August 18, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
EXELON GENERATION COMPANY, LLC.	)	Docket No. 52-007-ESP
	)	
(Early Site Permit for Clinton ESP Site)	)	

NRC STAFF RESPONSE
TO LICENSING BOARD'S ORDER OF AUGUST 2, 2006

On August 2, 2006, the Licensing Board in this proceeding issued an "Order (Addressing: (a) Commission Order dated 7/26/06; (b) requiring briefings in preparation for a public hearing; and (c) establishing a preliminary schedule)." The Order required, among other things, that the NRC Staff "provide, in tabular form, a list of all sections of the FSER wherein the applicable regulatory guidance documents were not expressly followed by the Applicant or the Staff, together with brief explanations of how the Staff addressed those failures and its logic for its elected review process. That information shall be delivered to the Board by August 18, 2006, along with the responses to queries 43, 49, and 50." Order at 3. The Board further required that the Staff deliver to the Board by August 18th four copies of all presentation materials prepared by the Staff for ACRS meetings on the Clinton ESP. Order at 4.

Pursuant to the Board's directions noted above, the documents required by the Board are enclosed.

Respectfully submitted,

Ann P. Hodgdon

Ann P. Hodgdon
Counsel for the NRC Staff

Dated at Rockville, Maryland
this 18th day of August, 2006

Staff Response to Clinton ASLB Order Dated 20060802
Section A. "list of . . . applicable regulatory guidance documents . . . not expressly followed"

SER Section	Regulatory Guidance	Discussion
Section 2.3.1	RG 1.70, Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, Section 2.3.1, Regional Climatology RS-002, Processing Applications for Early Site Permits, Attachment 2, Section 2.3.1, Regional Climatology	The applicant did not identify or evaluate vertical profiles and gust factors associated with the 100-year return period "fastest mile of wind." However, vertical profiles and gust factors are no longer input parameters to the latest versions (e.g., 1998, 2005) of the American Society of Civil Engineers (ASCE) and Structural Engineering Institute (SEI) Standard ASCE/SEI-7, "Minimum Design Loads for Buildings and Other Structures." Neither is the "fastest mile of wind"; it has been replaced by the "3-sec gust," which has been defined as a climatic site characteristic.
Section 2.3.2	RG 1.70, Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, Section 2.3.2, Local Meteorology	Not all of the onsite climatic data summaries specified in RG 1.70 were provided. Examples of onsite data summaries not provided included monthly and annual extremes of absolute humidity, monthly precipitation wind roses, and monthly summaries of atmospheric stability. Some of the specified long-term monthly and annual summaries of off-site data from nearby representative locations were not provided either. Examples of offsite data summaries not provided include monthly averages of temperature, dewpoint temperature, relative humidity, absolute humidity, and mixing height data. Sufficient details describing the mean and extreme meteorological characteristics of the site have been presented and evaluated to meet 10 CFR §100.20(c)(2)and (d) requirements to (1) identify and characterize the meteorological characteristics of the site that are necessary for safety analysis or that may have an impact upon plant design and (2) establish meteorological site characteristics such that potential threats from such characteristics will pose no undue risk to the type of facility to be located at the site.

SER Section	Regulatory Guidance	Discussion
Section 2.3.2	RG 1.70, Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, Section 2.3.2, Local Meteorology RS-002, Processing Applications for Early Site Permits, Attachment 2, Section 2.3.2, Local Meteorology	The applicant did not provide a scaled map showing topography within a 50-mile (80-kilometer) radius of the plant and a plot of maximum elevation versus distance from the center of the plant in each of sixteen 22½ degree compass point sectors radiating from the plant to a distance of 50 miles (80 kilometers). However, the terrain in central Illinois is relatively flat. The applicant did provide a scaled map showing topography within a 5-mile (8-kilometer) radius of the plant and a plot of maximum elevation versus distance from the center of the plant in each of sixteen 22½ degree compass point sectors radiating from the plant to a distance of 5 miles (8 kilometers). This information provides sufficient details to meet 10 CFR § 100.21(c) requirements to evaluate site atmospheric dispersion characteristics and establish atmospheric dispersion parameters to calculate radiological dose consequences of (1) postulated accidents to an individual located at any point on the boundary of the exclusion area and at any point on the outer boundary of the low population zone and (2) routine releases to a hypothetically maximally exposed member of the public. This is because all of these receptors (i.e., exclusion area boundary, low population zone, hypothetically maximal exposed member of the public) are located within 5 miles (8 kilometers) of the ESP site.

SER Section	Regulatory Guidance	Discussion
Section 2.3.3	RG 1.23 (Second Proposed Revision), Meteorological Measurement Program for Nuclear Power Plants	The onsite meteorological monitoring program does not conform to RG 1.23 with regard to (1) accuracy of dewpoint temperature, (2) digital recording of precipitation, and (3) digital accuracies. Wind speed, wind direction, and vertical temperature data collected from the existing CPS meteorological measurement program were used to derive atmospheric dispersion site characteristics for the Clinton ESP site. The staff concluded that the existing CPS meteorological measurements program provided data adequate to meet regulatory requirements to evaluate atmospheric dispersion characteristics and establish atmospheric dispersion parameters pursuant to 10 CFR § 100.21(c) based, in part, on its review of (1) sensor types and performance specifications, data transmission, and recording methods and (2) the 2000–2002 hourly meteorological database using the methodology described in NUREG-0917, "Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data." After examining the 2000–2002 data, the staff concluded that the data were reasonable.

SER Section	Regulatory Guidance	Discussion
Section 2.3.3	RS-002, Processing Applications for Early Site Permits, Attachment 2, Section 2.3.3, Onsite Meteorological Measurements Programs	The climatic representativeness of the onsite 2000–2002 wind speed, wind direction, and atmospheric stability joint frequency distribution was not checked by comparison with nearby stations, which have collected reliable meteorological data over a long period of time (10-20 years), to ensure that the data are reasonable. It is difficult to perform a meaningful comparison of onsite wind and atmospheric stability data to offsite data because the airflow and vertical temperature structure (which is used to derive onsite atmospheric stability data) can vary substantially from one location to another. The nearest offsite data sources with wind data are National Weather Service (NWS) stations at Peoria, IL, and Springfield, IL, both of which are located 50 miles from the Clinton ESP site. Neither of these sites collect the vertical temperature data required to derive atmospheric stability. These NWS stations also collect wind data using instrumentation with different performance specifications and data recording criteria more suitable to monitoring severe weather to support airport operations than monitoring light wind conditions for characterizing conservative atmospheric dispersion conditions. A comparison of the 2000–2002 onsite data with the 1972–1977 onsite data was used to demonstrate how the 2000–2002 data represent long-term conditions at the site. Therefore, the staff determined that comparison with nearby stations was not meaningful.

SER Section	Regulatory Guidance	Discussion
Section 2.5	Regulatory Guide (RG) 1.165	To determine the Safe Shutdown Earthquake (SSE) ground motion spectrum, the applicant used a performance-based approach rather than the guidance provided in Regulatory Guide (RG) 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion." The performance-based approach used by the applicant is described in American Society of Civil Engineers (ASCE) Standard 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities." RG 1.165 provides guidance on a number of different procedures that together satisfy the requirements of 10 CFR § 100.23 for determining the SSE. Specifically, RG 1.165 provides guidance on (1) conducting geological, geophysical, seismological, and geotechnical investigations, (2) identifying and characterizing seismic sources, (3) conducting probabilistic seismic hazard analyses (PSHA), and (4) determining the SSE. The applicant followed the guidance in RG 1.165 for the first three steps, listed above, but used a new approach for the final determination of the SSE (Step 4). A description of the performance-based approach, the applicant's rationale for deviating from RG 1.165, and a derivation of the underlying equations and assumptions is provided in SER Section 2.5.2.1.6. NRC staff evaluation of the performance-based approach, including resolution of staff requests for additional information (RAIs) and open items, is provided in SER Section 2.5.2.3.6.

SER Section	Regulatory Guidance	Discussion
		To review the performance-based approach, NRR staff first informed the applicant that it would need additional time. Next, staff formed a Seismic Issues Task Advisory Group (SITAG) to solicit the opinions and recommendations of other Geophysicists and Civil Engineers in the Office of Research and Office of Nuclear Material Safety and Safeguards (SITAG Charter). NRR also contracted with the U.S. Geological Survey for additional review of ASCE 43-05. Together with SITAG, NRR staff submitted a number of RAIs, evaluated the applicant's RAI responses, developed open items, evaluated the applicant's open item responses, and then reached a final conclusion regarding the adequacy of the performance-based approach. The staff's review of the performance-based approach focused primarily on the adequacy of the performance target , the modeling and parameter assumptions, and the final SSE ground motion spectrum.

SER Section	Regulatory Guidance	Discussion
		ASCE 43-05 provides seismic design criteria in order to ensure that nuclear facilities can withstand the effects of earthquakes with a desired performance level, expressed as a target performance goal. ASCE 43-05, for the most stringent seismic design basis category, recommends using a target performance goal of $1x10^{-5}$/yr for the minimum structural damage state, which is described as essentially elastic behavior. Specifically, essentially elastic behavior means that localized inelasticity might occur at stress concentrations, but the overall seismic response will be essentially in the elastic range. NRC staff verified that the target performance goal of 1×10^{-5}/yr for the minimum damage state was adequate by comparing this value to the seismic core damage frequency (SCDF) values determined through seismic probabilistic risk assessments of 25 nuclear power plants as per NUREG-1742, "Perspective Gained From the Individual Plant Examination of External Events (IPEEE) Program." The median SCDF value for the 25 nuclear power plants in NUREG-1742 is $1x10^{-5}$/yr, which is the same as the target value used for the performance-based approach. The staff concluded that equating the target performance goal with the median SCDF value for the 25 plants is conservative, because seismic core damage represents a higher damage state (i.e., actual failure of structures and components), while the minimum damage state specified by ASCE 43-05 implies that structures and components remain essentially elastic in their performance.

SER Section	Regulatory Guidance	Discussion
		The staff also reviewed the underlying equations as well as the parameter and modeling assumptions used to develop the performance-based approach. The performance-based approach is derived from the risk integral (SER Equation 2.5.2-9), which combines the mean site seismic hazard curves and seismic structural fragility curves. To ensure the adequacy of the final equations used to determine the SSE ground motion, the staff requested the site seismic hazard curves from the applicant. Using the site seismic hazard curves, the staff performed direct numerical convolution of the risk integral to ensure that the simplifying assumptions used to develop the final performance-based equations provide SSE values that are the same as those from direct convolution of the risk integral. Using the performance-based SSE values, the staff then calculated SCDF values for comparison with those presented in NUREG-1742. The staff used a range of structural fragility parameter values and assumed that the seismic margin against core damage is 1.67, as specified for new standard plant designs (see SRM dated July 21, 1993, on SECY 93-087). SCDF values for the Clinton performance-based SSE values are close to 1x10-6/yr, which is about 10 times lower than the median SCDF value for the 25 nuclear power plants in NUREG-1742. Based on its evaluation, NRC staff concluded that the approach described in ASCE Standard 43-05 for the most stringent seismic design basis category provides acceptable seismic design spectra. In accordance with this decision, the NRC staff is currently preparing a new regulatory guide that will describe in detail its recommendations for implementation of the performance-based approach, as described in ASCE 43-05.

SER Section	Regulatory Guidance	Discussion
Chapter 11	Standard Review Plans: 11.3, Gaseous Waste Management Systems 11.4, Solid Waste Management Systems 11.5, Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems	The applicant did not provide detailed information on plant systems, components, piping, and the location of the effluent discharge points. However, this is acceptable because the applicant used the Plant Parameter Envelope method, which is acceptable to the NRC. The applicant provided sufficient information on the systems to allow the staff to compare the resultant generic system description and maximum calculated dose to members of the public from the routine radiological gaseous and liquid effluent discharges to the NRC dose acceptance criteria in the SRPs.
Chapter 15	The regulations at 10 CFR § 52.17(a)(1) require that ESP applications contain an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under radiological consequence evaluation factors identified in 10 CFR § 50.34(a)(1).	The applicant did not provide, and the staff did not evaluate, an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under radiological consequence evaluation factors identified in 10 CFR § 50.34(a)(1). Instead, as discussed in Section 15, "Accident analysis," of the Clinton ESP Safety Evaluation Report (NUREG-1844), the applicant developed a set of reactor design basis accident source term parameters, in conjunction with site characteristics for accident analysis purposes, to assess the suitability of the proposed ESP site. These source term parameters collectively constitute a plant parameter envelope (PPE). As discussed in Review Standard (RS)-002, the staff considers the PPE approach to be an acceptable method for assessing site suitability. Therefore, a PPE is a set of plant design parameters that are expected to bound the characteristics of a reactor or reactors that may be constructed at a site, and it serves as a surrogate for actual reactor design information. The PPE values and associated information in the Clinton ESP application provided sufficient information for the staff to make a determination regarding the acceptability of the proposed Clinton ESP site using the radiological consequence evaluation factors identified in 10 CFR § 50.34(a)(1).

SER Section	Regulatory Guidance	Discussion
Chapter 15	RS-002 calls for the staff to perform a confirmatory radiological consequence calculation using the radiological consequence evaluation factors identified in 10 CFR § 50.34(a)(1).	As discussed in Section 15.3.4, "Source Terms and Radiological Consequence Evaluation," of NUREG-1844, the staff did not consider an independent confirmatory radiological consequence calculation to be useful or necessary because the applicant simply used the ratios of the site-specific atmospheric dispersion factors (χ/Q values) to the postulated design χ/Q values and the radiological consequence doses from the certified designs. Therefore, the staff did not perform an independent confirmatory radiological consequence calculation.
Chapter 17	Inspection procedure 35002, "Early Site Permit Pre-Docketing Quality Assurance Controls Meetings," prescribes to the staff applicability of 10 CFR Part 21 reporting requirements to contracts for ESP activities.	Exelon did not initially impose Part 21 on its suppliers that participated in the ESP. However, once OGC concurred with the staff position that implementation of Part 21 was required for an ESP, Exelon did decide to meet Part 21. This was accomplished by requiring suppliers to submit corrective action and nonconformance documents for Exelon's review for any potential Part 21 issues. The staff considers this to be an acceptable method for meeting Part 21 requirements.

