December 5, 2011

- MEMORANDUM TO: John Segala, Chief EPR Projects Branch Division of New Reactor Licensing Office of New Reactors
- FROM: Prosanta Chowdhury, Project Manager EPR Projects Branch /RA/ Division of New Reactor Licensing Office of New Reactors
- SUBJECT: 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

This report summarizes the U.S. Nuclear Regulatory Commission (NRC) staff's activities involving the Geosciences and Geotechnical Engineering Site Audit in conjunction with the PSEG Site Early Site Permit application review.

By letter dated May 25, 2010, PSEG Power, LLC and PSEG Nuclear, LLC submitted the PSEG Site Early Site Permit (PSEG Site ESP) application to the NRC (Agencywide Documents Access and Management System (ADAMS) Accession No. ML101480484). The staff has begun reviewing the application and identified the need to conduct an audit related to the geology, seismology and geotechnical characteristics of the proposed plant site. The audit was necessary in support of the review of Section 2.5 (Geology, Seismology, and Geotechnical Information) of the PSEG Site ESP application Site Safety Analysis Report (SSAR). The audit, conducted on September 29 and 30, 2011, included a field trip to view and observe outcrops, soil, and rock formation of the Site Area, in addition to other geological features unique to the proposed plant site. The field trip portion of the audit, which involved observing the Turkey Point beds and local geologic features of the Site Area, was conducted at and around the Turkey Point Lighthouse, and the onsite portion of the audit was conducted at the PSEG's Energy and Environmental Resource Center in Salem, New Jersey. Preliminary results of the audit were discussed with the applicant in a public meeting which was conducted at the conclusion of the audit activities on September 30, 2011. A summary of the public meeting can be found at ADAMS Accession No. ML112940705.

A comprehensive report of the audit activities is enclosed.

Docket No.: 52-043

Enclosure: As stated

CONTACT: Prosanta Chowdhury, NRO/DNRL/NARP (301) 415-1647

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/RA/

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Distribution: PUBLIC MPlaza-Toledo, NRO RKaras, NRO PChowdhury, NRO JSegala, NRO

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ADAMS AC	CESSION NO: ML11334	0144 *vi	a email	NRO-002	
OFFICE	DNRL/NARP:PM	DNRL/NARP:LA*	DSEA/RGS1	DSEA/RGS1:BC	
NAME	PChowdhury	JMcLellan	MPlaza-Toledo	RKaras; CCook for	
DATE	12/01/2011	12/02/2011	12/05/2011	12/05/2011	

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### PSEG SITE EARLY SITE PERMIT APPLICATION GEOSCIENCES AND GEOTECHNICAL ENGINEERING SITE AUDIT REPORT

## A. Background

PSEG Power, LLC and PSEG Nuclear, LLC submitted to the U.S. Nuclear Regulatory Commission (NRC) information on the geology, seismology, and geotechnical characteristics of the PSEG Site as part of the PSEG Site Early Site Permit (ESP) application. The staff reviewed documentation in Section 2.5 of the Site Safety Analysis Report (SSAR), Revision 0, and identified the need for an audit of the information related to selected areas of the geology, seismology and geotechnical sections of the SSAR. This audit promoted a better understanding of the detailed analyses and bases underlying the information in the formal application.

The purpose of this audit was for the staff to review the geology, seismology and geotechnical modeling and calculations, as well as analyses and results of selected soil samples. The audit included a field trip to view and observe outcrops, soil, and rock formation of the Site Area, possible faults extending to the Site Area, evidence of lineaments in the Site Area, and elliptical patches northeast of the Site, and other geological features unique to the proposed plant site. 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 Site ESP application.

### B. Regulatory Audit Bases

This regulatory audit was based on the following:

- NUREG 0800, "Standard Review Plan"
  - 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"
  - Section 2.5.5, "Stability of Slopes"
- Review Standard (RS)-002, "Guidance for Processing Applications for Early Site Permits"
- Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants"
- C. Regulatory Audit Scope or Methodology
  - The area of focus for the audit was the PSEG Site ESP application and supporting documentation.
- D. Information and Other Material Necessary for the Regulatory Audit
  - PSEG Site ESP Application, Revision. 0, Section 2.5, "GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL INFORMATION"

### E. Audit Team

The audit team consisted of the following NRC members:

Meralis Plaza-Toledo, NRC Audit Team Lead Christopher Cook, NRC Audit Team, Branch Chief Gerry Stirewalt, NRC Audit Team Member Luissette Candelario, NRC Audit Team Member Frankie Vega, NRC Audit Team Member Dogan Seber, NRC Audit Team Member Laurel Bauer, NRC Audit Team Member Stephanie Devlin, NRC Audit Team Member Prosanta Chowdhury, NRO Licensing Project Manager

