



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

June 16, 2014

Mr. Thomas Joyce  
President and Chief Nuclear Officer  
PSEG Nuclear LLC  
P.O. Box 236, N09  
Hancocks Bridge, NJ 08038

**SUBJECT: SALEM GENERATING STATION UNITS 1 AND 2 – STAFF ASSESSMENT OF FLOODING WALKDOWN REPORT SUPPORTING IMPLEMENTATION OF NEAR-TERM TASK FORCE RECOMMENDATION 2.3 RELATED TO THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT (TAC NOS. MF0276 AND MF0277)**

Dear Mr. Joyce:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information letter per Title 10 of the Code of Federal Regulations, Section 50.54(f) (50.54(f) letter). The 50.54(f) letter was issued to power reactor licensees and holders of construction permits requesting addressees to provide further information to support the NRC staff's evaluation of regulatory actions that may be taken in response to lessons learned from Japan's March 11, 2011, Great Tōhoku Earthquake, resultant tsunami, and subsequent accident at the Fukushima Dai-ichi nuclear power plant. The request addressed the methods and procedures for nuclear power plant licensees to conduct seismic and flooding hazard walkdowns to identify and address degraded, nonconforming, or unanalyzed conditions through the corrective action program, and to verify the adequacy of the monitoring and maintenance procedures.

By letter dated November 26, 2012, PSEG submitted a Flooding Walkdown Report as requested in Enclosure 4 of the 50.54(f) letter for Salem Generating Station, Units 1 and 2.

The NRC staff has reviewed the information provided and, as documented in the enclosed staff assessment, determined sufficient information was provided to be responsive to Enclosure 4 of the 50.54(f) letter. This closes the NRC's efforts associated with TAC Nos. MF0276 and MF0277.

T. Joyce

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If you have any questions, please contact me at 301-415-3100 or by e-mail at [john.lamb@nrc.gov](mailto:john.lamb@nrc.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "John G. Lamb". The signature is written in a cursive style with a large initial "J".

John Lamb, Senior Project Manager  
Plant Licensing Branch I-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-272 and 50-311

Enclosure:  
Staff Assessment of Flooding  
Walkdown

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT OF FLOODING WALKDOWN REPORT  
NEAR-TERM TASK FORCE RECOMMENDATION 2.3 RELATED TO  
THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT  
PSEG NUCLEAR LLC  
SALEM GENERATING STATION, UNITS 1 AND 2  
DOCKET NOS. 50-272 AND 50-311

1.0 INTRODUCTION

On March 12, 2012,<sup>1</sup> the U.S. Nuclear Regulatory Commission (NRC) issued a request for information per Title 10 of the *Code of Federal Regulations*, Subpart 50.54(f) (50.54(f) letter) to all power reactor licensees and holders of construction permits in active or deferred status. The request was part of the implementation of lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 4,<sup>2</sup> "Recommendation 2.3: Flooding," to the 50.54(f) letter requested licensees to conduct flooding walkdowns to identify and address degraded, nonconforming, or unanalyzed conditions using the corrective action process (CAP), verify the adequacy of monitoring and maintenance procedures, and report the results to the NRC.

Enclosure 4 to the 50.54(f) letter requested licensees to respond with the following:

- a. Describe the design basis flood hazard level(s) for all flood-causing mechanisms, including groundwater ingress.
- b. Describe protection and migration features that are considered in the licensing basis evaluation to protect against external ingress of water into SSCs [structures, systems, and components] important to safety.
- c. Describe any warning systems to detect the presence of water in rooms important to safety.
- d. Discuss the effectiveness of flood protection systems and exterior, incorporated, and temporary flood barriers. Discuss how these systems and barriers were evaluated using the acceptance criteria developed as part of Requested Information item 1.h [item 1.h requests that licensees verify that flood protection systems are available, functional, and implementable].
- e. Present information related to the implementation of the walkdown process (e.g., details of selection of the walkdown team and procedures) using the

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<sup>1</sup> Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340.

<sup>2</sup> ADAMS Accession No. ML12056A050.

documentation template discussed in Requested Information item 1.j, including actions taken in response to the peer review.

- f. Results of the walkdown including key findings and identified degraded, nonconforming, or unanalyzed conditions. Include a detailed description of the actions taken or planned to address these conditions using guidance in Regulatory Issues Summary 2005-20, Revision 1, Revision to the NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety," including entering the condition in the corrective action program.
- g. Document any cliff-edge effects identified and the associated basis. Indicate those that were entered into the corrective action program. Also include a detailed description of the actions taken or planned to address these effects.
- h. Describe any other planned or newly installed flood protection systems or flood mitigation measures including flood barriers that further enhance the flood protection. Identify results and any subsequent actions taken in response to the peer review.

