



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: HOPE CREEK GENERATING STATION – STAFF ASSESSMENT OF THE FLOODING WALKDOWN REPORT SUPPORTING IMPLEMENTATION OF NEAR-TERM TASK FORCE RECOMMENDATION 2.3 RELATED TO THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT (TAC NO. MF0236)

Dear Mr. Joyce:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information letter pursuant to 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 Hope Creek Generating Station, Unit 1. The initial response was supplemented by letter dated April 12, 2013.

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 No. MF0236.

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.

Sincerely,

A handwritten signature in black ink, appearing to read "John Lamb", written over a printed name.

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

Docket No. 50-354

Enclosure:
Staff Assessment of Flooding
Walkdown Report

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
HOPE CREEK GENERATING STATION, UNIT NO. 1
DOCKET NO. 50-354

1.0 INTRODUCTION

On March 12, 2012,¹ the U.S. Nuclear Regulatory Commission (NRC) issued a request for information per Title 10 of the *Code of Federal Regulations*, Section 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, "Recommendation 2.3: Flooding,"² 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 of the 50.54(f) letter requested licensees to respond with the following information:

- 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

¹ Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340.

² 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 Park 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,"³ 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, 2012,⁴ the NRC endorsed the walkdown guidance

By letter dated November 26, 2012,⁵ 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 Hope Creek Generating Station (HCGS). PSEG supplemented its response by letter dated April 12, 2013.⁶

The NRC staff evaluated the licensee's submittals 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.

³ ADAMS Accession No. ML121440522.

⁴ ADAMS Accession No. ML12144A142.

⁵ ADAMS Accession No. ML12334A452.

⁶ ADAMS Accession No. ML13106A066.

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 for Nuclear Power Plants," Criterion 2: "Design bases for protection against natural phenomena;" and Appendix A to 10 CFR Part 100, "Seismic and 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.

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.

Section 3.1 of the HCGS Updated Final Safety Analysis Report (UFSAR) discusses conformance of the HCGS design with the GDC in Appendix A of 10 CFR Part 50. With respect to GDC 2, UFSAR Section 3.1.2.1.2.1 states that the HCGS design basis for protection against natural phenomena is in accordance with GDC 2.

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 licensee identified the design basis flood hazard for the HCGS is flooding from a probable maximum hurricane (PMH) surge with wave runup coincident with the 10 percent exceedence high tide. Under this scenario, the maximum stillwater level is 113.8 feet (ft.) PSD.⁷ The maximum wave runup elevation is to be 134 ft. PSD at the intake structure and 124.4 ft. PSD (along Fetch No. 1)⁸ at the powerblock structures (the maximum wave runup elevations are

⁷ 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).

⁸ Fetch defines the distance and direction of wave-generating wind travelling across a body of open water. The HCGS Updated Final Safety Analysis Report (UFSAR) evaluated nine fetch directions, each radiating from HCGS in the downstream direction of the Delaware River towards the Delaware Bay, to cover the entire length of Delaware Bay, from the bay entrance towards the plant site. Fetch No. 1 is at 134 degrees azimuth from the north. Each fetch direction is 15 degrees from the adjacent fetch (e.g., Fetch No. 2 is at 149 degrees azimuth from the north). Fetch 1

equal to or less than 119 ft. PSD for other fetch directions). The expected duration of flood surge above grade is about 12 hours; 6 hours for flood build up to maximum surge level followed by an unspecified period for flood level subsidence. The flood warning time was assumed to be more than 24 hours. The licensee also considered the flood hazard for single and multiple dam breaks.

Based on the NRC staff's review, the licensee appears to have sufficiently described the design basis flood hazard level(s) requested in the 50.54(f) letter and consistent with the walkdown guidance.