- F. Logistics
- Date/Time: September 29, 2011; 8:00 A.M. 4:30 P.M. September 30, 2011; 8:00 A.M. 1:30 P.M.
- Location: Field Trip Turkey Point Lighthouse

Onsite Audit -

PSEG Nuclear Development Energy and Environmental Resource Center 244 Chestnut St. Salem, New Jersey 08079

G. Audit Agenda

See Attachment 1

H. List of Audit Attendees

See Attachment 2

I. Details of Audit Activities

The following activities were accomplished during the site audit:

### September 29, 2011

 NRC staff and the applicant started the field trip at the Turkey Point Lighthouse, located in Elk Neck, MD. The first outcrop examined showed a sedimentary sequence composed of several lithofacies of Pliocene age (5.3-2.6 Ma), including a section of the Pensauken Formation containing cross bedding that was directly overlain by a sedimentary unit made up of boulders, coarse sand, and gravel. Early Pleistocene (2.6-1.8 ma) Turkey Point beds were observed to overlie the Pensauken Formation. The Turkey Point units consist of fluvial, estuarine, colluvial and aeolian sediments (Figure 1). The second outcrop examined at this location showed similar field relationships (i.e., cross bedded strata overlain by coarser boulders, sand, and gravel, overlain in turn by the Turkey Point beds). Neither of the two outcrops showed any evidence for faulting of the sedimentary sequence at this location.

- The applicant provided a presentation to NRC staff on site characteristics related to geology, seismology, and geotechnical engineering.
- The applicant provided a tour of the proposed plant site for observing general plant layout, including locations of the future nuclear island, the intake area, and borehole NB-1, a deep boring at the site location.
- NRC staff examined undisturbed (intact tube) samples from the site location (Figure 2). Most of the samples were from the Vincentown Formation, which is the foundation unit at the site. The Vincentown is of Paleocene age (66.5-55.8 ma) and is characterized by fine to medium grained silty sand with some zones of clayey sand. Some samples also showed the Hornestown Formation, which lies stratigraphically below the Vincentown Formation. The Hornestown Formation is a Paleocene age glauconitic sand. Disturbed soil samples collected using split-spoon sampling stored in glass jars were also examined.

### September 30, 2011

- NRC staff reviewed aerial photographs of site area and region as well as oversized figures from the PSEG SSAR containing geologic maps. The staff also observed photos of previous excavations performed for proposed sites for the Salem and Hope Creek stations.
- NRC staff reviewed the following calculation packages:
  - o Calc. No. 2251-ESP-GE-001, "Geologic Stratification"
  - ESP 798\_Calc. No. 2251-ESP-GT-001 "Correction of Field SPT N-Values for Field Variables and Effective Overburden Pressures"
  - o Calc. No. 2251-ESP-GT-004 "Engineering Stratigraphy"
  - PSEG-Calc. No. 2251-ESP-GT-005, "Discussion of Excavation methods and backfill material for the PSEG Site".
  - o ESP 811-PSEG-Calc. No. 2251-ESP-GT-006, "Dynamic Soil Profile"
  - o PSEG-CALC-2251-ESP-GT-003, Rev. 1, "Bearing Capacity and Settlement"
  - DCN-ESP-750-Calc-2251-ESP-GT-008, Rev-5-8-25-11, "Potential Liquefaction Evaluation"

- PSEG-Calc-2251-ESP-GT-009, Rev. 2, "Evaluation of ground settlement in the area of existing structures due to temporary dewatering"
- ESP 1087-Calc-2251-RAI-008-004, "Total and Effective Overburden Pressures used in Liquefaction Calculations"
- o PSEG Calc 2251 ESP-GE 001, Rev. 3, "Geologic Stratification"
- 2251-ESP-REI-2047-ACR-001, Rev. 4, "PSEG Site earthquake catalogs for sensitivity study"
- #2251-ESP-REI-2047-ACR-003, Rev. 1, "Sensitivity analysis on updated seismicity for the PSEG Site"
- #2251-ESP-REI-2047-ACR-005, Rev. 1, "Create \*.SRC files for EPRI-SOG sources, PSEG Site"
- #2251-ESP-REI-2047-ACR-007, Rev. 0, "Recurrence rates for WLA Charleston characteristic sources"
- o #2251-ESP-REI-2047-ACR-009, Rev. 0, "Source file for WLA Charleston fault"
- #2251-ESP-REI-2047-ACR-011 Rev. 1 "Source files for WLA Charleston exponential sources"
- #2251-ESP-REI-2047-ACR-013, Rev. 1, "Documentation of ground motion equations for the PSEG site"
- #2251-ESP-REI-2047-ACR-014, Rev. 1, "PSEG Site hazard contribution by Source"
- #2251-ESP-REI-2047-ACR-016, Rev. 1, "Base rock hazard calculation (no CAV) for PSEG Site"
- #2251-ESP-REI-2047-ACR-018, Rev. 3, "Deaggregation of 10-4 rock hazard at the PSEG Site"
- #2251-ESP-REI-2047-ACR-020, Rev. 2, "Deaggregation of 10-5 rock hazard at the PSEG Site"
- #2251-ESP-REI-2047-ACR-022, Rev. 1, "Deaggregation of 10-6 rock hazard at the PSEG Site"
- #2251-ESP-REI-2047-ACR-024, Rev. 1, "High- and low-frequency horizontal spectra for the PSEG Site"