In accordance with the 50.54(f) letter, Enclosure 4, Required Response Item 2, licensees were required to submit a response within 180 days of the NRC's endorsement of the flooding walkdown guidance. By letter dated May 21, 2012, the Nuclear Energy Institute (NEI) staff submitted NEI 12-07, Revision 0, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features,"<sup>3</sup> to the NRC staff to consider for endorsement. NEI 12-07 describes a methodology for performing walkdowns in a manner that will address requested information items 1.a through 1.j of Enclosure 4 of the 50.54(f) letter. By letter dated May 31, 2012,<sup>4</sup> the NRC staff endorsed the walkdown guidance.

By letter dated November 26, 2012,<sup>5</sup> Public Services Enterprise Group Nuclear LLC (PSEG), provided a response to Enclosure 4 of the 50.54(f) letter Required Response Item 2, for the Salem Generating Station (SGS).

The NRC staff evaluated the licensee's submittal to determine if the information provided in the walkdown report met the intent of the walkdown guidance and if the licensee responded appropriately to Enclosure 4 of the 50.54(f) letter.

## 2.0 REGULATORY EVALUATION

The structures, systems and components (SSCs) important to safety in operating nuclear power plants are designed either in accordance with, or meet the intent of Appendix A to 10 CFR Part 50, "General Design Criteria [GDC] for Nuclear Power Plants," Criterion 2: "Design bases for protection against natural phenomena," and Appendix A to 10 CFR Part 100, "Seismic and

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<sup>3</sup> ADAMS Accession No. ML121440522.

<sup>4</sup> ADAMS Accession No. ML12144A142.

<sup>5</sup> ADAMS Accession No. ML12334A450.

Geological Siting Criteria for Nuclear Plants.” Criterion 2 states that SSCs important to safety at nuclear power plants shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their safety functions.

For initial licensing, each licensee was required to develop and maintain design bases that, as defined by 10 CFR 50.2, identify the specific functions to be performed by an SSC and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design.

SGS was designed to the Atomic Industrial Forum version of the GDC, dated October 2, 1967. In Section 3.1.3 of the Salem Updated Final Safety Analysis Report, the licensee discusses compliance with each of the GDC Criterion in Appendix A of 10 CFR Part 50, and does not identify any deviations from GDC Criterion 2.

The design bases for the SSCs reflect appropriate consideration of the most severe natural phenomena that have been historically reported for the site and surrounding area. The design bases also reflect sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The current licensing basis (CLB), as defined in 10 CFR 54.3(a), is the set of NRC requirements applicable to a specific plant, and a licensee’s written commitments for ensuring compliance with, and operation within, applicable NRC requirements and the plant-specific design basis that are in effect.

### 3.0 TECHNICAL EVALUATION

#### 3.1 Design Basis Flooding Hazard

The design basis flood hazard for SGS is an induced surge and wave flooding from a probable maximum hurricane (PMH). Under this scenario, the maximum stillwater level was assumed to be 113.8 feet (ft.) PSD.<sup>6</sup> The maximum wave runup on safety-related structures inside the sea wall was estimated to be 120.4 ft. PSD; the maximum wave runup on the service water intake structure was calculated to be 127.3 ft. PSD.

The licensee also considered the flood hazard for the probable maximum precipitation (PMP), as it pertains to yard drainage and possible loading on critical structures. The Yard Drainage System is designed to accept drainage from a maximum rainfall rate of 4 inches per hour for time periods of less than 20 minutes (equal to a rainfall intensity with a return frequency of 15 years). During precipitation events exceeding the capacity of the Yard Drainage System, excess water would accumulate in puddles in the vicinity of the catch basins and run off. Since structures housing safety-related equipment are watertight up to an elevation of 115 ft. PSD, no adverse effects are expected during such events.

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<sup>6</sup> PSD=Public Service Electric and Gas Company datum; the PSD is equal to the National Geodetic Vertical Datum (NVGD) plus 89 ft.; for example, 10 ft. (NVGD) would be 99 ft. (PSD).

Probable maximum floods due to river flooding, dam breaks, and probable maximum tsunami flooding were not considered applicable to the SGS site.

