant and river water level	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design. Details on radiation monitoring and related

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
		monitoring requirements, associated with the chosen reactor technology that support accident assessment activities. The emergency plan should also identify the specific monitoring capability for the radiological parameters identified in NRC Regulatory Guide 1.97, Revision 2, and dose assessment and projection modeling system.	systems are not known at the ESP stage.
13.3-5	13.3.4.3.10	An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the availability of a proposed causeway for use as an alternate route for evacuating the site. If appropriate, the applicant should update the evacuation time estimate (ETE) analysis for the PSEG Site to reflect the causeway, and provide confirmation that the ETE update was provided to State and local governmental authorities for use in developing offsite protective action strategies.	The ESP applicant is not required to and is not planning to build the proposed causeway at the ESP stage.
13.3-6	13.3.4.3.11	An applicant for a COL or CP referencing this early site permit and the US-APWR design control document (DCD) should revise the emergency plan to identify the location of the onsite personnel decontamination facility.	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design. A COL applicant will select a specific plant design in conjunction with the COL application.
13.3-7	13.3.4.3.13	An applicant for a COL or CP referencing this early site permit should revise the emergency plan to describe the method for determining atmospheric transport and diffusion throughout the 10-mile plume exposure emergency planning zone during	The ESP applicant used a Plant Parameter Envelope (PPE) instead of a specific plant design. A method for determining atmospheric transport and diffusion will be adopted following

Action Item No.	SER Section	Subject To Be Addressed	Reason For Deferral
		emergency conditions, including the ability to periodically estimate total population exposure.	the selection of a reactor technology by the COL applicant.
13.3-8	13.3.4.3.17	An applicant for a COL or CP referencing this early site permit should explain how any updated evacuation time estimate (ETE) information for the PSEG Site interfaces with any ETE updates that may have been provided for the nearby Salem and Hope Creek units.	The ESP applicant used the year 2000 U.S. Census Bureau data - the most current available at the ESP application submission - to develop the ETE, which is required to be updated at the COL application stage.

A.3 Site Characteristics

Site Characteristics: Based on site investigation, exploration, analysis, and testing, the applicant initially proposes a set of site characteristics. These site characteristics are specific physical attributes of the site, whether natural or man-made. Site characteristics, if reviewed and approved by the staff, are specified in the ESP. The staff proposes to include the following site characteristics in any ESP that might be issued for the PSEG Site.

Site Characteristic	Value	Definition
2.1 - Geography and Demography		
Exclusion Area Boundary	Since PSEG has not selected a specific reactor design, only boundaries of the power block area and a theoretical plant center point within the power block area are shown within the proposed EAB. The proposed EAB is a circle at least 600 meters (1968 feet) from the edge of the power block area in all directions, and extends beyond the PSEG Site property line to the west into the Delaware River and to the north and northeast. The total area encompassed by the EAB is 743 acres, of which 224 acres is in the Delaware River and 288 acres is in land currently owned by PSEG. No public roads, railroads, or structures other than existing Salem and Hope Creek power plant facilities are located within any part of the EAB. See Figure A.3-1.	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.

Site Characteristic		Value	Definition
Low Population Zone		The area falling within a 5-mile radius around the center point of the new plant. This area is dominated by the open waters of Delaware Bay and low coastal wetlands to the east and west of the bay.	The area immediately surrounding the exclusion area that contains residents.
Population Center Distance		The population center nearest to the PSEG Site containing more than about 25,000 residents is the city of Wilmington, DE, with the nearest boundary 14.8 miles (23.8 km) north of the new plant center point.	The minimum allowable distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents is 1 and 1/3 times the distance from the reactor to the outer boundary of the Low Population Zone (LPZ).
2.3 - Meteorology			
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2% annual exceedance	88 ºF / 73 ºF	The ambient dry-bulb temperature (and mean coincident wet-bulb temperature) that will be exceeded 2% of the time annually.
	1% annual exceedance	90 °F / 75 °F	The ambient dry-bulb temperature (and mean coincident wet-bulb temperature) that will be exceeded 1% of the time annually.
	0.4% annual exceedance	93 ºF / 76 ºF	The ambient dry-bulb temperature (and mean coincident wet-bulb temperature) that will be exceeded 0.4% of the time annually.

Site Characteristic		Value	Definition
	0% annual exceedance (record)	108 ºF / 79 ºF	The highest recorded ambient dry-bulb temperature and mean coincident wet-bulb temperature.
	100-year return period	105.9 °F / 82.4 ºF	The ambient dry-bulb temperature (and mean coincident wet-bulb temperature) that has a 1% annual probability of being exceeded (100-year mean recurrence interval).
Minimum Dry-Bulb Temperature	99% annual exceedance	14 °F	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 1% of the time annually.
	99.6% annual exceedance	10 °F	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 0.4% of the time annually.
	100% annual exceedance (record)	-15 °F	Lowest recorded dry-bulb temperature.
	100-year return period	-18.7 °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	1% annual exceedance	77 °F	The ambient wet-bulb temperature that will be exceeded 1% of the time annually.

Site Characteristic		Value	Definition
	0.4% annual exceedance	79 °F	The ambient wet-bulb temperature that will be exceeded 0.4% of the time annually.
	0% annual exceedance (record)	86.2 °F	Highest recorded wet-bulb temperature.
	100-year return period	87.4 °F	The ambient wet-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval).
UHS Ambient Air Temperature and Humidity			
Meteorological Conditions Resulting in the Minimum Water Cooling During any 1 Day		82.69°F WBT 87.12°F DBT	Historic worst 1-day daily average wet-bulb temperature and coincident dry-bulb temperature.
Meteorological Conditions Resulting in the Minimum Water Cooling During any Consecutive 5 Days		78.02°F WBT 83.47°F DBT	Historic worst 5-day daily average wet-bulb temperature and coincident dry-bulb temperature.
Meteorological Conditions Resulting in the Minimum Water Cooling During any Consecutive 30 Days		75.87°F WBT 82.65°F DBT	Historic worst 30-day daily average wet-bulb temperature and coincident dry-bulb temperature.

Site Characteristic		Value	Definition
Basic Wind Speed			
3-Second Gust		117.7 mi/h	The nominal 3-second gust wind speeds in miles per hour (mph) at 33 ft. above ground associated with a 100-year return period.
Importance Factors		1.15	Multiplication factor applied to basic wind speed used to assess wind impacts on strucutres.
Hurricane			
Hurricane Wind Speed		159 mi/h	Maximum nominal 3-second gust wind speed at 33 ft. above ground over open terrain having a probability of exceedance of 10-7 per year.
Hurricane Missiles	Schedule 40 Pipe	6.625 in dia x 15 ft long 287-lb pipe at 99 ft/sec Horizontal	Design-Basis Hurricane Missile Spectrum from RG 1.221.
	Automobile	16.4 ft x 6.6 ft x 4.3 ft 4000-lb. automobile at 130 ft/sec Horizontal	Design-Basis Hurricane Missile Spectrum from RG 1.221.
	Solid Steel Sphere	1 in diameter sphere at 86 ft/sec Horizontal	Design-Basis Hurricane Missile Spectrum from RG 1.221.

Site Characteristic		Value	Definition
Tornado			
Maximum Wind Speed		200 mi/h	Maximum wind speed resulting from passage of a tornado having a probability of occurrence of 10^{-7} per year.
Maximum Translational Speed		40 mi/h	Translation component of the maximum tornado wind speed.
Rotational Speed		160 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		0.9 $lbf/in.^2$	Decrease in ambient pressure from normal atmospheric pressure resulting from passage of the tornado.
Rate of Pressure Drop		0.4 psi/s	Rate of pressure drop resulting from the passage of the tornado.
Tornado Missiles	Schedule 40 Pipe	6.625 in dia x 15 ft long 287-lb pipe at 112 ft/sec Horizontal	Design-Basis Tornado Missile Spectrum from RG 1.76, Revision 1.
	Automobile	16.4 ft x 6.6 ft x 4.3 ft 4000-lb. automobile at 112 ft/sec Horizontal	Design-Basis Tornado Missile Spectrum from RG 1.76, Revision 1.

Site Characteristic		Value	Definition
	Solid Steel Sphere	1 in diameter sphere at 23 ft/sec Horizontal	Design-Basis Tornado Missile Spectrum from RG 1.76, Revision 1.
Winter Precipitation			
100-Year Snowpack		24 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		21 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).
Normal Winter Precipitation Event		24 lb/ft^2	The highest ground-level weight (in lb/ft^2) among: (1) the 100-year return period snowpack; (2) the historical maximum snowpack; (3) the 100-year return period two-day snowfall event; or (4) the historical maximum two-day snowfall event in the site region. (to be used in determining the precipitation load for roofs).
Extreme Frozen Winter Precipitation Event		20.51 lb/ft^2	The highest of (1) the 100-year return period two-day snowfall event; and (2) the historical maximum snowfall event in the site region. (to be used in determining the precipitation load for roofs).
Short-Term (Accident Release) Atmospheric Dispersion			
0-2 hr χ/Q Value @ EAB		4.71×10^{-4} s/m^3	The 0-2 hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the EAB.

Site Characteristic	Value	Definition
0-8 hr χ/Q Value @ LPZ outer boundary	8.47×10^{-6} 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	5.50×10^{-6} s/m^3	The 8-24 hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ.
1-4 day χ/Q Value @ LPZ outer boundary	2.15×10^{-6} 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	5.60×10^{-7} s/m^3	The 4-30 day atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ.
Long-Term (Routine Release) Atmospheric Dispersion		
Annual Average Undepleted/No Decay χ/Q Value @ Site Boundary, east-northeast, 0.24 mile	1.00×10^{-5} s/m^3	The maximum annual average site boundary undepleted/2.26-day 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 @ Site Boundary, east-northeast, 0.24 mile	1.00×10^{-5} s/m^3	The maximum annual average site boundary 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 @ Site Boundary, east-northeast, 0.24 mile	9.50×10^{-6} s/m^3	The maximum annual average site boundary 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 @ Site Boundary, east-northeast, 0.24 mile	4.10×10^{-8} 1/m^2	The maximum annual average site boundary 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, northwest, 2.8 mile	2.40×10^{-7} 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, northwest, 2.8 mile	2.40×10^{-7} 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, northwest, 2.8 mile	1.90×10^{-7} 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, northwest, 2.8 mile	9.60×10^{-10} 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.

Site Characteristic	Value	Definition
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Farm, northwest, 4.9 mile	1.10×10^{-7} s/m^3	The maximum annual average farm 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 Farm, northwest, 4.9 mile	1.10×10^{-7} s/m^3	The maximum annual average farm 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 Farm, northwest, 4.9 mile	8.20×10^{-8} s/m^3	The maximum annual average farm 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 Farm, northwest, 4.9 mile	3.50×10^{-10} 1/m^2	The maximum annual average farm relative deposition factor (D/Q) value for use in determining gaseous pathway doses to the maximally exposed individual.
2.4 – Hydrologic Engineering		
Hydrology		
Proposed Facility Boundaries	Figure A.3-1 (taken from SSAR Figure 1.2-3) depicts the proposed facility boundary.	PSEG Site boundary areas within which all safety-related SSCs will be located.
Highest Ground Water	3.05 m (10 ft) NAVD88	The maximum elevation of groundwater at the PSEG Site.

Site Characteristic	Value	Definition
Maximum Stillwater Flood Elevation (Storm Surge) + 10% Astronomical High Tide	7.53 m (24.7 ft) NAVD88	The stillwater elevation, without accounting for wind-induced waves, the water surface reaches during a flood event.
Wave Runup (Storm Surge)	2.26 m (7.4 ft)NAVD88	The height of water reached by wind-induced waves running up on the site.
Combined Effects Maximum Flood Elevation (Design Basis Flood)	9.78 m (32.1 ft) NAVD88	The water surface elevation at the point in time where the combination of the still water level and wave runup is at its maximum.
Local Intense Precipitation	46.7 cm (18.4 in.) per hour	The depth of PMP for duration of 1 hour on a 1 square-mile drainage area. The surface water drainage system should be designed for a flood produced by the local intense precipitation.
Frazil, Surface or Anchor Ice	The PSEG Site has the potential for frazil and surface ice.	Potential for accumulated ice formation in a turbulent flow condition.
Minimum River Water Surface Elevation	-4.85 m (-15.9 ft) NAVD88 for less than 6 hours	The river surface water elevation and duration for which the low water level conditions exist at the PSEG Site.
Maximum Ice Thickness	45.2 cm (17.8 in.)	Maximum potential ice thickness on the Delaware River at the PSEG Site.
Hydraulic Conductivity	SSAR Table 2.4.12-9	Groundwater flow rate per unit hydraulic gradient.
Hydraulic Gradient	SSAR Tables 2.4.12 -7 and 2.4.12-8	Slope of groundwater surface under unconfined conditions or slope of hydraulic pressure head under confined conditions.

Site Characteristic	Value	Definition
2.5 – Geology, Seismology, and Geotechnical Engineering		
Basic Geologic and Seismic Information		
Capable Tectonic Structures	No capable tectonic structures were identified in the site vicinity that could generate surface deformation or vibratory ground motion.	In SSAR Section 2.5.3.3, the applicant concluded no data suggest there are capable tectonic sources that could generate surface deformation or vibratory ground motion in the site vicinity. Based on review of SSAR Section 2.5.3.3, independent examination of references cited in the SSAR, and direct geologic field observations performed during a site audit, the staff confirmed the applicant's conclusion that no data suggested the presence of capable tectonic sources which could generate surface deformation or vibratory ground motion in the site vicinity.
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	Soils below the competent layer are not susceptible to liquefaction.	Liquefaction potential for the subsurface material at the site.
Minimum ultimate bearing capacity	420,000 psf	Load bearing capacity of the competent soil layer supporting the loads exerted by plant structures without soil failure.

Site Characteristic	Value	Definition
Minimum shear wave velocity	1613 ft/sec	The minimum propagation velocity of shear waves through the foundation materials.

Figure A.3-1 – The proposed facility boundary for the PSEG Site (from SSAR Figure 1.2-3)

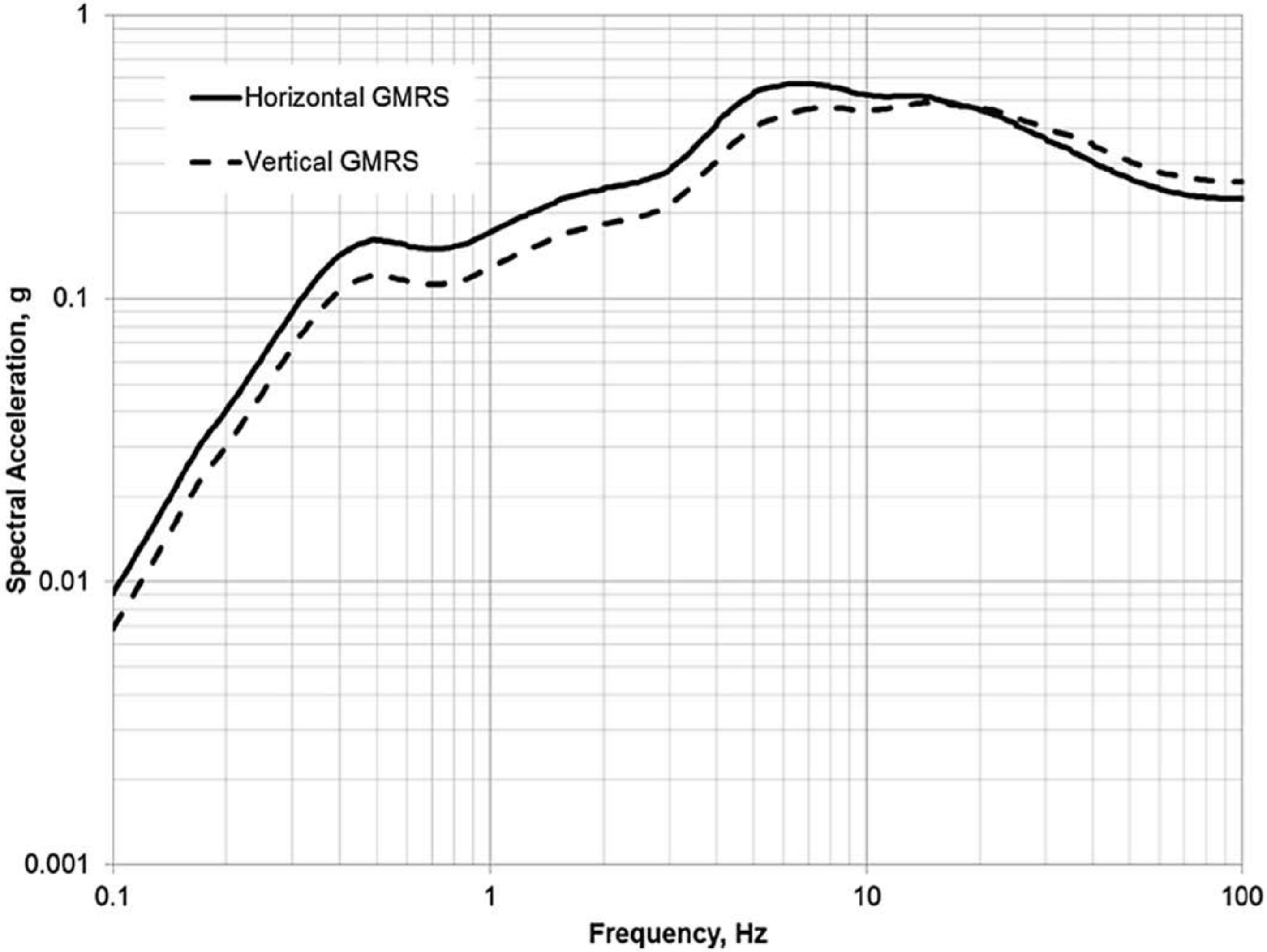

Figure A.3-2 – Plots of the horizontal and vertical GMRS (reproduced from SSAR Revision 3 Figure 2.5.2-54)

A.4 Bounding Design Parameters

Bounding Parameters: The bounding design parameters set forth postulated values of design parameters that provide design details to support the NRC staff's review of an ESP application. Since the NRC staff is relying on certain design parameters specified in the ESP application to reach its conclusions on site suitability, these bounding design parameters would be included in any ESP that might be issued for the PSEG 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 Design Parameters	Value	Definition
2.4 – Hydrologic Engineering		
Site Grade	11.25 m (36.9 ft) NAVD88	Finished plant grade for the power block area on the PSEG Site.

Note: Since PSEG has not selected a reactor design, accident source terms (activity by isotope, contained in post-accident airborne effluents) specific to the reactor design that will be selected are not available at the ESP stage.

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.