Staff Response to Clinton ASLB Order Dated 20060802
Section A. "filing of responses to queries 43, 49, and 50" of Board's July 20, 2006, Order

Q#	Page	Section	INQUIRY
43	2-216	2.5.2.1.5	Vibratory Ground Motions - Site Response Analysis. How were the "pairings" of the 60 randomized velocity profiles with the 60 sets of randomized shear modulus and damping curves performed? Describe the facts and logic underlying the staff's evaluation of those pairings. What is the mathematical foundation for the use of an arithmetic mean of 60 individual response spectral ratios, what facts underlie the evaluation, and what was the staff's logic in assessment of that approach?

Response

For the seismic site response analysis, the seismic shear wave velocity profile and shear modulus and damping curves are the primary input variables. To model the uncertainty as well as the variability across the site in the dynamic properties of the soil, the applicant developed 60 randomized shear wave velocity profiles and 60 sets of randomized shear modulus and damping curves based on estimates of the variability in the velocity, shear modulus, and damping. Rather than evaluate each possible combination of the 60 velocity profiles with the 60 shear modulus and damping curves, the applicant used the Monte Carlo sampling method. Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. Inputs (velocity profile and shear modulus and damping curves) are randomly generated to simulate the process of sampling from the entire population of possible combinations. A total of 60 randomly selected combinations is enough to generate close estimates of the mean and plus/minus one sigma site response. This result is based on work done to support NUREG/CR-6728, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard and Risk-consistent Ground Motion Spectra Guidelines."

The staff evaluated the randomized velocity profiles and shear modulus and damping curves. The staff also evaluated the mean site response for each of the deaggregation earthquakes at the 10^{-4} and 10^{-5} probability levels. The staff concluded that the applicant's use of three different deaggregation earthquakes for both the 10^{-4} and 10^{-5} probability levels - combined with using 30 time histories for each deaggregation earthquake, 60 shear wave velocity profiles, 60 sets of shear modulus and damping curves along with the Monte Carlo sampling method to combine each of these input variables - resulted in an adequate representation of the site response to earthquake ground motion. In addition, the staff concluded that the applicant also accurately determined the variability in the site response to input ground motion.

Q#	Page	Section	INQUIRY
49	2-256	2.5.2.3.5	The staff notes that it found large variability in soil strength and stiffness, and noted that the applicant used a randomized process to make its computations but, because the upper 60 ft will be replaced during construction with fill material, used a single site velocity model. Was the velocity used by applicant for this region representative of the compacted fill material or was it based upon the results of the randomization? Explain the facts and logic of the staff's acceptance of this part of the applicant's computation.
			Response The applicant's shear wave velocity profile represents the actual site conditions (soil properties) and not those of future fill material. The shear wave velocity profile used by the applicant to determine the site response to input earthquake ground motion is from geophysical and geotechnical field work performed by the applicant prior to submittal of the ESP application. The applicant used a single base case model to represent the median shear wave velocity profile and then estimated the variability in the shear wave velocity across the site. The staff noted in RAI 2.5.4-4 that the results of the geotechnical field measurements showed that there was a large range of values in the shear wave velocities for the uppermost soil layers. In response to the staff's RAI, the applicant stated that its development of 60 different shear wave velocity profiles based on its estimate of the variability in the shear wave velocity profile adequately modeled the velocity variability across the site. At the time, staff did not believe the information provided by the applicant adequately characterized the variability demonstrated by the actual field geotechnical measurements and, therefore, the staff issued Open Item 2.5.2-2. The applicant responded to the staff's open item by stating that the soils in the upper 60 ft of the site will be removed during plant construction and replaced by engineering fill. Since the fill material will be placed under consistent compaction and gradation controls, the variability in shear wave velocity of the engineered fill will be significantly lower than that of the in situ soils. Staff accepted this response and closed Open Item 2.5.2-2.

Q#	Page	Section	INQUIRY
			Response (cont'd) Even though the uppermost soil layers will be replaced by compacted fill material, ESP applicants are required to determine the Safe Shutdown Earthquake (SSE) ground motion using the actual site conditions and not anticipated future conditions. Therefore, staff clarifies that it accepted the applicant's response to RAI 2.5.4-4 based on a comparison of the randomized shear wave velocity profiles, shown in FSAR Figures 4.2-11 and 4.2-12 in Appendix B, with the actual shear wave velocity measurements, shown in FSAR Table 5-2 in Appendix A. A comparison by the staff of these 60 shear wave velocity profiles and the table of shear wave velocity results showed that the applicant's randomization process adequately encompassed the range of field measurements.
50	2-257	2.5.2.3.5	The staff refers to the applicant's description of computation of a range of modulus and damping curves through "a randomization process." Provide a brief description of the "randomization" process and a concise description of the facts and logic underlying the staff conclusions regarding that process.
			Response See response to Question #43.

Staff Response to Clinton ASLB Order Dated 20060802
Section A. Copies of ACRS Presentation Materials

Date	ACRS Committee	Topic
September 7, 2005	ACRS - Early Site Permit Subcommittee Meeting	Geology, seismology, and geotechnical review
September 7, 2005	ACRS - Early Site Permit Subcommittee Meeting	Exelon ESP application and status of staff's safety review
September 8, 2005	ACRS - Full Committee 525th Meeting	Exelon ESP application and status of staff's safety review; overview of remaining open items
March 8, 2006	ACRS - Early Site Permit Subcommittee Meeting	Exelon ESP application seismic review
March 9, 2006	ACRS - Full Committee 530th Meeting	Exelon ESP application safety review

Exelon Early Site Permit Safety Review Status

March 9, 2006

Advisory Committee on Reactor Safeguards Full Committee Meeting

John Segala, Senior Project Manager
Office of Nuclear Reactor Regulation

Purpose

- To provide the ACRS an overview of the Exelon early site permit (ESP) application safety review
- Answer the ACRS's questions

Meeting Agenda

- Project Milestones
- Exelon ESP Safety Review
- Key Review Areas
- Open Items
- Permit Conditions/COL Action Items
- FSER Conclusions
- Seismic Review
- Questions or Comments

Completed Milestones

- Received Exelon ESP application - September 25, 2003
- FRN published announcing acceptance – October 31, 2003
- FRN published for mandatory hearing – December 12, 2003
- RAIs issued to the Applicant – July, 27, 2004
- Draft SER issued – February 10, 2005
- Applicant responds to Draft SER open items – April 26, 2005
- Supplemental Draft SER issued – August 26, 2005
- ACRS Full Committee Meeting - September 8, 2005
- ACRS interim letter – September 22, 2005
- Staff provided Final SER to ACRS – February 9, 2006
- **Staff issued Final SER – February 17, 2006**
- ACRS Subcommittee Meeting – March 8, 2006

Remaining Milestones

- ACRS letter assumed – March 30, 2006
- Staff issue Final SER as NUREG – May 1, 2006
- Mandatory hearings begin Fall 2006
- Commission decision assumed mid 2007

Exelon ESP Safety Review

- Final SER documents the staff's technical review of the applicant's site safety analysis report and emergency planning information
- Exelon requests ESP site be approved for total core thermal power rating between 2400 and 6800 MWt
- Exelon has chosen not to submit specific design but instead has submitted a plant parameter envelope (PPE) based on a number of current and future reactor designs

Key Review Areas

- Exclusion Area Authority and Control
- Nearby Industrial, Transportation, and Military Facilities
- Meteorology
- Hydrology
- Seismology and Geology
- Radiological Effluents
- Thermal Discharges
- Radiological Consequences of Accidents
- Physical Security
- Aircraft Hazards
- Emergency Planning
- Quality Assurance

Principal Contributors

Brad Harvey - Meteorology

Goutam Bagchi – Hydrology

- Contract support from PNNL

Kazimieras Campe - Site Hazards

- Contract support from PNNL

Clifford Munson and Tom Cheng – Geology, Seismology, and Geotechnical

- Support from U.S. Geologic Survey and BNL

Jay Lee – Demography, Geography, and Radiological Consequence Analysis

Robert Moody - Emergency Planning

- Consultation with FEMA

Paul Prescott - Quality Assurance

Al Tardiff - Physical Security

Open Items

Review Area	Open Items
Exclusion Area Authority and Control	1
Meteorology	3
Hydrology	21
Seismology and Geology	7
Radiological Consequences of Accidents	1
Emergency Planning	6
Quality Assurance	1
Total:	40

Proposed Permit Conditions and COL Action Items

- There are 6 proposed Permit Conditions (15 in the Draft SER)

- There are 32 proposed COL Action Items (17 in the Draft SER)

FSER Conclusions

Overall:

- Site safety and emergency planning is acceptable and meets the regulations

Seismology and Geology:

- Site is acceptable from a geologic and seismologic standpoint and meets the requirements of 10 CFR 100.23

NRC Experience with the Performance-Based Methodology

- Use of a performance-based approach for determining the SSE first identified in Exelon's application in September 2003
- NRC formed a Seismic Technical Advisory Group
  - Seismic & Civil Engineers from NRR, NMSS, and RES
  - Served in an advisory role to NRR for review of performance-based approach

Exelon's Performance-Based (PB) Safe Shutdown Earthquake (SSE)

NRC staff concluded:

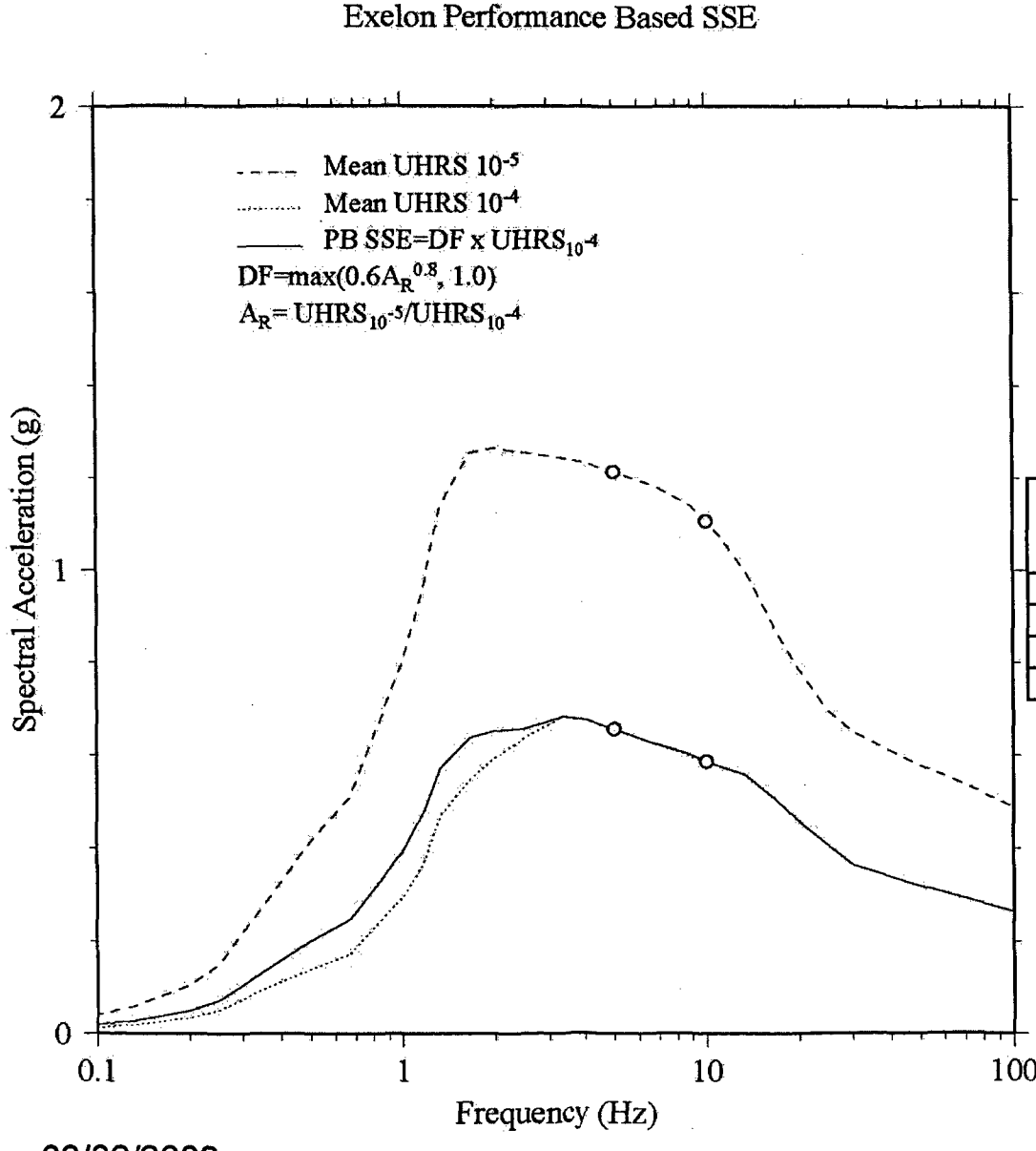
1. PB method based on sound technical approach
2. Seismic design using PB SSE achieves safety level generally higher than operating plants
3. PB SSE adequately reflects local ground motion hazard