3.2 Flood Protection and Mitigation

3.2.1 Flood Protection and Mitigation Description

The HCGS 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 101.5 ft. PSD. Natural drainage flows toward the river and into the marsh areas to the north and east. Plant buildings are 500 to 2,700 ft. from the edge of the island (depending on fetch). Large waves break before reaching plant buildings as they encounter earth dikes along the shoreline, with top elevations of 106.5 ft. PSD, 5 ft. above plant grade. Structures of the Salem Nuclear Generating Station also provide protection against waves from the southerly direction. Sheetpile retaining walls and riprap construction, extending 100 ft. on both sides of the Intake Structure, provide protection against slope failure and minimize shoreline erosion.

The licensee indicated that structures that house HCGS safety-related equipment (e.g., the Reactor Building, the Auxiliary Building, and the Station Service Water System (SSWS) intake structure) are Seismic Category 1 structures and are designed to withstand the loads and effects of postulated floods. The ground floor elevation of these structures is 102 ft. PSD. All such structures are made of reinforced concrete and have the following protective characteristics:

- Exterior wall thicknesses below flood level of not less than 2 ft;
- Waterstops in exterior wall construction joints and seismic separation joints;
- Minimum number of openings in exterior walls and slabs below flood level to prevent flood water intrusion;
- Water pressure tight doors in exterior walls below flood level;
- Exposed equipment hatches above flood level (those below flood level have been installed behind exterior walls to prevent flood water intrusion);⁹

was chosen for the design basis flood hazard because the analysis (presented in the UFSAR) indicated that the surge level and coincident wind-wave action along Fetch No. 1 result in the highest maximum wave run-up elevation at the power block (relative to the other eight fetch directions).

⁹ One exception to this is the exterior hatch located at grade level in the north Radwaste Building. The hatch is designed to be water pressure tight.

- Continuous waterproofing systems applied to the underside of base slabs and on exterior walls to grade.

The licensee indicated that all Seismic Category 1 buildings are condition monitored on a regular basis.

3.2.2 Incorporated and Exterior Barriers

The site has incorporated exterior barriers that are permanently in-place, requiring no operator manual actions. There are numerous incorporated passive and active flood features at the HCGS, including penetration seals, watertight perimeter doors, river water level sensors (at the SSWS intake structure), leak detection sensors, and floor drainage systems. Earth dikes are located along the shoreline.

3.2.3 Temporary Barriers and Other Manual Actions

There are no temporary flood protection features credited in the HCGS CLB. Manual actions requiring operator action are triggered when the water level of the Delaware River reaches 95.0 ft. PSD at the SSWS intake structure. These include:

- Closing all SSWS intake structure watertight perimeter flood doors within 1 hour, or declare affected service water system components inoperable and take other required actions;
- Closing all power block watertight perimeter flood doors within 1.5 hours. The facility will be in at least hot shutdown within the following 12 hours and in cold shutdown within the following 24 hours. Once closed, all access through the doors is administratively controlled.

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;
- Verify operability of intake structure sump pumps;
- Initiate a notification to inspect the shoreline protection and dike system;
- Consider implementation of other procedures (e.g., "Acts of Nature");
- Verify the closure of all water tight doors, as required.

The "Acts of Nature" procedure ensures compliance with required actions such as closing and securing all watertight doors, monitoring and recording tide level on an hourly basis, and commencing shutdown procedures.

3.2.4 Reasonable Simulation and Results

HCGS credits active flood protection features (watertight perimeter doors) that require the implementation of a procedure to perform manual/operator actions (closing of doors) to enable the features to perform their intended design flood protection function. Reasonable simulation

of closing the perimeter doors was demonstrated and documented on September 18, 2012, and October 29, 2012 (Hurricane Sandy), in response to actual weather conditions, which resulted in river levels approaching and/or exceeding 95 ft. PSD. The excerpts of narrative logs of these events and actions are provided in the walkdown report.