A.5.1 ITAAC for the ESP

PSEG Site Emergency Planning ITAAC

Planning Standard	EP Program Elements	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 response plans for reliance on information provided by facility licensees for determinations of minimum initial offsite response measures.	1.1 A standard emergency classification and emergency action level (EAL) scheme exists, and identifies facility system and effluent parameters constituting the bases for the classification scheme. [D.1**] [**D.1 corresponds to NUREG-0654/ FEMA-REP-1 evaluation criteria.]	1.1 An inspection of the Control Room, Technical Support Center (TSC), and Emergency Operations Facility (EOF) will be performed to verify that they have displays for retrieving facility system and effluent parameters as specified in the Emergency Classification and EAL scheme, and the displays are functional.	1.1(a) The parameters referenced in the Emergency Classification and EAL scheme are retrievable in the Control Room, TSC and EOF. 1.1(b) The ranges of the displays encompass the values specified in the Emergency Classification and EAL scheme.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
2.0 Notification Methods and Procedures			
10 CFR 50.47(b)(5) – 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 means to provide early notification and clear instruction to the populace within the plume exposure pathway Emergency Planning Zone have been established.	2.1 The means exist to notify responsible State and local organizations within 15 minutes after the licensee declares an emergency. [E.1]	2.1 A test will be performed to demonstrate the capabilities for providing initial notification to the offsite authorities after a simulated emergency classification.	2.1 The States of Delaware and New Jersey, and Kent, New Castle, Cumberland, and Salem Counties received notification within 15 minutes after the declaration of an emergency from the Control Room, TSC, or EOF.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
	2.2 The means exist to notify emergency response personnel. [E.2]	2.2 A test of the primary and backup emergency response organization (ERO) notification systems will be performed	2.2 A test of the primary and backup ERO notification system resulted in: a. ERO personnel received the notification message; b. Mobilization communication validated by personnel response to the notification system or by telephone; c. Response to electronic notification and plant public address system demonstrated during normal working hours, and off hours
	2.3 The means exist to notify and provide instructions to the populace within the plume exposure emergency planning zone (EPZ). [E.6]	2.3 A full test of the Prompt Alerting and Notification System and the Emergency Alert System capabilities will be conducted.	2.3 Notification and clear instructions to the public accomplished in accordance with the emergency plan requirements.
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 exist for communications among the Control Room, TSC, EOF, principal State and local emergency operations centers (EOCs), and field monitoring teams. [F.1.d]	3.1(a) A test will be performed to demonstrate (both primary and secondary methods/systems) the ability to communicate from the Control Room, TSC and the EOF to responsible State and local government agencies. 3.1(b) A test will be performed to demonstrate (both primary and secondary methods /systems) the ability to	3.1(a) Demonstrated (both primary and secondary methods/systems) the ability to communicate from the Control Room, TSC and the EOF to responsible State and local government agencies. 3.1(b) Demonstrated (both primary and secondary methods/systems) the ability to communicate from the TSC and the EOF to PSEG field monitoring teams.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
		communicate from the TSC and the EOF to PSEG field monitoring teams	
	3.2 The means exist for communications from the Control Room, TSC, and EOF to the NRC headquarters and regional office EOCs (including establishment of the Emergency Response Data System (ERDS) [or its successor system] between the onsite computer system and the NRC Operations Center.) [F.1.f]	3.2 A test will be performed to demonstrate the ability to communicate from the Control Room, TSC and the EOF to the NRC Operations Center utilizing the Emergency Notification System (ENS). The Health Physics Network (HPN) is tested to ensure communications between the TSC and EOF with the NRC Operations Centers. ERDS is established [or its successor system] between the onsite computer systems and the NRC Operations Center.	3.2 Communications are established between the Control Room, TSC and EOF to the NRC headquarters and regional office EOCs utilizing the ENS. The TSC and EOF demonstrated communications with the NRC Operations Center using the HPN. The access port for ERDS [or its successor system] is provided and successfully completes a transfer of data from the Unit to the NRC Operations Center.
4.0 Public Education and Information			
10 CFR 50.47(b)(7) – Information is made available to the public on a periodic basis on how they will be notified and what their initial actions should be in an emergency (e.g., listening to a local	4.1 The licensee has provided space which may be used for a limited number of the news media. [G.3.b]	4.1 An inspection of the as-built facility/area provided for the news media will be performed in the Emergency News Center/Joint Information Center (ENC/JIC).	4.1 The ENC/JIC included equipment to support the ENC/JIC operations, including communications with: a. TSC and EOF b. Principal State and local EOCs c. The news media Designated space is available for news media briefings.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
broadcast station and remaining indoors), the principal points of contact with the news media for dissemination of information during an emergency (including the physical location or locations) are established in advance, and procedures for coordinated dissemination of information to the public are established.			
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 TSC and an onsite Operations Support Center (OSC). [H.1, H.9]	5.1 An inspection of the as-built TSC and OSC will be performed, including a test of their capabilities.	5.1.1 The TSC has at least 1875 ft^2 of floor space (75 ft^2 per person for a minimum of 25 persons).
			5.1.2 Communication equipment is installed in the TSC and OSC, and voice transmission and reception are accomplished.
			5.1.3 The TSC ventilation system includes a high-efficiency particulate air (HEPA), and charcoal filter and radiation monitors are installed.
			5.1.4 The TSC has the means to receive, store, process, and display plant and environmental information, and

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
			enable the initiation of emergency measures and the conduct of emergency assessment. These capabilities are demonstrated during testing and acceptance activities.
			5.1.5 A reliable and backup electrical power supply is available for the TSC.
			5.1.6 There is an OSC located inside the Protected Area.
	5.2 The licensee has established an EOF. [H.2]	5.2 An inspection of the EOF will be performed, including a test of the capabilities.	5.2.1 Demonstrated communications between the Control Room, TSC, EOF, field monitoring teams, NRC, responsible State and county agencies, and the ENC/JIC.
			5.2.2 The parameters referenced in the Emergency Classification and EAL scheme are retrievable in the EOF.
			5.2.3 Demonstrated the capability of the EOF to respond to events at two or more reactors on the site in accordance with emergency plan implementing procedures (EPIPs), including the capabilities to discriminate plant data, staffing and operation of the facility.
6.0 Accident Assessment			
10 CFR 50.47(b)(9) – Adequate methods, systems and equipment for assessing and monitoring actual or potential off-site consequences of a radiological emergency condition are in use.	6.1 The means exist 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 or exercise to verify the capability to perform accident assessment.	6.1 Using selected monitoring parameters specified in the PSEG Site Emergency Plan, including EALs (ITAAC Acceptance Criteria 1.1), simulated degraded plant conditions are assessed and protective actions are initiated in accordance with the following criteria: a. Demonstrated the ability to obtain onsite radiological surveys and samples. b. Demonstrated the ability to continuously monitor and control radiation exposure to emergency workers.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
			c. Demonstrated the ability to assemble and deploy field monitoring teams within 60 minutes from the decision to do so. d. Demonstrated the ability to satisfactorily collect and disseminate field team data. e. Demonstrated the ability to develop dose projections. f. Demonstrated the ability to make the decision whether to issue radioprotective drugs (KI) to onsite emergency workers. g. Demonstrated the ability to develop appropriate protective action recommendations (PARs) and notify appropriate authorities within 15 minutes of development.
	6.2 The means exist 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 A test will be performed to demonstrate that the means exist 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.	6.2 Demonstrated through training or drills that Emergency Plan Implementing Procedures (EPIPs) provide direction to accurately calculate the source terms and the magnitude of the release of postulated accident scenario releases.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
	6.3 The means exist 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 A test will be performed that provides evidence that the impact of a radiological release to the environment can be assessed by using the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for various meteorological conditions.	6.3 Demonstrated through training or drills that EPIPs provide direction 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.
	6.4 The means exist to acquire and evaluate meteorological information. [I.5]	6.4 A test will be performed to acquire and evaluate meteorological data/ information.	6.4 Demonstrated that meteorological data necessary to implement the EPIPs is retrievable in the Control Room, TSC and EOF.
	6.5 The means exist to determine the release rate and projected doses if the instrumentation used for assessment is off-scale or inoperable. [I.6]	6.5 A test will be performed of the capabilities to determine the release rate and projected doses if the instrumentation used for assessment if off-scale or inoperable.	6.5 Demonstrated through training or drills that EPIPs provide direction to determine release rate and projected dose rates when instruments are off-scale or inoperable.
	6.6 The means exist for field monitoring within the plume exposure EPZ. [I.7]	6.6 A test will be performed of the capabilities for field monitoring within the plume exposure EPZ.	6.6 Demonstrated through training or drills that the field monitoring teams were dispatched and able to locate and monitor a radiological release within the plume exposure EPZ during a radioactive release scenario.
	6.7 The means exist to make rapid assessment of actual or potential	6.7 A test will be performed of the capabilities to make rapid assessments of	6.7 Demonstrated through training or drills using EPIPs:

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
	magnitude and locations of 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]	actual or potential magnitude and locations of radiological hazards through liquid or gaseous release pathways, including activation, notification means, field team composition, transportation, communication, monitoring equipment, and estimated deployment times.	a. A qualified field monitoring team was promptly notified, activated, briefed and dispatched from the EOF during a radiological release scenario. b. The team used monitoring equipment, transportation, communication from the field and located specific sampling locations. c. The team made rapid assessment of actual or potential magnitude and locations of any radiological hazards from simulated liquid or gaseous releases.
	6.8 The capability exists to detect and measure radioiodine concentrations in air in the plume exposure EPZ, as low as 10^{-7} µCi/cc (microcuries per cubic centimeter) under field conditions. [I.9]	6.8 A test will be performed of the capabilities to detect and measure radioiodine concentrations in air in the plume exposure EPZ, as low as 10^{-7} µCi/cc under field conditions.	6.8 A field monitoring team demonstrated, in accordance with the appropriate EPIP(s), the use of sampling and detection equipment for air concentrations in the plume exposure EPZ during a radioactive release scenario as low as 10^{-7} µCi/cc.
	6.9 The means exist to estimate integrated dose from the projected and actual dose rates, and for comparing these estimates with the Environmental Protection Agency (EPA) protective action guides (PAGs). [I.10]	6.9 A test will be performed of the capabilities to estimate integrated dose from the projected and actual dose rates, and for comparing these estimates with the EPA PAGs.	6.9 Personnel demonstrated the ability to estimate integrated dose from the dose assessment program and the field monitoring team reading during a radioactive release scenario. The results were successfully compared with the EPA PAGs.
7.0 Protective Response			

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
10 CFR 50.47(b)(10) – A range of protective actions has been developed for the plume exposure 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. Guide-lines 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 EPZ appropriate to the locale have been developed.	7.1 The means exist to warn and advise onsite individuals of an emergency, including those in areas controlled by the operator, including: [J.1] 1. Employees not having emergency assignments. 2. Visitors. 3. Contractor and construction personnel. 4. Other people who may be in the public access areas, on or passing through the site, or within the owner controlled area.	7.1 A test will be performed of the capabilities to warn and advise onsite individuals of an emergency, including those in the Owner Controlled Area and the immediate vicinity.	7.1 Demonstrated the ability to warn and advise onsite individuals including: 1. Non-essential employees. 2. Visitors. 3. Contractor and construction personnel. 4. Other personnel within the Owner Controlled Area and the immediate vicinity.
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	8.1 Licensee conducts a full participation exercise to evaluate major portions of emergency response capabilities, which includes participation by	8.1 A full participation exercise (test) will be conducted within the specified time periods of	8.1.1 The exercise is completed within the specified time periods of 10 CFR Part 50, Appendix E; onsite exercise objectives have been met, and there are no uncorrected onsite exercise deficiencies.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
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.	the State and local agency within the plume exposure EPZ, and each State within the ingestion control EPZ. [N.1]	10 CFR Part 50, Appendix E.	
			A. Accident Assessment and Classification 1. Demonstrated the ability to identify initiating conditions, determine EAL parameters, and correctly classify the emergency throughout the exercise. Standard Criteria: a. Determined 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. Demonstrated the ability to alert, notify and mobilize site emergency response personnel. Standard Criteria: a. Completed the designated checklist and performed the plant page announcement of the emergency classification. b. Activated the Emergency Outdial System following the initial event classification for an Alert or higher. 2. Demonstrated the ability to notify responsible State agencies within 15 minutes and the NRC within

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
			60 minutes after declaring an emergency. Standard Criteria: a. Transmitted information using the designated checklist, in accordance with approved Emergency Plan documents within 15 minutes of event classification b. Transmitted follow-up notification information using the designated checklist, in accordance with approved Emergency Plan documents. c. Transmitted information using designated checklist within 60 minutes of event classification to the NRC. 3. Demonstrated the ability to warn or advise onsite individuals of emergency conditions. Standard Criteria: a. Initiated notification of onsite individuals (via public address, Owner Controlled Area sirens or telephone) using designated checklist. 4. Demonstrated the capability of the Prompt Alerting System to operate properly for public notification when required. Standard Criteria: a. $\geq$90 percent of the sirens operate properly as indicated by the siren feedback system.
			C. Emergency Response 1. Demonstrated the capability to direct and control

			emergency operations. Standard Criteria: a. Overall emergency command and control demonstrated in the Control Room (simulator) in the early phase of the emergency and by the TSC within 90 minutes from initial event classification of Alert or higher. 2. Demonstrated the ability to transfer Emergency Coordinator function from the Shift Manager in the Control Room (simulator) to the Emergency Duty Officer in the TSC and later to the Emergency Response Manager in the EOF. Standard Criteria: a. Briefings were conducted prior to turnover responsibility. Personnel documented transfer of duties. 3. Demonstrated the ability to prepare for 24-hour staffing requirements. Standard Criteria: a. Completed 24-hour staff assignments. 4. Demonstrated the ability to perform assembly and accountability for all personnel in the Protected Area within 30 minutes of an emergency (after accountability message has been announced) requiring Protected Area accountability. Standard Criteria: a. Protected Area personnel accountability completed within 30 minutes of an emergency (after accountability message has been announced) requiring Protected Area accountability.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
			D. Emergency Response Facilities 1. Demonstrated activation of the Operations Support Center (OSC) and full functional operation of the TSC and EOF within 90 minutes of event classification. Standard Criteria: a. The TSC and OSC activated within 90 minutes of the initial classification of an Alert or higher. b. The EOF activated within 90 minutes of the initial classification of Site Area Emergency or higher. 2. Demonstrated the adequacy of the equipment, security provisions, and habitability precautions for the TSC, OSC, EOF and ENC/JIC, as appropriate. Standard Criteria: a. Demonstrated the adequacy of the emergency equipment in the emergency response facilities including availability and general consistency with the EPIPs. b. Personnel assigned to the ERO implemented and followed applicable EPIPs. c. The Shift Radiation Protection Technician (on-shift), Radiological Assessment Coordinator (TSC), and Radiological Support Manager (EOF) implemented the designated checklist if an onsite/offsite release occurred. 3. Demonstrated the adequacy of communications for all

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
			emergency support resources. Standard Criteria: a. Emergency response communications listed in the EPIPs are available and operational. b. Communications systems are tested in accordance with the TSC, OSC and EOF activation checklists. c. Emergency response facility personnel are able to operate all specified communications systems. d. Clear primary and backup communications links are established and maintained for the duration of the exercise.
			E. Radiological Assessment and Control 1. Demonstrated the ability to obtain onsite radiological surveys and samples. Standard Criteria: a. Radiation Protection Technicians demonstrated the ability to obtain appropriate instruments (range and type) and perform surveys. b. Airborne samples taken when the conditions indicate the need for the information. 2. Demonstrated the ability to continuously monitor and control radiation exposure to emergency workers. Standard Criteria: a. Emergency workers issued self-reading dosimeters when radiation levels require, and exposures

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
			controlled to 10 CFR Part 20 limits (unless the Shift Manager or Emergency Duty Officer, or designee, authorizes emergency limits). b. Exposure records are available from the site database (primary), a personal computer database (backup), or a hard copy report (backup). 3. Demonstrated the ability to assemble and dispatch field monitoring teams. Standard Criteria: a. An onsite Field Monitoring Team is ready to be deployed within 60 minutes of being requested from the declaration of an Alert or higher. 4. Demonstrated 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. Radiological data disseminated from the Field Team to the Offsite Field Team Coordinator/ Communicator. 5. Demonstrated the ability to develop dose projections. Standard Criteria: a. The Shift Radiation Protection Technician performed timely and accurate dose projections, in accordance with the EPIPs. 6. Demonstrated the ability to develop appropriate

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
			protective action recommendations (PARs), and notified New Jersey and Delaware within 15 minutes of a General Emergency declaration or of an update of the previously issued PARs. Standard Criteria: a. Total Effective Dose Equivalent (TEDE) and Committed Dose Equivalent (CDE) dose projections from the dose assessment computer code, established in accordance with the EPIPs. b. PARs developed within 15 minutes of data availability. c. PARs transmitted via voice, fax, or electronically within 15 minutes, as required by the EPIPs.
			F. Public Information 1. Demonstrated the capability to develop and disseminate clear, accurate, and timely information to the news media. Standard Criteria: a. Media briefings provided within approximately 60 minutes of activation of the ENC/JIC. 2. Demonstrated the capability to establish and effectively operate rumor control in a coordinated fashion. Standard Criteria: a. Calls answered in a timely manner with the correct information. b. Calls returned or forwarded, as appropriate, to demonstrate responsiveness.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
			c. Rumors identified and addressed.
			G. Evaluation 1. Demonstrated the ability to conduct a post-exercise critique, to determine areas requiring improvement and corrective action. Standard Criteria: a. Drill and Exercise objectives developed to allow for performance evaluation. b. Significant problems in achieving the objectives discussed to ensure understanding of why objectives were not fully achieved.
			8.1.2 Onsite emergency response personnel were mobilized in sufficient numbers to fill emergency response positions identified in Emergency Plan Section 3, Emergency Organization, and they successfully performed assigned responsibilities.
			8.1.3 The exercise was completed within the specified time periods of Appendix E to 10 CFR Part 50, offsite exercise objectives were met, and there were no uncorrected offsite exercise deficiencies; or a license condition requires offsite deficiencies to be corrected prior to operation above 5 percent of rated thermal power.
9.0 Implementing Procedures			
10 CFR Part 50, Appendix E.V - No less than 180 days before the scheduled issuance of an operating license for a nuclear power reactor	9.1 The licensee has submitted detailed implementation procedures for its emergency plan no less	9.1 An inspection of the submittal letter will be performed.	9.1 The licensee has submitted detailed EPIPs for the onsite emergency plan no less than 180 days before fuel load.

Planning Standard	EP Program Elements	Inspections, Tests, Analyses	Acceptance Criteria
or a license to possess nuclear material, the applicant's detailed implementation procedures for its emergency plan shall be submitted to the Commission.	than 180 days before fuel load.		

APPENDIX B

CHRONOLOGY OF AN EARLY SITE PERMIT APPLICATION

FOR THE PSEG SITE

This appendix lists correspondence, including between the PSEG Power, LLC and PSEG Nuclear, LLC, (PSEG or the applicant) and the U.S. Nuclear Regulatory Commission, regarding the PSEG Site early site permit (ESP) application through June 05, 2015, with the exception of legal filings related to the hearing. Source: Agencywide Documents Access and Management System (ADAMS).

Revisions to the PSEG Site ESP Application

Revision	Date	Accession Number
0	May 25, 2010	ML101480484
1	May 21, 2012	ML12170A637
2	March 27, 2013	ML13098A975
3	March 31, 2014	ML14093A588
4	June 05, 2015	ML15168A201

