



ND-2012-0002  
January 10, 2012

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555-0001

Subject: **PSEG Early Site Permit Application**  
**Docket No. 52-043**  
**Response to Request for Additional Information, RAI No. 43, Vibratory**  
**Ground Motion**

- References: 1) PSEG Power, LLC letter to USNRC, Application for Early Site Permit for the PSEG Site, dated May 25, 2010
- 2) RAI No. 43, SRP Section: 02.05.02 – Vibratory Ground Motion, dated December 12, 2011 (eRAI 6162)

The purpose of this letter is to respond to the request for additional information (RAI) identified in Reference 2 above. This RAI addresses Vibratory Ground Motion, as described in Section 2.5.2 of the Site Safety Analysis Report (SSAR), as submitted in Part 2 of the PSEG Site Early Site Permit Application, Revision 0.

Enclosure 1 provides our response for RAI No. 43, Question Nos. 02.05.02-3, 02.05.02-6, 02.05.02-7 and 02.05.02-8. The response to RAI No. 43, Question No. 02.05.02-9 will be provided by January 26, 2012. The response to RAI No. 43, Question Nos. 02.05.02-1, 02.05.02-2 and 02.05.02-4 will be provided by February 10, 2012. The response to RAI No. 43, Question No. 02.05.02-5 will be provided by April 10, 2012.

Enclosure 2 includes the revisions to SSAR Subsection 2.5.2 resulting from our response to RAI No. 43, Question No. 02.05.02-7. Enclosure 3 includes the new regulatory commitments established in this submittal.

If any additional information is needed, please contact David Robillard, PSEG Nuclear Development Licensing Engineer, at (856) 339-7914.

D079  
LRO

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 10th day of January, 2012.

Sincerely,



James Mallon  
Early Site Permit Manager  
Nuclear Development  
PSEG Power, LLC

- Enclosure 1: Response to NRC Request for Additional Information, RAI No. 43, Questions Nos. 02.05.02-3, 02.05.02-6, 02.05.02-7 and 02.05.02-8, SRP Section: 2.5.2 – Vibratory Ground Motion
- Enclosure 2: Proposed Revisions, Part 2 – Site Safety Analysis Report (SSAR), Section 2.5.2 - Vibratory Ground Motion
- Enclosure 3: Summary of Regulatory Commitments

cc: USNRC Project Manager, Division of New Reactor Licensing, PSEG Site (w/enclosures)  
USNRC, Environmental Project Manager, Division of Site and Environmental Reviews (w/enclosures)  
USNRC Region I, Regional Administrator (w/enclosures)

**PSEG Letter ND-2012-0002, dated January 10, 2012**

**ENCLOSURE 1**

**RESPONSE to RAI No. 43**

**QUESTION Nos.**

**02.05.02-3**

**02.05.02-6**

**02.05.02-7**

**02.05.02-8**

**Response to RAI No. 43, Question 02.05.02-3:**

In Reference 2, the NRC staff asked PSEG for information regarding Vibratory Ground Motion, as described in Section 2.5.2 of the Site Safety Analysis Report. The specific request for Question 02.05.02-3 was:

*In Tables 2.5.2.-203 through 2.5.2-208 the applicant listed seismic sources that contribute more than 1% of the total hazard at the PSEG site. It is not clear to the staff if these contributing sources are based on the results of the original EPRI PSHA study or they are based on the results of the applicant's own assessments conducted using the updated ground motion prediction models and the latest PSEG earthquake catalog. In compliance with 10 CFR 100.23 and in conformance to NUREG-0800, Standard Review Plan, Section 2.5.2, "Vibratory Ground Motion," and Regulatory Guide (RG) 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," please discuss whether these sources were selected using the original ground motion prediction equations and the original earthquake catalog or the most recent EPRI 2004 and 2006 ground motion prediction equations and the updated PSEG earthquake catalog. If it is the former, discuss why you concluded that changes in ground motion prediction models and/or the updated catalog would not result in higher hazard contributions from some of the unused seismic sources which will make them viable sources to be used in the site PSHA study.*

**PSEG Response to NRC RAI:**

As described in SSAR Subsection 2.5.2.2.1, all EPRI-SOG seismic sources within 322 km (200 mi.) of the PSEG Site, in addition to the seismic sources characterizing the Charlevoix seismic zone, were included in a seismic hazard screening evaluation to determine whether they contributed to 99% of the seismic hazard at the PSEG Site. If the sources did contribute, they were included in the seismic hazard calculations for the GMRS at the PSEG Site. The screening evaluation conducted as part of the preparation of the ESPA used the original EPRI-SOG (SSAR Reference 2.5.2-35) source characterizations (see SSAR Tables 2.5.2-3 through 2.5.2-8) in conjunction with the EPRI 2004 ground motion equations of McCann et al. (SSAR Reference 2.5.2-39) and the EPRI 2006 updated aleatory uncertainties of Abrahamson and Bommer (SSAR Reference 2.5.2-41).