Conclusion 1

PB method based on sound technical approach

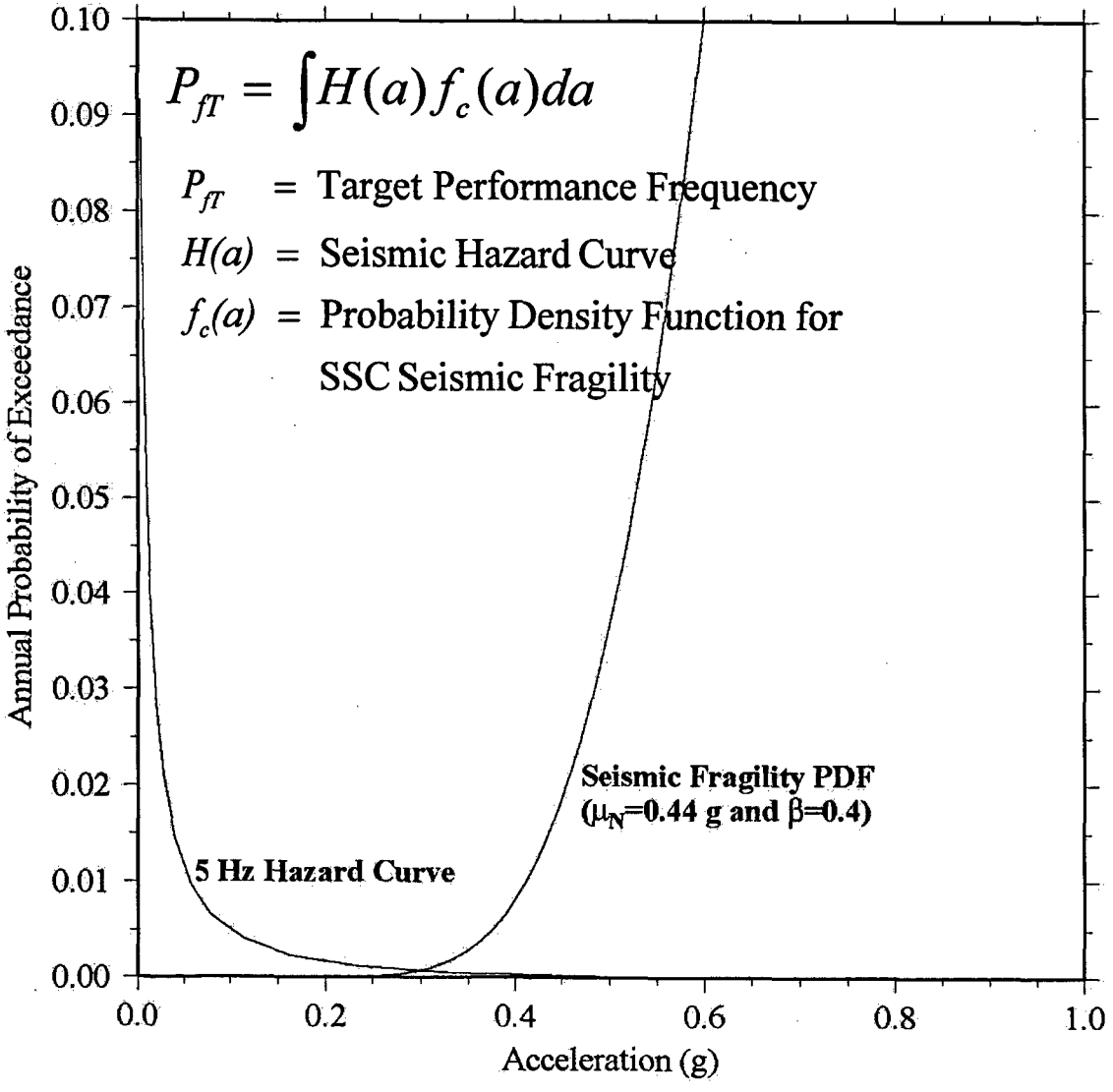
- PB approach is risk-based
- PB approach requires structures be designed to achieve target performance goal
- PB SSE determined by two approaches:
  - Design Factor Method (ASCE 43-05)
  - Direct Integration of Risk Equation

Conclusion 1 (Cont.)



Spectral Frequency (Hz)	10-4 Mean UHRS (g)	10-5 Mean UHRS (g)	AR	DF	Horiz. SSE (g)
1	0.297	0.802	2.700	1.328	0.395
2.5	0.638	1.256	1.968	1.031	0.658
5	0.657	1.215	1.849	1.000	0.657
10	0.586	1.107	1.887	1.000	0.586

Conclusion 1 (Cont.)

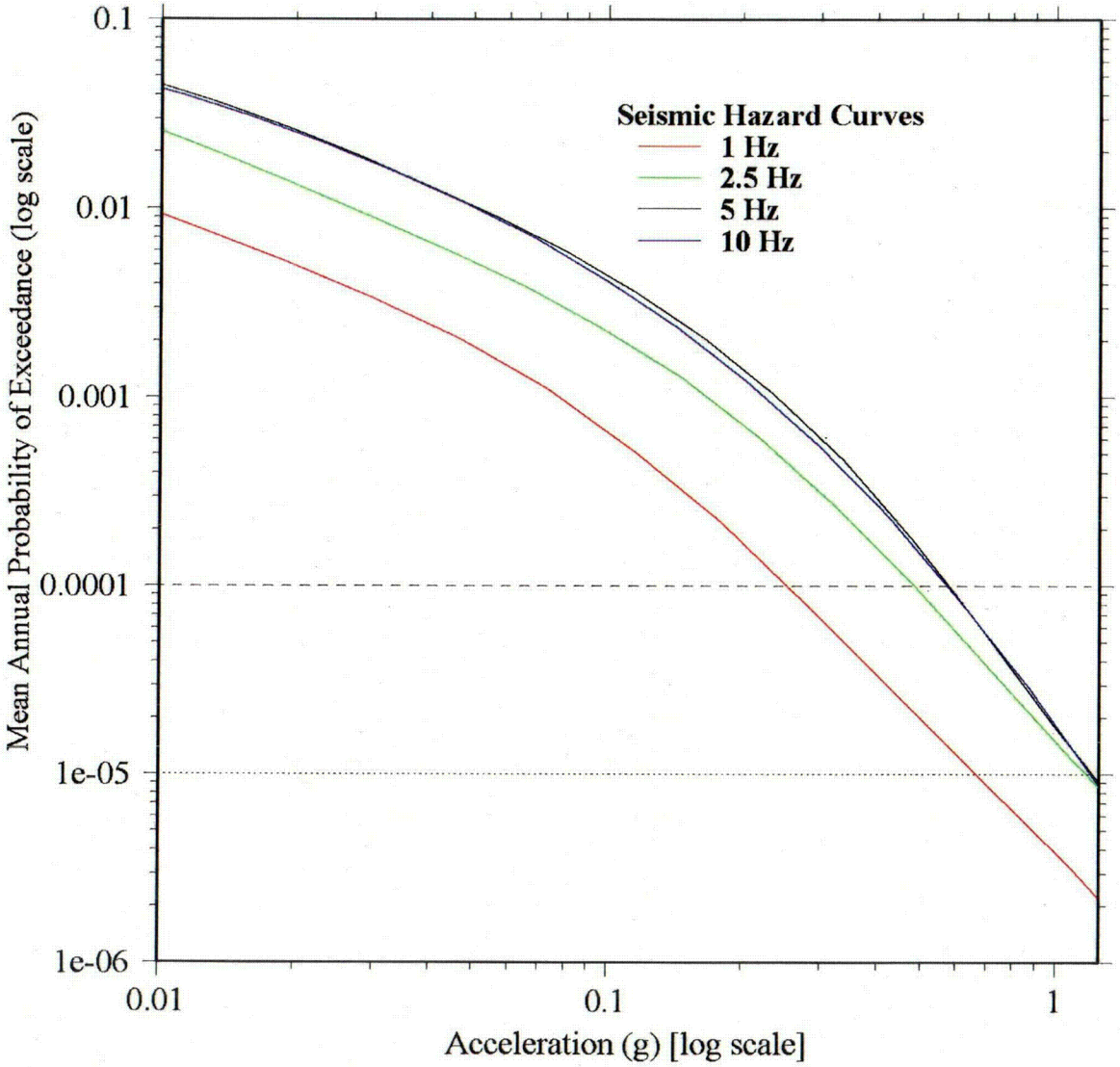


Conclusion 1 (Cont.)

Parameter/Model Assumptions:

- Performance Target (P_{FT}) is $1x10^{-5}$ per year
  - P_{FT} corresponds to most stringent seismic design class
- ASCE 43-05 assumes a linear hazard curve between 10^{-4} and 10^{-5}
- SSC seismic fragility modeled using lognormal distribution
  - $\beta = 0.4$
  - Seismic Margin = 1

Conclusion 1 (Cont.)



Conclusion 1 (Cont.)

Summary of Conclusion 1:

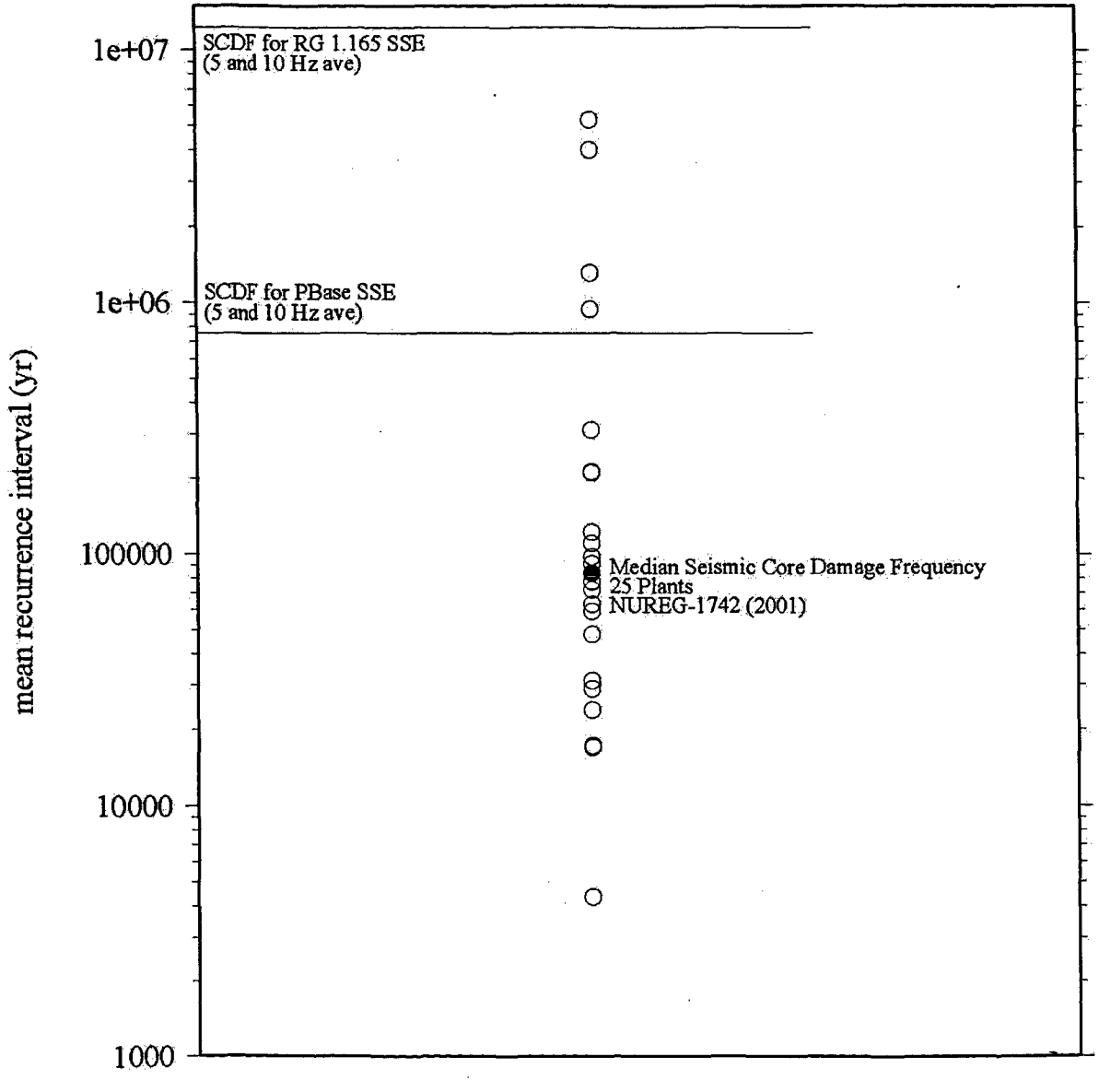
- PB Approach
  - Achieves both high and consistent level of seismic safety
  - No credit for seismic margin
  - Conservative performance target
  - Based on conservative parameter and modeling assumptions

Conclusion 2

PB SSE achieves safety level generally higher than operating NPPs

- Using Clinton PB SSE values and HCLPF seismic margin of 1.67 (SECY 93-087)
  - What are SCDF values?
  - How do Clinton PB SCDF values compare to current NPPs?

Conclusion 2 (Cont.)