- #2251-ESP-REI-2047-ACR-026, Rev. 2, "\*.SRC files for EPRI-SOG sources (CAV, Mmin=4.3), PSEG Site)"
- #2251-ESP-REI-2047-ACR-028, Rev. 1, "\*.SRC files for comparison to 1989 hazard, Hope Creek Plant"
- #2251-ESP-REI-2047-ACR-030, Rev. 1, "Replication of 1989 EPRI-SOG hazard for the Hope Creek plant"
- #2251-ESP-REI-2047-ACR-032, Rev. 1, "Artificial Shear-Wave Velocity Profiles for PSEG Site Response Calculations"
- #2251-ESP-REI-2047-ACR-034, Rev. 1, "Calculation of Site Response for the PSEG site"
- #2251-ESP-REI-2047-ACR-036, Rev. 1, "Calculation of soil hazard for the PSEG Site"
- #2251-ESP-REI-2047-ACR-038, Rev. 1, "Calculation of smooth horizontal GMRS for the PSEG Site"
- #2251-ESP-REI-2047-ACR-040, Rev. 1, "Calculation of Smooth Vertical GMRS for the PSEG site"
- #2251-ESP-REI-2047-ACR-044, Rev. 2, "Replication of 1989 EPRI-SOG Hazard for Individual Law Engineering Sources"
- #2251-ESP-REI-2047-ACR-046, Rev. 2, "Sensitivity of Site Amplification Factors for the PSEG Site ESP to Revisions in Degradation Curves"
- The NRC staff presented to and discussed with the applicant preliminary results of the audit in an exit meeting that was open to the public via a teleconference bridge. A summary of the exit public meeting can be found at ADAMS Accession No. ML112940705.



Figure 1. First outcrop visited showing the Pensauken Formation and Turkey Point beds