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

Each isolated compartment housing safety-related components or systems is provided with a floor drainage system and alarm. The licensee indicated that the floor drainage systems are designed to handle normal leakage due to leaking pipe joints, valves, minor breaks, and concrete cracking. High water detectors and alarms are provided in compartments where water from internal flood events (like pipe breaks or tank failures) may occur. These detectors and alarms would notify operators when flood water enters the compartments unexpectedly.

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 the HCGS 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, 2012,¹⁰ the licensee 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."¹¹

¹⁰ ADAMS Accession No. ML12160A292.

¹¹ ADAMS Accession No. ML12173A215.

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.

The licensee stated that it used acceptance criteria in accordance with NEI 12-07.

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

The licensee reported that flood protection features at the HCGS are functional and in conformance with the CLB. There were 149 potential deficiencies to be further evaluated as part of the PSEG CAP per Attachment A 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 149 potential deficiencies because of the flood walkdowns.

NEI 12-07 requires licensees to identify observations in the CAP that were not yet dispositioned at the time the walkdown report was submitted. PSEG submitted 149 observations awaiting disposition.

3.6.3 Flood Protection and Mitigation Enhancements

The licensee has implemented or planned the following enhancement that improves or increases flood protection or mitigation: the licensee will improve a flood protection feature preventive maintenance procedure entitled "Missile Resistant and Watertight Doors P.M."

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 to Address

The licensee noted 149 potential deficiencies at the HCGS site (listed in Attachment A 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 183 restricted access features (listed in Attachment C 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 26 inaccessible features (listed in Attachment B of the walkdown report); these features were entered into the PSEG CAP. Further evaluation of these features was presented in the walkdown report:

- Waterproofing and Waterstops (General). Waterproofing and waterstops prevent or limit groundwater and floodwater intrusion at the concrete construction joints and seismic gap joints to protect safety-related equipment from flood level. They are inaccessible because waterproofing is located below grade and waterstops are located within the poured concrete. Inspection would require excavation and major disassembly of the concrete structure. 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 provided if the sump levels reach a pre-established setpoint at which excess water is collected and pumped to a waste holding tank.
- Penetration Seals W-5215-001 through W-5215-020. Penetration seals prevent ingress of groundwater and floodwater entering the Diesel Control Building through an exterior wall where electrical conduit enters the building. They are inaccessible because they are located below grade and cannot be inspected from either side of the wall. There were no physical signs of groundwater ingress.
- Exterior Walls of Rooms 111, 112, 113, 114. The exterior walls in each of these rooms prevent ingress of groundwater and floodwater. They are inaccessible because they are located below grade (since they are located vertically below an extended floor slab in the SSWS intake structure). The walkdown inspection found no signs of water ingress at the junction of the floor slabs and the exterior walls.

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 Staff Assessment of Walkdowns

The NRC staff reviewed the licensee walkdown report dated November 26, 2012, and a supplemental letter dated April 12, 2013.

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.

3.7 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."¹² In accordance with the TI, NRC inspectors independently verified that that licensee implemented the flooding walkdowns consistent with the intent of the walkdown guidance. Additionally, inspectors performed walkdowns of a sample of flood protection features. In Inspection Report 050003554/2012005, dated February 11, 2013,¹³ the results of this inspection were documented. No findings of significance were identified.

3.8 NRC Staff Audit

The NRC staff performed an audit of HCGS during the week of June 25, 2013. During the audit, the staff gained a better understanding of the process used by the licensee to perform the walkdowns. The audit report dated November 18, 2013,¹⁴ provides the results of this audit for HCGS.

3.9 SSCs to be Walked Down at a Later Date

The licensee identified restricted access features. See Attachment C of the walkdown report for a summary of the restricted areas.

¹² ADAMS Accession No. ML12129A108.

¹³ ADAMS Accession No. ML13042A376.

¹⁴ ADAMS Accession No. ML13266A297.

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.

Sincerely,

/RA/

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

Docket No. 50-354

Enclosure:
Staff Assessment of Flooding
Walkdown Report

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