### 3.2 Flood Protection and Mitigation

#### 3.2.1 Flood Protection and Mitigation Description

The SGS site is located on the southern part of Artificial Island on the east bank of the Delaware River in Salem County, New Jersey. The island is connected to the mainland (of New Jersey) by a strip of tideland formed by hydraulic fill from dredging operations on the Delaware River. The site area is generally flat with an elevation of 99.5 ft. PSD. Natural drainage flows toward the river and into the marsh areas to the north and east. Large waves break before reaching plant buildings as they encounter a seawall along the shoreline, with a top elevation of 108 ft. PSD, 8.5 ft. above plant grade.

All structures that house safety-related equipment at SGS are Seismic Category 1 structures. They are designed to withstand the loads and effects of postulated floods, and are watertight to an elevation of 115 ft. PSD.

#### 3.2.2 Incorporated and Exterior Barriers

All structures that house safety-related equipment at SGS are Seismic Category 1 structures. They are designed to withstand the loads and effects of postulated floods, and are watertight to an elevation of 115 ft. PSD.

#### 3.2.3 Temporary Barriers and Other Manual Actions

There are no temporary passive flood protection features credited in the SGS CLB. In the event of a major storm, a number of temporary sump pumps would be used to remove water entering the SGS Auxiliary Building.

Manual actions requiring operator action are initiated in the event of a major storm per plant procedures including "Severe Weather and Natural Disaster Guidelines," and "Adverse Environmental Conditions," as well as the SGS Technical Specifications. Additional procedures provide planning and preparation for potential flooding events, depending on site conditions. These include:

- Review out-of-service equipment (e.g., sump pumps) to prioritize restoration efforts;
- Ensure the Material Center has adequate sump pumps totaling 2,000 gallons per minute;
- Ensure that adequate water removal pumps, hoses, drain pipes, etc. are available and pre-staged at the Material Center;
- Verify operability of intake structure sump pumps;
- Review plant work activities having breaches that could cause flooding in the plant due to flood tides;
- Initiate a notification to inspect the shoreline protection and dike system;

- Consider implementation of other procedures (e.g., “Adverse Environmental Conditions”);
- Verify the closure of all watertight doors, as required;
- Consider maximizing room in the Waste Holdup Tanks to support potential water intrusion into the Auxiliary Building.

The “Adverse Environmental Conditions” procedure ensures compliance with required actions such as evaluating the need for sump pumps, closing and securing all watertight doors, monitoring and recording river level until it has stabilized, and commencing shutdown procedures.

#### 3.2.4. Reasonable Simulation and Results

SGS performed a reasonable simulation to confirm that actions described in the procedure entitled “Adverse Environmental Conditions” could be performed within the required period of time and that sufficient resources are allocated and staged to perform those actions. The actions are focused on the availability and implementation of temporary sump pumps and were demonstrated during preparations for an actual weather event (Hurricane Sandy) on October 28 and 29, 2012.

#### 3.2.5 Conclusion

Based on the NRC staff’s review, the licensee appears to have described protection and mitigation features as requested in the 50.54(f) letter and is consistent with the walkdown guidance.

### 3.3 Warning Systems

There is no installed permanent or temporary plant warning system in the SGS external flooding CLB. During adverse weather conditions, operators are instructed to monitor plant areas (i.e., rooms containing safety equipment) for water ingress via seals or excessive crack leakage. Flood alarms are credited for internal flooding sources to detect the accumulation of water from ingress (exceeding sump level) at the Service Water Intake Structure and the Auxiliary Building. Operators also monitor and report observed leakage on their routine inspections.

Based on the NRC staff’s review, the licensee appears to have provided information to describe any warning systems as requested in the 50,54(f) letter and consistent with the walkdown guidance.

### 3.4 Effectiveness of Flood Protection Features

The walkdown inspection found that flood protection features at SGS were functional and in conformance with the CLB. A review of applicable flood protection procedures determined that cited operator actions were appropriate for maintaining flood protection at the site. Discrepancies found between the plant’s physical condition (and condition of flood protection

features) and that described in the design/licensing documentation were noted and entered into the PSEG CAP for evaluation and disposition.

Based on the NRC staff's review, the licensee appears to have discussed the effectiveness of flood protection features as requested in the 50.54(f) letter and is consistent with the walkdown guidance.

### 3.5 Walkdown Methodology

By letter dated June 7, 2012,<sup>7</sup> PSEG responded to the 50.54(f) letter indicating that it intended to utilize the NRC-endorsed walkdown guidelines contained in NEI 12-07, Rev. 0-A, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features."

The licensee's walkdown submittal, dated November 27, 2012, indicated that the licensee implemented the walkdowns consistent with the intent of the guidance provided in NEI 12-07. The licensee did not identify any exceptions from NEI 12-07.