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
1/31/1974	ML14093A488	TN2280 - The District: A History of the Philadelphia District U.S. Army Corps of Engineers, 1866-1971	Report, Miscellaneous	US Dept of the Army, Corps of Engineers, Philadelphia District	NRC/NRO	5200043
10/19/1978	ML13274A004	"Order In the Matter of Rochester Gas and Electric Corporation, et al," ALAB-502	No Document Type Applies	NRC/ASLBP		5200043
12/31/1981	ML14094A406	TN2772 - NOAA Technical Memorandum NMFS-SEFC-24	Manual	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO	5200043
10/31/1982	ML13282A001	Final Report on Funding Nuclear Power Plant Decommissioning	Decommissioning Funding Plan DKTs 30, 40, 50, 70	The National Regulatory Research Institute	NRC/NRO, US Dept of Energy, Economic Regulatory Administration	5200043
6/6/1983	ML14091A199	TN1054 - Baltimore Gas and Electric Co. v. Natural Resources Defense Council, Inc., et al. 462 U.S. 87 (1983)., United States Supreme Court Decision June 6, 1983	Report, Miscellaneous	No Known Affiliation	NRC/NRO	5200043
10/31/1984	ML14094A414	TN2780 - "Synopsis of Biological Data on Shortnose Sturgeon, Acipenser brevirostrum, LeSeuer 1818" NOAA Technical Report NMFS-14, FOA Fisheries Synopsis No. 140	Memoranda, Report, Technical	US Dept of Commerce, National Marine Fisheries Service, US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO	5200043
4/30/1986	ML14098A069	TN82 LADTAP II - Technical Reference and User Guide. NUREG/CR-4013	NUREG	NRC/NRR,Pacific Northwest National Lab	NRC/NRO/DNRL	5200043
1/29/1987	ML13309A653	Hope Creek Generating Station, Cooling Tower Bird Mortality Survey, Annual Report and Modification Request	Letter	Public Service Electric & Gas Co	NRC/NRO, State of NJ, Dept of Environmental Protection	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
3/31/1987	ML14098A066	TN83 - "GASPAR II - Technical Reference and User Guide," NUREG/CR-4653	NUREG	Battelle Memorial Institute, Pacific Northwest National Lab, NRC/RES		5200043
9/3/1987	ML12290A080	INPO O&MR 276 Protection Against Pathogenic Organisms in Cooling Water Systems Hope Creek Generating Station	Letter, Operating Procedures	PSEG Power, LLC	NRC/NRO	5200043
7/15/1988	ML14093A481	TN3311 - Dames and Moore, 1988. Final Report: Study of Ground-water Conditions and Future Water Supply Alternatives, Salem/Hope Creek Generating Station, Artificial Island, Salem County, New Jersey	Report, Technical	Dames & Moore, Inc	NRC/NRO, PSEG Nuclear, LLC	5200043
1/1/1995	ML14094A329	TN2508 - Plotkin, P.T. (editor), 1995, 'Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973, National Marine Fisheries Service"	Report, Miscellaneous	US Dept of Commerce, National Marine Fisheries Service, US Dept of Interior, Fish & Wildlife Service	NRC/NRO	5200043
3/15/1996	ML14111A188	TN69_Griego et al_ 1996 Investigation of RADTRAN Stop Model Input Parameters for Truck Stops	Technical Paper	Sandia National Labs (SNL)	NRC/NRO	5200043
6/17/1996	ML14086A040	TN3224 - Carleton, G.B., C. Welty, and H.T. Buxton, 1999. Design and Analysis of Tracer Tests to Determine Effective Porosity and Dispersivity in Fractured Sedimentary Rocks, Newark Basin, New Jersey. USGS Water-Resources Investigations Report 98-4126A	Report, Technical, Technical Paper	Drexel Univ, State of NJ, Dept of Environmental Protection, US Dept of Interior, Geological Survey (USGS)	NRC/NRO	5200043
12/31/1997	ML14093A125	TN1238 - Integrated Database Report 1996: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections, and Characteristics. DOE/RW-0006, Revision 13	Report, Technical	Lockheed Martin Energy Research Corp,Oak Ridge National Lab (ORNL)	NRC/NRO, US Dept of Energy (DOE)	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
1/1/1998	ML14086A284	TN3217 - Herman, G.C., R.J. Canace, S.D. Stanford, R.S. Pristas, P.J. Sugarman, M.A. French, J.L. Hoffman, M.S. Serfes, and W.J. Mennel. 1998. "Aquifers of New Jersey," New Jersey Geological Survey Open-File Map 24	Map	State of NJ, Dept of Environmental Protection, State of NJ, Geologic Survey	NRC/NRO	5200043
4/22/1999	ML14093B303	TN2416 - Lower Alloways Creek Township, 1999, "Zoning Map, Township of Lower Alloways Creek, Salem County, New Jersey"	Map	Remington & Vernick Engineers	NRC/NRO	5200043
4/30/2000	ML14094A396	TN2729 "Emission Facts: Average Annual Emissions and Fuel Consumption for Passenger Cars and Light Trucks" (EPA 420-F-00-013)	Report, Miscellaneous	US Environmental Protection Agency (EPA)	NRC/NRO	5200043
2/28/2001	ML14345A531	Warren et al. (2001) Rates, Patterns, and Impacts of Phragmites Australis Expansion and Effects of Experimental Phragmites Control on Vegetation, Macroinvertebrates, and Fish within Tidelands of the Lower Connecticut River. Estuaries, 24(1), 90-107	Technical Paper	Connecticut College	NRC/ADM/DAS	5200043
12/31/2001	ML14091A145	TN2384 - Phase I New Facilities Technical Development Document for the Final Regulation	Database File	US Environmental Protection Agency (EPA)	NRC/NRO/DNRL	5200043
4/16/2002	ML14345A551	Landsat Imagery Shows Decline of Coastal Marshes in Chesapeake and Delaware Bays	News Article	American Geophysical Union	NRC/ADM/DAS	5200043
11/30/2002	ML14133A486	2002 US Census Bureau - "Summary Population and Housing Characteristics in New Jersey and Delaware"	Report, Miscellaneous	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
1/31/2003	ML14345A575	High intensity anthropogenic sound damages fish ears	Journal Article, Technical Paper	Acoustical Society of America, Curtin University, Australia,Univ of Maryland - College Park	NRC/ADM/DAS	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
2/27/2003	ML14086A034	TN3225 - Barton, G.J., D.W. Risser, D.G. Galeone, and D.J. Goode. 2003, Case Study for Delineating a Contributing Area to a Well in a Fractured Siliciclastic-Bedrock Aquifer Near Lansdale, Pennsylvania. USGS Water-Resources Investigations Report 02-4271	Report, Technical, Technical Paper	State of PA, Dept of Environmental Protection, US Dept of Interior, Geological Survey (USGS)	NRC/NRO	5200043
6/19/2003	ML14077A037	Merrill Creek Reservoir Plan of Operation Docket D-77-110 CP (Amendment 1)	Letter, Operating Plan	Delaware River Basin Commission	Merrill Creek Reservoir, NRC/NRO	5200043
10/20/2003	ML14345A586	Noise-Induced Stress Response and Hearing Loss in Goldfish (Carassius Auratus)	Journal Article,Technical Paper	Univ of Maryland - College Park	NRC/ADM/DAS	5200043
11/18/2003	ML14086A082	TN3223 - NJDEP Chloride and Water Use Reported Values Summary, Salem and Hope Creek Generating Stations, 2003-2013	Report, Miscellaneous	State of NJ, Dept of Environmental Protection	NRC/NRO/DNRL	05000272 05000311 05000354 05200043
7/31/2004	ML14093A260	TN2086 - Fact Sheet: "Biomass Energy Focus on Wood Waste"	FACT Sheet	US Dept of Energy, Office of Energy Efficiency & Renewable Energy	NRC/NRO	5200043
7/31/2004	ML14345A544	Relyea, R. (2005), "The Impact of Insecticides and Herbicides on the Biodiversity and Productivity of Aquatic Communities." Ecological Applications 15(2): 618-627	Journal Article, Technical Paper	Ecological Society of America, Univ of Pittsburgh	NRC/ADM/DAS	5200043
9/30/2004	ML14094A041	TN2406 - U.S. Geological Survey, 2004, "Office of the Delaware River Master"	Report, Miscellaneous	US Dept of Interior, Geological Survey, Water Resources Div	NRC/NRO	5200043
12/3/2004	ML14085A468	TN3234 - Navoy, et. Al., "Vulnerability of Production Wells in the Potomac-Raritan-Magothy Aquifer System (Delaware River)" NJ SIR 2004-5096 (2005)	Technical Paper	Delaware River Basin Commission, US Dept of Interior, Geological Survey (USGS)	NRC/NRO	5200043
6/6/2005	ML14345A569	"Differential Effects of Glyphosate and Roundup on Human Placental Cells and Aromatase"	Journal Article	Univ Of Caen, France	NRC/ADM/DAS	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
6/30/2005	ML14345A588	ENV Report 56, "Evaluation of Towboat Propeller-Induced Mortality of Juvenile and Adult Fishes"	Report, Technical, Technical Paper	Elliott Bay Design Group LLC, US Dept of the Army, Corps of Engineers, St. Louis District, US Dept of the Army, Research, Development & Engineering Command	NRC/ADM/DAS, US Dept of the Army, Corps of Engineers, Rock Island District	5200043
8/31/2005	ML14345A564	Relyea, R. (2005) "The Lethal Impact of Roundup on Aquatic and Terrestrial Amphibians. Ecological Applications" 15(4): 1118-1124	Journal Article, Technical Paper	Ecological Society of America,Univ of Pittsburgh	NRC/ADM/DAS	5200043
9/30/2005	ML14087A250	TN2358 - U.S. Department of Energy, 2005. "Cost Estimating Guidelines for Generation IV Nuclear Energy Systems," Rev. 2.02 Final, Economic Modeling Working Group - Sept. 30, 2005	Technical Paper	US Dept of Energy (DOE)	NRC/NRO/DNRL	5200043
5/31/2006	ML14094A579	TN2831- Atlantic States Marine Fisheries Commission. 2013. "Scup (Stenotomus chrysops) Life History and Habitat Needs"	FACT Sheet	Atlantic States Marine Fisheries Commission	NRC/NRO/DNRL	5200043
12/31/2006	ML14090A033	TN2148 - Silver Hake in Mayo, R., F. Serchuk, and E. Holmes (editors), "Status of Fishery Resources off the Northeastern US," NOAA Technical Memo NMFS-NE-115.	Technical Paper	US Dept of Commerce, National Marine Fisheries Service	NRC/NRO	5200043
12/31/2006	ML14090A042	TN2153 - Windowpane Flounder (Scophthalmus aquosus), In Mayo, R., F. Serchuk, and E. Holmes (editors), "Status of Fishery Resources Off the Northeastern United States"	Technical Paper	No Known Affiliation	NRC/NRO/DNRL	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
12/31/2006	ML14090A046	TN2154 - Winter flounder (Pseudopleuronectes Americanus) In Mayo, R., F. Serchuk, and E. Holmes (editors), "Status of Fishery Resources Off the Northeastern United States"	Technical Paper	US Dept of Commerce, National Marine Fisheries Service, US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO/DNRL	5200043
12/31/2006	ML14091A056	TN2288 - "2006 National Electric Transmission Congestion Study," Department of Energy	Database File	US Dept of Energy (DOE)	NRC/NRO	5200043
5/31/2007	ML14345A541	Perez, G. L., Torremorell, A., Mugni, H., Rodriguez, P., Vera, M. S., Nascimento, M. D.,... & Zagarese, H. (2007), "Effects of the Herbicide Roundup on Freshwater Microbial Communities: a Mesocosm Study"	Journal Article, Technical Paper	Ecological Society of America, Instituto de Investigaciones Biotecnologicas, Instituto De Limnologia Dr. Ringuelet, Instituto Tecnologico De Chascomus (Intech), Lehigh Univ, Universidad de Buenos Aires	NRC/ADM/DAS	5200043
9/30/2007	ML14097A248	TN2660 - "EPA Biomass Combined Heat and Power Catalog of Technologies"	Report, Technical	US Environmental Protection Agency (EPA)	NRC/NRO	5200043
11/5/2007	ML14093B317	TN2417 - Elsinboro (Elsinboro Township, New Jersey), 2007, "Zoning Map, Township of Elsinboro" Salem, New Jersey.	Map	Elsinboro Township, NJ	NRC/NRO/DNRL	5200043
12/31/2007	ML14085A131	TN3112 - U.S. Department of Agriculture, "DE-NJ Farm Labor Statistics"	Database File	US Dept of Agriculture, National Agricultural Statistics Service	NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
12/31/2007	ML14086A457	TN3133 - "Accommodations and Food Services: Summary Statistics for New Castle County, Delaware and Cumberland, Salem, and Gloucester Counties, New Jersey: 2007 Economic Census" Table Eco772A1	Report, Miscellaneous	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
3/4/2008	ML14086A280	TN3219 - Serfes, M., R. Bousenberry, and J. Gibs. 2007. "New Jersey Ambient Ground Water Quality Monitoring Network: Status of Shallow Ground-Water Quality, 1999-2004" New Jersey Geological Survey, Information Circular on Groundwater Quality 1999-2004	FACT Sheet	State of NJ, Dept of Environmental Protection	NRC/NRO	5200043
3/21/2008	ML14092A563	TN2439 - Centers for Disease Control and Prevention. 2008. "Summary of Notifiable Diseases - United States, 2006." Morbidity and Mortality Weekly Report 55(53):1-94.	Report, Miscellaneous	US Dept of Health & Human Services, Centers for Disease Control & Prevention (CDC)	NRC/NRO	5200043
3/31/2008	ML14345A537	Derr, J. F. (2008) "Common Reed (Phragmites Australis) Response to Mowing and Herbicide Application," Invasive Plant Science and Management	Newsletter	Invasive Plant Science and Management	NRC/ADM/DAS	5200043
6/16/2008	ML14345A566	"Glyphosate Formulations Induce Apoptosis and Necrosis in Human Umbilical, Embryonic, and Placental Cells"	Journal Article	Univ Of Caen, France	NRC/ADM/DAS	5200043
7/16/2008	ML14086A563	TN3210 - Delaware River Basin Commission, 2008. "Resolution No. 2008-09 to amend the Water Quality Regulations, Water Code and Comprehensive Plan"	No Document Type Applies	Delaware River Basin Commission	NRC/NRO	5200043
12/31/2008	ML14084A034	"Water-level conditions in selected confined aquifers of the New Jersey and Delaware Coastal Plain," 2003	Report, Miscellaneous	State of NJ, Dept of Environmental Protection,US Dept of	NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
				Interior, Geological Survey (USGS)		
12/31/2008	ML14345A590	Aquatic Toxicology - "Contaminant Accumulation and Biomarker Responses in Caged Mussels, Mytilus Galloprovincialis, to Evaluate Bioavailability and Toxicological Effects of Remobilized Chemicals During Dredging and Disposal Operations in Harbour Areas"	Journal Article	Istituto Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare (ICRAM), Universita Politecnica delle Marche, Italy	NRC/ADM/DAS	5200043
1/4/2009	ML093560527	Enclosure 3 - Presentation, Public Service Enterprise Group to Discuss Hazardous Material Shipments and Probable Maximum Flood Determination for their Early Site Permit Application	Meeting Briefing Package/Handouts, Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO	PROJ0771
2/20/2009	ML090510065	NRC Visit to the Hancocks Bridge, NJ Site to Observe Early Site Permit Subsurface Investigation Activities	Letter	NRC/RGN-II/DCI/CIB2	PSEG Power, LLC	PROJ0771
3/4/2009	ML090630324	03/23/2009 Notice of Meeting with Public Service Electric & Gas Company to Discuss Plant Parameter Envelope Approach for Their Early Site Permit Application	Meeting Agenda, Meeting Notice	NRC/NRO/DNR/NGE2	NRC/NRO/DNRL/ NGE2	PROJ0771
4/17/2009	ML090910638	3/23/2009 - Summary of March 23, 2009 Meeting With Public Service Enterprise Group To Discuss Plant Parameter Envelope Approach For the Early Site Permit Application	Meeting Summary	NRC/NRO/DNRL/ NGE2	NRC/NRO/DNRL/ NGE2	PROJ0771
4/17/2009	ML090910674	Enclosure 3 - Meeting With Public Service Enterprises Group to Discuss Plant Parameter Envelope Approach For Their Early Site Permit Application	Meeting Briefing Package/Handouts	PSEG Power, LLC	NRC/NRO/DNRL	PROJ0771

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5/19/2009	ML14094A342	TN2511 - National Marine Fisheries Service 2009. "Species of Concern, River Herring (Alewife and Blueback Herring) Alosa pseudoharengus and A. aestivalis"	FACT Sheet	US Dept of Commerce, National Marine Fisheries Service,US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO	5200043
6/8/2009	ML14345A568	"Glyphosate-based herbicides are toxic and endocrine disruptors in human cell lines"	Journal Article	Univ of Burgundy, France, Univ Of Caen, France	NRC/ADM/DAS	5200043
7/15/2009	ML13113A126	SL-009924, Revision 0, "Nuclear Development Project Conceptual Barge Facilities and Haul Roads," Enclosure 1 to ND-2013-0009.	Report, Technical	Sargent & Lundy	NRC/NRO, PSEG Power, LLC	5200043
7/24/2009	ML12283A124	PSEG Early Site Permit Application, Regarding Property at Salem and Hope Creek, Alloway Creek Neck Road and Notification of Submittal of Application for a Permit or Approval	Letter	PSEG Nuclear, LLC	NRC/NRO, State of NJ, Dept of Environmental Protection	05000272 05000311 05000354 05200043
7/31/2009	ML101660319	Enclosure 2 to ND-2010-0089 - Report of Phase 1 Archaeological Survey for Selected Portions of Two Proposed Access Road Alternatives, dated July 31, 2009	Report, Miscellaneous	MACTEC Engineering & Consulting, Inc	NRC/NRO, PSEG Power, LLC, Sargent & Lundy, LLC	PROJ0771
8/13/2009	ML12283A127	PSEG Early Site Permit Application, Application for Line Verification Letter of Interpretation - Salem and Hope Creek Generating Station	Letter, Facsimile	AKRF, Inc	NRC/NRO, State of NJ, Dept of Environmental Protection	05000272 05000311 05000354 05200043
8/28/2009	ML12286A197	TR-441, Rev. 4, "Traffic Impact Analysis at the PSEG Site Preliminary Findings Report", Cover through Appendix B, Traffic Data Collected in Field, Page B-204	Report, Miscellaneous	KLD Engineering, PC	NRC/NRO, PSEG Power, LLC	5200043

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8/28/2009	ML12286A199	TR-441, Rev. 4, "Traffic Impact Analysis at the PSEG Site Preliminary Findings Report", Appendix B, Traffic Data Collected in Field, Page B-205 through Appendix K, LOS Analysis Worksheets, Page K-121	Report, Miscellaneous	KLD Engineering, PC	NRC/NRO, PSEG Power, LLC	5200043
9/1/2009	ML14086A118	TN3221 - NJDEP 2009 NJ Stormwater Best Management Practices Manual (webpage with links)	Manual	State of NJ, Dept of Environmental Protection, Div of Water Monitoring and Standards	NRC/NRO	5200043
10/6/2009	ML12290A154	Letter from Daniel Saunders (NJHPO) to Jeffrey J. Pantazes (PSEG) w/ Comments on August 6, 2009 Submittal of Report of Phase I Archaeological Survey of Selected Portions of Two Access Road Alternatives, PSEG Early Site Permit Applications, Salem, NJ	Letter	State of NJ, Dept of Environmental Protection,State of NJ, Historic Preservation Office	NRC/NRO, PSEG Power, LLC, NRC/NRR	05000272 05000311 05000354 05200043
10/22/2009	ML12146A119	2251-ESP-REI-2047-ACR-014, Rev 1, "PSEG Site Hazard Contribution by Source"	Calculation	MACTEC, Inc	NRC/NRO	5200043
11/2/2009	ML12146A116	2251-ESP-REI-2047-ACR-040, Rev 1, "Calculation of Smooth Vertical GMRS for the PSEG Site"	Calculation, Report, Technical	MACTEC, Inc	NRC/NRO	5200043
11/19/2009	ML093140718	12/08/2009-Notice of Meeting with Public Service Enterprise Group to Discuss Hazardous Material Shipments and Probable Maximum Flood Determination	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/ NGE2	NRC/NRO/DNRL/ NGE2	PROJ0771
11/24/2009	ML12146A117	2251-ESP-REI-2047-ACR-044, Rev 2, "Replication of 1989 EPRI-SOG Hazard for Individual Law Engineering Sources"	Calculation, Report, Technical	MACTEC, Inc	NRC/NRO	5200043
12/16/2009	ML12290A159	Historic Properties Visual Impact Assessment PSEG Early Site Permit Application Salem County, New Jersey	Report, Miscellaneous	MACTEC Engineering & Consulting, Inc	NRC/NRO, PSEG Power, LLC	5200043

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12/16/2009	ML101660417	Enclosure 8 to ND-2010-0089 - Historic Properties Visual Impact Assessment, dated December 16, 2009, Cover Page through Figure 5 Sheet C6	Report, Miscellaneous	MACTEC Engineering & Consulting, Inc	NRC/NRO, PSEG Power, LLC, Sargent & Lundy, LLC	PROJ0771
12/16/2009	ML101660418	Enclosure 8 to ND-2010-0084 - Historic Properties Visual Impact Assessment, dated December 16, 2009, Figure 5 Sheet D1 through Enclosure 9, DE SHPO Letter, April 15, 2010	Report, Miscellaneous	MACTEC Engineering & Consulting, Inc	NRC/NRO, PSEG Power, LLC, Sargent & Lundy, LLC	PROJ0771
12/24/2009	ML101660320	Enclosure 3 to ND-2010-0089 - Report of Phase I Archaeological Survey for Selected Portions of Two Proposed Access Road Alternatives, dated December 24, 2009	Report, Miscellaneous	MACTEC Engineering & Consulting, Inc	NRC/NRO,PSEG Power, LLC,Sargent & Lundy, LLC	PROJ0771
12/31/2009	ML14345A572	The effects of anthropogenic sources of sound on fishes.	Journal Article	Pennsylvania State Univ, State College, PA,The Fisheries Society of the British Isles, Univ of Maryland	NRC/ADM/DAS	5200043
12/31/2009	ML14345A581	The Effects of Human-Generated Sound on Fish.	Journal Article, Technical Paper	Pennsylvania State Univ, State College, PA,Univ of Maryland - College Park	NRC/ADM/DAS	5200043
12/31/2009	ML101660433	Enclosure 10 to ND-2010-0084 - Submerged Cultural Resources Survey of a Proposed Barge Facility and Water Intake, dated December 2009, Draft	Report, Miscellaneous	Panamerican Consultants, Inc	MACTEC Engineering & Consulting, Inc, NRC/NRO	PROJ0771
1/4/2010	ML093560107	12/08/09-Summary of December 8, 2009 Meeting with Public Service Enterprise Group to Discuss Hazardous Material shipments and Probable Maximum Flood Determination for their Early Site Permit Application	Meeting Agenda, Meeting Summary, Memoranda	NRC/NRO/DNRL/ NGE2	NRC/NRO/DNRL/ NGE2	PROJ0771

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1/26/2010	ML12286A198	GIS Analysis of Potential Off-Site Transmission Macro-Corridors, Revision 1, Cover through Figure 3-4, Streams and NWI Wetlands within Potential Off-Site Transmission Macro-Corridors, Sheet 4, Rev. A	Report, Technical	MACTEC Engineering & Consulting, Inc	NRC/NRO, PSEG Power, LLC, Sargent & Lundy	5200043
1/26/2010	ML12286A200	GIS Analysis of Potential Off-Site Transmission Macro-Corridors, Revision 1, Figure 3-4, Streams and NWI Wetlands within Potential Off-Site Transmission Macro-Corridors, Sheet 5, Rev. A through Figure 3-6, Sheet 8, Rev. A	Report, Technical	MACTEC Engineering & Consulting, Inc	NRC/NRO,PSEG Power, LLC,Sargent & Lundy	5200043
1/26/2010	ML12286A202	GIS Analysis of Potential Off-Site Transmission Macro-Corridors, Revision 1, Figure 3-7, Sheet 1, Rev. A through Figure 3-8, Sheet 8, Rev. A	Report, Technical	MACTEC Engineering & Consulting, Inc	PSEG Power, LLC,NRC/NRO,Sargent & Lundy	5200043
1/29/2010	ML12290A150	Letter from Daniel Saunders (NJHPO) to Jeffrey J. Pantazes (PSEG) With Comments on the January 11, 2010 Submittal of the Draft Submerged Cultural Resources Survey.	Letter	State of NJ, Dept of Environmental Protection,State of NJ, Historic Preservation Office	NRC/NRO,PSEG Power, LLC,NRC/NRR	05000272 05000311 05000354 05200043
1/29/2010	ML12290A152	Letter from Daniel Saunders (NJHPO) to Jeffrey J. Pantazes (PSEG) With Comments on the January 11, 2010 Submittal of the Draft Submerged Cultural Resources Survey	Letter	State of NJ, Dept of Environmental Protection,State of NJ, Historic Preservation Office	NRC/NRO,PSEG Power, LLC	5200043
2/12/2010	ML12146A118	2251-ESP-REI-2047-ACR-046 Rev 2, "Sensitivity of Site Amplification Factors for the PSEG Site ESP to Revisions in Degradation Curves"	Calculation	MACTEC, Inc	NRC/NRO	5200043
2/18/2010	ML12284A425	PSEG Early Site Permit Application, Subsistence Living in the Vicinity of Salem and Hope Creek Nuclear Generating Stations	Note to File incl Telcon Record, Verbal Comm	Tetra Tech NUS, Inc	NRC/NRO,PSEG Nuclear, LLC	05000272 05000311 05000354 05200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
2/28/2010	ML14345A600	Carol Collier, Executive Director Delaware River Basin Commission, Global Climate Change Talk, Heinz Refuge, February 2010.	Meeting Briefing Package/Handouts, Slides and Viewgraphs	Delaware River Basin Commission	NRC/ADM/DAS	5200043
3/9/2010	ML14077A032	Calculation No. 2251-ESP-GW-002, Rev 0, "PSEG Site ESP Application" Pages 1 - 40.	Calculation	MACTEC, Inc	NRC/NRO	5200043
3/9/2010	ML14077A034	Calculation No. 2251-ESP-GW-002, Rev 0, "PSEG Site ESP Application" Pages 41 - 80.	Calculation	MACTEC, Inc	NRC/NRO	5200043
3/9/2010	ML14077A035	Calculation No. 2251-ESP-GW-002, Rev 0, "PSEG Site ESP Application" Page 81 - Page 114 Attachment D	Calculation	MACTEC, Inc	NRC/NRO	5200043
3/9/2010	ML14093A796	TN3323 - MACTEC Engineering and Consulting, Inc., 2009. "PSEG Site Application Project." CP 2251 ESP-GW-002, Revision 0.	Calculation, Report, Miscellaneous	MACTEC Engineering & Consulting, Inc	NRC/NRO ,PSEG Nuclear, LLC	5200043
3/11/2010	ML12290A147	Letter from Daniel Saunders (NJHPO) to Jeffrey J. Pantazes (PSEG) With Comments on the Draft Historic Properties Visual Impact Assessment (MACTEC 2009) and Phase I Archaelogical Study (MACTEC 2009)	Letter	State of NJ, Dept of Environmental Protection,State of NJ, Historic Preservation Office	NRC/NRO, PSEG Power, LLC ,NRC/NRR	05000272 05000311 05000354 05200043
3/31/2010	ML101600083	Alternative Site Evaluation Study - Potential Site Maps, Appendix D	Map	Sargent & Lundy, LLC	NRC/NRO	PROJ0771
3/31/2010	ML101600084	Enclosure 1 - Report SL-010099, "Alternative Site Evaluation Study"	Report, Technical	Sargent & Lundy, LLC	NRC/NRO, PSEG Power, LLC	PROJ0771
3/31/2010	ML101600085	Alternative Site Evaluation Study - Potential Site Descriptions, Appendix E	No Document Type Applies	Sargent & Lundy, LLC	NRC/NRO	PROJ0771
4/9/2010	ML100990105	PSEG ESP: Government to Government Meeting - Letter of Invitation	Letter	NRC/NRO/DNRL/ NARP		PROJ0771