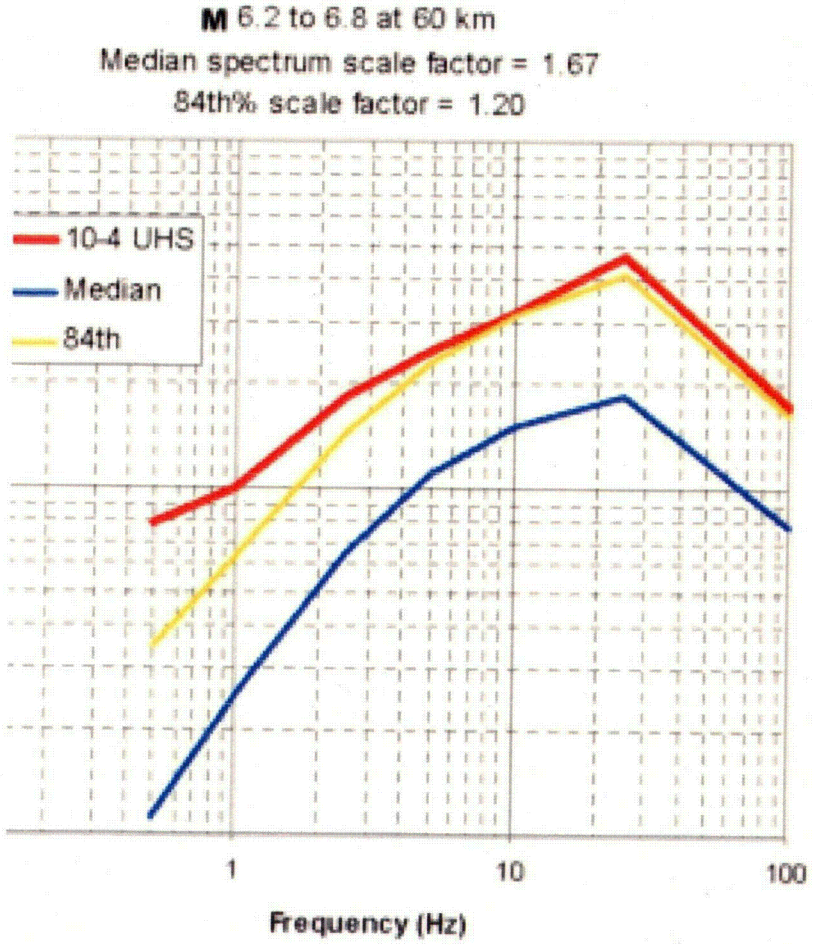


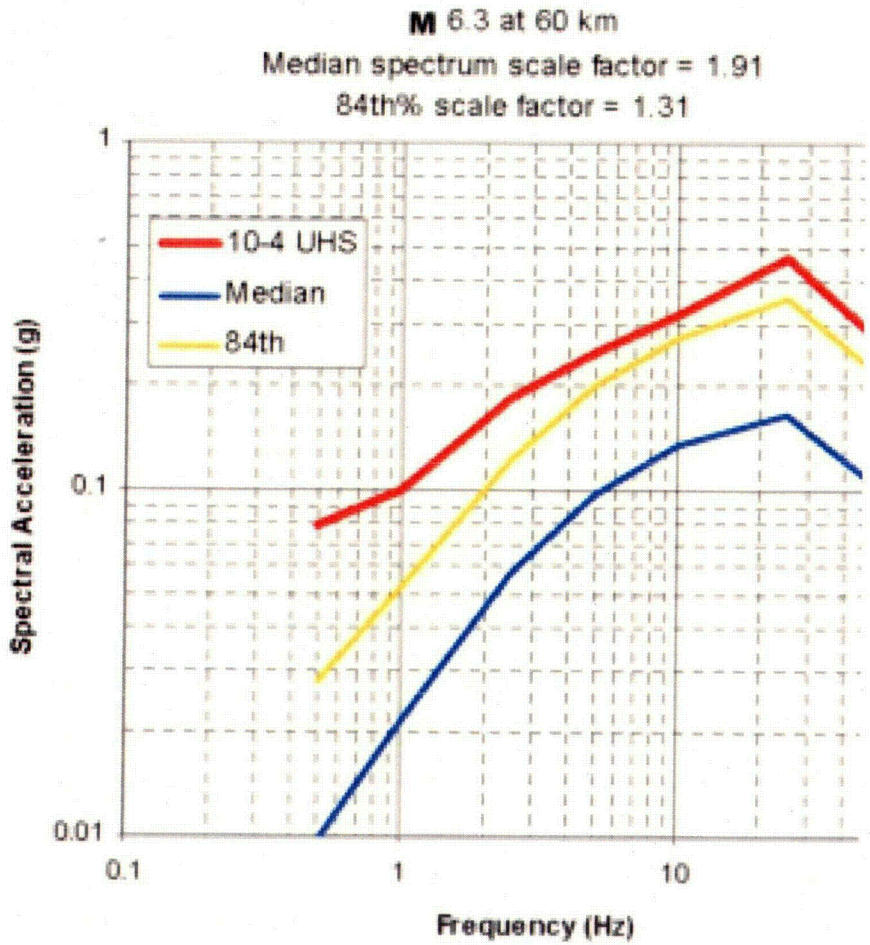
Conclusion 3

PB SSE adequately reflects local ground motion hazard

- Greatest local seismic hazard for central Illinois from Springfield earthquake
  - Prehistoric earthquake (5900 to 7400 years ago)
  - Near Springfield (60 km SW of ESP site)
  - Magnitude estimates (6.2 to 6.8)

Conclusion 3 (Cont.)





Summary

- All open items resolved
- Looking forward to receiving the interim ACRS letter
- Questions or comments?

Exelon Early Site Permit
Seismic Review Status

March 8, 2006

Advisory Committee on Reactor Safeguards
Early Site Permit Subcommittee Meeting

John Segala, Senior Project Manager
Office of Nuclear Reactor Regulation

Purpose

- To provide the ACRS an overview of the Exelon early site permit (ESP) application seismic review
- Answer the Subcommittee's questions

Meeting Agenda

- Schedule Milestones
- Seismic Open Items
- Presentation Conclusions
- Discussion / Subcommittee questions

Completed Milestones

- Received Exelon ESP application - September 25, 2003
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- ACRS Full Committee Meeting - September 8, 2005
- ACRS interim letter – September 22, 2005
- Staff provided Final SER to ACRS – February 9, 2006
- **Staff issued Final SER – February 17, 2006**

Remaining Milestones

- ACRS Full Committee Meeting – March 9, 2006
- ACRS letter assumed – March 30, 2006
- Final SER issued as NUREG – May 1, 2006
- Mandatory hearings begin Fall 2006
- Commission decision assumed mid 2007

Seismic Open Items

- 7 Seismology and Geology Open Items
  - 2 - Performance-based (PB) approach for determining safe shutdown earthquake (SSE)
  - 2 – Seismic
  - 3 - Geotechnical

Seismic Open Items

- 2.5.1-1, Incorporate most recent New Madrid seismic source model into the PSHA and SSE

- 2.5.2-1, Clarify the EPRI ground motion attenuation study distance-conversion method

Geotechnical Open Items

- 2.5.2-2, Site response model does not adequately represent variability of soil properties
- 2.5.2-3, Site response analysis should use appropriate shear modulus and damping curves
- 2.5.4-1, Further soil exploration needed for COL

NRC Experience with the Performance-Based Methodology

- NUREG/CR-6728 (April 2002) first introduced the staff to the performance-based approach
- NRC staff participated on the Committee that developed ASCE 43-05
- Use of a performance-based approach for determining the SSE first identified in Exelon's application in September 2003
- NRC formed a Seismic Technical Advisory Group
  - Seismic & Civil Engineers from NRR, NMSS, and RES
  - Served in an advisory role to NRR for review of performance-based approach

Exelon's Performance-Based (PB) Safe Shutdown Earthquake (SSE)

NRC staff concluded:

1. PB method based on sound technical approach
2. Seismic design using PB SSE achieves safety level generally higher than operating plants
3. PB SSE adequately reflects local ground motion hazard from Springfield earthquake

Conclusion 1

PB method based on sound technical approach

- Overriding Goal: Achieve both high and consistent level of seismic safety in the design of future NPPs
- PB approach is risk-based
  - Incorporates both site specific seismic hazard and structural fragility model
- PB approach requires structures be designed to achieve target performance goal

Conclusion 1 (Cont.)

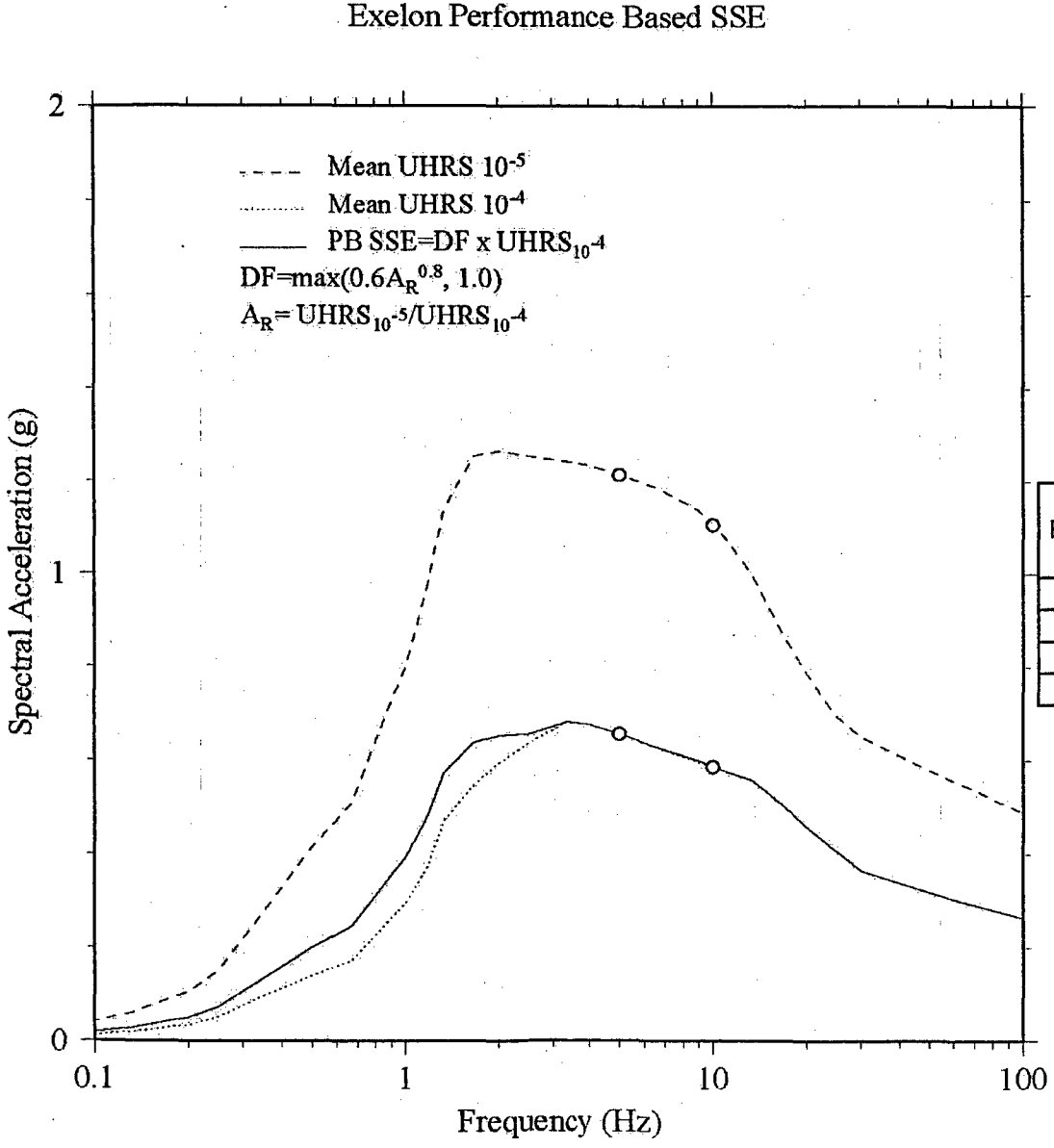
- PB SSE determined by two approaches:
  - Design Factor Method (ASCE 43-05)
  - Direct Integration of Risk Equation
- Design Factor Method
  - PB SSE determined by multiplying 10^{-4} UHRS by design factor to achieve target performance goal

$$PB\ SSE = DF \times UHRS_{10^{-4}}$$

$$DF = \mathrm{Max}\,(0.6 A_R{}^{0.8}, 1.0)$$

$$A_R = \frac{UHRS_{10^{-5}}}{UHRS_{10^{-4}}}$$

Conclusion 1 (Cont.)



Spectral Frequency (Hz)	10-4 Mean UHRS (g)	10-5 Mean UHRS (g)	AR	DF	Horiz. SSE (g)
1	0.297	0.802	2.700	1.328	0.395
2.5	0.638	1.256	1.968	1.031	0.658
5	0.657	1.215	1.849	1.000	0.657
10	0.586	1.107	1.887	1.000	0.586

Conclusion 1 (Cont.)