Based on the NRC staff's review, the licensee appears to have presented information related to the implementation of the walkdown process as requested in the 50.54(f) letter, and is consistent with the walkdown guidance.

### 3.6 Walkdown Results

#### 3.6.1 Walkdown Scope

The licensee performed walkdowns of 1,476 flood protection features, of which most (1,413) were of the passive type. These included walls, floors, roofs, penetration seals, doors, sump pumps, and check valves.

#### 3.6.2 Licensee Evaluation of Flood Protection Effectiveness, Key Findings, and Identified Deficiencies

The licensee reported that flood protection features at SGS are functional and in conformance with the CLB. A total of 9 inaccessible and 252 restricted access flood protection features were identified. There were 512 potential deficiencies to be further evaluated as part of the PSEG CAP process (these are listed in Attachments A and D of the walkdown report).

NEI 12-07 defines a deficiency as follows: "a deficiency exists when a flood protection feature is unable to perform its intended function when subject to a design basis flooding hazard." The licensee identified 512 potential deficiencies because of the flood walkdowns and placed them in the CAP.

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<sup>7</sup> ADAMS Accession No. ML12160A292.



### 3.6.3 Flood Protection and Mitigation Enhancements

The licensee reported that a notification to suggest enhancements to two procedures (“Adverse Environmental Conditions” and “Severe Weather and Natural Disaster Guidelines”) has been issued as a result of the preparations for Hurricane Sandy in October 2012. Enhancements to these procedures would involve the addition of instructions for implementing temporary sump pumps.

### 3.6.4 Planned or Newly Installed Features

The licensee determined that no changes were necessary as a result of the flood walkdowns.

### 3.6.5 Deficiencies Noted and Actions Taken or Planned

The licensee noted 512 potential deficiencies at the SGS site (listed in Attachments A and D of the walkdown report). For flood protection features with potential deficiencies, detailed observations, photographs, and qualitative dispositions were entered into the PSEG CAP for further review.

### 3.6.6 Walkdowns Not Performed for Flood Protection Features

#### 3.6.6.1 Restricted Access

The licensee identified 252 restricted access features (listed in Attachments C and F of the walkdown report); these features were entered into the PSEG CAP. The associated plan and schedule for performing the flood protection feature walkdown for restricted access features will be addressed within the PSEG CAP. Dates for further inspection of these features were not specified in the walkdown report.

#### 3.6.6.2 Inaccessible Features

The licensee identified 9 inaccessible features (listed in Attachments B and E of the walkdown report); these features were entered into the PSEG CAP. Further evaluation of these features was presented in the walkdown report:

- Waterproofing (Common to Units 1 and 2). Waterproofing consists of an impervious membrane placed under the mat and on the outside of walls to prevent seepage of groundwater through cracks in the concrete in the underground portion of the Containment Structure, the Auxiliary Building, and the Fuel Handling Buildings. Together with rubber waterstops (located within the structure’s poured concrete), this feature prevents or limits water intrusion at the concrete construction joints and seismic gap joints so that safety-related equipment is not affected by groundwater ingress. It is inaccessible because it is located below grade and inspection would require excavation of the building structures. Because groundwater level at the site is just a few feet below the surface, these features are continually subjected to hydrostatic pressure. Control room alarms are triggered if the sump levels reach a pre-established setpoint. The plant drain systems are not challenged by the ingress of groundwater.

- Waterstops (Common to Units 1 and 2). A waterstop is installed at the vertical and horizontal seismic joints between the Reactor Building to Auxiliary Building, Reactor Building to Fuel Handling Building, and Auxiliary Building to Fuel Handling Building to prevent groundwater and floodwaters from entering safety-related structures through the seismic joints. Although partially visible, a fire barrier would have to be disassembled in some areas to facilitate a full inspection. Control room alarms are triggered if the sump levels reach a pre-established setpoint. The plant drain systems are not challenged by the ingress of groundwater.
- Elevator Shafts – Protection Bevel Plates (E-15333-EL 84, -EL 100, and –EL 122). Two Auxiliary Building elevator shaft walls have installed steel plate structures that prevent observation and therefore preclude visual inspection of about 20 percent of the below-grade portion of one wall per shaft. The plate structures were installed in locations above and below grade, as required by the Safety Code to eliminate personnel shear hazard at several elevations within the elevator shaft. The remainder of the wall surfaces were inspected and found to be without visible defects, and there are no signs of previous water marks on the wall surfaces below the steel structures. Control room alarms are triggered if the sump levels reach a pre-established setpoint.
- East Pipe Chase (S-15206, W-25206). The exterior walls of the East Pipe Chase are below grade and are part of the Auxiliary Building flood boundary, which is designed to preclude groundwater and flood water intrusion to protect safety-related equipment. Although the pipe shafts are accessible from the pipe alley at Elevation 84 ft., access to them is dose-restricted. Drainage in the pipe chase is designed for internal flooding (which can occur as a result of breaks in the pipe alley) and is connected to the pump room sumps on Elevation 55 ft. Sump level alarms in the Control room would alert an operator to take action by reducing the sump water level using temporary sump pumps.
- Penetration Seals (E-25504-001, -002, -249, and -250). Penetration seals prevent ingress of groundwater into safety-related areas and structures. They are inaccessible because they are embedded in concrete. Additional embedment of these features in concrete augments the length that seeping groundwater would have to travel to reach the room interior. In addition, Control Room alarms are triggered if the sump levels reach a pre-established setpoint.