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4/10/2010	ML14085A424	TN3119 - US Census Bureau 2012 - Largest Metro Areas.	Graphics incl Charts and Tables	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
4/15/2010	ML12290A146	Letter from Joan Larrivee (DESHPO) to Jeffrey J. Pantazes (PSEG) With Comments on the Draft Historic Properties Visual Impact Assessment (MACTEC 2009)	Letter	State of DE, Historic Preservation Office	PSEG Power, LLC, NRC/NRO, NRC/NRR	05000272 05000311 05000354 05200043
4/20/2010	ML101030431	05/06/2010-Notice of Public Outreach Meeting on Forthcoming PSEG Early Site Permit Application	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/ NARP	NRC/NRO/DNRL/ NARP	PROJ0771
4/21/2010	ML12283A139	PSEG Early Site Permit Application, Freshwater Wetlands Letter of Interpretation/Line Verification	Letter	State of NJ, Dept of Environmental Protection	NRC/NRO,AKRF, Inc	05000272 05000311 05000354 05200043
4/23/2010	ML12286A365	Calculation No. 2009-09771, Rev. 1, "Doses to Construction Workers"	Calculation	Sargent & Lundy	NRC/NRO,PSEG Nuclear, LLC	5200043
5/3/2010	ML101540492	PSEG Power LLC, "Nuclear Development Quality Assurance Program Description"	Quality Assurance Program	PSEG Power, LLC	NRC/NRO	PROJ0771
5/20/2010	ML12146A120	2251-ESP-REI-2047-ACR-034, Rev 1, "Calculation of Site Response for the PSEG Site"	Calculation	MACTEC, Inc	NRC/NRO	5200043
5/25/2010	ML101470299	Quality Assurance Program Document for the Early Site Permit Application for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
5/25/2010	ML101480484	Application for Early Site Permit for the PSEG Site	Letter	PSEG Nuclear, LLC,PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771

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5/25/2010	ML101480803	PSEG POWER, LLC (SUNSI), Rev. 0 - Withheld Information (SUNSI)	Emergency Preparedness-Emergency Plan, License-Application for Early Site Permit (ESP)	PSEG Nuclear, LLC,PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
5/25/2010	ML101520306	PSEG Power, LLC - Offsite Radiological Emergency Response Plans for the Early Site Permit Application for the PSEG Site	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
5/27/2010	ML101470209	06/14/2010 Notice of Meeting with PSEG Power, LLC, and PSEG Nuclear, LLC for Overview of Early Site Permit Application	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/NARP,NRC/NRR	NRC/NRO/DNRL/NARP, NRC/NRR	PROJ0771
5/31/2010	ML12047A125	PSEG Costal Zone Management Act Consistency Certification for the Early Site Permit.	Report, Miscellaneous	PSEG Nuclear, LLC,PSEG Power, LLC	NRC/NRO	5200043
5/31/2010	ML14345A546	Paganelli., A., Gnazzo, V., Acosta, H., Lopez, S. L., & Carrasco, A. E. (2010) Glyphosate-based Herbicides Produce Teratogenic Effects on Vertebrates by Impairing Retinoic Acid Signaling Chemical Research in Toxicology, 23(10), 1586-1595.	Technical Paper	American Chemical Society, Universidad de Buenos Aires	NRC/ADM/DAS	5200043
6/4/2010	ML101590553	PSEG Power, LLC, Submittal of Document in Support of Application Early Site Permit for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
6/9/2010	ML101660318	PSEG Power, LLC - Documents in Support of Early Site Permit Application for PSEG Site, NRC Project No. 771	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
6/11/2010	ML101620213	Press Release-10-101: PSEG Application for Early Site Permit in N.J. Available on NRC Website	Press Release	NRC/OPA		PROJ0771

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6/14/2010	ML101590319	Letter to PSEG on Receipt of PSEG Site ESP Application.	Letter	NRC/NRO/DNRL/ NARP	PSEG Power, LLC	PROJ0771
6/14/2010	ML101590720	Federal Register Notice on Receipt of PSEG Site ESP Application	Federal Register Notice	NRC/NRO/DNRL/ NARP		PROJ0771
6/14/2010	ML101660404	June 14, 2010 Public Meeting with PSEG - Presentation Slides, Early Site Permit Application ESP Application Overview	License-Application for Early Site Permit (ESP)	PSEG Nuclear, LLC	NRC/NRR	PROJ0771
6/22/2010	ML101760159	Submittal of Meteorological Data in Support of Early Site Permit Application for PSEG Site NRC Project Number 771	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
7/6/2010	ML101900489	PSEG Power, LLC, Submittal of Meteorological Data in Support of Early Site Permit Application	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
7/7/2010	ML102020480	PSEG Power, LLC, Submittal of Initial Radionuclide Concentrations Used in Radioactive Transport Analysis in Support of Early Site Permit Application	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
7/23/2010	ML102020606	06/14/2010-Summary of Public Meeting with PSEG Power, LLC, and PSEG Nuclear, LLC on Overview of PSEG Site Early Site Permit Application	Meeting Summary	NRC/NRO/DNRL/ NARP		PROJ0771
7/29/2010	ML102140332	PSEG Power, LLC, Submittal of Revision to Site Safety Analysis Report Section 13.6 in Support of Early Site Permit Application for PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771
7/29/2010	ML102160628	PSEG Power, LLC Transmittal of Offsite Radiological Emergency Response Plans for the Early Site Permit Application for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	PROJ0771

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7/31/2010	ML14345A589	Yeager, K. M., Brinkmeyer, R., Rakocinski, C. F., Schindler, K. J., & Santaschi, P. H. (2010). Impacts of Dredging Activities on the Accumulation of Dioxins in Surface Sediments of the Houston Ship Channel, Texas. Journal of Coastal Research, 743-752.	Journal Article	Coastal Education & Research Foundation, Inc, Journal of Coastal Research, Texas A&M Univ, Univ of Southern Mississippi	NRC/ADM/DAS	5200043
8/4/2010	ML102010714	Acceptance Review For An Early Site Permit Application For PSEG Site	Acceptance Review Letter	NRC/NRO/DNRL/ NARP	PSEG Power, LLC	5200043
8/4/2010	ML102010722	Federal Register Notice - "Acceptance for Docketing of an Application for Early Site Permit for the PSEG Site"	Federal Register Notice	NRC/NRO/DNRL		5200043
8/6/2010	ML102180073	Press Release-10-136: "NRC Accepts Application for Early Site Permit at PSEG Site in New Jersey"	Press Release	NRC/OPA		5200043
8/18/2010	ML102350224	Service of Notice of Availability of Application for an Early Site Permit	Letter	PSEG Nuclear, LLC,PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/23/2010	ML102240060	Letter to PSEG Regarding PSEG ESP Application Online Reference Portal	Letter	NRC/NRO/DSER/ RAP1	PSEG Power, LLC	5200043
9/8/2010	ML102530617	PSEG Power, LLC Document in Support of Application Early Site Permit for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/8/2010	ML103260561	PSEG ESP Scoping Meeting: Attachment to the Transcripts from South Jersey BayShore Coalition	Letter	No Known Affiliation	US Dept of the Army, Corps of Engineers, Philadelphia District, NRC/NRO	5200043
9/10/2010	ML102570065	PSEG Power, LLC - Early Site Permit Application Online Reference Portal	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
9/24/2010	ML102630546	Letter to Salem Library: PSEG ESP Application Library Letters	Letter	NRC/NRO/DSER/ RAP1	Salem County, NJ	5200043
9/24/2010	ML102630552	Letter to Penns Grove: PSEG ESP Application Library Letters	Letter	NRC/NRO/DSER/ RAP1	Carney's Point Township, NJ	5200043
9/24/2010	ML102630558	Letter to Pennsville: PSEG ESP Application Library Letters	Letter	NRC/NRO/DSER/ RAP1	Pennsville, NJ, Public Library	5200043
10/20/2010	ML103020442	Letter of Transmittal from Sandia National Labs for PSEG ESP ETE Review	Letter	Sandia National Labs (SNL)	NRC/NSIR	5200043
10/20/2010	ML103020447	PSEG ESP ETE Review Template Report	Policy and Program Guidance	Sandia National Labs (SNL)	NRC/NSIR	5200043
10/20/2010	ML103020449	PSEG ESP ETE Review Boilerplate Report	Report, Technical	Sandia National Labs (SNL)	NRC/NSIR	5200043
10/20/2010	ML103020454	PSEG ESP ETE Review Requests for Additional Information (RAIs)	Request for Additional Information (RAI)	Sandia National Labs (SNL)	NRC/NRO	5200043
10/26/2010	ML102850545	Letter to Maresca Notification and Request for Consultation and Participation in the Scoping Process for the PSEG Site Early Site Permit Application Review	Letter	NRC/NRO/DSER/ RAP1	State of NJ, Dept of Environmental Protection	5200043
10/26/2010	ML102850562	Letter to ACHP Nelson: Notification and Request for Consultation and Participation in the Scoping Process for the PSEG Site Early Site Permit Application Review	Letter	NRC/NRO/DSER/ RAP1		5200043
11/1/2010	ML14093B136	TN2428 - U.S. Bureau of Labor Statistics, 2010. "Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, 2009-New Jersey," Table 6 in Survey of Occupational Injuries, and Illnesses by Industry and Case Types.	Graphics incl Charts and Tables	US Dept of Labor, Bureau of Labor Statistics	NRC/NRO	5200043

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11/3/2010	ML103070255	Slides: 11/04/2010 PSEG Public Meeting	Meeting Briefing Package/Handouts, Slides and Viewgraphs	NRC/NRO/DSER/ RAP1		5200043
11/4/2010	ML103260578	PSEG ESP Scoping Meeting: Attachment to the Transcripts from Dr. Edward H. Salmon	No Document Type Applies	New Jersey Energy Coalition,Salem Community College	NRC/NRO	5200043
11/4/2010	ML103260611	11/04/2010 PSEG Scoping Meeting: Attachment to the Transcripts Letter From Maria Patouhas+C10.	Speech	Chamber of Commerce of Southern New Jersey	NRC/NRO/DSER/RAP 1	5200043
11/4/2010	ML103270162	11/04/2010 PSEG ESP Scoping Meeting: Attachment to the Transcripts from Kenneth B. Lewis, M.D.	No Document Type Applies	No Known Affiliation	NRC/NRO	5200043
11/4/2010	ML103270178	11/04/2010 PSEG ESP Scoping Meeting: Attachment to the Transcripts from Salem County Improvement Authority by Jack Kugler, Executive Director.	Speech	Salem County Improvement Authority	NRC/NRO	5200043
11/4/2010	ML103270540	11/04/2010 PSEG Scoping Meeting Attendee List.	No Document Type Applies	NRC/NRO/DSER/ RAP1		5200043
11/4/2010	ML103270568	Transcript of PSEG Early Site Permit Application, November 4, 2010, Pages 1-109.	Meeting Transcript	NRC/NRO		5200043
11/4/2010	ML103270579	Transcript OF PSEG Early Site Permit Application, Evening Session, 11/04/2010, Pages 1-50.	Meeting Transcript	NRC/NRO		5200043
11/4/2010	ML103270654	PSEG ESP Scoping Meeting: Attachment to the Transcripts from Robert F. Molzahn	No Document Type Applies	Water Resources Association of the Delaware River Basin	NRC/NRO/DSER/RAP 1	5200043
11/4/2010	ML103270664	PSEG ESP Scoping Meeting: Attachment to the Transcripts from Ajax Eastman	Letter	Maryland Conservation Council	NRC/NRO/DSER/RAP 1	5200043

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11/5/2010	ML102930260	Invitation Letter to US Army Corps of Engineers, Philadelphia District, to Cooperate on PSEG ESP Review	Letter	NRC/NRO/DSER/ RAP1	US Dept of the Army, Corps of Engineers, Philadelphia District	5200043
11/8/2010	ML102460154	Letter - PSEG Early Site Permit, Transmitting FRN, "Oppurtunity for Petition for Leave to Interve and Order"	Federal Register Notice,Letter	NRC/NRO/DNRL/ NARP	PSEG Nuclear, LLC	5200043
11/22/2010	ML103260587	PSEG ESP Scoping Meeting: Attachment to the Transcripts from Charles Hassler	Letter	No Known Affiliation	NRC/NRO	5200043
11/22/2010	ML103270170	11/04/2010 PSEG ESP Scoping Meeting: Attachment to the Transcripts from The State University of New Jersey Rutgers by Roger R. Locandro.	Letter	Rutgers State Univ of New Jersey	NRC/NRO	5200043
11/22/2010	ML103270230	PSEG ESP Scoping Meeting: Attachment to the Transcripts from Jim Applegate.	No Document Type Applies	No Known Affiliation	NRC/NRO	5200043
11/29/2010	ML102780654	PSEG Site Early Site Permit Application Review Schedule	Letter, Schedule and Calendars	NRC/NRO/DNRL/ NARP	PSEG Nuclear, LLC	5200043
11/30/2010	ML103370042	Comment (2) of Joanna Burger, on Behalf of Self, on PSE&G Early Site Permit Application - Salem Nuclear Plant	General FR Notice Comment Letter	Rutgers State Univ of New Jersey	NRC/ADM/DAS/RDEB	5200043
12/2/2010	ML103470078	Comment (3) of John J. Elk, on Behalf of Self, Supporting Docket ID NRC-2010-0215, PSEG's Proposal to Construct an Additional New Nuclear Reactor in Salem County	General FR Notice Comment Letter	Elsinboro Township, NJ	NRC/ADM/DAS/RDEB	5200043
12/9/2010	ML103570197	Letter from National Marine Fisheries Service Regarding Consultation Process for PSEG ESP Application Review	Letter	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO/DSER/ RAP1	5200043

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1/4/2011	ML110070357	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 1, Emergency Plan Considerations for Multi-Unit Sites	Letter	Public Service Electric & Gas Co	NRC/Document Control Desk, NRC/NRO	5200043
1/31/2011	ML14093A257	TN2083 - Solid State Energy Conversion Alliance (SECA)." Office of Fossil Energy.	Database File	US Dept of Energy (DOE)	NRC/NRO	5200043
2/2/2011	ML110350196	PSEG Power - Response to Request for Additional Information re RAI No. 2, Emergency Plan Evacuation Time Estimate, dated January 4, 2011 (ERAI 5207)	Emergency Preparedness-Emergency Plan, Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/7/2011	ML110320606	02/15/11 - 02/18/11, Audit of PSEG Power, LLC, and Early Site Permit Application Hydrology Analyses	Memoranda, Operating Plan	NRC/NRO/DNRL/ NARP	NRC/NRO/DNRL/ NARP	5200043
2/14/2011	ML110460532	Response to Request for Additional Information, RAI No. 3. Physical Security - Early Site Permit Application Section: 13.6	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/25/2011	ML110600732	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 4, Design Basis Accidents Radiological Consequence Analyses for Advanced Light Water Reactors	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/25/2011	ML110680201	Response to Request for Additional Information, RAI No. 5, Short Term Atmospheric Dispersion Estimates for Accident Releases	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/3/2011	ML110660201	PSEG Early Site Permit, Response to Request for Additional Information, RAI No. 6, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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3/3/2011	ML110660202	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 7, Liquid Waste Management System	Letter, Request for Additional Information (RAI)	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/10/2011	ML110740084	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 7, Liquid Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/10/2011	ML110740085	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 11, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/21/2011	ML110820190	PSEG Early Site Permit Application, Response to Request for Additional Location and Description Information, RAI No. 9, Site Location and Description	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/21/2011	ML110880422	PSEG Early Site Permit Application, Response Request for Additional Information, RAI No. 8, SRP Section: 02.05.04 - Stability of Subsurface Materials and Foundations	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/31/2011	ML110910539	PSEG Early Site Permit Application,C44 - Response to Request for Additional Information, RAI No. 13, Accidental Release of Radioactive Liquid Effluents in Ground and Surface Waters	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/5/2011	ML110960572	PSEG, Response to Request for Additional Information No. 17, Physical Security - Early Site Permit Application Section: 13.6	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/6/2011	ML11111A075	PSEG Power, LLC, Response to Request for Additional Information No. 16, Long-	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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		Term Atmospheric Dispersion Estimates for Routine Releases				
4/7/2011	ML110940111	PSEG Power LLC, and PSEG Nuclear, LLC, (PSEG) Quality Assurance Implementation Inspection	Letter	NRC/NRO/DCIP/ CQVB	PSEG Power, LLC	5200043
4/8/2011	ML111010359	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 15, Vertical Temperature Difference Used to Determine Atmospheric Stability Class	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/12/2011	ML11103A129	PSEG Early Site Permit Application, Response to Request for Additional Waste Management System Information, RAI No. 18, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/13/2011	ML13226A126	New Jersey's Renewable Portfolio Standard Rules 2010 Annual Report dated April 13, 2011.	Annual Report	State of NJ, Dept of Public Utilities	NRC/NRO/DSEA	5200043
4/15/2011	ML111010160	Site Audit Information needs for the PSEG Site Early Permit Application	No Document Type Applies	NRC/NRO/DSER/ RAP1		5200043
5/5/2011	ML12283A138	PSEG Early Site Permit Application, Jurisdictional Determination Request U.S. Army Corps of Engineers Confined Disposal Facility Lower Alloways Creek Township, Salem County, NJ	Letter	PSEG Power, LLC	NRC/NRO,US Dept of the Army, Corps of Engineers, Philadelphia District	5200043
5/11/2011	ML11132A157	PSEG Early Site Permit Application, Response to Request for Additional Information No. 19, SRP Section: 17.5 - Quality Assurance Program Description - Design Certification, Early Site Permit and New License Applicants	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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5/11/2011	ML11132A158	PSEG Early Site Permit Application, Response to Request for Additional Information No. 21, Population Distribution	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/11/2011	ML11164A259	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 20, Probable Maximum Tsunami Flooding.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/13/2011	ML11136A236	PSEG Early Site Permit Application, Response to Request for Additional (eRAI 5483), Regional Climatology	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/13/2011	ML14092A571	TN2446 - Centers for Disease Control and Prevention. 2011. "Summary of Notifiable Diseases - United States, 2009." Morbidity and Mortality Weekly Report 58(53):1-100.	Report, Miscellaneous	US Dept of Health & Human Services, Centers for Disease Control & Prevention (CDC)	NRC/NRO/DNRL	5200043
5/18/2011	ML110950380	PSEG Site - Hydrology (Chapter 2.4) Review Site Audit Information Needs	Audit Report	NRC/NRO/DNRL/ NARP	NRC/NRO/DNRL	5200043
5/18/2011	ML111300108	Memorandum Regarding 02/15-16/11 Hydrology Regulatory Audit Summary for the PSEG Power, LLC and PSEG Nuclear, LLC Early Site Permit Application	Audit Report, Memoranda	NRC/NRO/DNRL/ NARP	NRC/NRO/DNRL/NAR P	5200043
5/31/2011	ML11160A169	PSEG Early Site Permit Application, Submittal of Revised Figures for RAI No. 20.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/3/2011	ML11157A126	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 28, Gaseous Waste Management System.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/3/2011	ML11160A067	PSEG Early Site Permit Application, Response to Request for Additional	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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		Information, No. 23, Liquid Waste Management System.				
6/3/2011	ML11160A068	PSEG Early Site Permit Application, Response to Request for Additional Information, No. 24, Gaseous Waste Management System.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/7/2011	ML11159A235	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 21, Population Distribution.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/9/2011	ML11161A160	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 26, Potential Dam Failures.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/9/2011	ML11161A161	PSEG Early Site Permit Application, Regarding Response to Request for Additional Information, RAI No. 27, Low Water Considerations.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/23/2011	ML11179A080	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 25, Hydrologic Description.	Letter	Public Service Electric & Gas Co	NRC/Document Control Desk, NRC/NRO	5200043
6/29/2011	ML111823177	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 30, SRP Section: 02.05.04 - Stability of Subsurface Materials and Foundations.	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/30/2011	ML111823178	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 31, Accidental	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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		Releases of Radioactive Liquid Effluents in Ground and Surface Waters.				
7/7/2011	ML11195A163	PSEG Early Site Permit Application, Supplemental Response to Request for Additional Information 25, Hydrologic Description.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
7/21/2011	ML11206A420	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 22, Emergency Planning.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRR	5200043
7/25/2011	ML11217A026	PSEG Early Site Permit Application, Supplemental Response to Request for Additional Information, RAI No. 31, Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters.	Final Safety Analysis Report (FSAR), Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
7/27/2011	ML112020215	IR 05200043-11-201 and Notice of Violation for PSEG Site.	Inspection Report, Letter, Notice of Violation	NRC/NRO/DCIP/ CQVB	PSEG Power, LLC	5200043
8/10/2011	ML11227A139	PSEG Power, LLC, Offsite Radiological Emergency Response Plans for the Early Site Permit Application for PSEG Site. Enclosure 1 re affidavit for withholding enclosed with letter.	Letter	PSEG Power, LLC	NRC/NRO,NRC/NRR	5200043
8/15/2011	ML12290A149	Cover Letter from Molly McDonald (AKRF) to Charles Scott (NJHPO) Accompanying Submittal of Three Draft Intensive Level Historic Resource Inventory Forms for the Abbott House, the Chambless House, and the Mason House	Letter	AKRF, Inc	State of NJ, Dept of Environmental Protection, State of NJ, Historic Preservation Office, NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
8/22/2011	ML14093A985	TN2422 - Maryland Department of Labor, Licensing and Regulation, 2011. "Workforce Investment Area (WIA) Industry and Occupational Projections - 2008-2018"	Report, Administrative	State of MD, Dept of Labor, Licensing and Regulation	NRC/NRO	5200043
8/24/2011	ML11238A015	PSEG Early Site Permit Reply to Notice of Violation 05200043/2011-201-01	Letter, Licensee Response to Notice of Violation	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/8/2011	ML112450051	September 29 and 30, 2011, Audit Related to Geology, Seismology, and Geotechnical Engineering Section of Power, LLC and Nuclear, LLC Early Site Permit Application	Memoranda	NRC/NRO/DNRL /NARP	NRC/NRO/DNRL/NAR P	5200043
9/8/2011	ML11256A053	PSEG Early Site Permit, Response to Request for Additional Information, RAI No. 33, Regional Climatology	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/8/2011	ML11256A054	PSEG Early Site Permit Response to Request for Additional Information, RAI No. 34, Short Term Atmospheric Dispersion Estimates for Accident Releases.	Letter	PSEG Power, LLC	NRC/Document Control Desk,NRC/NRO	5200043
9/9/2011	ML11256A172	PSEG Early Site Permit Response to Request for Additional Information, RAI No. 35, Long - Term Atmospheric Dispersion Estimates for Routine Releases	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/15/2011	ML112560149	9/30/11 - Notice of Meeting re: Exit Briefing on The Geosciences and Geotechnical Engineering Site Audit Related to Power, LLC and Nuclear, LLC Early Site Permit Application	Meeting Notice, Meeting Agenda	NRC/NRO/DNRL/ NARP	NRC/NRO/DNRL/ NARP	5200043
9/19/2011	ML11264A079	PSEG Early Site Permit Application Response to Request for Additional Information, RAI Waste Management System No. 37, Gaseous	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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9/19/2011	ML11264A080	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 36, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/20/2011	ML112580335	PSEG Response to NRC Inspection Report 052000043-11-201 and Notice of Violation	Letter	NRC/NRO/DCIP/ CQVP	PSEG Power, LLC	5200043
9/29/2011	ML12290A156	Transmittal Letter from Molly McDonald (AKRF) to Charles Scott (NJHPO) Accompanying Submittal of Revised Intensive Level Historic Resource Inventory Forms for the Abbott House, the Chambless House, and the Mason House	Letter	AKRF, Inc	NRC/NRO,State of NJ, Historic Preservation Office	5200043
9/30/2011	ML14090A027	TN2145 - American Eel (Anguilla rostrata)	Report, Technical	US Dept of Interior, Fish & Wildlife Service	NRC/NRO	5200043
9/30/2011	ML14091A086	TN2319 - Crime in the United States, 2010 - Police Employment Data	Database File	US Dept of Justice, Federal Bureau of Investigation (FBI)	NRC/NRO	5200043
9/30/2011	ML14345A549	Pennsylvania Coastal Zone Management Program; Final Report	Report, Miscellaneous	Partnership for the Delaware Esturay Inc	NRC/ADM/DAS	5200043
10/1/2011	ML13269A021	New Jersey Department of Transportation (NJDOT), 2011. New Jersey Statewide Transportation Improvement Program, Fiscal Years 2012-2021. October 1, 2011	Report, Administrative	State of NJ, Dept of Transportation	NRC/NRO/DNRL	5200043
10/5/2011	ML11286A124	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 32, Population Distribution	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
10/5/2011	ML11286A135	PSEG Early Site Permit Application, Figure 2.1-21, Rev, 1, PSEG Site 2010 Resident Population Within the Low Population Zone	Map	PSEG Power, LLC	NRC/NRO	5200043