As stated above, the original EPRI-SOG source characterizations (SSAR Reference 2.5.2-35) were used in the screening study, i.e., the updated seismicity catalog developed for the PSEG Site was not explicitly included in the screening. However, as discussed in SSAR Subsection 2.5.2.4.2.1, a separate sensitivity analysis was conducted to determine if the updated catalog had higher rates of seismicity (than the original EPRI-SOG catalog) that might affect hazard estimates. This sensitivity analysis showed that the updated catalog does not have higher seismicity rates than the original EPRI-SOG catalog. Therefore, incorporating the updated catalog in the screening

evaluation would not result in significantly higher hazard contributions from those zones identified as non-contributing.

**Associated PSEG Site ESP Application Revisions:**

None.

**Response to RAI No. 43, Question 02.05.02-6:**

In Reference 2, the specific request for Question 02.05.02-6 was:

*In regards to eliminating duplicate events in the updated earthquake catalog developed for the PSEG site, the SSAR Subsection 2.5.2.1.2 states "For events that occurred in a short time window in the same area, the largest event was retained." In compliance with 10 CFR 100.23 and in conformance to NUREG-0800, Standard Review Plan, Section 2.5.2, "Vibratory Ground Motion," and Regulatory Guide (RG) 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion, please clarify specifically what the terms "short time window" and "same area" refer to.*

**PSEG Response to NRC RAI:**

In comparing earthquake catalogs, possible duplicates or dependent events were flagged if they occurred within 1 day ("short time window") and within 0.1 degree longitude and 0.1 degree latitude ("same area"). These flagged events were reviewed manually to confirm that they appeared to be duplicates or dependent events, and only the largest earthquake was retained.

**Associated PSEG Site ESP Application Revisions:**

None.

**Response to RAI No. 43, Question 02.05.02-7:**

In Reference 2, the specific request for Question 02.05.02-7 was:

*SSAR Subsection 2.5.2.4.2.1 states that "Seismic hazard generally has an important contribution from earthquakes within 100km (62 mi.) of a site, and the test area captures this distance and also the seismicity to the northeast." However, the test area shown in Figure 2.5.2-2 does not completely cover the 100 km area from the site. In compliance with 10 CFR 100.23 and in conformance to NUREG-0800, Standard Review Plan, Section 2.5.2, "Vibratory Ground Motion," and Regulatory Guide (RG) 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," please clarify the quoted statement above.*

**PSEG Response to NRC RAI:**

As described in SSAR Subsection 2.5.2.4.2.1, the updated seismicity catalog was tested to determine whether there was a significant difference in the seismicity rate compared to the EPRI-SOG catalog. The test area for rate comparison (SSAR Figure 2.5.2-2) was picked for three primary reasons:

1. The test area included the Ramapo seismic zone (see SSAR Subsection 2.5.2.4.2.2 and the response to RAI 42, Question 02.05.01-7) and much of the Sykes et al. (2008) seismicity catalog, ensuring that any post-EPRI-SOG seismicity associated with this zone was taken into consideration;
2. The test area included the portion of the site region that has the most post-EPRI-SOG earthquakes, ensuring a conservative comparison. That is, the test region focused on the region with the most earthquakes in the updated catalog; and
3. The test area included the site.

As indicated by these considerations, the test area was never intended to represent a 100-km radius around the site, but was chosen to make the most critical comparison between original and updated seismicity rates. Conducting the rate comparison over the test area was a more severe test than if a test geometry had been chosen that included regions with no earthquakes in the updated catalog.

**Associated PSEG Site ESP Application Revisions:**

SSAR Subsection 2.5.2.4.2.1 will be updated as described in Enclosure 2 to clarify that the test area was not intended to be a set radius about the site.