- Direct Integration

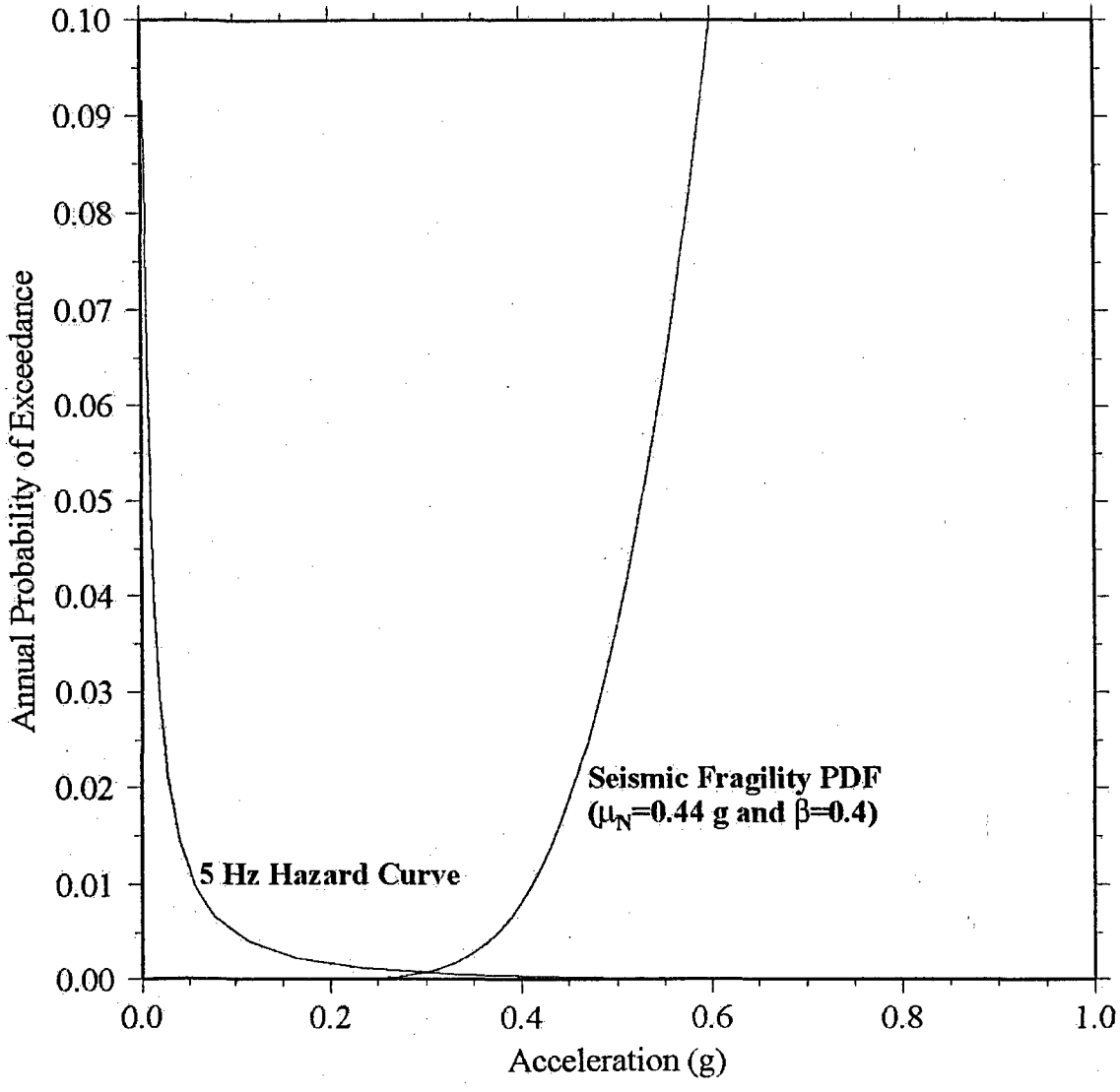
$$P_{fT} = \int H(a) f_c(a) da$$

P_{fT} = Target Performance Frequency

$H(a)$ = Seismic Hazard Curve

$f_c(a)$ = Probability Density Function for SSC Seismic Fragility

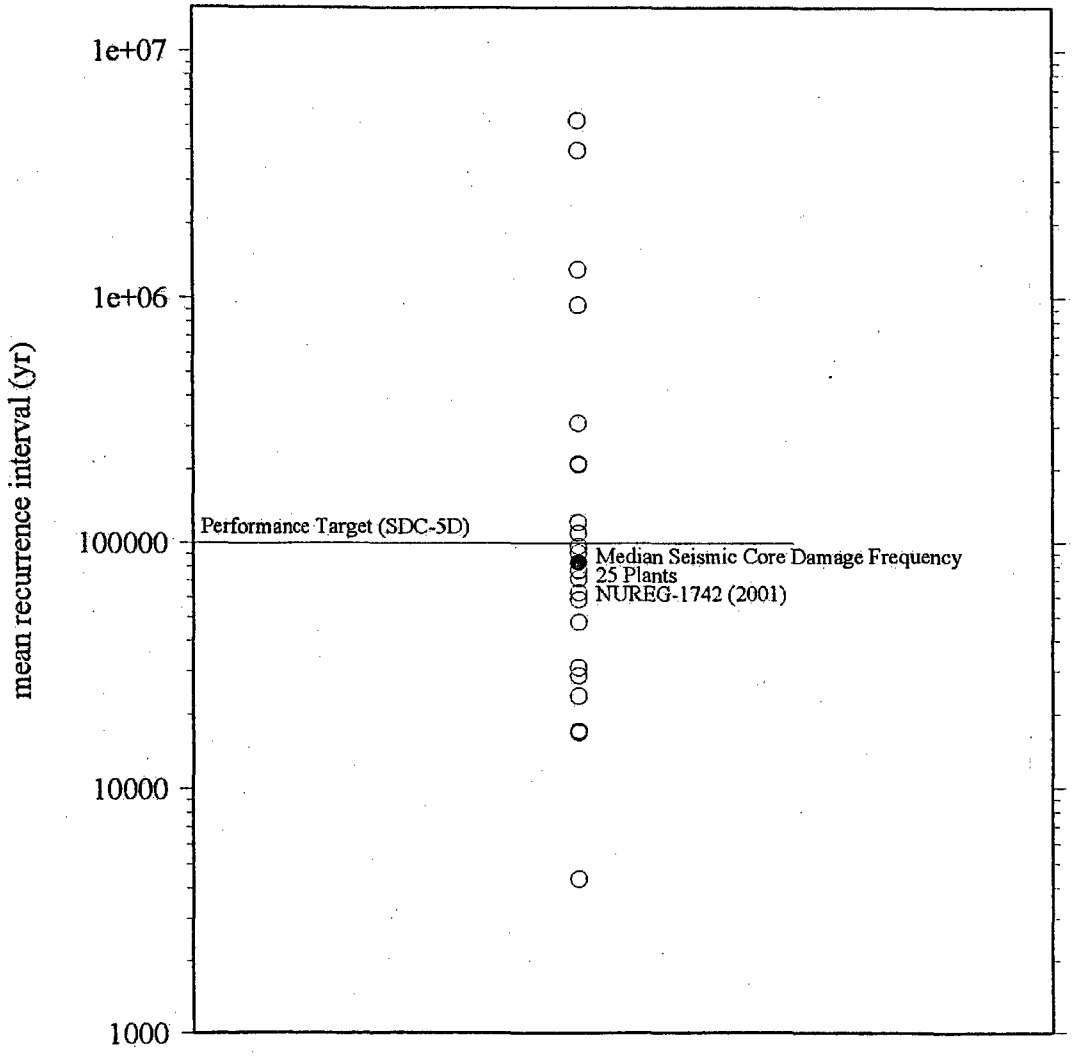
Conclusion 1 (Cont.)



Conclusion 1 (Cont.)

- Performance Target (P_{FT}) is $1x10^{-5}$ per year
  - Implies probability of onset of inelastic behavior shall be less than 10^{-5}/yr
- Basis for P_{FT} 10^{-5}/yr:
  - IPEEE Seismic PRAs conducted for 25 NPPs during mid/late 1990s determined annual seismic CDF values
  - Median SCDF is 1.2x10-5/yr
- P_{FT} corresponds to minimum damage state
- SCDF implies a higher damage state

Conclusion 1 (Cont.)

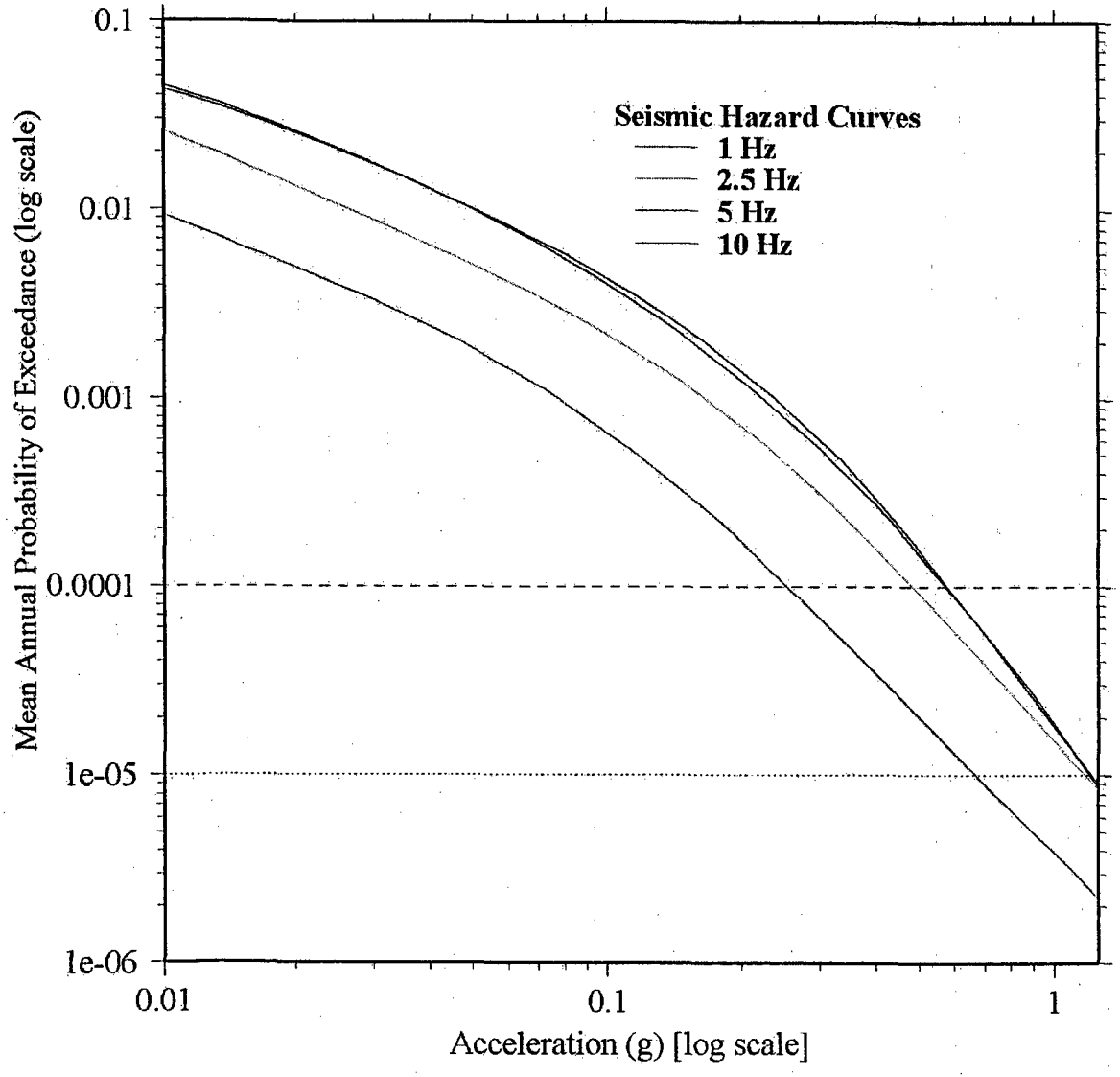


Conclusion 1 (Cont.)

- Seismic Hazard Curve
  - ASCE 43-05 assumes a linear hazard curve between 10^{-4} and 10^{-5}
  - Slight downward curvature of hazard curve

	SSE	
Frequency (Hz)	Risk Integral (g)	Risk Equation (g)
1	0.337	0.395
2.5	0.574	0.658
5	0.604	0.657
10	0.559	0.586

Conclusion 1 (Cont.)



Conclusion 1 (Cont.)

- Seismic Fragility
  - PB approach models SSC seismic fragility using lognormal distribution

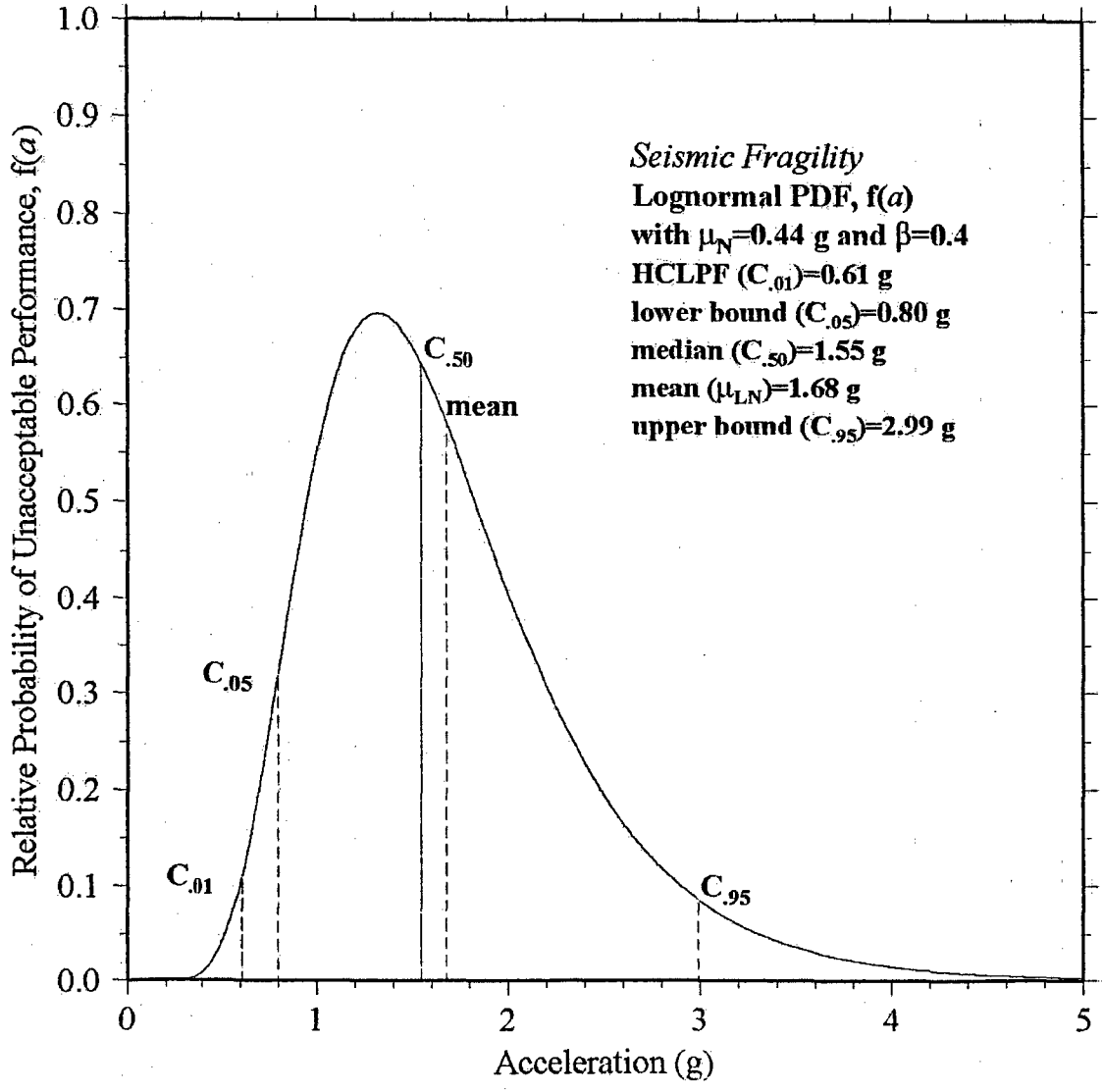
$$f_c(a) = \frac{1}{\sqrt{2\pi}\beta a} \exp\left[-\frac{1}{2}\left(\frac{\ln a - \mu}{\beta} \right)^2 \right], a > 0$$

  - Fragility Parameters: Mean (μ), SD (β)
    - Mean expressed in terms of $C_{1\%}$ or HCLPF
    - HCLPF corresponds to 1% capacity level on mean fragility curve

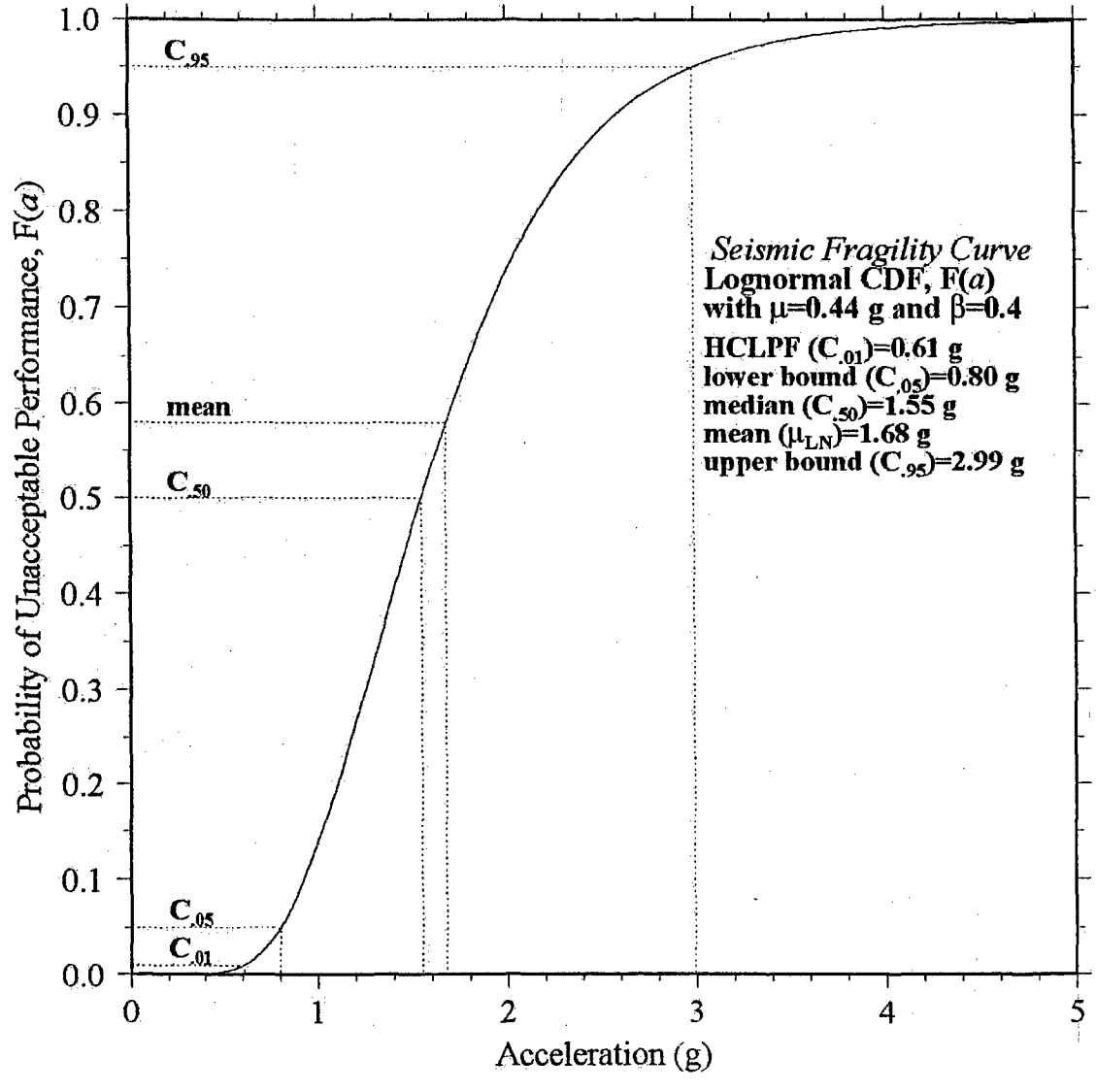
$$\mu = \ln HCLPF + 2.32\beta$$

$$HCLPF = SSE \times M_s$$

Conclusion 1 (Cont.)



