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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	Docket No. 52-043-ESP
PSEG POWER, LLC AND PSEG NUCLEAR, LLC	
(Early Site Permit Application)	February 25, 2016

PSEG PRE-FILED TESTIMONY ON SER TOPIC 3 (HYDRAULIC MODELING)

I. INTRODUCTION

Q1. Please state your name.

A1. My name is James Mallon. I am the Nuclear Development Manager for the Nuclear Development Department at PSEG Power, LLC.

Q2. Please describe your educational background and expertise.

A2. My Statement of Professional Qualifications is provided as Exhibit PSEG002. As shown in that document, I have a B.A. degree in Physics from Franklin and Marshall College and I have completed graduate business courses for an M.B.A. from the University of Southern Maine. I also hold an ANSI 3.1 Senior Reactor Operator (SRO) certification.

I have 34 years of experience working in the nuclear industry. I have worked at a number of nuclear consulting and utility companies, including Stone and Webster Engineering Corporation (1982-1986), PECO Energy Co (1987-1995), Environmental Dimensions Inc. (1995-1996), Maine Yankee Atomic Power Company (1996-2000), Exelon Nuclear (2000-2008), and PSEG Power, LLC (2008-Present). That experience has included positions related to engineering, radiation protection, health physics, waste management, training, regulatory assurance, licensing, and nuclear development.

At PSEG Power, I was the Early Site Permit Manager during the initial phases of the project, including the decision to pursue an Early Site Permit (ESP), vendor selection, application preparation, and responses to Nuclear Regulatory Commission (NRC) requests for additional information. In 2011, I became the Manager of Nuclear Development, which covers the ESP project and other activities related to small modular reactors and advanced nuclear technology.

Q3. What is the purpose of your testimony?

A3. The purpose of my testimony is to respond to SER Topic 3, which is one of six pre-filed testimony areas identified by the Atomic Safety and Licensing Board (Board) in its January 27, 2016 Memorandum and Order (Identifying Areas for Prefiled Testimony) and that primarily relate to the *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* (SER), dated September 2015 (Exhibit NRC003). The Board requested the following testimony for SER Topic 3:

> In response to SER Question No. 20 the Staff stated as follows:
>
>> While the Staff recognizes that increasing the resolution of the overall watershed basin model could improve the precision of the Applicant's river flooding model results, the Staff determined <u>on the basis of experience with hydraulic modeling</u> that such improvements could not change the conclusion that storm surge is the bounding flood hazard for the PSEG ESP site and additional analyses were not necessary.
>
> To what extent is the "experience with hydraulic modeling" upon which this decision was based documented? If experience based knowledge is used in the Staff's decision-making process generally, how is this experience documented?

The purpose of my testimony is to address this topic on behalf of PSEG Power, LLC and PSEG Nuclear, LLC (collectively, PSEG), the applicants for the ESP, and provide some additional discussion about the analyzed flood hazard and the impacts of any changes to the river flooding model on the overall conclusion that storm surge is the design basis flood hazard for the PSEG Site. PSEG defers to the NRC Staff regarding documenting experience with hydraulic modeling.

Q4. Please summarize your overall conclusions for this testimony.

A4. As discussed below, PSEG analyzed a number of potential causes of flooding at the PSEG Site. Based on those analyses, PSEG concluded that the probable maximum hurricane represents the design basis flood for a new plant at the PSEG Site. There is a significant margin between the design basis flood level, induced by the probable maximum hurricane, and that from the river flooding event and the resulting probable maximum flooding. Even if PSEG increased the resolution of the overall watershed basin model, that would not change the conclusion regarding the design basis flood. Therefore, the safety of the plant would not be impacted by changing the resolution of the overall watershed basin model.

Q5. Please describe the structure of your testimony.

A5. Section II of my testimony below discusses the analyses in the Site Safety Analysis Report (SSAR) (Exhibits PSEG004B to PSEG004R) that were used to determine the design basis flood for a new plant at the PSEG Site. Section III then discusses whether improving the precision of the river flooding model could change the conclusion that the probable maximum hurricane is the bounding flood hazard for a new plant at the PSEG Site. Section IV provides PSEG's overall conclusions for this testimony on SER Topic 3.

II. DESIGN BASIS FLOOD

Q6. Provide a high-level description of the hydrosphere for a new plant at the PSEG Site.

A6. As discussed in SSAR Subsection 2.4.1.2 (Exhibit PSEG004B), the Delaware River and the Delaware Bay are the main hydrologic features that may affect or be affected by new plant construction at the PSEG Site. Other hydrologic features considered include Alloway Creek, Hope Creek, and the Chesapeake and Delaware Canal. SSAR Table 2.4.1-1 lists these and other hydrological features and their distances from the PSEG Site. The Delaware River Basin covers 13,600 square miles and includes portions of Delaware, Maryland, New Jersey, New York, and Pennsylvania.