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10/28/2011	ML14093B267	TN2412 - Delaware River Basin Commission, 2011, "River Mileage System."	Map, Report, Miscellaneous	Delaware River Basin Commission	NRC/NRO	5200043
11/1/2011	ML13225A126	Excerpt from EERE 2010 Solar Technologies Market Report	Report, Technical	US Dept of Energy (DOE)	NRC/NRO	5200043
11/9/2011	ML112940705	9/30/2011 - Summary Of Public Meeting With PSEG To Discuss Preliminary Results Of The Geosciences And Geotechnical Engineering Site Audit Conducted In Conjunction With The PSEG Site Early Site Permit Application	Meeting Summary	NRC/NRO/DNRL/ NARP	PSEG Nuclear, LLC	5200043
11/22/2011	ML11329A069	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 39, Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
12/5/2011	ML113340144	Report on the Sept 29 - 30, 2011, Geosciences And Geotechnical Engineering Site Audit Related To PSEG Power, LLC And PSEG Nuclear, LLC Early Site Permit Application	Audit Report, Memoranda	NRC/NRO/DNRL/ NARP	NRC/NRO/DNRL/ NARP	5200043
12/9/2011	ML11349A356	PSEG Early Site Permit Application, Supplemental Response to Request for Additional Information, RAI No. 39, Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
12/14/2011	ML11350A199	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 40, Aircraft Hazards	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
12/19/2011	ML11356A066	PSEG Power, LLC, Response to Request for Additional Information No. 45, Stability of Subsurface Materials and Foundations	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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12/23/2011	ML111390147	Change in Schedule of PSEG Site Early Site Permit Application Review	Letter	NRC/NRO/DNRL/ NARP	PSEG Power, LLC	5200043
12/31/2011	ML13225A318	U.S. Department of Energy, Energy Information Agency - 2010 New Jersey Electricity Profile	Graphics incl Charts and Tables	US Dept of Energy, Energy Information Administration (EIA)	NRC/NRO	5200043
12/31/2011	ML14093B101	TN2425 - U.S. Bureau of Labor Statistics, 2011. "Fatal Work Injuries, 1992-2009." Census of Fatal Occupational Injury Charts	Graphics incl Charts and Tables	US Dept of Labor, Bureau of Labor Statistics	NRC/NRO	5200043
1/10/2012	ML12012A037	PSEG Early Site Permit Application, Response to Request for Additional Information No. 43, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
1/18/2012	ML14093A322	TN2100 - Order Issuing Preliminary Permit and Granting Priority to File License Application to Natural Currents Energy Services, LLC for Margate Tidal Energy Project No. 14224 to be located on the Beach Thoroughfare in Atlantic County, New Jersey	No Document Type Applies	US Dept of Energy, Federal Energy Regulatory Commission (FERC)	NRC/NRO	5200043
1/20/2012	ML12025A260	PSEG Early Site Permit Application, Response to Request for Additional Information No. 41, Stability of Subsurface Materials and Foundations	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
1/25/2012	ML12026A704	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 44, Surface Faulting	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/3/2012	ML12038A051	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 46, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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2/3/2012	ML14093A271	TN2090 - Renewable Portfolio Standards - EIA Web Definitions	Report, Miscellaneous	US Energy Information Administration (EIA)	NRC/NRO	5200043
2/9/2012	ML12047A010	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 43, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/10/2012	ML12053A281	PSEG Early Site Permit Application, Docket No. 52-043, Response to Request for Additional Information, RAI No. 44, Surface Faulting	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/16/2012	ML12052A029	PSEG Early Site Permit Application - Response to Request for Additional Information, RAI No. 48, Regional Climatology	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/24/2012	ML12059A340	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 49, Site Location and Description	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/27/2012	ML14345A570	Glyphosate Kills Rat Testis Cells.	Report, Miscellaneous	Institute of Science in Society	NRC/ADM/DAS	5200043
3/7/2012	ML12072A092	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 47, Emergency Planning	Letter, Site Safety Analysis Report (SSAR)	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/7/2012	ML12072A155	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 54, Evaluation of Potential Accidents	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/7/2012	ML12072A156	PSEG Power LLC - Response to Request for Additional Information, RAI No. 51, Evaluation of Potential Accidents.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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3/9/2012	ML12076A257	PSEG Early Site Permit Application, Response to Additional Information, RAI No. 50, Identification of Potential Hazards in Site Vicinity	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/13/2012	ML12076A258	PSEG Early Site Permit Application, Supplemental Response to Request for Additional Information, RAI No. 40, Aircraft Hazards	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/15/2012	ML12079A107	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 43, Vibratory Ground Motion	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/21/2012	ML12116A046	Early Site Permit (ESP) Application for PSEG Site - Updated New Jersey and Delaware RERPs, FEMA Letter	Letter	US Dept of Homeland Security,US Federal Emergency Mgmt Agency (FEMA)	NRC/NSIR	PROJ0771
3/23/2012	ML12086A089	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 53, Evaluation of Potential Accidents	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/23/2012	ML12086A090	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 52, Evaluation of Potential Accidents	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/26/2012	ML12080A123	Exit Briefing on the Audit of Alternative Sites Related To PSEG Power, LLC And PSEG Nuclear, LLC Early Site Permit Application	Meeting Agenda, Meeting Notice	NRC/NRO/DNRL/ EPB2	NRC/NRO/DNRL/ EPB2	5200043
3/28/2012	ML13275A199	USCB (U.S. Census Bureau) 2010. 2010 Municipal Population - Hunterdon County, Washington, D.C.	Database File	US Dept of Commerce, Bureau of Census	NRC/NRO/DNRL	5200043

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3/29/2012	ML12093A003	PSEG Early Site Permit Application, Response to Request for Additional Information No. 46, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/29/2012	ML12093A007	PSEG Early Site Permit Application, Response to Request for Additional Information No. 59, Population Distribution	Letter	PSEG Power, LLC	NRC/NRO, NRC/Document Control Desk	5200043
3/30/2012	ML12090A415	PSEG ESP Audit Items (Information Needs) Table - Revised March 2012	No Document Type Applies	NRC/NRO/DNRL/ EPB2		5200043
3/30/2012	ML12094A054	PSEG Early Site Permit Application, Response to Request for Additional Information No. 58, Exclusion Area Authority and Control	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/3/2012	ML12097A144	PSEG Early Site Permit Application, Withdrawal of Response to Request for Additional Information, RAI No. 43, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/10/2012	ML12088A321	Alternative Sites Audit Execution Plan for the PSEG ESP Site - April 17-19, 2012.	Task Action Plan	NRC/NRO/DNRL/ EPB2		5200043
4/23/2012	ML12115A187	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 55, Evaluation of Potential Accidents	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/26/2012	ML12115A132	05/11/2012 Notice of Meeting on Exit Briefing on PSEG ESP Site Audit	Meeting Notice, Meeting Agenda, Memoranda	NRC/NRO/DNRL/ EPB2	NRC/NRO/DNRL/ EPB2	5200043
4/30/2012	ML12290A143	Cover Letter from Molly McDonald (AKRF) to Joan Larrivee (DESHPO) Accompanying Submittal of the Draft Addendum to the Historic Properties Visual Impact	Letter	AKRF, Inc	NRC/NRO, State of DE, Historic Preservation Office	5200043

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		Assessment and Preliminary Draft Programmatic Agreement				
4/30/2012	ML12290A148	Cover Letter from Molly McDonald (AKRF) to Joan Larrivee (DESHPO) Accompanying Submittal of the Draft Addendum to the Historic Properties Visual Impact Assessment and Preliminary Draft Programmatic Agreement	Letter	AKRF, Inc	State of NJ, Dept of Environmental Protection, State of NJ, Historic Preservation Office, NRC/NRO	5200043
5/3/2012	ML12125A303	Response to Request for Additional Information, RAI No. 50, Identification of Potential Hazards in Site Vicinity, Change in Supplemental Response Date	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/3/2012	ML12143A428	PSEG Early Site Application, Response to Request for Additional Information, RAI No. 60, Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/14/2012	ML12135A608	Visit PSEG Early Site Permit Met Trip Report May 2012, to Review the Pre-Operational and Operational Onsite Metrological Monitoring Program	Trip Report	NRC/NRO		5200043
5/16/2012	ML12146A053	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 43, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/21/2012	ML12170A637	Submittal of Revision 1 of the Early Site Permit Application for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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5/21/2012	ML14077A030	Quarterly Remedial Action Progress Report, Fourth Quarter 2011 PSEG Nuclear, LLC, Salem Generating Station	Letter, Report, Technical	PSEG Nuclear, LLC	NRC/NRO, State of NJ, Dept of Environmental Protection, Bureau of Nuclear Engineering	5200043
5/30/2012	ML14094A359	TN2483 - "Occupational Employment Statistics; Area: Philadelphia-Camden-Wilmington, PA-NJ-DE-MD," May 2012	Graphics incl Charts and Tables	US Dept of Labor, Bureau of Labor Statistics	NRC/NRO/DNRL	5200043
5/31/2012	ML121070466	Change In Schedule of PSEG Site Early Site Permit Application Review	Letter	NRC/NRO/DNRL	PSEG Power, LLC	5200043
6/1/2012	ML14087A372	TN2378 - Centers for Disease Control and Prevention. 2012. "Summary of Notifiable Diseases - United States, 2010." Morbidity and Mortality Weekly Report 59(53): 1-111.	Report, Technical	US Dept of Health & Human Services, Centers for Disease Control & Prevention (CDC)	NRC/NRO	5200043
6/11/2012	ML12166A389	PSEG Power, LLC, Documents in Support of Application Early Site Permit for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/11/2012	ML12170A635	Re-Submittal of Revision 1 of the Early Site Permit Application for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
7/16/2012	ML121950106	PSEG Site Early Site Permit Application Review - Public Meeting with PSEG On Seismic Hazard Evaluation	Meeting Notice	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
7/19/2012	ML12215A382	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 43, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
7/19/2012	ML12215A385	Map, Figure 2.5.2-3, Rev 2, "Regional Seismicity"	Map	PSEG Power, LLC	NRC/NRO	5200043

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7/19/2012	ML12215A387	Map, Figure 2.5.2-4, Rev 1, "Seismiciy within 200 Miles and 50 Miles of Site"	Map	PSEG Power, LLC	NRC/NRO	5200043
8/7/2012	ML12221A400	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 62, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/9/2012	ML12223A213	PSEG Early Site Permit Application - Submittal to Correct Typographical Errors in Responses to Requests for Additional Information and SSAR	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/9/2012	ML12223A215	PSEG Power, LLC, Documents in Support of Application Early Site Permit for the PSEG Site	Graphics incl Charts and Tables, Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/21/2012	ML12235A517	PSEG Early Site Permit Application, Schedule for Response to Request for Additional Information, RAI No. 61, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/24/2012	ML12283A137	PSEG Early Site Permit Application, Memo Report, Supplemental Studies -15G Surveys	Memoranda	AMEC Environment & Infrastructure, Inc	NRC/NRO,AMEC Environment & Infrastructure, Inc	5200043
8/29/2012	ML12248A013	PSEG Early Site Permit Application, Implementation of Emergency Preparedness Rule Changes	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/30/2012	ML14085A530	TN3125 - Docket No. CP12-30 Northeast Supply Link Project Review	Letter	US Environmental Protection Agency (EPA)	NRC/NRO,US Federal Energy Regulatory Commission	5200043
9/5/2012	ML122410422	9/27/2012 - Notice of Forthcoming Public Meeting with PSEG Power, LLC, and PSEG Nuclear, LLC, Involving U.S. Nuclear Regulatory Comission Requests For	Meeting Notice, Meeting Agenda, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043

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		Additional Information On Seismic Hazard Evaluation				
9/10/2012	ML12255A327	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 65, Emergency Planning	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/12/2012	ML13275A211	Hunterdon and Bucks Selected Housing Characteristics.	Database File	US Dept of Commerce, Bureau of Census	NRC/NRO/DNRL	5200043
9/13/2012	ML12283A136	PSEG Early Site Permit Application, Memo Report, Supplemental Studies - Green Treefrog Surveys	Memoranda	AMEC Environment & Infrastructure, Inc	NRC/NRO, AMEC Environment & Infrastructure, Inc	5200043
9/19/2012	ML13275A215	Bucks County Quick Facts.	Database File	US Dept of Commerce, Bureau of Census	NRC/NRO/DNRL	5200043
9/20/2012	ML12268A033	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 64, Stability of Subsurface Material and Fountains	Letter	PSEG Power, LLC	NRC/Document Control Desk,NRC/NRO	5200043
9/24/2012	ML12283A270	Calculation 0360-RAI-061-1, Rev. 1, "Update of the CEUS SSC Seismicity Catalog and Regional Ssismicity Catalog for the PSEG Site"	Calculation	PSEG Power, LLC	NRC/NRO	5200043
9/25/2012	ML12271A287	PSEG Early Site Permit Application, Response to Request for Additional Information RAI No. 63, Basic Geologic and Seismic Information	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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9/28/2012	ML12275A460	PSEG Power, LLC, Early Site Permit Application, Waste Confidence Decision and Temporary Storage Rule	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
10/2/2012	ML12283A268	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 61, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
10/4/2012	ML12284A427	PSEG Early Site Permit Application, Calculation of Multiplier Effects for ER Section 10.4	Calculation, Graphics incl Charts and Tables	PSEG Power, LLC	NRC/NRO	05000272 05000311 05000354 05200043
10/4/2012	ML12290A078	Response to Request for Additional Information, 4.8 - Nonradiological Health Impacts No. Env-09, ESP EIS.	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
10/4/2012	ML12290A079	HC.MD-PM.DB-0001(Z) - Rev. 7, "Cooling Tower Inspection"	Inspection Report	PSEG Nuclear, LLC	NRC/NRO	5200043
10/4/2012	ML12290A144	EN-AA-602-0006, Revision 0, "Cultural and Historic Resources"	No Document Type Applies	No Known Affiliation	NRC/NRO, NRC/NRR	05000272 05000311 05000354 05200043
10/5/2012	ML14190B177	PJM (PJM Interconnection, LLC). 2012. "2012 PJM Reserve Requirement Study, 11-year Planning Horizon: June 1st 2012 - May 31st 2023." Norristown, Pennsylvania.	Report, Technical	PJM Interconnection	NRC/NRO	5200043
10/10/2012	ML14093A367	TN2111 - Case No. 99-1626-EL-BGN; Compressed Air Energy Storage.	No Document Type Applies	Norton Energy Storage, LLC,State of OH, Power Siting Board	NRC/NRO	5200043

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10/10/2012	ML14097A270	TN2668 - Delaware City Refinery (Formerly Motiva Enterprises).	No Document Type Applies	State of DE, Dept of Natural Resources & Environmental Control,US Environmental Protection Agency (EPA)	NRC/NRO/DNRL	5200043
10/11/2012	ML12283A076	10/24/12 - Forthcoming Teleconference Meeting With PSEG Power, LLC, And PSEG Nuclear, LLC, To Discuss Responses To Nuclear Regulatory Commission Requests For Additional Information Relating To Health Physics	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
10/18/2012	ML12296A443	PSEG Early Site Permit Application, Response to Request for Additional Information, 5.10 - Non-radioactive Waste Impacts	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043
10/19/2012	ML12296A452	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 66, Emergency Planning	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043
10/26/2012	ML12310A180	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 61, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
10/26/2012	ML12310A182	PSEG Early Site Permit Application, Calculation/Analysis No. 0360-RAI-061-2, "Base Rock Hazard Calculation (no CAV) for the BSEG Site"	Calculation	PSEG Nuclear, LLC	NRC/NRO	5200043
10/31/2012	ML14085A435	TN3121 - DE 2012-2013 Property Tax Report	Database File, Report, Miscellaneous	State of DE, Economic Development Office	NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
11/5/2012	ML12299A160	09/27/2012 Summary of Public Meeting with PSEG Power, LLC, and PSEG Nuclear, LLC, Regarding NRC Requesting for Additional Information on Seismic Hazard Evaluation	Memoranda	NRC/NRO/DNRL/LB1		5200043
11/7/2012	ML13014A012	PSEG Early Site Permit Application, Deaggregation of 10, Base Rock Hazard (no CAV) for the PSEG Site	Calculation	PSEG Power, LLC	NRC/NRO	5200043
11/7/2012	ML13014A013	High-End and Low-Frequency Horizontal Spectra for the PSEG Site.	Calculation	PSEG Power, LLC	NRC/NRO	5200043
11/19/2012	ML12318A129	12/12/2012 - Notice of Forthcoming Public Meeting With PSEG Power, LLC, And PSEG Nuclear, LLC, Regarding U.S. Nuclear Regulatory Commission Requests For Additional Information On Seismic Hazard Evaluation	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
11/24/2012	ML13014A014	Artificial Shear-Wave Velocity Profiles for Updated PSEG Site Response Calculations Under CEUS SSC	Calculation	PSEG Power, LLC	NRC/NRO	5200043
11/24/2012	ML13014A015	Updated PSEG Site Response Based on CEUS SSC	Calculation	PSEG Power, LLC	NRC/NRO	5200043
11/26/2012	ML13014A016	Soil Hazard Calculation (no CAV) for the PSEG Site	Calculation	PSEG Power, LLC	NRC/NRO	5200043
11/26/2012	ML13014A017	Smooth Horizontal GMRS for the PSEG Site	Calculation	PSEG Power, LLC	NRC/NRO	5200043
11/27/2012	ML12334A030	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 67, Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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11/28/2012	ML13014A018	Smooth Vertical GMRS for PSEG Site Based on CEUS SSC	Calculation	PSEG Power, LLC	NRC/NRO	5200043
11/30/2012	ML14093A606	TN2390 - Data Book Delaware Economic Development Office - Right Place, Right Size	Report, Miscellaneous	State of DE, Economic Development Office	NRC/NRO	5200043
12/12/2012	ML12353A442	12/12/2012 - Slides from NRC-PSEG Public Meeting on Seismic Hazard Evaluation	Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO	5200043
12/20/2012	ML12361A029	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 68, Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
12/20/2012	ML13014A019	PSEG, RAI 61, Submittal 3, RAI Figures, Page 1 of 26 - Page 26 of 26	Graphics incl Charts and Tables, Site Safety Analysis Report (SSAR)	PSEG Power, LLC	NRC/NRO	5200043
12/20/2012	ML13014A066	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 61, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
12/31/2012	ML14086A640	TN2119 - Extreme and Mean Elevations by State and Other Areas. Table 366 in Statistical Abstract of the United States	Graphics incl Charts and Tables	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
12/31/2012	ML14345A530	Technical Report for the Delaware Estuary & Basin	Report, Technical	Partnership for the Delaware Esturay Inc	NRC/ADM/DAS	5200043
1/1/2013	ML14085A093	TN3094 - Local Area Unemployment by County 2002-2012	No Document Type Applies	NRC/NRO/DNRL		5200043