Conclusion 1 (Cont.)



Conclusion 1 (Cont.)

- Parameter Assumptions
  - SSE is back-calculated by assuming:
    - Target P_{FT} = $1x10^{-5}$/yr
    - Linear Hazard Curve
    - β = 0.4
    - Seismic Margin = 1

Conclusion 1 (Cont.)

Target Performance Frequency for $\beta = 0.4$

		PFT*10-5/yr			
Freq (Hz)	SSE (g)	β=0.3	β=0.4	β=0.5	β=0.6
1	0.395	1.08	0.95	0.7	0.55
2.5	0.658	1.05	0.97	0.73	0.59
5	0.657	1.03	0.96	0.71	0.58
10	0.586	1.02	0.91	0.65	0.52

Conclusion 1 (Cont.)

- Seismic Margin (M_s)
  - SECY 93-087 requires an overall HCLPF Seismic Margin of 1.67
  - ASCE 43-05 does not take credit for Seismic Margin ($M_s = 1$)
    - Higher M_s results in lower SSE

$$SSE = \frac{1}{M_s}(\ldots)$$

Conclusion 1 (Cont.)

Summary of Conclusion 1:

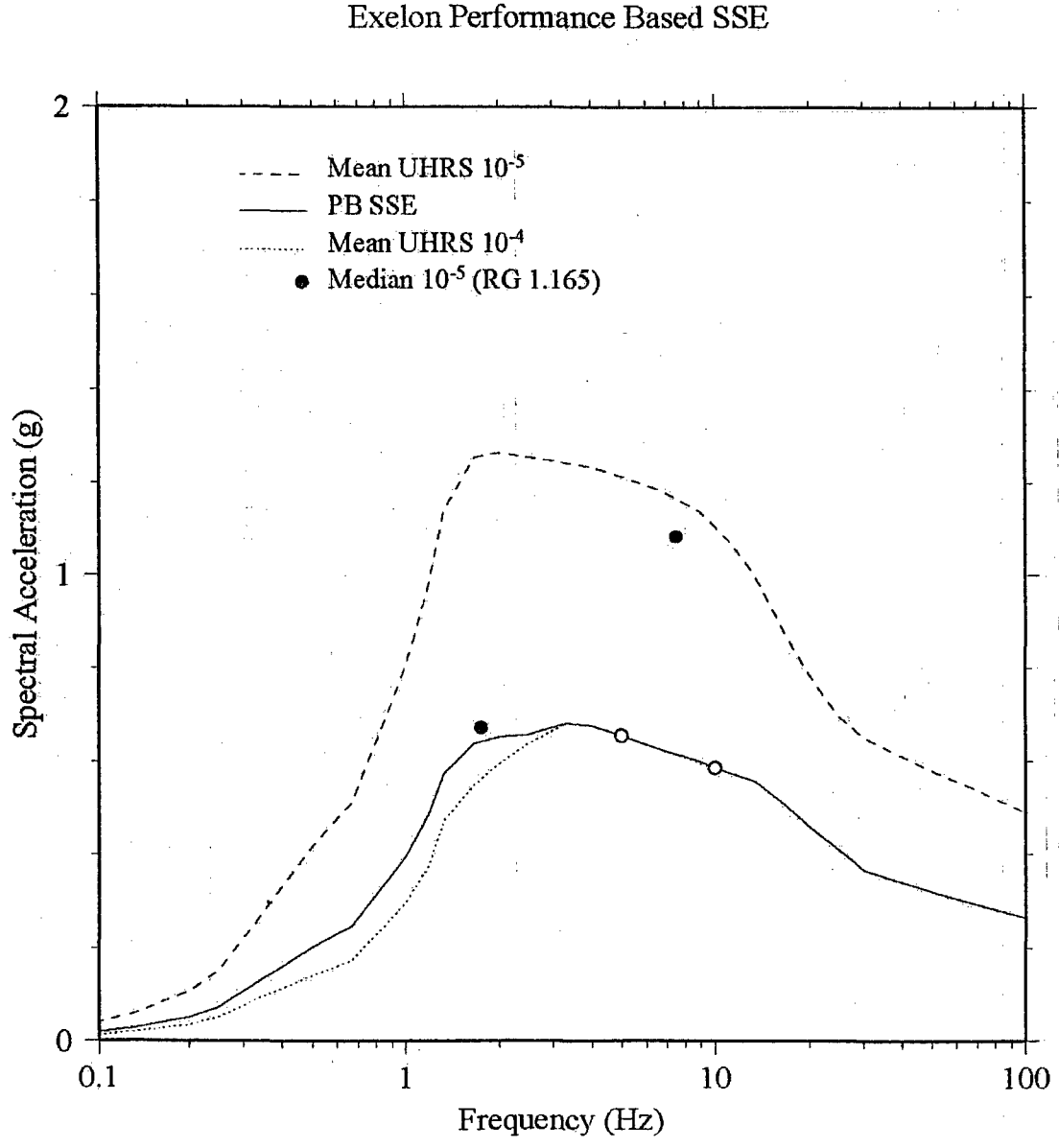
- PB Approach
  - Achieves both high and consistent level of seismic safety
  - No credit for seismic margin
  - Equates performance target to SCDF for existing NPPs
  - Based on conservative parameter and modeling assumptions

Conclusion 2

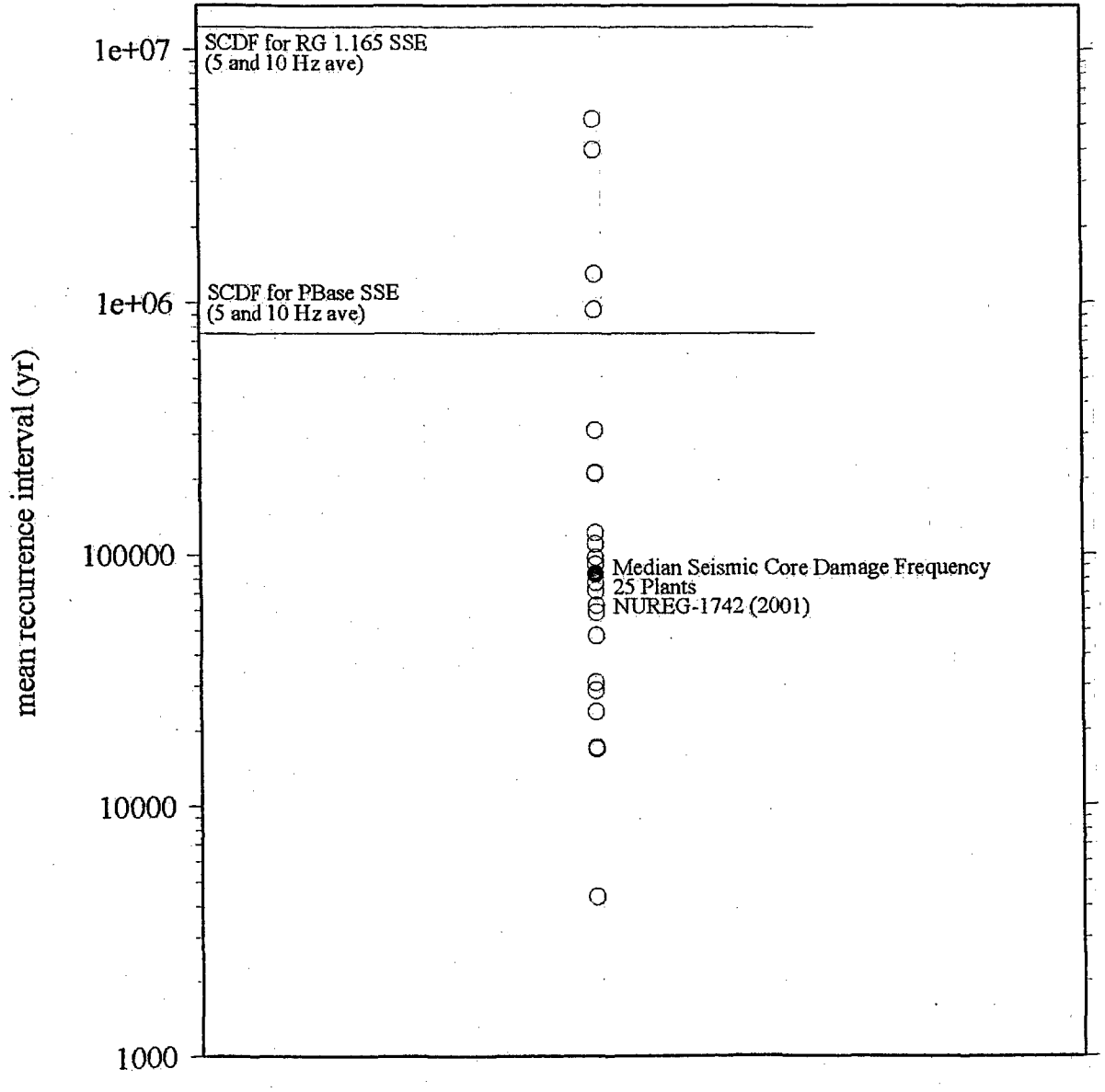
PB SSE achieves safety level generally higher than operating NPPs

- Commission Policy on Advanced RXs
  - Advanced RXs same degree of protection as operating NPPs
  - Advanced RXs provide enhanced margins of safety
- Using Clinton PB SSE values and HCLPF seismic margin of 1.67 (SECY 93-087)
  - What are SCDF values?
  - How do Clinton PB SCDF values compare to current NPPs?

Conclusion 2 (Cont.)



Conclusion 2 (Cont.)

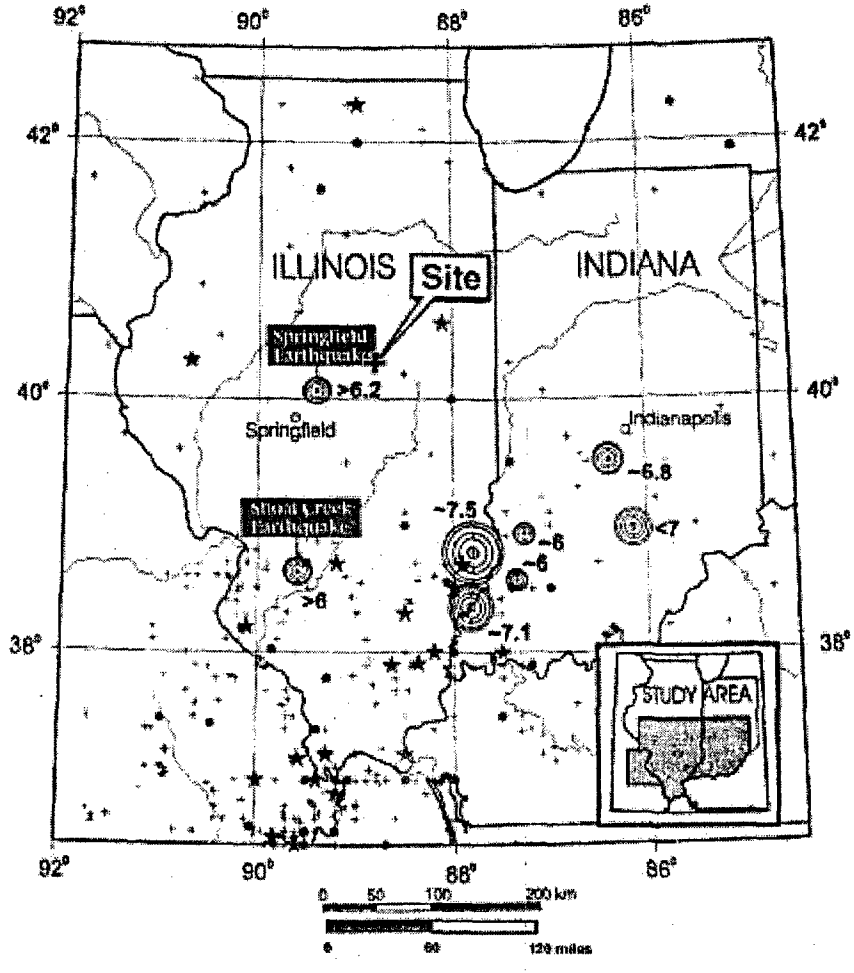


Conclusion 3

PB SSE adequately reflects local ground motion hazard

- Staff reviewed SSE to ensure it reflects local seismic hazards
- Greatest seismic hazard for central Illinois from Springfield earthquake
  - Prehistoric earthquake (5900 to 7400 years ago)
  - Near Springfield (60 km SW of ESP site)
  - Magnitude estimates (6.2 to 6.8)
    - Recent Study (M6.3)

Conclusion 3 (Cont.)