**Response to RAI No. 43, Question 02.05.02-8:**

In Reference 2, the specific request for Question 02.05.02-8 was:

*SSAR Figure 2.5.2-11 shows comparisons of recurrence calculations obtained using the original EPRI and the updated PSEG earthquake catalogs in a test zone. The figure shows the results of recurrence calculations between magnitudes 5 and 7. However, in the EPRI 1989 PSHA methodology, the recurrence calculations are conducted using magnitudes 3 and above. In compliance with 10 CFR 100.23 and in conformance to NUREG-0800, Standard Review Plan, Section 2.5.2, "Vibratory Ground Motion," and Regulatory Guide (RG) 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," please confirm that the actual calculations were conducted using the catalog earthquakes with magnitudes 3 and above.*

**PSEG Response to NRC RAI:**

The EPRI and PSEG earthquake catalogs were updated using earthquakes with magnitudes  $m_b \geq 3.0$ . The activity rates for these small magnitudes were then calculated and converted to activity rates for  $m_b \geq 5$  for the purpose of comparison in the SSAR figures.

**Associated PSEG Site ESP Application Revisions:**

None.



**PSEG Letter ND-2012-0002, dated January 10, 2011**

**ENCLOSURE 2**

**Proposed Revisions  
Part 2 – Site Safety Analysis Report (SSAR)**

**Section 2.5.2 – Vibratory Ground Motion**

**Marked Up Page  
2.5-123**

**PSEG Site  
ESP Application  
Part 2, Site Safety Analysis Report**

- Effects caused by an updated earthquake catalog and resulting changes in the characterization of the rate of earthquake occurrence as a function of magnitude for one or more seismic sources
- Identification of possible new seismic sources that might affect the site, and evaluation of the characteristics of those sources

Possible changes to seismic hazard caused by the changes outlined above are the following subsections.

ADD: "(e.g., a fixed 100-km/62 mi. radius around the site)" per Question 02.05.02-7.

**2.5.2.4.2.1 Updated Seismicity Catalog**

A comparison of seismicity rates using the two updated catalogs described in Subsection 2.5.2.1.2 was made to determine if the additional historical data would significantly change estimated seismicity rates in the CEUS, potentially affecting the PSEG Site. For this purpose, a test area (Figure 2.5.2-2) was chosen that includes the PSEG Site and encompasses historical seismicity to the north and east of the site, including historical seismicity around New York City. This is a more critical test than if a broad region surrounding the site were used that included, for example, historical earthquakes in the EPRI catalog west of the site where there are few earthquakes subsequent to 1984. Seismic hazard generally has an important contribution from earthquakes within 100 km (62 mi.) of a site, and the test area captures this distance and also the seismicity to the northeast. The seismicity around New York City is included in the test area because some seismic source interpretations might smooth this seismicity along the coastal plain thus affecting the site.

Seismicity rates were determined for the test area using 3 catalogs of historical seismicity, as follows:

- The original EPRI-SOG seismicity catalog
- The original EPRI-SOG seismicity catalog with the updated catalog from 1985 through March 31, 2009 (described in Subsection 2.5.2.1.2) appended
- The EPRI-Sykes08 seismicity catalog (described above) with the updated catalog from 1985 through March 31, 2009 (described in Subsection 2.5.2.1.2) appended

Seismicity rates were calculated using the EQPARAM program from the EPRI-SOG project, and completeness times for the updated catalog were extended to 2008 (the EQPARAM program only works with whole years). A homogeneous solution for a- and b-values was obtained for the test area, and this was used to calculate the total annual rate of occurrence of earthquakes, with  $m_b > 5, 6, \text{ and } 7$  in the test area, as estimated from the three catalogs listed above.

Figure 2.5.2-11 shows a comparison of these annual rates for the 3 catalogs. The annual rates are very similar, so that it is difficult to distinguish the 3 curves in Figure 2.5.2-11. One of the reasons that the Sykes08 earthquakes do not increase rates of seismicity, even though 12 earthquakes were added as new events (Subsection 2.5.2.1.2), is that many of the Sykes08 events had lower magnitude estimates than their counterparts in the original EPRI catalog. For example, an earthquake that occurred on 3/23/1957 had an estimated RMB of 4.65 in the EPRI catalog, but this was replaced by an earthquake in the Sykes08 catalog with an estimated RMB of 3.60 (Table 2.5.2-2).

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2.5-123

**PSEG Letter ND-2012-0002, dated January 10, 2012**

**ENCLOSURE 3**

**Summary of Regulatory Commitments**

### ENCLOSURE 3

#### SUMMARY OF REGULATORY COMMITMENTS

The following table identifies commitments made in this document. (Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)

COMMITMENT	COMMITTED DATE	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	Programmatic (Yes/No)
PSEG will revise SSAR Subsection 2.5.2 to incorporate the changes in Enclosures 2 in response to NRC RAI No. 43, Question 02.05.02-7.	This revision will be included in a future update of the PSEG ESP application.	Yes	No