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1/1/2013	ML14345A587	Entrainment of Shovelnose Sturgeon by Towboat Navigation in the Upper Mississippi River	Journal Article, Technical Paper	Univ of Nebraska, Lincoln,US Dept of Interior, Geological Survey (USGS), US Dept of the Army, Corps of Engineers	NRC/ADM/DAS	5200043
1/3/2013	ML14091A135	TN2346 - The 2012 Statistical Abstract, U.S. Census Bureau	Database File	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
1/9/2013	ML13029A110	Calculation 0360-RAI-061-10, Revision 2, "Updated SPT-Based Liquefaction Screening Based on GMRS from NUREG-2115 (CEUS SSC) Site Seismicity Analysis"	Calculation	AMEC Environment & Infrastructure, Inc	NRC/NRO	5200043
1/11/2013	ML13014A634	PSEG Early Site Permit Application, Supplemental Response to Request for Additional Information, RAI No. 46 and No. 62, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
1/11/2013	ML13024A015	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 61, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
1/14/2013	ML14086A008	TN3228 - USGS 2013 Aquifer and Well Characteristics in New Jersey	Graphics incl Charts and Tables	US Dept of Interior, Geological Survey, Water Resources Div	NRC/NRO/DNRL	5200043
1/14/2013	ML14087A046	TN2357 - U.S. Geological Survey, 2013. "Delaware River Study Unit Description" National Water-Quality Assessment Program	No Document Type Applies	US Dept of Interior, Geological Survey, Water Resources Div	NRC/NRO	5200043

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1/16/2013	ML14087A334	TN2375 - Centers for Disease Control and Prevention, 2013 "Facts About Naegleria fowleri and Primary Amebic Meningoencephalitis"	FACT Sheet	US Dept of Health & Human Services, Centers for Disease Control & Prevention (CDC)	NRC/NRO	5200043
1/22/2013	ML14090A031	TN2147 - Endangered Species	No Document Type Applies	US Dept of Interior, Fish & Wildlife Service	NRC/NRO	5200043
2/4/2013	ML13043A330	PSEG Early Site Permit Application - Response to Request for Additional Information, RAI No. 20, Probable Maximum Tsunami Flooding	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/14/2013	ML14090A011	TN2121 - Wastes-Non-Hazardous Waste Municipal Solid Waste: Combustion	Database File	US Environmental Protection Agency (EPA)	NRC/NRO	5200043
2/14/2013	ML14090A197	TN2176 - NOAA 2012 Fish Facts: Menhaden	Database File	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO	5200043
2/20/2013	ML13064A025	Cover Note on PSEG RAI 61 Response - Revised SSAR Section 2.5 with Change Bar_2-20-2013	Letter	Public Service Electric & Gas Co	NRC/NRO	5200043
2/20/2013	ML13064A031	PSEG RAI 61 Response - Revised SSAR Section 2.5 with Change Bar_2-20-2013	Site Safety Analysis Report (SSAR)	PSEG Power, LLC	NRC/NRO	5200043
2/28/2013	ML14135A366	PJM Interconnection, LLC. 2013. PJM Load Forecast Report, January 2013. Norristown, Pennsylvania	Map, Report, Technical	PJM Interconnection	NRC/NRO/DNRL	5200043
3/1/2013	ML14087A029	TN2349 - U.S. Bureau of Labor Statistics, 2013, "Unemployment Rate Over-The-Year	Graphics incl Charts and Tables	US Dept of Labor, Bureau of Labor Statistics	NRC/NRO	5200043

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		Change for Large Metropolitan Areas" (2010 to 2011)				
3/1/2013	ML14094A019	TN2394 - U.S. Bureau of Labor Statistics, 2013. "Labor Force Data by County, 2011 Annual Averages"	Report, Miscellaneous	US Dept of Labor, Bureau of Labor Statistics	NRC/NRO	5200043
3/13/2013	ML14091A137	TN2345 - Electric Power Monthly Energy Information Administration..	Database File	US Energy Information Administration (EIA)	NRC/NRO	5200043
3/14/2013	ML14091A091	TN2325 - Kennedy Health System, Kennedy's Facts and History.	Report, Miscellaneous	Kennedy Health System - Washington Township Campus	NRC/NRO	5200043
3/14/2013	ML14091A094	TN2334 - State of Delaware Agency Services.	Database File	State of DE	NRC/NRO/DNRL	5200043
3/15/2013	ML14087A026	TN2348 - U.S. Bureau of Economic Analysis. 2013. "Local Area Personal Income and Employment, Total Full-time and Part-time Employment by Industry." CA25 and CA25N	Report, Administrative	US Dept of Commerce, Bureau of Economic Analysis	NRC/NRO	5200043
3/15/2013	ML14087A039	TN2352 - U.S. Geological Survey, 2013. "Physiographic Province Map of Maryland, Delaware, and the District of Columbia"	Map	US Dept of Interior, Geological Survey, Water Resources Div	NRC/NRO	5200043
3/15/2013	ML14087A267	TN2361 - U.S. Census Bureau 2010, "American Factfinder: Hispanic or Latino Origin by Race" 2010 Census Summary File 1, Table P5 Results	FACT Sheet, Report, Miscellaneous	US Dept of Commerce, Bureau of Census	NRC/NRO/DNRL	5200043
3/15/2013	ML14087A270	TN2362 - U.S. Census Bureau, 2012, "American Community Survey, Table B17017: Poverty Status in the Past 12 Months by Household Type by Age of Householder, 2006-2010 5-Year Estimates" Summary File	Report, Miscellaneous	US Dept of Commerce, Bureau of Census	NRC/NRO/DNRL	5200043

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3/15/2013	ML14087A309	TN2363 - U.S. Census Bureau "Frequently Asked Questions" (Informational Webpage)	Report, Miscellaneous	US Dept of Commerce, Bureau of Census	NRC/NRO/DNRL	5200043
3/15/2013	ML14087A313	TN2366 - Delaware River Basin Commission, 2013. "About DRBC." (Webpage fact sheet)	Database File	Delaware River Basin Commission	NRC/NRO	5200043
3/15/2013	ML14091A131	TN2342 - Civilian Labor Force States and Selected Areas: Employment Status of the Civilian Non-institutional Population, 1976 to 2012 Annual Averages	Report, Miscellaneous, Status Report	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
3/18/2013	ML14087A358	TN2377 - Centers for Disease Control and Prevention). 2009. "Legionellosis (Legionnaires' Disease and Pontiac Fever)"	Database File	US Dept of Health & Human Services, Centers for Disease Control & Prevention (CDC)	NRC/NRO	5200043
3/19/2013	ML14091A153	TN2388 - About DHSS Divisions and Programs	Database File	State of DE, Health & Social Services	NRC/NRO	5200043
3/19/2013	ML14094A006	TN2396 - U.S. Bureau of Economic Analysis, 2013, "Annual State Personal Income and Employment, Personal Income, Per Capita Personal Income, Disposable Personal Income, and Population." SA1-3m and SA51-53	Database File	US Dept of Commerce, Bureau of Economic Analysis	NRC/NRO	5200043
3/19/2013	ML14094A026	TN2399 - Archaeological Society of New Jersey, 2013. "New Jersey Archaeological Timeline"	Report, Miscellaneous	Archaeological Society of New Jersey	NRC/NRO	5200043
3/21/2013	ML14094A032	TN2404 - National Oceanic and Atmospheric Administration, 2012, "NOAA Atlas 2 Precipitation Frequency Estimates in GIS Compatible Formats"	Report, Miscellaneous	US Dept of Commerce, National Oceanic & Atmospheric Admin, National Weather Service	NRC/NRO	5200043

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3/21/2013	ML14094A035	TN2405 - U.S. Geological Survey, 2013, "Peak Streamflow for the Nation: USGS 01463500 Delaware River at Trenton, New Jersey."	Report, Miscellaneous	US Dept of Interior, Geological Survey (USGS)	NRC/NRO	5200043
3/21/2013	ML14094A049	TN2407 - U.S. Army Corps of Engineers, 2013, "National Inventory of Dams"	Database File	US Dept of the Army, Corps of Engineers	NRC/NRO/DNRL	5200043
3/21/2013	ML14094A050	TN2408 - U.S. Army Corps of Engineers (Philadelphia District), 2012, "Chesapeake and Delaware Canal - Canal History"	Database File	US Dept of the Army, Corps of Engineers, Philadelphia District	NRC/NRO	5200043
3/21/2013	ML14094A055	TN2411 - National Oceanic and Atmospheric Administration 2014, "Tides and Currents: Data for Lewes, Delaware, Cape May, New Jersey, and Trenton Marine Terminal, New Jersey"	Map, Report, Miscellaneous	US Dept of Commerce, National Oceanic & Atmospheric Admin, National Ocean Service	NRC/NRO	5200043
3/22/2013	ML14093A928	TN2421 - Delaware Department of Labor, 2013. "Delaware Occupation and Industry Projections"	Database File	State of DE	NRC/NRO	5200043
3/22/2013	ML14093B053	TN2423 - New Jersey Department of Labor and Workforce Development, 2013. "Data Tools: Long-Term Occupational Employment Projections, Estimated and Projected Employment by Detailed Occupation"	Report, Administrative	State of NJ, Dept of Labor and Workforce Development	NRC/NRO/DNRL	5200043
3/22/2013	ML14093B218	TN2429 - National Highway Traffic and Safety Administration, 2012, "Fatality Accident Reporting System, New Jersey, 2007-2011"	Graphics incl Charts and Tables	US Dept of Transportation, National Highway Traffic Safety Admin	NRC/NRO	5200043
3/25/2013	ML14092A556	TN2434 - NSC (National Safety Council). 2013, "The Odds of Dying From...."	No Document Type Applies	National Safety Council	NRC/NRO	5200043

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3/27/2013	ML13098A975	Submittal of Revision 2 of the Early Site Permit Application for the PSEG Site	Letter, License-Application for Combined License (COLA)	PSEG Nuclear, LLC,PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/3/2013	ML13247A438	County of Salem (County of Salem, New Jersey), 2013 Budget of the County of Salem for 2013	Financial Assurance Document	Salem County, NJ	NRC/NRO	5200043
4/4/2013	ML13095A374	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 69, Stability of Subsurface Materials and Foundations	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/4/2013	ML13112A100	UFSAR, Chapter 11, Raioactive Waste Management	Updated Final Safety Analysis Report (UFSAR)	PSEG Power, LLC,Southern Co	NRC/NRO	5200043
4/5/2013	ML14094A355	TN2482- "Unemployed Persons by Industry and Class of Worker, not Seasonally Adjusted"	Graphics incl Charts and Tables	US Dept of Labor, Bureau of Labor Statistics	NRC/NRO/DNRL	5200043
4/9/2013	ML13093A259	Early Site Permit Application Revision 2, for the PSEG Site - Letter	Letter	NRC/NSIR/DPR	US Dept of Homeland Security, US Federal Emergency Mgmt Agency (FEMA)	5200043
4/16/2013	ML13253A011	County of Hunterdon (County of Hunterdon, New Jersey), 2013, Budget of the County of Hunterdon for 2013. Flemington, New Jersey	No Document Type Applies	County of Hunterdon, NJ	NRC/NRO/DNRL	5200043
4/18/2013	ML13113A124	Document in Support of Application Early Site Permit for the PSEG Site	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
4/18/2013	ML14094A574	TN2826 - Atlantic States Marine Fisheries Commission, 2013, "ASMFC Summer Flounder, Scup, and Black Sea Bass Board Approves Addendum XXIV, New York and New Jersey May Modify Regulations to Access Additional Fish"	Press Release	Atlantic States Marine Fisheries Commission	NRC/NRO	5200043
4/24/2013	ML13058A438	Letter to US Army Corps of Engineers, Philadelphia District on Agency Roles under Section 106 of NHPA for the PSEG ESP EIS	Letter	NRC/NRO/DNRL/ EPB2	US Dept of the Army, Corps of Engineers, Philadelphia District	5200043
4/30/2013	ML13253A313	DOE/EIA (U.S. Department of Energy/Energy Information Administration), 2013, Annual Energy Outlook 2013, Main Report	Report, Administrative	US Dept of Energy, Energy Information Administration (EIA)	NRC/NRO/DNRL	5200043
4/30/2013	ML13281A003	US Governments 2011 Revenues for Delaware, New Jersey, and Delaware	No Document Type Applies	State of DE, Div of Revenue	NRC/NRO/DNRL	5200043
5/9/2013	ML14086A551	TN3182 - Frequently Asked Questions: What is U.S. Electricity Generation by Energy Source	Database File	US Dept of Energy, Energy Information Administration (EIA)	NRC/NRO	5200043
5/10/2013	ML13134A473	PSEG Early Site Permit Application, Documents in Support of Application Early Site Permit for PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/10/2013	ML13134A474	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 67, Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/13/2013	ML13135A177	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 67, Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk,NRC/NRO	5200043

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5/20/2013	ML13142A330	PSEG Early Site Permit Application - Supplemental Response to Request for Additional Information, No. 18, Gaseous Waste Management System	Letter	PSEG Power, LLC	NRC/Document Control Desk,NRC/NRO	5200043
5/28/2013	ML13154A310	Documents in Support of Application Early Site Permit for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/28/2013	ML13253A013	County of Cumberland (County of Cumberland, New Jersey), 2013, Budget of the County of Cumberland for 2013. Bridgeton, New Jersey	No Document Type Applies	Cumberland County, NJ	NRC/NRO/DNRL	5200043
6/6/2013	ML14097A509	TN2877 - "Current Dollar Gross Domestic Product by State, 2009-2012"	Graphics incl Charts and Tables	North American Industry Classification System	NRC/NRO	5200043
6/17/2013	ML13163A240	07/01/13 Notice of Public Meeting with PSEG Power, LLC and PSEG Nuclear, LLC, on Flooding Hazard Reanalysis	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
6/27/2013	ML13169A202	7/19/2013 - Notice Of Forthcoming Teleconference Meeting With PSEG Power, LLC, And PSEG Nuclear, LLC, To Discuss Implementation Of Enhancements To Emergency Preparedness Regulations	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
7/1/2013	ML13183A106	07/01/2013 NRC-PSEG Public Meeting on Flooding Hazard Reanalysis PSEG Slides	Meeting Briefing Package/Handouts,Meeting Notice,Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO/DNRL	5200043
7/15/2013	ML13214A258	TR-441, Revision 5, "Traffic Impact Analysis at the PSEG Site, Preliminary Findings Report." Cover Page to Page 72	Report, Technical	KLD Engineering, PC	NRC/NRO, PSEG Power, LLC	5200043

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7/15/2013	ML13214A260	TR-441, Revision 5, "Traffic Impact Analysis at the PSEG Site, Preliminary Findings Report." Appendix A to End	Report, Technical	KLD Engineering, PC	NRC/NRO,PSEG Power, LLC	5200043
7/17/2013	ML13200A055	PSEG Early Site Permit Application, Response to Request for Additional Information No. 70, Stability of Subsurface Materials and Foundations	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
7/31/2013	ML13186A107	07/01/2013 Summary of Public Meeting with PSEG Power, LLC, and PSEG Nuclear, LLC, Regarding NRC Requests for Additional Information on Flooding Hazard Reanalysis	Meeting Summary	NRC/NRO/DNRL/LB1		5200043
8/6/2013	ML13220A036	PSEG Early Site Permit Application - Supplemental Response to Request for Additional information, RAI No. 70, Stability of Subsurface Materials and Foundations	Graphics incl Charts and Tables, Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/7/2013	ML13231A119	FWS (U.S. Fish and Wildlife Service), 2013. Supwana Meadows National Wildlife Refuge. Pennsville, New Jersey	Database File	US Dept of Interior, Fish & Wildlife Service	NRC/RGN-IV	5200043
8/8/2013	ML13231A207	USACE (U.S. Army Corps of Engineers), 2013. Delaware River Main Channel Deepening. Philadelphia, Pennsylvania	Database File	US Dept of the Army, Corps of Engineers, Philadelphia District	NRC/RGN-IV	5200043
8/8/2013	ML13233A301	U.S. Fish and Wildlife Service (FWS). 2013. Bombay Hook National Wildlife Refuge	FACT Sheet	US Dept of Interior, Fish & Wildlife Service	NRC/NRO	5200043
8/14/2013	ML13253A316	DOE/EIA (U.S. Department of Energy/Energy Information Administration), 2013, Annual Energy Outlook 2013, Table 9, Electricity Generating Capacity, Reference case	Report, Miscellaneous	US Dept of Energy, Energy Information Administration (EIA)	NRC/NRO	5200043

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8/14/2013	ML13253A328	DOE/EIA (U.S. Department of Energy/Energy Information Administration), 2013. Annual Energy Outlook 2013, Table 8, Electricity Supply, Disposition, Prices, and Emissions, Reference case	Report, Technical, Spreadsheet File	US Dept of Energy, Energy Information Administration (EIA)	NRC/NRO	5200043
8/14/2013	ML13253A331	DOE/EIA (U.S. Department of Energy/Energy Information Administration), 2013. Annual Energy Outlook 2013, Table 58.9, Renewable Energy Generation by Fuel, Reliability First Corporation/East, Reference case	Graphics incl Charts and Tables	US Dept of Energy, Energy Information Administration (EIA)	NRC/NRO/DNRL	5200043
8/15/2013	ML13233A154	DOE/EIA (U.S. Department of Energy/Energy Information Administration). 2013. Net Generation by Energy Source: Total (All Sectors), 2003-May 2013	Graphics incl Charts and Tables, Report, Technical	US Dept of Energy, Energy Information Administration (EIA)	NRC/NRO	5200043
8/19/2013	ML14087A321	TN2372 - U.S. Department of Transportation, 2013. Transportation Statistics Annual Report 2012. Research and Innovative Technology Administration, Bureau of Transportation Statistics	Annual Report	US Dept of Transportation, Research and Innovative Technology Administration	NRC/NRO	5200043
8/22/2013	ML14097A265	TN2666 - Senator Menendez Announces $1.2 Million for Millville, Lakewood Airport Improvements	Press Release	State of NJ, Governor	NRC/NRO	5200043
8/27/2013	ML13246A293	Response to Request for Additional Information, RAI 71, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/28/2013	ML13246A294	PSEG Early Site Permit Application - Implementation of Emergency Preparedness Rule Changes	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRR	5200043
8/29/2013	ML13246A113	Response to Request for Additional Information, RAI 71, Vibratory Ground Motion	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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9/5/2013	ML13233A329	09/26/2013 Notice of Public Meeting with PSEG on PSEG's Methodology for Flooding Hazard Reanalysis	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
9/9/2013	ML14086A268	TN3220 - New Jersey Geological Survey, "Digital Geodata Series DGS-13 Computer Workbook Summarizing New Jersey Withdrawals and Discharges on a HUC11 Basis"	Database File	State of NJ, Dept of Environmental Protection	NRC/NRO	5200043
9/12/2013	ML12361A136	Change In Schedule Of PSEG Site Early Site Permit Application Review	Letter, Schedule and Calendars	NRC/NRO/DNRL	PSEG Power, LLC	5200043
9/18/2013	ML13262A071	U.S. Bureau of Economic Analysis (BEA). 2013. RIMS II Multipliers (2010/2010), Table 2.5 Total Multipliers for Output, Earnings, Employment, and Value Added by Industry Aggregation, PSEG EIA (Type II)	Spreadsheet File	US Dept of Commerce, Bureau of Economic Analysis	NRC/NRO	5200043
9/19/2013	ML13274A002	Hunterdon County Tax Rates	Spreadsheet File	County of Hunterdon, NJ	NRC/NRO/DNRL	5200043
9/24/2013	ML103090654	PSEG ESP Phase B Chapter 15 Transient and Accident Analysis	NRO Safety Evaluation Report (SER)-Delayed, Safety Evaluation	NRC/NRO/DNRL/LB1		5200043
9/24/2013	ML13280A448	PSEG Early Site Permit Application, Document in Support of Application	Letter	PSEG Nuclear, LLC,PSEG Power, LLC	NRC/Document Control Desk,NRC/NRO	5200043
9/24/2013	ML13280A458	Document in Support of Application for Early Site Permit for the PSEG Site	Letter	PSEG Nuclear, LLC,PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/25/2013	ML13275A113	Letter from the Delaware SHPO Regarding No Adverse Effect for the PSEG ESP, dated September 25, 2013	Letter	State of DE, Historic Preservation Office	NRC/NRO	5200043