A star represents a magnitude of 5 or higher. A solid circle represents a magnitude between 4.5 and 5. A plus sign represents a magnitude between about 2.3 and 4.5. Historical earthquake data are from USGS/NEIC Global Hypocenter Data Base CD-ROM (Version 3.0). Concentric circles show estimated energy centers of large prehistoric earthquakes. The estimated moment magnitude, M, for a prehistoric earthquake is located near the circle.

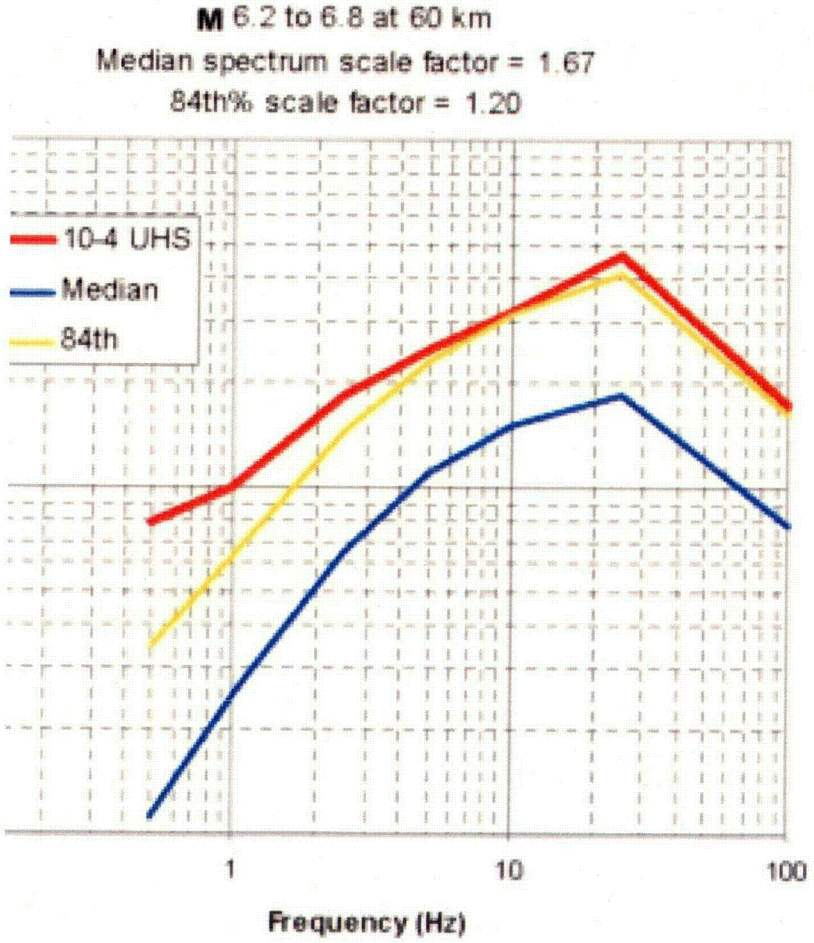
Note:

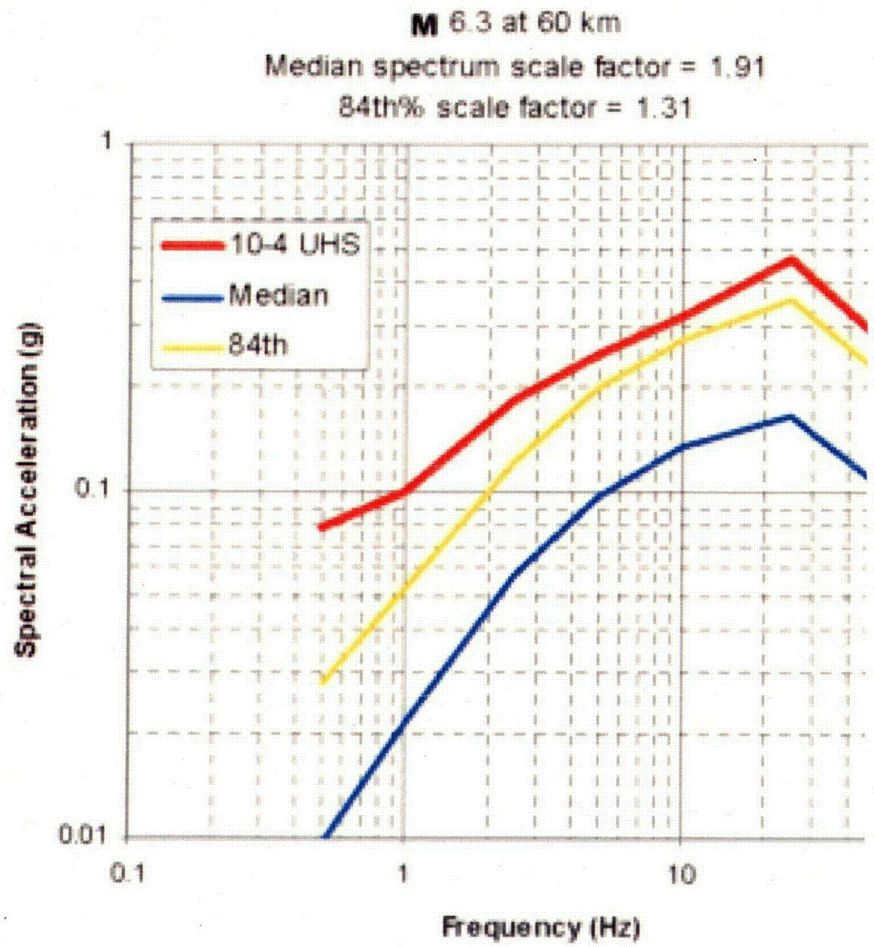
Conclusion 3 (Cont.)

- Exelon conducted Paleoliquefaction surveys on streams near ESP site
  - Found no evidence of repeated moderate to large earthquakes comparable to Springfield earthquake

- Exelon determined ground motion estimates from Springfield earthquake enveloped by $UHRS_{10-4}$ and PB SSE

Conclusion 3 (Cont.)





Summary

- All seismic open items resolved
- SSE is appropriate for the ESP site
- Questions or comments?

Exelon Early Site Permit Safety Review Status

September 8, 2005

Advisory Committee on Reactor Safeguards Early Site Permit Full Committee Meeting

John Segala, Senior Project Manager
Office of Nuclear Reactor Regulation

Purpose

- Brief the Full Committee on the Exelon early site permit (ESP) application and the status of the NRC staff's safety review
- Provide overview of the remaining open items
- Support the Full Committee's review of the application and subsequent interim ACRS letter
- Answer the Full Committee's questions

Meeting Agenda

- Key Review Areas
- Permit Conditions/COL Action Items
- DSER Conclusions
- Open Items
- Schedule Milestones
- Presentation Conclusions
- Discussion / Subcommittee questions

Key Review Areas

- Exclusion Area Authority and Control
- Nearby Industrial, Transportation, and Military Facilities
- Meteorology
- Hydrology
- Seismology and Geology
- Radiological Effluents
- Thermal Discharges
- Radiological Consequences of Accidents
- Physical Security
- Aircraft Hazards
- Emergency Planning
- Quality Assurance

Principal Contributors

Brad Harvey - Meteorology

Goutam Bagchi – Hydrology

- Contract support from PNNL

Kazimieras Campe - Site Hazards

- Contract support from PNNL

Clifford Munson and Tom Cheng – Geology, Seismology, and Geotechnical

- Support from U.S. Geologic Survey and BNL

Jay Lee – Demography, Geography, and Radiological Consequence Analysis

Robert Moody - Emergency Planning

- Consultation with FEMA

Paul Prescott - Quality Assurance

Al Tardiff - Physical Security

Proposed Permit Conditions and COL Action Items

- There are 15 proposed Permit Conditions
- There are 17 proposed COL Action Items
- Applying new criteria developed during the review of the North Anna ESP application

DSER Conclusions

- DSER defers conclusion regarding site safety and suitability to FSER after open items addressed
- Some conclusions from individual sections without open items:
  - Potential hazards associated with nearby transportation routes, industrial and military facilities pose no undue risk to facility that might be constructed on the site.

DSER Conclusions

- Additional conclusions from individual sections without open items
  - The proposed site is acceptable for constructing a plant falling within the PPE with respect to radiological effluent release dose consequences from normal operation
  - Site characteristics are such that adequate security plans and measures can be developed

Open Items

Review Area	Open Items
Exclusion Area Authority and Control	1
Meteorology	3
Hydrology	21
Seismology and Geology	7
Radiological Consequences of Accidents	1
Emergency Planning	6
Quality Assurance	1
Total:	40

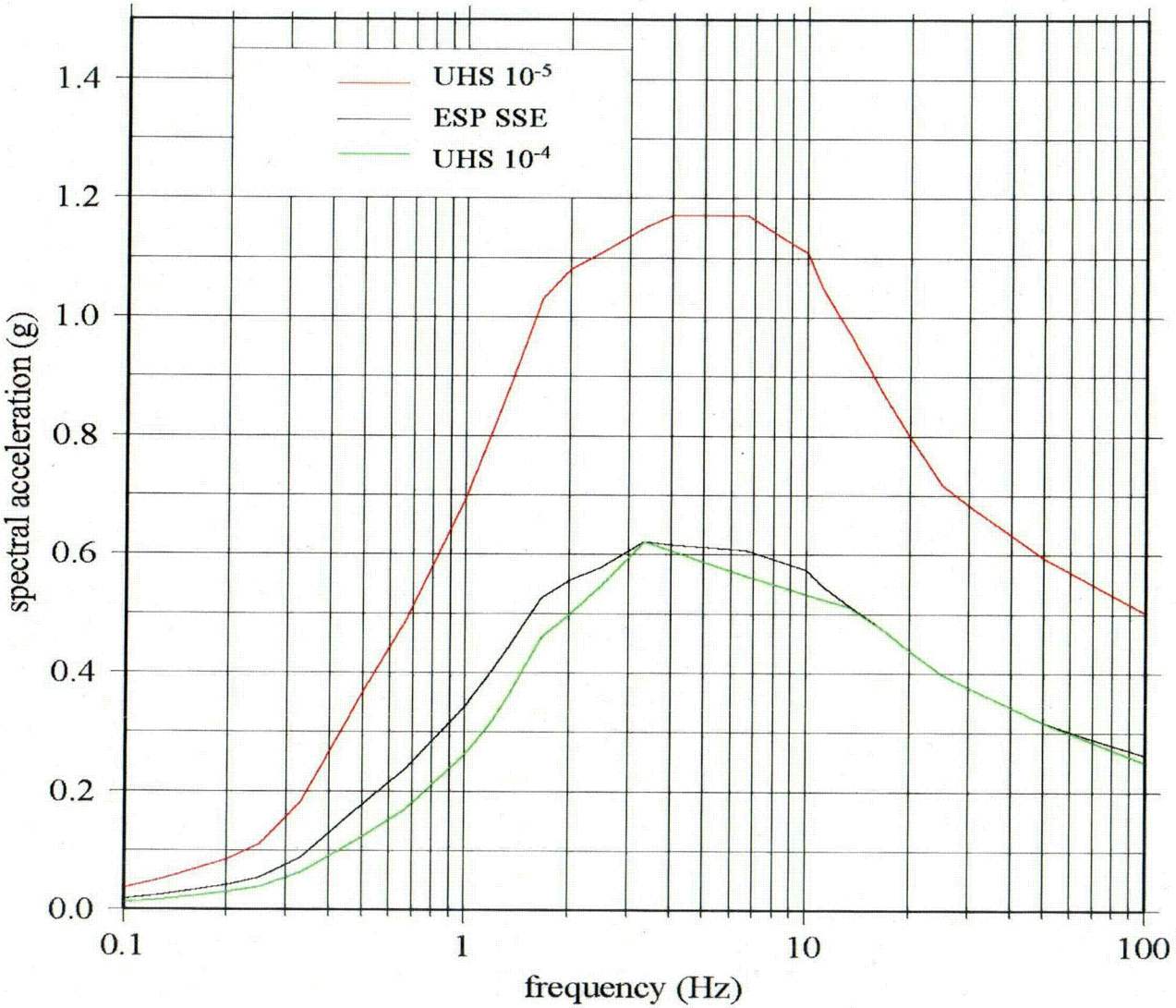
Seismic Open Items 2.5.2-4 and -5

- Exelon proposed new "performanced-based" approach for determining safe shutdown earthquake (SSE)
  - Not entirely consistent with NRC-approved method in RG 1.165
  - ASCE Standard 43-05 describes this approach
  - Risk-based approach that targets performance goal
    - $1x10^{-5}$ annual probability of unacceptable performance under seismic loading of Category 1 SSCs
    - Target performance probability based on seismic PRAs for existing nuclear power plants
  - Staff reviewed applicant's final SSE to determine the appropriateness of the performance-based approach

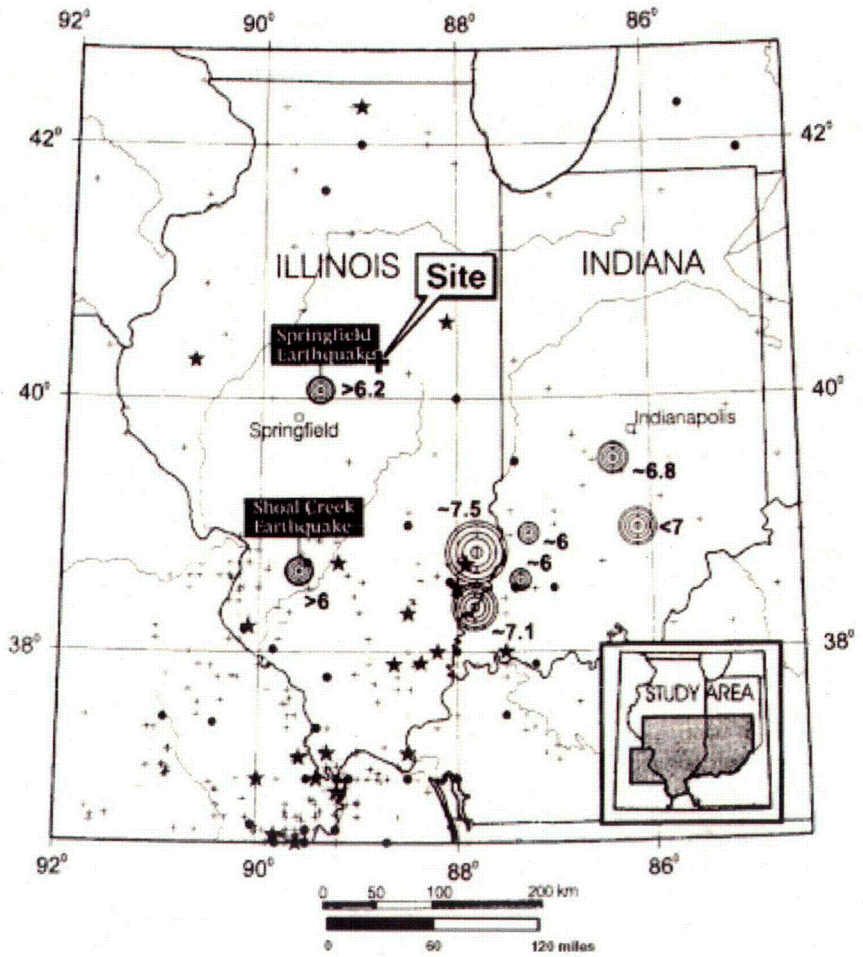
Seismic Open Items 2.5.2-4 and -5

- Open Item 2.5.2-4:
  - The performance-based SSE spectrum for the ESP site is approximately equal to the mean 10^{-4} uniform hazard spectrum
  - The performance-based SSE at 10^{-4} may not adequately represent the seismic hazard from local earthquakes
- Open Item 2.5.2-5:
  - Assumptions underlying the performance-based approach