The licensee stated that condition monitoring of these structures (which are Seismic Category 1 buildings) provides assurance that the structural elements will remain capable of performing their design function.

### 3.6.7 NRC Staff Assessment of Walkdowns

The NRC staff reviewed the licensee walkdown report dated November 26, 2012. Based on the above assessment, the NRC staff concludes that the licensee met the intent of the walkdown guidance, NEI 12-07.

Based on the NRC staff's review, the licensee appears to have provided results of the walkdown and described any other planned or newly installed flood protection systems or flood mitigation measures as requested in the 50.54(f) letter and consistent with the walkdown guidance. Based on the information provided in the licensee's submittals, the NRC staff concludes that the licensee's implementation of the walkdown process meets the intent of the walkdown guidance.

### 3.6.8 Available Physical Margin

During the site audit discussed in Section 3.8 below, the NRC staff reviewed the processes used to calculate and address the available physical margin (APM) at flood protection features. The NRC staff concluded that the licensee met the intent of the APM process.

## 3.7 NRC Oversight

### 3.7.1 Independent Verification

On June 27, 2012, the NRC issued Temporary Instruction (TI) 2515/187, "Inspection of Near-Term Task Force Recommendation 2.3 Flooding Walkdowns."<sup>8</sup> In accordance with the TI, NRC inspectors independently verified that the licensee implemented the flooding walkdowns consistent with the intent of the walkdown guidance. Additionally, inspectors performed walkdowns of a sample of flood protection features. The results of this inspection were documented in Inspection Report 05000272/2012005 and 05000311/2015005, dated February 7, 2013.<sup>9</sup> No findings of significance were identified.

## 3.8 NRC Staff Audit

The NRC staff performed an audit of SGS during the week of June 25, 2013. During the audit, the NRC staff gained a better understanding of the process used by the licensee to perform the walkdowns, including the available physical margin determinations. The audit report dated February 6, 2014,<sup>10</sup> provides the results of this audit for SGS.

## 3.9 SSCs to be Walked Down at a Later Date

The licensee identified restricted access features. See Attachments C and F of the walkdown report for a listing of the restricted areas.

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<sup>8</sup> ADAMS Accession No. ML12129A108.

<sup>9</sup> ADAMS Accession No. ML13038A672.

<sup>10</sup> ADAMS Accession No. ML13308C286.

All of the features require plant shutdown and cooldown for access. The licensee entered the restricted access features into the CAP.

#### 4.0 CONCLUSION

The NRC staff concludes that the licensee's implementation of the flooding walkdown methodology met the intent of the NEI 12-07 walkdown guidance. The NRC staff concludes that through the implementation of the walkdown guidance activities, and in accordance with plant processes and procedures, the licensee verified: the plant configuration with the current flooding licensing basis; addressed degraded, nonconforming, or unanalyzed flooding conditions; and verified the adequacy of monitoring and maintenance programs for protective features. Furthermore, the licensee's walkdown results, which were verified by the NRC staff's audit and inspection, identified no immediate safety concerns. The NRC staff concludes that the information provided by the licensee appropriately responds to Enclosure 4 of the 50.54(f) letter, dated March 12, 2012.

T. Joyce

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If you have any questions, please contact me at 301-415-3100 or by e-mail at [john.lamb@nrc.gov](mailto:john.lamb@nrc.gov).

Sincerely,

*/RA/*

John Lamb, Senior Project Manager  
Plant Licensing Branch I-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-272 and 50-311

Enclosure:  
Staff Assessment of Flooding  
Walkdown

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