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9/26/2013	ML103090381	PSEG ESP Phase B Chapter 03 Design of Structures, Components, Equipment and Systems, Section 3.5.1.6 Aircraft Hazards	NRO Safety Evaluation Report (SER)-Delayed, Safety Evaluation	NRC/NRO/DNRL/LB1		5200043
9/26/2013	ML13281A952	Hunterdon County 2012-2013 Enrollment	Spreadsheet File	County of Hunterdon, NJ	NRC/NRO	5200043
9/26/2013	ML13281A955	Hunterdon County Hospitals.	No Document Type Applies	County of Hunterdon, NJ	NRC/NRO	5200043
9/26/2013	ML13281A958	Bucks County 2012-2013 enrollment	Spreadsheet File	Bucks County, PA	NRC/NRO	5200043
9/26/2013	ML13281A961	Hunterdon County EMS	No Document Type Applies	County of Hunterdon, NJ	NRC/NRO	5200043
9/26/2013	ML13281A963	Hunterdon County Parks	Spreadsheet File	NRC/NRO		5200043
9/26/2013	ML13281A966	Bucks County Parks	No Document Type Applies	Bucks County, PA	NRC/NRO	5200043
9/26/2013	ML13281A968	Hunterdon County Fire Departments	No Document Type Applies	County of Hunterdon, NJ	NRC/NRO	5200043
9/26/2013	ML13281A970	Hunterdon County Police	No Document Type Applies	County of Hunterdon, NJ	NRC/NRO	5200043
9/26/2013	ML13281A971	Hunterdon County Water Wastewater	No Document Type Applies	County of Hunterdon, NJ	NRC/NRO	5200043
9/26/2013	ML13281A972	2011 Bucks County Comprehensive Plan	Report, Miscellaneous	Bucks County, PA	NRC/NRO	5200043
9/30/2013	ML103090450	PSEG ESP Phase B Chapter 13, Conduct of Operations, Section 13.6 Physical Security	NRO Safety Evaluation Report (SER)-Delayed, Safety Evaluation	NRC/NRO/DNRL/LB1		5200043

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9/30/2013	ML14085A073	TN3293 - Delaware Economic Development Office, 2013-2014 Property Tax Report	Report, Miscellaneous	State of DE, Economic Development Office	NRC/NRO/DNRL	5200043
9/30/2013	ML14097A147	TN2792 - NMFS (National Marine Fisheries Service), 2013, Loggerhead Turtle (Caretta caretta). Office of Protected Resources	No Document Type Applies	US Dept of Commerce, National Marine Fisheries Service	NRC/NRO/DNRL	5200043
10/4/2013	ML13270A390	Request For Rare Or Endangered Species And Natural Communities Information For The PSEG Early Site Permit Application	Letter	NRC/NRO/DNRL/ EPB2	Natural Heritage Program	5200043
10/4/2013	ML13275A604	PSEG - Early Site Permit Application - Alternative Site 4-1	No Document Type Applies	NRC/NRO/DNRL/ EPB2	State of NJ, Dept of Environmental Protection	5200043
10/4/2013	ML13275A610	PSEG - Early Site Permit Application - Alternative Site 7-1	No Document Type Applies	NRC/NRO/DNRL/ EPB2	State of NJ, Dept of Environmental Protection	5200043
10/4/2013	ML13275A613	PSEG - Early Site Permit Application - Alternative Site 7-2	No Document Type Applies	NRC/NRO/DNRL/ EPB2	State of NJ, Dept of Environmental Protection	5200043
10/4/2013	ML13275A615	PSEG - Early Site Permit Application - Alternative Site 7-3	No Document Type Applies	NRC/NRO/DNRL/ EPB2	State of NJ, Dept of Environmental Protection	5200043
10/4/2013	ML13275A619	PSEG - Early Site Permit Application - Alternatice Site 7-4	No Document Type Applies	NRC/NRO/DNRL/ EPB2	State of NJ, Dept of Environmental Protection	5200043
10/4/2013	ML14097A343	TN2832 - Summer Flounder (Paralichthys dentatus) Life History and Habitat Needs	FACT Sheet	Atlantic States Marine Fisheries Commission	NRC/NRO/DNRL	5200043
10/10/2013	ML13275A212	USCB (U.S. Census Bureau) 2013, Fact Finder - Hunterdon and Bucks County	Database File	US Dept of Commerce, Bureau of Census	NRC/NRO/DNRL	5200043

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		Selected Economic Characteristics, 2007 - 2011				
10/15/2013	ML14085A470	TN3233 - National Oceanic and Atmosphere Administration 2014 Tides webpage report for Lewes, DE, Cape May, NJ, and Trenton Marine Terminal, NJ (PSEG)	Report, Technical	US Dept of Commerce, National Ocean Service	NRC/NRO/DNRL	5200043
10/17/2013	ML103090665	PSEG ESP Phase B Chapter 17 Quality Assurance	NRO Safety Evaluation Report (SER)-Delayed, Safety Evaluation	NRC/NRO/DNRL/LB1		5200043
10/18/2013	ML14091A132	TN2344 - American FactFinder - ACS Demographic and Housing Estimates: 2008	Report, Miscellaneous	US Dept of Commerce, Bureau of Census	NRC/NRO/DNRL	5200043
10/25/2013	ML14097A280	TN2679 - Chinese Pond Mussel (Sinanodonta woodiana)	FACT Sheet	New Jersey Invasive Species Strike Team	NRC/NRO/DNRL	5200043
10/31/2013	ML13277A443	PSEG ESP Phase B SER Section 3.5.1.6 Letter to Applicant	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
10/31/2013	ML13277A462	PSEG ESP Phase B SER Section 15.0.3 Letter to Applicant	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
10/31/2013	ML13277A574	PSEG ESP Phase B SER Section 13.6 Letter to Applicant	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
10/31/2013	ML13297A141	PSEG ESP Phase B SER Chapter 17 Letter to Applicant	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
10/31/2013	ML13308A420	Response to Request for Additional Information, RAI No. 67, Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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10/31/2013	ML13310A545	Document in Support of Application Early Site Permit for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
10/31/2013	ML13310A546	Historic Properties Visual Impact Assessment PSEG Early Site Permit Application, Salem County, New Jersey: Addendum. Page 1 through Figure 9	No Document Type Applies	PSEG Power, LLC	NRC/NRO	5200043
10/31/2013	ML13310A547	Historic Properties Visual Impact Assessment PSEG Early Site Permit Application, Salem County, New Jersey: Addendum. Figure 10 through Figure 37	No Document Type Applies	PSEG Power, LLC	NRC/NRO	5200043
11/6/2013	ML13310B345	11/20/13 Notice of Forthcoming Teleconference Meeting with PSEG Power, LLC, and PSEG Nuclear, LLC, To Discuss Responses to the U.S. Nuclear Regulatory Commission's requests for Additional Information Relating to Land Use Data	Meeting Agenda, Meeting Notice,Memoranda	NRC/NRO/DNRL/ EPB2	NRC/NRO/DNRL/ EPB2	5200043
11/8/2013	ML14094A029	TN2400 - National Park Service. 2013. "National Register of Historic Places: Salem County, New Jersey"	Report, Miscellaneous	US Dept of Interior, National Park Service	NRC/NRO	5200043
11/11/2013	ML14094A058	TN2424 - U.S. Census Bureau 2011, "American FactFinder Profile of General Population and Housing Characteristics: 2010, 2010 Census American Indian and Alaska Native Summary Files for Cumberland, Gloucester, New Castle, and Salem Counties, New Jersey"	Database File	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
11/13/2013	ML13322A594	Documents in Support of Application Early Site Permit for the PSEG Site Comments on Advanced Safety Evaluation 3.5.1.6, "Aircraft Hazards" for Chapter 3, Section.	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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11/13/2013	ML13322A596	Documents in Support of Application Early Site Permit for the PSEG Site Comments on Advanced Safety Evaluation for Chapter 13, Section 13.6, "Physical Security".	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
11/13/2013	ML13322A598	Documents in Support of Application Early Site Permit for the PSEG Site Comments on Advanced Safety Evaluation for Chapter 15, Section 15.0.3, "Radiological Consequences of Design Basis Accidents".	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
11/13/2013	ML13322A599	Documents in Support of Application Early Site Permit for the PSEG Site Comments on Advanced Safety Evaluation for Chapter 17, Section 17.5, "Quality Assurance Program Description".	Letter	PSEG Power, LLC	NRC/Document Control Desk,NRC/NRO	5200043
11/14/2013	ML14086A469	TN3154 - Public Water System Deficit/Surplus - Division of Water Supply and Geoscience	Report, Miscellaneous	State of NJ, Dept of Environmental Protection	NRC/NRO	5200043
11/21/2013	ML14085A144	TN3114 - State of Delaware Per Capita Income 2003 - 2012	No Document Type Applies	US Dept of Commerce, Bureau of Economic Analysis	NRC/NRO/DNRL	5200043
11/27/2013	ML13339A864	PSEG Early Site Permit Application, Response to Request for Additional Information, RAI No. 67, Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
12/4/2013	ML13311A483	9/26/2013 - Summary Of Public Meeting With PSEG Power, LLC, And PSEG Nuclear, LLC, Regarding U.S. Nuclear Regulatory Commission Requests For Additional Information On Flooding Hazard Reanalysis	Meeting Summary, Memoranda	NRC/NRO/DNRL/LB1	PSEG Nuclear, LLC	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
12/4/2013	ML14086A542	TN3212 - Delaware River Basin Commission, 2014. "Map of DRBC Docket and Permit Holders"	Database File	Delaware River Basin Commission	NRC/NRO	5200043
12/9/2013	ML13358A139	Letter from NJ DEP SHPO - Consultation Comments Pertaining to the PSEG ESP Application, December 9, 2013.	Letter	State of NJ, Dept of Environmental Protection	NRC/NRO	05000272, 05000311, 05000354, 05200043
12/11/2013	ML14097A360	TN2874 - EIA Average Retail Price of Electricity to Residential Sector-State Rankings	Graphics incl Charts and Tables	US Energy Information Administration (EIA)	NRC/NRO	5200043
12/16/2013	ML14085A112	TN3283 - PSEG Jurisdictional Wetlands Map for Artificial Island, NJ, provided by U.S. Army Corps of Engineers, Philadelphia District, to AKRF	Map	US Dept of the Army, Corps of Engineers, Philadelphia District	AKRF, Inc., NRC/NRO/DNRL	5200043
12/18/2013	ML13354A973	PSEG Early Site Permit Application - Implementation of Emergency Preparedness Rule Changes	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
12/23/2013	ML13357A738	01/08/14 - Notice Of Forthcoming Public Teleconference With PSEG Power, LLC, And PSEG Nuclear, LLC, Regarding U.S. Nuclear Regulatory Commission Requests For Additional Information On Flooding Hazard Reanalysis	Meeting Agenda, Meeting Notice, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
12/31/2013	ML14091A089	TN2320 - Camping In New Jersey - NJ Campgrounds	No Document Type Applies	FunNewJersey.com	NRC/NRO	5200043
1/6/2014	ML103090395	PSEG ESP Phase B Chapter 11 Radioactive Waste Management	NRO Safety Evaluation Report (SER)-Delayed, Safety Evaluation	NRC/NRO/DNRL/LB1		5200043
1/8/2014	ML13350A598	SER Section 2 1-2 2 - Letter to Applicant	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043

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1/8/2014	ML13350A625	SER Section 11 2-11 3 - Letter to Applicant	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
1/8/2014	ML14083A430	State of Deleware, Division of Fish & Wildlife, "About Us" Webpage	Database File	State of DE, Dept of Natural Resources & Environmental Control	NRC/NRO	5200043
1/13/2014	ML14086A007	TN3229 - USGS - StreamStas Data-Collection Station Report, Delaware River at Riegelsville, NJ	Report, Miscellaneous	US Dept of Interior, Geological Survey, Water Resources Div	NRC/NRO/DNRL	5200043
1/15/2014	ML14006A334	Letter to Applicant-PSEG Site Early Site Permit Application Advanced Safety Evaluation with no Open Items for Chapter 2, Section 2.3, "Meteorology"	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
1/15/2014	ML14086A564	TN3208 - New Jersey Municipalities with Hibernation or Maternity Occurrence of Indiana Bat or Northern Long-eared Bat	Graphics incl Charts and Tables	US Dept of Interior, Fish & Wildlife Service	NRC/NRO	5200043
1/16/2014	ML103090303	PSEG ESP Phase B Chapter 02 Site Characteristics Section 2.3 Meteorology	Safety Evaluation	NRC/NRO/DNRL/LB1		5200043
1/16/2014	ML14007A454	SER Section 13 3 Letter to Applicant	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
1/16/2014	ML14085A098	TN3095 - U.S. Census Bureau - Poverty	Database File, FACT Sheet	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
1/16/2014	ML14086A541	TN3178 - Income In The Past 12 Months (in 2011 Inflation-Adjusted Dollars), 2011 American Community Survey 1-Year Estimates	Graphics incl Charts and Tables	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
1/21/2014	ML14027A003	PSEG Power, LLC, Early Site Permit Comments on Advanced Safety Evaluation for Chapter 2, Section 2.1, "Geography and Demography" and Section 2.2, "Identification of Potential Hazards in Site Vicinity"	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

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1/22/2014	ML14085A130	TN3113 - Employment by Industry 2012	Database File, FACT Sheet	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
1/23/2014	ML14023A750	02/06/2014 Notice of Forthcoming Exit Briefing on the Hydrology Audit Related to PSEG Power LLC and PSEG Nuclear, LLC Early Site Permit Application	Meeting Notice	NRC/NRO		5200043
1/23/2014	ML14027A339	PSEG Power, LLC, Early Site Permit, Comments on Advanced Safety Evaluation for Chapter 11, Section 11.2, "Liquid Waste Management System" and Section 11.3 "Gaseous Waste Management System"	Letter	PSEG Nuclear, LLC	NRC/Document Control Desk, NRC/NRO	5200043
1/23/2014	ML14085A529	TN3124 - "State of Delaware, New Castle Area Transit Authority County Bus"	No Document Type Applies	State of DE, Dept of Transportation	NRC/NRO	5200043
1/23/2014	ML14086A428	TN3132 - "Census Bureau EIA Housing"	Graphics incl Charts and Tables	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
1/24/2014	ML14084A158	USGS Groundwater Levels for the Nation - Art Island.	No Document Type Applies	US Dept of Interior, Geological Survey (USGS)	NRC/NRO/DNRL	5200043
1/24/2014	ML14084A174	USGS Distribution of chloride concentrations in the Principal Aquifers of the New Jersey Coastal Plain, 1977-81	Report, Technical	US Dept of Interior, Geological Survey (USGS)	NRC/NRO	5200043
1/27/2014	ML14085A107	TN3109 - "State of Delaware Colleges"	No Document Type Applies	US Dept of Education	NRC/NRO/DNRL	5200043
1/27/2014	ML14085A111	TN3111 - "FBI List of Full Time Active Law Enforcement Employees by City for the State of Delaware"	Database File	US Dept of Justice, Federal Bureau of Investigation (FBI)	NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
1/27/2014	ML14086A478	TN3162 - "Clean Watersheds Needs Survey (CWNS)," 2008 Data and Reports	Report, Miscellaneous	US Environmental Protection Agency (EPA)	NRC/NRO	5200043
1/28/2014	ML14024A169	PSEG Site ESPA_Feb 4-6, 2014 Audit Plan.	Audit Plan, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
1/28/2014	ML14093A670	TN3319 - U.S. Fish and Wildlife Service, 2014. "Sensitive Joint-Vetch (Aeschynomene virginica) [Threatened]."	FACT Sheet	US Dept of Interior, Fish & Wildlife Service	NRC/NRO	5200043
1/29/2014	ML14086A503	TN3167 - "State of Delaware Public School Choice Program"	No Document Type Applies	State of DE	NRC/NRO	5200043
1/31/2014	ML14035A099	PSEG POWER, LLC, Early Site Permit, Comments on Advanced Safety Evaluation for Chapter 13, Section 13.3, "Emergency Planning."	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
1/31/2014	ML14035A100	PSEG POWER, LLC, Early Site Permit, Comments on Advanced Safety Evaluation, "Meteorology"	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/4/2014	ML14085A085	TN3067 - DNREC 2013 Updated Species	No Document Type Applies	State of DE, Dept of Natural Resources & Environmental Control	NRC/NRO/DNRL	5200043
2/10/2014	ML14085A413	TN3118 - Delaware and Raritan Canal State Park	FACT Sheet, Highlights	State of NJ, Dept of Environmental Protection	NRC/NRO/DNRL	5200043
2/10/2014	ML14086A425	TN3127 - Electric Utilities Territory Map New Jersey OCE Website	Map	State of NJ, Dept of Public Utilities	NRC/NRO	5200043
2/14/2014	ML14045A260	PSEG ESP Phase B Chapter 13 "Conduct of Operations" Section 13.3 "Emergency Planning"	Safety Evaluation	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
2/18/2014	ML14086A553	TN3211 - Delaware River Basin Commission, 2014. "Salt Line"	Database File	Delaware River Basin Commission	NRC/NRO	5200043
2/20/2014	ML14038A165	PSEG Phase B Chapter 17 (Section 17.5) SE Transmittal Memo to ACRS.	Memoranda	NRC/NRO/DNRL/LB1	NRC/ACRS	5200043
2/20/2014	ML14038A194	PSEG Phase B Chapter 3 (Section 3.5.1.6) SE Transmittal Memo to ACRS.	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
2/20/2014	ML14038A206	PSEG Phase B Chapter 13 (Section 13.6) SE Transmittal Memo to ACRS.	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
2/20/2014	ML14038A215	PSEG Phase B Chapter 15 (Section 15.0.3) SE Transmittal Memo to ACRS.	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
2/20/2014	ML14041A121	PSEG Phase B Chapter 13 (Section 13.3) SE Transmittal Memo to ACRS	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
2/20/2014	ML14041A175	PSEG Site Early Site Permit Application, Advanced Safety Evaluation with no Open Items for Chapter 11, Section 11.2, "Liquid Waste Management System" and Section 11.3 "Gaseous Waste Management System"	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
2/20/2014	ML14086A511	TN3170 - EIA - Electricity Consumption Data	Database File	US Dept of Energy, Energy Information Administration (EIA)	NRC/NRO	5200043
2/20/2014	ML14091A057	TN2297 - American FactFinder, Profile of General Demographic Characteristics, 2000	Graphics incl Charts and Tables	US Dept of Commerce, Bureau of Census	NRC/NRO	5200043
2/24/2014	ML14055A409	03/10/2014, Notice of Category 1 Public Meeting to Discuss Portions of Site Characteristics Related to PSEG Power, LLC and PSEG Nuclear, LLC early Site Permit Application	Meeting Agenda, Meeting Notice	NRC/NRO		5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
2/24/2014	ML14085A121	TN3282 - Ltr to G. Bickle, AKRF, Inc., From W. L. Jenkins, USACE CENAP-OP-R 2009-157 (JD) [PSEG]	Letter	US Dept of the Army, Corps of Engineers, Philadelphia District	AKRF, Inc., NRC/NRO/DNRL	5200043
2/24/2014	ML14085A485	TN3230 - U.S. Geological Survey 2014 National Water Information System (NWIS) Mapper NJ	Map	US Dept of Interior, Geological Survey, Water Resources Div		5200043
2/25/2014	ML14093A838	TN3328 - National Marine Fisheries Service, 2014. "Protected Species - Species Information"	Database File	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/NRO/DNRL	5200043
2/26/2014	ML14085A226	TN3266 - "Delaware EcoTour Augustine Wildlife Area"	No Document Type Applies	State of DE, Dept of Natural Resources & Environmental Control	NRC/NRO/DNRL	5200043
2/26/2014	ML14085A230	TN3265 - "Delaware EcoTour Cedar Swamp Wildlife Area (PSEG)"	No Document Type Applies	State of DE, Dept of Natural Resources & Environmental Control	NRC/NRO/DNRL	5200043
2/28/2014	ML14038A276	PSEG Phase B Chapter 2 (Section 2.3) SE Transmittal Memo to ACRS	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
2/28/2014	ML14085A125	TN3280 - U.S. Geological Survey TNM (The National Map) 2.0 Viewer (of PSEG site)	Map	US Dept of Interior, Geological Survey (USGS)	NRC/NRO/DNRL	5200043
3/5/2014	ML14049A130	Letter to PSEG on Hydrology Schedule	Letter	NRC/NRO/DNRL	PSEG Power, LLC	5200043
3/6/2014	ML14093A559	TN3313 - PSEG Nuclear, LLC. 2012, Consumptive Release & Pumping History - Merrill Creek Reservoir.	Graphics incl Charts and Tables	PSEG Nuclear, LLC	Merrill Creek Reservoir, NRC/NRO	5200043
3/10/2014	ML14077A029	Documents in Support of Application Early Site Permit for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
3/10/2014	ML14077A036	Consumptive Release & Pumping History Merrill Creek Reservoir	Graphics incl Charts and Tables	Merrill Creek Reservoir	NRC/NRO	5200043
3/10/2014	ML14085A525	TN3123 - Gloucester County, New Jersey, Bus Information	FACT Sheet	State of DE, Dept of Transportation	NRC/NRO	5200043
3/11/2014	ML14093A633	TN3314 - New Jersey Department of Labor and Workforce Development, 2013. "Gross Domestic Product by State - Industry Detail."	Graphics incl Charts and Tables	State of NJ, Dept of Labor	NRC/NRO/DNRL	5200043
3/13/2014	ML14065A465	Summary of the Site Audit Related to the Review of the PSEG Early Site Permit Application for the PSEG Site	Memoranda	NRC/NRO/DNRL	NRC/NRO/DNRL	5200043
3/19/2014	ML14072A167	3-19-14 ACRS Subcommittee Meeting 'Safety Review of the PSEG Site Early Site Permit Application NRC Slides	Meeting Briefing Package/Handouts, Slides and Viewgraphs	NRC/NRO/DNRL/LB1		5200043
3/20/2014	ML14133A470	TN2326 - 2012 "Comprehensive Plan - New Castle County, Delaware"	Report, Technical	New Castle County, DE	NRC/NRO	5200043
3/27/2014	ML14090A429	PSEG Early Site Permit Application, Information in Support of Early Site Permit Application	Graphics incl Charts and Tables, Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/31/2014	ML14093A588	PSEG Power, LLC, Submittal of Early Site Permit Application, Revision 3	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/3/2014	ML14098A061	PSEG Power, LLC, Documents in Support of Application, Early Site Permit Supplemental Comments on Advanced Safety Evaluation for Chapter 2, Section 2.1, "Geography and Demography" and Section 2.2, "Identification of Potential Hazards in Site Vicinity"	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
4/10/2014	ML14101A384	PSEG Early Site Permit Application, Documents in Support of Application Early Site Permit for PSEG	Graphics incl Charts and Tables, Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/28/2014	ML14106A081	PSEG Site Early Site Permit Application Review - Hydrology Audit Summary Report	Audit Report, Memoranda	NRC/NRO/DNRL/LB1	NRC/NRO/DNRL/LB1	5200043
4/30/2014	ML14134A205	Request for Temporary Exemption Regarding the PSEG Early Site Permit Application (Docket 52-043) Analysis of Probable Maximum Surge Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/2/2014	ML14345A577	Responses of Free-Living Coastal Pelagic Fish to Impulsive Sounds.	Conference/Symposium/Workshop Paper, Technical Paper	North Highland College, Thurso, UK, Environmental Research Institute	NRC/ADM/DAS	5200043
5/12/2014	ML14135A029	Request for NRC to Suspend Review of the PSEG Early Site Permit Application Analysis of Probable Maximum Surge Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/22/2014	ML14142A348	PJM (PJM Interconnection, LLC). 2013, PJM Load Forecast Report 2006 - 2012	Graphics incl Charts and Tables, Map, Slides and Viewgraphs	PJM Interconnection	NRC/NRO	5200043
6/10/2014	ML14167A306	PSEG Public Meeting on Hydrology Storm Surge Exemption Request 6-10-14 PSEG Slides	Meeting Briefing Package/Handouts, Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO/DNRL	5200043
6/17/2014	ML14127A308	Letter to PSEG Regarding Exemption from Hydrology Storm Surge Analysis	Letter	NRC/NRO	PSEG Power, LLC	5200043
6/24/2014	ML14176B158	Documents in Support of Application Early Site Permit for PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
6/26/2014	ML14184B414	Interim Part 21 Report - "Containment Loads Potentially Exceed Limits With High Suppression Pool Water Level in the ABWR Design"	Deficiency Report (per 10CFR50.55e and Part 21), Letter	GE-Hitachi Nuclear Energy Americas, LLC	NRC/Document Control Desk, NRC/NRR	05000272 05000311 05000354 05200007 05200009 05200012 05200013 05200017 05200042 05200043 05200045
7/10/2014	ML14196A490	NRC PSEG Public Meeting on Flooding Hazard Reanalysis 7-10-14 PSEG Slides	Meeting Briefing Package/Handouts, Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO/DNRL/LB1	5200043
7/14/2014	ML14121A455	PSEG Site Early Site Permit Application; Advanced Safety Evaluation with No Open Items for Chapter 2, Section 2.5, "Geology, Seismology, And Geotechnical Engineering"	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
7/14/2014	ML14184A962	SER Chapter 2 (Sec 2.5) Transmittal Letter	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
7/17/2014	ML14202A197	Response to NRC Letter - PSEG Site Early Site Permit Application - Denial of Exemption Request Regarding Deferral of Probable Maximum surge Flooding Analysis	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
7/17/2014	ML14204A060	PSEG Early Site Permit Application, Documents in Support of PSEG Early Site Permit Application	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
7/17/2014	ML14345A596	Jacobson et al. (2014) 100% Wind, Water, Sunlight (WWS) All-Sector Energy Plans for the 50 United States. July 17, 2014	Journal Article, Technical Paper	Stanford Univ	NRC/ADM/DAS	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
7/25/2014	ML14203A225	PSEG ESP Phase B Chapter 02 Site Charac-Sec 2.1-2.2 Geography-Demography-Potential Hazards	Safety Evaluation	NRC/NRO/DNRL/LB1		5200043
7/28/2014	ML14038A273	PSEG Chapter 2 (Secs 2.1 and 2.2) SE Transmittal Memo to ACRS	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
7/28/2014	ML14211A005	PSEG Power, LLC, Documents in Support of Application Early Site Permit Comments on Advanced Safety Evaluation for Chapter 2, Section 2.5, "Geology, Seismology, and Geotechnical Engineering"	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
7/28/2014	ML14211A006	Submittal of Document in Support of the PSEG Early Site Permit Application	Emergency Preparedness-Emergency Plan,Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
8/7/2014	ML14282A838	TN3739_EPA 2014-Corning Fall Brook Plt 2014 Envirofacts US EPA	FACT Sheet, Report, Miscellaneous	US Environmental Protection Agency (EPA)	NRC/NRO	5200043
8/8/2014	ML14255A054	Calculation No. 2014-04441, Revision 1, "Probable Maximum Hurricane Analysis for the PSEG ESPA using ADCIRC+SWAN"	Calculation	PSEG Power, LLC	NRC/NRO	5200043
8/8/2014	ML14255A055	Calculation No. 2014-06515, "Analysis of RAI-57 Question on Wave Run-up"	No Document Type Applies	PSEG Power, LLC	NRC/NRO	5200043
8/14/2014	ML14226A316	NRC-PSEG Public Meeting on Hydrology Storm Surge Analysis Review 8-14-14 Draft RAI 67 Response	Letter	PSEG Nuclear, LLC	NRC/NRO	5200043
8/14/2014	ML14226A398	NRC-PSEG, Public Meeting on Hydrology Storm Surge Analysis Review 8-14-14 PSEG Slides	Meeting Briefing Package/Handouts, Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
8/19/2014	ML14255A056	Calculation No. 2014-06517, "Analysis of RAI-67 QuesUons on HEC-RAS"	No Document Type Applies	PSEG Power, LLC	NRC/NRO	5200043
8/21/2014	ML14226A921	PSEG Site ESPA - Chapter 2 Section 2 5 Adv SE with no Open Items	NRO Safety Evaluation Report (SER)-Delayed, Safety Evaluation	NRC/NRO/DNRL/LB1		5200043
8/21/2014	ML14238A022	Response to Request for Additional Information, RAI No. 67, Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/5/2014	ML14255A051	Documents in Support of PSEG Early Site Permit Application	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/5/2014	ML14282A840	TN3741_EPA 2014-World Kitchen Press EnvirofactsEPA2014	FACT Sheet, Report, Miscellaneous	US Environmental Protection Agency (EPA)	NRC/NRO	5200043
9/12/2014	ML14259A347	PSEG Early Site Permit Application, Supplemental Response to Request for Additional Information 50, Identification of Potential Hazards in Site Vicinity	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
9/15/2014	ML14272A074	Comment (1) of Roger R. Locandro on Behalf of the State Univ of NJ Supporting the Approval of the ESP Requested by PSE&G for Construction of a New, Nuclear Energy Power Plant Adjacent to the two Inservice Reactors at Salem Creek	General FR Notice Comment Letter	Univ of New Jersey	NRC/ADM/DAS	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
9/30/2014	ML14268A365	NRC Staff Slides for ACRS Subcommittee Meeting on 9-29-2014 & 9-30-2014(2)	Meeting Briefing Package/Handouts, Slides and Viewgraphs	NRC/NRO/DNRL/LB1		5200043
9/30/2014	ML15009A108	Transcript of the Advisory Committee on Reactor Safeguards Regulatory Policies & Practices Subcommittee Meeting - September 30, 2014	Meeting Transcript	NRC/ACRS		5200043
10/9/2014	ML14282A839	TN3740 - EPA 2014 - Corning Refractories Envirofacts EPA 2014	FACT Sheet	US Environmental Protection Agency (EPA)	NRC/NRO	5200043
11/3/2014	ML14345A592	NOAA. 2012. NOAA Lists Five Atlantic Sturgeon Populations Under Endangered Species Act	Journal Article	US Dept of Commerce, National Oceanic & Atmospheric Admin (NOAA)	NRC/ADM/DAS	5200043
11/3/2014	ML14345A593	Grunwald et al. 2007. Conservation of Atlantic Sturgeon Acipenser Oxyrinchus Oxyrinchus: Delineation of Stock Structure and Distinct Population Segments, Printed Springer Science+Business Media, B.V. 2007	Journal Article	Conservation Genetics, Springer Science+Business Media	NRC/ADM/DAS	5200043
11/3/2014	ML14345A595	Wirgin, I., Grunwald, C., Stabile, J., & Waldman, J. (2007). Genetic Evidence for Relict Atlantic Sturgeon Stocks Along the Mid-Atlantic Coast of the USA. North American Journal of Fisheries Management, 27(4), 1214-1229	Journal Article	American Fisheries Society, Iona College, New York Univ School Of Medicine, North American Journal of Fisheries Management, Queens College, Taylor & Francis Online	NRC/ADM/DAS	5200043
11/5/2014	ML14296A343	Letter - Change in Schedule of PSEG Site Early Site Permit Application Review	Letter, Schedule and Calendars	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043