Comparison of performance-based SSE spectrum for the ESP site and the mean 10-4 and 10-5 spectra



Historical Seismicity and Estimated Centers of Large Prehistoric Earthquakes in Site Region



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Seismic Open Items 2.5.2-4 and -5

The performance-based approach with a target 10^{-5} annual performance goal may not be suitable for determining the SSE for the Clinton ESP site

Other Seismic Open Items

- 2.5.1-1, Incorporate most recent New Madrid seismic source model into the PSHA and SSE

- 2.5.2-1, Clarify and justify the EPRI ground motion attenuation study distance-conversion method

Geotechnical Open Items

- 2.5.2-2, Site response model does not adequately represent variability of soil properties
- 2.5.2-3, Site response analysis should use appropriate shear modulus and damping curves
- 2.5.4-1, Further soil exploration needed for COL

Completed Milestones

- Received Exelon ESP application - September 25, 2003
- FRN published announcing acceptance – October 31, 2003
- FRN published for mandatory hearing – December 12, 2003
- RAIs issued to the Applicant – July, 27, 2004
- Draft SER issued – February 10, 2005
- Applicant responds to Draft SER open items – April 26, 2005
- Supplemental Draft SER issued – August 26, 2005
- ACRS Subcommittee Meeting - September 7, 2005

Remaining Milestones

- ACRS interim letter assumed – September 28, 2005
- Staff provides Final SER to ACRS – February 8, 2006
- Staff issues Final SER – February 17, 2006
- ACRS Full Committee Meeting – March 9, 2006
- ACRS letter assumed – March 30, 2006
- Staff incorporates ACRS letter and issues Final SER as NUREG – May 1, 2006
- Mandatory hearings begin Fall 2006
- Commission decision assumed mid 2007

Summary

- All open items resolved except for:
  - 7 Seismic open items
  - 1 Hydrology open item
- Working to resolve the remaining open items
- Looking forward to receiving the interim ACRS letter
- Questions or comments?

Exelon Early Site Permit Safety Review Status

September 7, 2005

Advisory Committee on Reactor Safeguards Early Site Permit Subcommittee Meeting

John Segala, Senior Project Manager
Office of Nuclear Reactor Regulation

Purpose

- Brief the Subcommittee on the Exelon early site permit (ESP) application and the status of the NRC staff's safety review
- Support the Subcommittee's review of the application and subsequent interim ACRS letter
- Answer the Subcommittee's questions

Meeting Agenda

- Schedule Milestones
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Paul Prescott - Quality Assurance

Al Tardiff - Physical Security

Exelon ESP Application

- Proposed ESP site is adjacent to existing Clinton Power Station (CPS)
- ESP applicant, Exelon Generation Company, LLC, is a subsidiary of Exelon Ventures Company, LLC
- AmerGen Energy Company is the owner of the CPS and ESP sites
- Exelon seeks authorization for limited work in accordance with 10 CFR 52.17(c) and 10 CFR 50.10(e)(1)

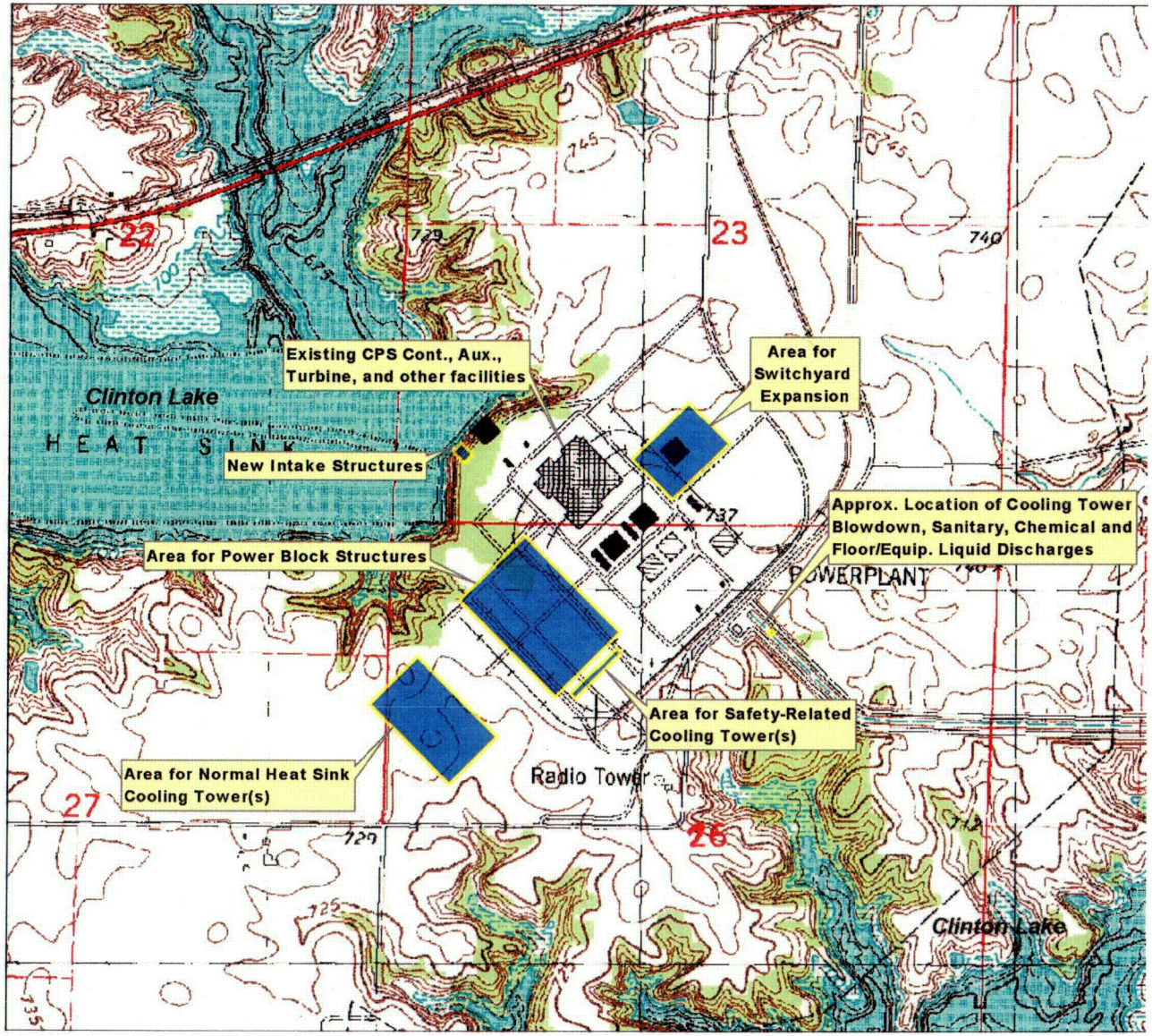
Exelon ESP Application

- Exelon requests ESP site be approved for total core thermal power rating between 2400 and 6800 MWt
- Single RX or multiple RXs (or modules) of the same RX type
- Exelon has chosen not to submit specific design but instead has submitted a plant parameter envelope (PPE) based on a number of current and future reactor designs
- Staff's review of PPE values in ESP application limited to whether they are reasonable

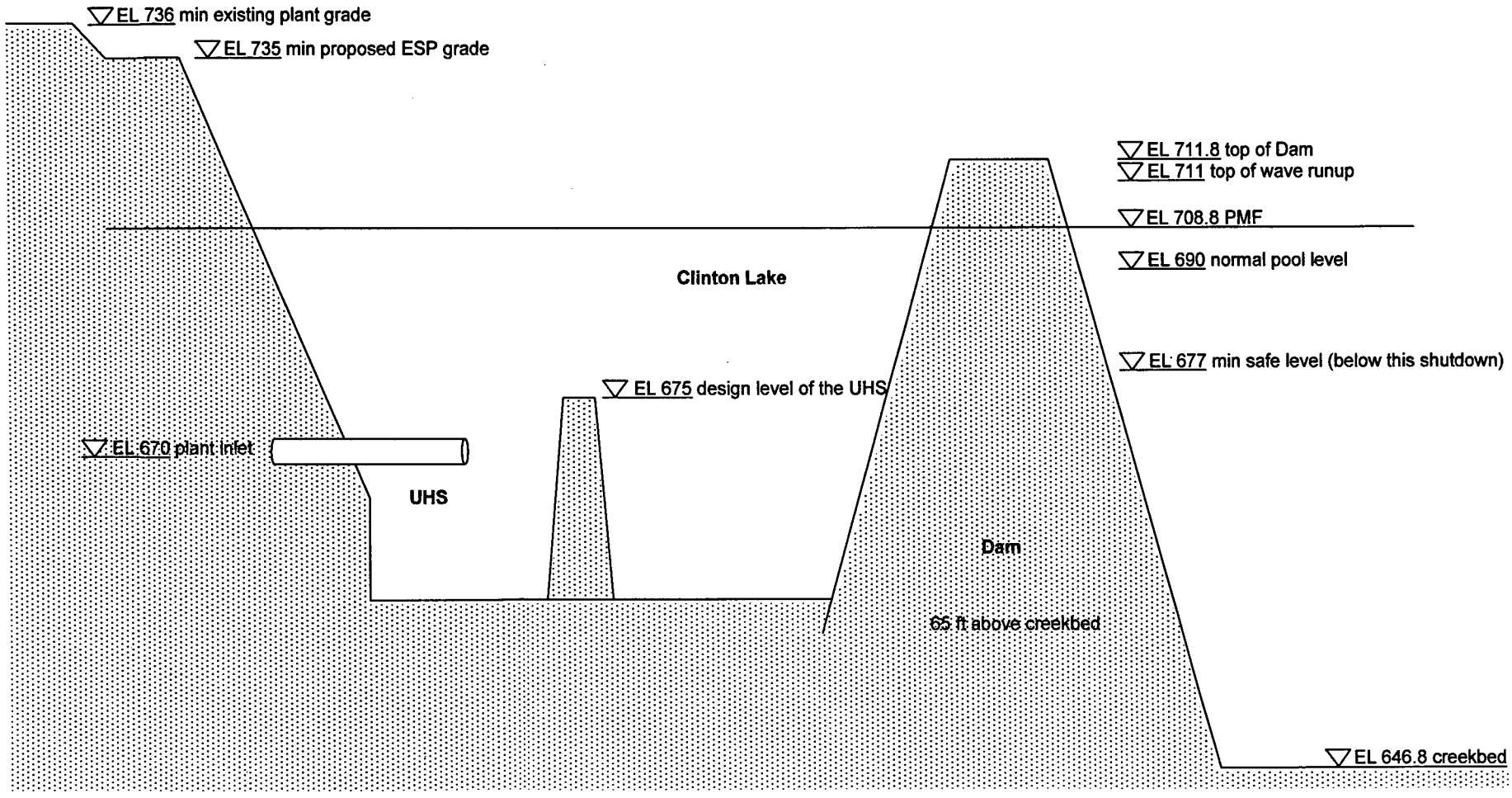
Exelon ESP Application

- Original CPS was designed for two identical units. Construction of second unit was halted prior to completion.
- Existing switchyard will be expanded to accommodate the output of the new facility
- Normal heat sink comprised of either mechanical or natural draft cooling towers
- UHS may be comprised of mechanical draft cooling towers
- Exelon seeks 20-year ESP term

Exelon ESP Site



Clinton Lake Elevations



Exelon Early Site Permit Safety Review Status

September 7, 2005

Advisory Committee on Reactor Safeguards Early Site Permit Subcommittee Meeting

John Segala, Senior Project Manager
Office of Nuclear Reactor Regulation

Purpose

- Provide overview of the staff's geology, seismology, and geotechnical review

Seismic Open Items 2.5.2-4 and -5

- Exelon proposed new "performanced-based" approach for determining safe shutdown earthquake (SSE)
  - Not entirely consistent with NRC-approved method in RG 1.165
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- 2.5.4-1, Further soil exploration needed for COL

Summary

- Working to resolve the seismic open items
- Questions or comments?

August 18, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
EXELON GENERATION COMPANY, LLC.	)	Docket No. 52-007-ESP
	)	
(Early Site Permit for Clinton ESP Site)	)	

NOTICE OF APPEARANCE

Notice is hereby given that the undersigned attorney enters an appearance in the above-captioned matter. In accordance with 10 C.F.R. § 2.314(b), the following information is provided:

Name:	Patrick A. Moulding
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Fax:	301-415-3725
E-mail Address:	PAM3@nrc.gov
Admissions:	State of Maryland
Name of Party:	NRC Staff

Respectfully submitted,

Patrick A. Moulding
Counsel for NRC Staff

Dated at Rockville, Maryland
this 18th day of August 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSINC BOARD

In the Matter of	)	
	)	
EXELON GENERATION COMPANY, LLC.	)	Docket No. 52-007-ESP
	).	
(Early Site Permit for Clinton ESP Site)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the "NRC STAFF RESPONSE TO LICENSING BOARD'S ORDER OF AUGUST 2, 2006" and "NOTICE OF APPEARANCE" for Patrick A. Moulding in the above-captioned proceeding have been served on members of the Licensing Board by hand delivery and the following by deposit in the NRC's internal mail system as indicated by a single asterisk, or by deposit in the U.S. Mail, first class, as indicated by a double asterisk, this 18th day of August, 2006:

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