Q7. What are potential causes of flooding at the PSEG Site?

A7. Potential causes of flooding at the PSEG Site include Delaware River flooding from precipitation in the watershed (SSAR Subsection 2.4.3), dam failures (SSAR Subsection 2.4.4), storm surge and seiche effects (SSAR Subsection 2.4.5), tsunamis (SSAR Subsection 2.4.6), and ice effects (SSAR Subsection 2.4.7).

Q8. Please describe the analysis and conclusions for the probable maximum flood (PMF) on streams and rivers.

A8. As discussed in SSAR Subsection 2.4.3.4 (Exhibit PSEG004B), two probable maximum precipitation (PMP) events are simulated to determine the PMF. Based on the results of these simulations, a PMP event centered over the upper estuary (Philadelphia, PA) produces the PMF maximum water surface elevation (WSEL) at the new plant location. The combined effects of coincident stream flooding due to precipitation, high tides, and a hurricane storm surge are evaluated in this subsection, using two alternative combinations of extreme flood-producing events, as defined by ANSI/ANS-2.8-1992. Of these two alternatives, the coincident effects of one-half of the PMF, coincident with the 10 percent exceedance high tide, and the additional effects of the storm surge from the worst regional hurricane, and coincident wave runup, results in a flood elevation of up to 21.0 ft. North American Vertical Datum (NAVD) at the PSEG Site. The primary flood-causing mechanism of the PMF contributes 2.1 ft. to the overall WSEL of 21.0 ft. NAVD.

Q9. Please describe the analysis and conclusions for flooding due to potential dam failures.

A9. As discussed in SSAR Subsection 2.4.4 (Exhibit PSEG004B), of the four seismic dam breach scenarios modeled, the scenario producing the maximum WSEL at the new plant location is the combined failure of the Pepacton and Cannonsville dams. This breach scenario results in a flood elevation of 9.4 ft. NAVD at the PSEG Site (Table 2.4.4-5) and includes the following components: the 10 percent exceedance high tide at 4.5 ft. NAVD, coincident with the 500-year frequency storm event of 2.0 ft., and the effects of the 2-year wind speed applied in the critical direction of 2.6 ft. The primary flood-causing mechanism of the combined Pepacton and Cannonsville dam breaches contributes 0.3 ft. to the overall WSEL of 9.4 ft. NAVD.

Q10. Please describe the analysis and conclusions for the probable maximum surge and seiche flooding.

A10. The flood level established in SSAR Subsection 2.4.5 (Exhibit PSEG004B) is based on the ADCRIC+SWAN model's simulation of the storm surge due to the probable maximum hurricane (PMH). Initially, the Bodine storm surge model is used to screen storm surge water levels based on varying PMH parameters in combination with HEC-RAS and the Kamphuis wind setup model. As discussed in SSAR Subsection 2.4.5.6.1.2, the ADCIRC+SWAN model used for the PMH event, is a high resolution, finite element analysis model that simulates complicated bathymetry encompassed by irregular seashore boundaries to more accurately simulate storm surge propagation onto a complex coastal landscape. SSAR Table 2.4.5-4 presents the resulting maximum WSEL's at the PSEG Site for each PMH event modeled. Run No. 2 represents the maximum realistic PMH event with a WSEL of 32.1 ft. The primary flood-causing mechanism of the PMH contributes 20.2 ft. to the overall WSEL of 32.1 ft. NAVD.

Q11. Please describe the analysis and conclusions for the probable maximum tsunami flooding.

A11. As discussed in SSAR Subsection 2.4.6.4.8 (Exhibit PSEG004B), runup values calculated during simulations are relative to 10 percent exceedance high tide, which serves as the static initial water level in the simulations. Maximum runup values are reported in SSAR Table 2.4.6-6 relative to the 10 percent exceedance high tide elevation. The 10 percent exceedance high tide is 4.5 ft. NAVD based on values from the NOAA tidal gage at Reedy Point. This provides an approximation for extreme water levels reached for wave runup events arriving coincident with high astronomical tide. The probable maximum tsunami (PMT) at the PSEG Site is caused by the Currituck Landslide. In the most conservative model without bottom friction, maximum runup at the PSEG Site is 5.65 ft. NAVD. The primary flood-causing mechanism of the PMT contributes 1.15 ft. to the overall WSEL of 5.65 ft. NAVD.

Q12. Please describe the analysis and conclusions for flooding due to ice effects.