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12/2/2014	ML14345A847	Comment (11) of Chantel Williams on Early Site Permit for the PSEG Site; Extension of Comment Period	General FR Notice Comment Letter	Clean Water Action, Cohansey Area Watershed Association, Delaware Audubon Society, Delaware River Shad Fisherman's Association, Delaware Riverkeeper Network, Lenape Nation of Pennsylvania, Sierra Club, New Jersey Chapter, South Jersey Land and Water Trust, Tidewaters Gateway Partnership, Inc	NRC/ADM/DAS	5200043
12/6/2014	ML14356A128	Comment (00025) of George R. C. on Permit to Build New Facilities at the Salem Nuclear Site in New Jersey	General FR Notice Comment Letter	No Known Affiliation	NRC/ADM/DAS/RADB	5200043
12/10/2014	ML14345A582	Development and Implementation of an Underwater Construction Noise Program	Conference/Symposium/Workshop Paper, Technical Paper	Thalheimer, Poling & Greene	NRC/ADM/DAS	5200043
12/10/2014	ML14356A275	PSEG Early Site Permit Application - Response to Request for Additional Information, RAI No. 25, Hydrologic Description	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
12/11/2014	ML14345A580	Effects of Pile Driving on the Behavior of Cod and Sole.	FACT Sheet	No Known Affiliation	NRC/ADM/DAS	5200043
12/11/2014	ML14345A583	Does Boat Traffic Cause Displacement of Fish in Estuaries?	News Article, Technical Paper	Elsevier, Norwegian Institute for Nature Research, South African Institute for Aquatic Biodiversity	NRC/ADM/DAS	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
12/11/2014	ML14345A584	A Noisy Spring: the Impact of Globally Rising Underwater Sound Levels on Fish	News Article, Technical Paper	Alfred Wegener Institute, Germany, Leiden Univ, The Netherlands, Pelagic Regional Advisory Council, Netherland, Univ of Antwerp, Belgium, Univ of Maryland - College Park	NRC/ADM/DAS	5200043
12/11/2014	ML14345A585	Effects of Ambient and Boat Noise on Hearing and Communication in Three Fish Species Living in a Marine Protected Area (Miramare, Italy)	Technical Paper	Elsevier,Natural Marine Reserve Of Miramare, Etho-Ecology Marine Lab, Italy, Univ of Trieste, Italy, Univ of Vienna, Austria	NRC/ADM/DAS	5200043
2/9/2015	ML15055A157	PSEG - Information in Support of Early Site Permit Application	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
2/20/2015	ML15055A158	PSEG Early Site Permit Application, Information in Support of Early Site Permit Application	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
3/13/2015	ML15092A732	Documents in Support of Application Early Site Permit for the PSEG Site	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/6/2015	ML15096A576	April 6, 2015 Public Meeting - PSEG Slides	Meeting Briefing Package/Handouts, Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
4/8/2015	ML15096A573	April 6 2015 Public Meeting - PSEG SSAR Markups	Meeting Briefing Package/Handouts, Safety Evaluation Report	PSEG Nuclear, LLC	NRC/NRO	5200043
4/15/2015	ML15114A008	PSEG Early Site Permit Application, Supplemental Response to Request for Additional Information, RAI No. 67 re Probable Maximum Surge and Seiche Flooding	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
4/16/2015	ML15106A724	Minutes of the ACRS Regulatory Policies and Practices Subcommittee Meeting on September 29-30, 2014	Meeting Minutes	NRC/ACRS	NRC/ACRS	5200043
4/22/2015	ML13211A144	PSEG ESP Phase B Chapter 02 Site Charac_Sec 2.4 Hydrology	Report, Miscellaneous	PSEG Nuclear, LLC	NRC/NRO	5200043
4/22/2015	ML15082A119	SER Chapter 2 (Sec 2.4) Issuance Memo to ACRS	Memoranda	NRC/NRO/DNRL	NRC/ACRS	5200043
4/22/2015	ML15082A133	SER Chapter 2 (Sec 2.4) Issuance Letter to Applicant	Letter	NRC/NRO/DNRL/LB1	PSEG Power, LLC	5200043
5/1/2015	ML15126A374	Documents in Support of Application Early Site Permit for the PSEG Site, Comments on Advanced Safety Evaluation for Chapter 2, Section 2.4 "Hydrologic Engineering"	Letter, Report, Miscellaneous	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
5/21/2015	ML15146A098	PSEG Early Site Permit Application, Information in Support of Early Site Permit Application	Letter	PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043
6/3/2015	ML15154B015	ACRS Subcommittee Meeting 6-09-2015 NRC Slides.	Slides and Viewgraphs	NRC/NRO, NRC/NRO/DNRL/LB1		5200043
6/5/2015	ML15168A201	Submittal of Revision 4 of the Early Site Permit Application for the PSEG Site.	Letter, License-Application for Early Site Permit (ESP)	PSEG Nuclear, LLC, PSEG Power, LLC	NRC/Document Control Desk, NRC/NRO	5200043

Document Date	Accession Number	Title	Document Type	Author Affiliation	Addressee Affiliation	Docket Number
6/9/2015	ML15162A335	6-09-15 ACRS Subcommittee Meeting - PSEG Site ESP Application Hydrology Review - PSEG Slides.	Meeting Briefing Package/Handouts, Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO	5200043
6/10/2015	ML15162A406	6-10-15 ACRS Full Committee Meeting - PSEG Site ESP Application - PSEG Slides.	Meeting Briefing Package/Handouts, Slides and Viewgraphs	PSEG Power, LLC	NRC/NRO	5200043
6/10/2015	ML15154B131	6-10-2015 ACRS Full Committee Meeting - NRC Slides.	Meeting Briefing Package/Handouts, Slides and Viewgraphs	NRC/NRO		5200043
6/17/2015	ML15168A985	NHL Nomination_Abel and Mary Nicholson House.	No Document Type Applies	US Dept of Interior, National Park Service	NRC/NRO	5200043

APPENDIX C

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APPENDIX D

PRINCIPAL CONTRIBUTORS

Name	Responsibility
Barss, Daniel	Emergency Planning
Bauer, Laurel	Geology
Beasten, Amy	Site Hazards
Bensi, Michelle	Hydrology
Braden, Michael	Accident Analysis and Radiological Consequences
Brown, David	Meteorology
Candelario, Luissette	Geotechnical Engineering
Canova, Michael	Project Management
Caverly, Jill	Hydrology
Chowdhury, Prosanta	Project Management
Clark, Phyllis	Project Management
Costa, Jr., Richard	Physical Security
Cozens, Ian	Accident Analysis and Radiological Consequences
Devlin-Gill, Stephanie	Seismology
Dexter, Robert	Physical Security
Dickson, Elijah	Accident Analysis and Radiological Consequences
Edmonds, Shavon	Quality Assurance Inspection
Erwin, Kenneth	Meteorology, Hydrology
Eudy, Michael	Project Management
Giacinto, Joseph	Hydrology
Gran, Zachary	Radioactive Waste Management
Harvey, Jr., Robert	Meteorology
Hebbar, Sudha	Document Administrative Processing
Hinson, Charles	Radioactive Waste Management
Jones, Henry	Hydrology
Keim, Andrea	Quality Assurance Program
Lee, Michael	Hydrology
Lipscomb, George	Quality Assurance Inspection
Mazaika, Michael	Meteorology
McCoppin, Michael	Radioactive Waste Management
McLellan, Judith	Document Editing, Formatting, Styling
Musico, Bruce	Emergency Planning
Patel, Jay	Project Management
Plaza-Toledo, Meralis	Geology
Quinlan, Kevin	Meteorology
Schaaf, Robert	Meteorology
Schaperow, Jason	Accident Analysis and Radiological Consequences
Seber, Dogan	Seismology
See, Kenneth	Hydrology

Smith, Stacy	Quality Assurance Inspection
Stirewalt, Gerry	Geology
Stovall, Scott	Seismology
Stutzcage, Edward	Radioactive Waste Management
Takacs, Michael	Project Management
Tammara, Seshagiri	Geography-Demography, Site Hazards, Aircraft Hazards, Accident Analysis and Radiological Consequences
Vaughn, James	Physical Security
Vega, Frankie	Geotechnical Engineering
Williams, Stephen	Radioactive Waste Management

Contractors	**Technical Area**
U.S. Department of Homeland Security	Emergency Planning
Sandia National Laboratory	Emergency Planning
Numark Associates, Inc./Taylor Engineering, Inc.	Hydrology
U.S. Army Corps of Engineers	Hydrology

REPORT BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

June 25, 2015

The Honorable Stephen G. Burns
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: PSEG EARLY SITE PERMIT

Dear Chairman Burns:

During the 625th meeting of the Advisory Committee on Reactor Safeguards, June 10-12, 2015, we completed our review of the early site permit application submitted by PSEG (PSEG Power, LLC and PSEG Nuclear, LLC or "applicant") and selected chapters of the associated safety evaluation report prepared by the NRC staff. Our Regulatory Policies and Practices Subcommittee reviewed these matters at its meetings on March 19, 2014, September 29-30, 2014, and June 9, 2015. During our reviews, we had the benefit of discussions with representatives of the NRC and PSEG. We also had the benefit of the documents referenced. This is the fifth early site permit application we have reviewed.

RECOMMENDATION

The PSEG early site permit should be issued.

DISCUSSION

PSEG applied for a 20-year early site permit for a location adjacent to its existing nuclear power plants, Salem Units 1 and 2 (each 3459 MW_{th}) and Hope Creek Unit 1 (3840 MW_{th}). The proposed site is Artificial Island, located at the transition between the Delaware River and the Delaware Bay. The site is approximately 30 miles southwest of Philadelphia, Pennsylvania, 7½ miles southwest of Salem, New Jersey, and about 18 miles south of Wilmington, Delaware. The 50-mile emergency planning radius for the site includes portions of New Jersey, Delaware, Pennsylvania, and Maryland.

The early site permit application is based on the "plant parameter envelope" approach. Plants considered in the development of the parameter envelope were single units of the US-APWR, the US-EPR, and the ABWR designs, and two units of the AP-1000 design. The application included a complete and integrated emergency plan. A limited work authorization was not requested.

Review of the application was complicated by new requirements dealing with seismic events, flooding events, and emergency planning imposed in the aftermath of the reactor accidents at Fukushima. The proposed site is located in a region of generally low seismic activity. The applicant analyzed the seismic hazard at the site using the complete, updated catalogue of seismic sources for the central and eastern United States including sources at Mineral, Virginia and Charleston, South Carolina. These analyses yielded a ground motion response spectrum that is acceptable for plants considered in the development of the plant parameter envelope.

The proposed site is susceptible to flooding. The applicant proposes that any unit located on the site be a so-called "dry" unit that does not require water tight closures such as those installed at the existing Salem and Hope Creek units. The power block for any new unit will be located on an engineered fill with grade level about 37 feet above sea level. The limiting flood for the site has been deduced to be a storm surge produced by a hurricane with a trajectory roughly parallel to the Delaware River. Screening analyses using a bounding one-dimensional model suggested that a limiting Category IV hurricane could produce, under extreme conditions, a storm surge including wave run-up above the proposed grade level. A Category IV hurricane would greatly exceed the intensity of historically observed hurricanes in the region, which have been of Category I. Two-dimensional models that account more realistically for details of the site showed the storm surge for a Category IV hurricane with wave run-up to remain below the proposed grade level. Independent staff analysis confirmed this prediction. The two-dimensional model used to analyze the storm surge has been validated by comparison of predictions with data for Hurricane Isabel and Northeaster Ida.

The staff has done a thorough review of the early site permit application. The effective use of site visits and audits by the staff during this review is noteworthy. Also noteworthy has been effective coordination of the staff review with other Federal agencies including the U.S. Coast Guard, the U.S. Army Corps of Engineers, and the Federal Emergency Management Agency. This coordination has leveraged agency resources and staff expertise for the review.

The safety evaluation report from the staff has no open items. It includes nine routine permit conditions and appropriate combined license action items. There are no contentions associated with the early site permit application.

Based on our reviews of the application and the staff safety evaluation report, we conclude that the early site permit should be issued.

Sincerely,

/RA/

John W. Stetkar
Chairman

REFERENCES

1. NRC, Selected Chapters from the Final Safety Evaluation Report, “Safety Evaluation of Early Site Permit Application for PSEG Site,” presented to the ACRS from March 2014 to June 2015 (ML14203A225, ML103090303, ML13211A144, ML14226A921, ML103090381, ML103090395, ML14045A260, ML103090654, ML103090665, ML15044A381 (Fukushima NTTF Recommendations – covered in specific Chapters))

2. PSEG Early Site Permit Application, Revision 4, June 5, 2015 (ML15168A201)

3. NRC, Review Standard, RS-002, “Processing Applications for Early Site Permit Applications,” May 3, 2004 (ML040700236)

4. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," March 2007 (ML070810350)

5. NRC, SECY12-0025 “Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami,” February 17, 2012 (ML12039A103)