Figure 2. Observation of the PSEG site undisturbed and disturbed soil samples



# PSEG Site ESPA - Geosciences and Geotechnical Engineering Site Audit September 29 and 30, 2011 Salem, New Jersey

# <u>Agenda</u>

8:00 A.M.       Introduction/Opening of Audit (via Conference Call)       NRC/PS         10:30 A.M.       Field Trip to Turkey Point Lighthouse; Observe the Turkey Point Beds and Local Geologic Features       NRC/PS         2:00 P.M.       Presentation on PSEG Site Characteristics       PSEG         3:00 P.M.       Observation of Core Intervals in Boreholes of Undisturbed/Disturbed Samples of Borings Located at and Near the Foundation Footprint in the Vincentown Formation: <ul> <li>Multiple Cores Representing the Local Stratigraphy, and Lateral and Vertical Variation in the Units</li> </ul> NRC           4:30 P.M.         Adjourn         Friday, September 30, 2011         NRC           8:00 A.M.         Review of:         NRC         NRC           •         Geotechnical Engineering Calculation Packages (Bearing Capacity, Settlement, Lateral Earth Pressure, and other packages, as necessary)         NRC           •         Liquefaction Calculation Packages         MACTEC Engineering Geotechnical Exploration and Testing Site Report (SSAR Reference 2.5.4.2-15)         Site Response Analysis Calculation Packages           •         Plots (or Electronic Copies) of all Individual Seismic Sources' Hazard Curves (for all Ground Motion Frequencies) Used in the PSHA Study         Aerial Photographs of the Site Area and Region	<u>Thursday, Ser</u>	<u>otember 29, 2011</u>	Lead by		
10:30 A.M.       Field Trip to Turkey Point Lighthouse; Observe the Turkey Point Beds and Local Geologic Features       NRC/PS         2:00 P.M.       Presentation on PSEG Site Characteristics       PSEG         3:00 P.M.       Observation of Core Intervals in Boreholes of Undisturbed/Disturbed Samples of Borings Located at and Near the Foundation Footprint in the Vincentown Formation: <ul> <li>Multiple Cores Representing the Local Stratigraphy, and Lateral and Vertical Variation in the Units</li> </ul> NRC           4:30 P.M.         Adjourn         Friday. September 30, 2011           8:00 A.M.         Review of:         NRC           o         Geotechnical Engineering Calculation Packages (Bearing Capacity, Settlement, Lateral Earth Pressure, and other packages, as necessary)         NRC           o         Liquefaction Calculation Packages         NACTEC Engineering Geotechnical Exploration and Testing Site Report (SAR Reference 2.5.4.2-15)         Site Response Analysis Calculation Packages           o         Probabilistic Seismic Hazard Analysis (PSHA) Implementation Related Calculation Packages         Probabilistic Seismic Hazard Analysis (PSHA) Implementation Related Calculation Packages           o         Plots (or Electronic Copies) of all Individual Seismic Sources' Hazard Curves (for all Ground Motion Frequencies) Used in the PSHA Study         Aerial Photographs of the Site Area and Region	8:00 A.M.	Introduction/Opening of Audit (via Conference Call)	NRC/PSEG		
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3:00 P.M.       Observation of Core Intervals in Boreholes of Undisturbed/Disturbed Samples of Borings Located at and Near the Foundation Footprint in the Vincentown Formation: <ul> <li>Multiple Cores Representing the Local Stratigraphy, and Lateral and Vertical Variation in the Units</li> <li>4:30 P.M.</li> <li>Adjourn</li> </ul> Friday, September 30, 2011           8:00 A.M.         Review of:         NRC <ld>•</ld> <li>Geotechnical Engineering Calculation Packages (Bearing Capacity, Settlement, Lateral Earth Pressure, and other packages, as necessary)</li> <li>Liquefaction Calculation Packages</li> <li>MACTEC Engineering Geotechnical Exploration and Testing Site Report (SSAR Reference 2.5.4.2-15)</li> <li>Site Response Analysis Calculation Packages</li> <li>Probabilistic Seismic Hazard Analysis (PSHA) Implementation Related Calculation Packages</li> <li>Plots (or Electronic Copies) of all Individual Seismic Sources' Hazard Curves (for all Ground Motion Frequencies) Used in the PSHA Study</li> <li>Aerial Photographs of the Site Area and Region</li> <li>Mare of the SSAB Becommiscence Bouter</li>	2:00 P.M.	Presentation on PSEG Site Characteristics PSEG			
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<ul> <li>Geotechnical Engineering Calculation Packages (Bearing Capacity, Settlement, Lateral Earth Pressure, and other packages, as necessary)</li> <li>Liquefaction Calculation Packages</li> <li>MACTEC Engineering Geotechnical Exploration and Testing Site Report (SSAR Reference 2.5.4.2-15)</li> <li>Site Response Analysis Calculation Packages</li> <li>Probabilistic Seismic Hazard Analysis (PSHA) Implementation Related Calculation Packages</li> <li>Plots (or Electronic Copies) of all Individual Seismic Sources' Hazard Curves (for all Ground Motion Frequencies) Used in the PSHA Study</li> <li>Aerial Photographs of the Site Area and Region</li> </ul>	8:00 A.M.	Review of:	NRC		
o maps of the SSAR reconnersative routes		<ul> <li>Geotechnical Engineering Calculation Packages (Bearing Capacity, Settlement, Lateral Earth Pressure, and other packages, as necessary)</li> <li>Liquefaction Calculation Packages</li> <li>MACTEC Engineering Geotechnical Exploration and Testing Site Report (SSAR Reference 2.5.4.2-15)</li> <li>Site Response Analysis Calculation Packages</li> <li>Probabilistic Seismic Hazard Analysis (PSHA) Implementation Related Calculation Packages</li> <li>Plots (or Electronic Copies) of all Individual Seismic Sources' Hazard Curves (for all Ground Motion Frequencies) Used in the PSHA Study</li> <li>Aerial Photographs of the Site Area and Region</li> <li>Maps of the SSAR Reconnaissance Routes</li> </ul>			

• Additional documents, as appropriate

PSEG Site ESPA - Geosciences and Geotechnical Engineering Site Audit September 29 and 30, 2011

11:30 A.M.	Lunch Break	
12:30 P.M.	Audit Exit - Public Meeting (Conference call format)	NRC
1:30 P.M.	Closing of Audit	NRC