A12. As discussed in SSAR Subsection 2.4.7.5 (Exhibit PSEG004B), based on review of historical ice jam information and model simulation of a major historic ice jam event, the flooding potential resulting from historic ice jam discharge is elevation 8.1 ft. NAVD. The primary flood-causing mechanism of the ice jam contributes 0.1 ft. to the overall WSEL of 8.1 ft. NAVD.

Q13. Please summarize the results of the flooding analyses discussed above.

A13. The following table provides a summary of the flooding analyses discussed above:

Event		Primary Flood Causing Mechanism	Combined Effects			Total (ft.)	SSAR Reference
SSAR	Description	Flood Height (ft. NAVD)	Tide (ft.)	Waves (ft.)	Other[(a)] (ft.)		
2.4.3	PMF	2.1	4.5	3.1	11.3	21.0	Table 2.4.3-4
2.4.4	Dam Break	0.3	4.5	2.6	2.0	9.4	Table 2.4.4-5
2.4.5	PMH	20.2	4.5	7.4	N/A	32.1	Table 2.4.5-4, Run #2
2.4.6	Tsunami	1.15	4.5	N/A	N/A	5.65	Table 2.4.6-6
2.4.7	Ice Jam Flooding	0.1	4.5	2.8	0.7	8.1	Table 2.4.7-3

(a) PMF is combined with the worst regional hurricane flood level.
Dam Break is combined with the 500 year flood.
Ice Jam Flooding includes spring base flow effects on water level.

Q14. What is the design basis flood for a new plant at the PSEG Site?

A14. The design basis flood is 32.1 ft. NAVD as calculated in SSAR Subsection 2.4.5 and is based on the PMH.

Q15. How will the plant be protected against the design basis flood?

A15. Floor elevations for safety-related structures, systems, and components (SSC) for the new plant, other than the intake structure, will be established to maintain at least one foot of clearance above the design basis flood, as required by Tier 1 of the design control document (DCD) for the technology selected. The area surrounding the safety-related SSC will be graded such that the runoff from PMP on the site drains away from the SSC into a system of swales and pipes that carry runoff to the Delaware River.

III. EFFECT OF HIGHER RESOLUTION OF OVERALL WATERSHED BASIN MODEL

Q16. What is the margin between the PMF and the PMH flood levels?

A16. As noted above, the total WSEL is 21.0 ft. for the PMF event and 32.1 ft. for the PMH event. Therefore, the margin between the total WSEL for these analyzed flood levels is 11.1 ft. That value is much larger than the entire contribution of 2.1 ft. from the primary flood-causing mechanism for the PMF event that could be impacted by modifying the overall watershed basin model.

Q17. In response to SER Question No. 20, the Staff stated that "increasing the resolution of the overall watershed basin model could improve the precision of the Applicant's river flooding model results." Do you agree?

A17. Yes. Increasing the resolution of the overall watershed basin model could improve the precision of the river flooding model results, which could affect the PMF level. However, increasing the resolution would not necessarily increase the resulting WSEL, but could result in a decrease in water level.

Q18. The Staff also stated that "such improvements could not change the conclusion that storm surge is the bounding flood hazard for the PSEG ESP site and additional analyses were not necessary." Do you agree?

A18. Yes. Given that there is a significant margin between the total WSEL for the PMF and PMH events, and the contribution from the primary flood-causing mechanism for the PMF event is small, increasing the resolution of the model used for the PMF event would not affect the conclusion that the PMH event represents the design basis flood.

Aside from the PMH event, the primary flood-causing mechanism associated with each flood hazard represents a small portion of the associated WSEL. Although not likely, if the change in resolution had a significant increase in the primary mechanism, for example, a 100% increase, the result would not significantly increase the associated total flood height, resulting in a WSEL that remains much less than the PMH WSEL of 32.1 ft. NAVD.

For these reasons, increasing the resolution would not result in the PMF overcoming the significant existing margin between the PMF and PMH events.

IV. CONCLUSIONS

Q19. What are your overall conclusions regarding SER Topic 3?

A19. PSEG concluded that the PMH event represents the design basis flood for a new plant at the PSEG Site. There is a significant margin between the design basis flood level for the PMH event and that from the river flooding model for the PMF event. Even if PSEG increased the resolution of the overall watershed basin model, that would not change the conclusion regarding the design basis flood. Therefore, the safety of the plant would not be impacted by changing the resolution of the overall watershed basin model.

Q20. Does this conclude your testimony?

A20. Yes.

I certify that this written testimony was prepared by me or under my direction, and I adopt the testimony as my sworn testimony in this proceeding.

I declare under penalty of perjury that the foregoing written testimony is true and correct to the best of my information, knowledge, and belief.

Executed on February 25, 2016.

Executed in Accord with 10 CFR § 2.304(d)

/s/ James Mallon
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