Name	Organization	9/29/11 Audit Entrance (via Conf. Call)	9/29/11 Field Trip	9/29/11 Audit at PSEG Facilities	9/30/11 Audit at PSEG Facilities
Prosanta Chowdhurv	NRC	x	x	x	x
Christopher Cook	NRC	x	х	х	x
Meralis Plaza-Toledo	NRC	x	x	x	x
Gerry Stirewalt	NRC	х	х	х	x
Luissette Candelario	NRC	х	х	х	x
Laurel Bauer	NRC	х	х	х	x
Dogan Seber	NRC	х	х	х	х
Stephanie Devlin	NRC	х	х	х	х
Frankie Vega	NRC	х	х	х	х
Dave Robillard	PSEG	х		х	х
James Mallon	PSEG	x	х	x	x
Christine Neely	PSEG	х			
Gary Ruf	PSEG	х	х	х	х
Mike Wiwel	PSEG			х	х
Guy Winebrenner	AMEC	х	х	х	х
Al Tice	AMEC	х	х	х	x
James Veith	AMEC	х	х	х	x
Stephen Criscenzo	AMEC	х	х	х	x
Chris Fuller	FUGRO	х	Х	х	х
Frank Syms	FUGRO	х	х	х	x
Gabriel Toro	FURGO	х		х	х
Stephanie Briggs	FURGO	х	х	х	х
Randy Cumbest	FURGO	х	Х	х	х
Dave Nielson	S&L	х	х	х	х
Dan Blount	S&L	х	х	х	х
Mike Shervin	S&L		х	x	x
Ira Owens	S&L			X(Audit Presentation only)	

# PSEG Site ESPA - Geosciences and Geotechnical Engineering Site Audit List of Attendees

x - Indicates individual was present at this portion of the audit

ESP - PSEG Mailing List cc:

Mr. Richard L. Baker Bechtel Power Corporation 5275 Westview Drive Frederick, MD 21703-8306

Mr. Lionel Batty Nuclear Business Team Graftech 12300 Snow Road Parma, OH 44130

Ms. Michele Boyd Legislative Director Energy Program Public Citizens Critical Mass Energy and Environmental Program 215 Pennsylvania Avenue, SE Washington, DC 20003

Norm Cohen Coord, Unplug Salem Campaign 321 Barr Ave. Linwood, NJ 08221

Mr. P. J. Davison Vice President Operations Support PSEG Nuclear, LLC One Alloway Creek Neck Rd. Hancock's Bridge, NJ 08038

Mr. Carey Fleming, Esquire Senior Counsel - Nuclear Generation Constellation Generation Group, LLC 750 East Pratt Street, 17th Floor Baltimore, MD 21202

Mr. Ronnie L. Gardner Manager AREVA NP Inc. 3315 Old Forrest Road P.O. Box 10935 Lynchburg, VA 24506-0935

### (Revised 11/16/2011)

Mr. Ian M. Grant Canadian Nuclear Safety Commission 280 Slater Street, Station B P.O. Box 1046 Ottawa, Ontario K1P 5S9

Mr. Eugene S. Grecheck Vice President Nuclear Support Services Dominion Energy, Inc. 5000 Dominion Blvd. Glen Allen, VA 23060

Mr. Roy Hickok NRC Technical Training Center 5700 Brainerd Road Chattanooga, TN 37411-4017

David Lochbaum Union of Concerned Scientists 1825 K St. NW, Suite 800 Washington, DC 20006-1232

Mr. James Mallon Early Site Permit Manager PSEG Power, LLC 224 Chestnut St. Salem, NJ 08079

Manager GT-MHR Safety & Licensing General Atomics Company PO Box 85608 San Diego, CA 92186-5608

Mr. Edward L. Quinn Longenecker and Associates Utility Operations Division 23292 Pompeii Drive Dana Point, CA 92629 **ESP - PSEG Mailing List** 

Mr. David Repka Winston & Strawn LLP 1700 K. Street, NW Washington, DC 20006-3817

David Robillard Principal Nuclear Engineer PSEG Power, LLC 224 Chestnut Street Salem, NJ 08079

Mr. Tony Robinson AREVA NP, Inc. 3315 Old Forest Road Lynchburg, VA 24501

Ms. Sandra Sloan AREVA NP Inc. 3315 Old Forrest Road P.O. Box 10935 Lynchburg, VA 24506-0935

Mr. Robert E. Sweeney IBEX ESI 4641 Montgomery Avenue Suite 350 Bethesda, MD 20814

Mr. Gary Wright, Director Division of Nuclear Facility Safety Illinois Emergency Management Agency 1035 Outer Park Drive Springfield, IL 62704

### ESP - PSEG Mailing List

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