



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

November 17, 2017

Mr. Robert S. Bement
Executive Vice President Nuclear/
Chief Nuclear Officer
Arizona Public Service Company
P.O. Box 52034, MS 7602
Phoenix, AZ 85072-2034

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 –
STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (CAC NOS.
MG0029, MG0030, MG0031, AND EPID L-2017-JLD-0020)

Dear Mr. Bement:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), "Conditions of Licenses" (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807). Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). By letter dated December 12, 2014 (ADAMS Accession No. ML14350A466), Arizona Public Service Company (the licensee) responded to this request for Palo Verde Nuclear Generating Station, Units 1, 2, and 3 (Palo Verde).


After its review of the licensee's response, by letter dated October 8, 2015 (ADAMS Accession No. ML15280A022), the NRC issued an interim staff response (ISR) letter for Palo Verde. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Palo Verde and parameters that are a suitable input for the mitigating strategies assessment (MSA). As stated in the letter, because the local intense precipitation (LIP) flood-causing mechanism at Palo Verde was not bounded by the plant's CDB, additional assessments of the LIP event are necessary.

By letter dated June 29, 2017 (ADAMS Accession No. ML17181A515), the licensee submitted the focused evaluation (FE) for Palo Verde. The FE is intended to confirm that the licensee has adequately demonstrated, for the unbounded LIP event identified in the ISR letter, that: 1) the LIP event is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the LIP event; or 3) a feasible response is provided for the LIP event. The purpose of this letter is to provide the NRC's assessment of the Palo Verde FE.

As set forth in the attached "staff assessment," the NRC staff has concluded that the Palo Verde FE was performed consistent with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). NEI 16-05, Revision 1, has been endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301). The NRC staff has further concluded that the licensee has demonstrated that effective flood protection, if appropriately implemented, exists for the LIP flood event during a beyond-design-basis external flooding event. This closes out the licensee's response for Palo Verde for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with CAC Nos. MG0029, MG0030, MG0031, and EPID L-2017-JLD-0020.

If you have any questions, please contact me at 301-415-2901 or at John.Boska@nrc.gov.

Sincerely,



John Boska, Senior Project Manager
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Enclosure:
Staff Assessment Related to the
Flooding Focused Evaluation for Palo Verde

Docket Nos: 50-528, 50-529, and 50-530

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO THE FOCUSED EVALUATION FOR
PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3
AS A RESULT OF THE REEVALUATED FLOODING HAZARD
NEAR-TERM TASK FORCE RECOMMENDATION 2.1 - FLOODING
(CAC NOS. MG0029, MG0030, MG0031, AND EPID L-2017-JLD-0020)

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 of the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). If the reevaluated hazard for any flood-causing mechanism is not bounded by the plant's current design basis (CDB) flood hazard, an additional assessment of plant response would be necessary. Specifically, the 50.54(f) letter states that an integrated assessment should be submitted, and described the information that the integrated assessment should contain. By letter dated November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015, the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants (ADAMS Accession No. ML15153A104). The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682). COMSECY-15-0019 outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's CDB. The revised process describes a graded approach in which licensees with hazards exceeding their CDB flood will not be required to complete an integrated assessment, but instead will perform a focused evaluation (FE). As part of the FE, licensees will assess the impact of the hazard(s) on their site and then evaluate and implement any necessary programmatic, procedural, or plant modifications to address the hazard exceedance.

Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), has been endorsed by the NRC as an appropriate methodology for licensees to perform the focused evaluation in response to the 50.54(f) letter. The NRC's endorsement of NEI 16-05, including exceptions, clarifications, and additions, is described in NRC JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force

Recommendation 2.1, Flood Hazard Reevaluation” (ADAMS Accession No. ML16162A301). Therefore, NEI 16-05, Revision 1, describes acceptable methods for demonstrating that Palo Verde Nuclear Generating Station, Units 1, 2, and 3 (Palo Verde) has effective flood protection.

2.0 BACKGROUND

This provides the final NRC staff assessment associated with the information that the licensee provided in response to the reevaluated flooding hazard portion of the 50.54(f) letter. Therefore, this background section includes a summary description of the reevaluated flood information provided by the licensee and the associated assessments performed by the NRC staff. The reevaluated flood information includes: 1) the flood hazard reevaluation report (FHRR); 2) the mitigation strategies assessment (MSA); and 3) the focused evaluation (FE).

Flood Hazard Reevaluation Report

By letter dated December 12, 2014 (ADAMS Accession No. ML14350A466), Arizona Public Service Company (the licensee) submitted the FHRR for Palo Verde. After reviewing the licensee’s response, by letter dated October 8, 2015 (ADAMS Accession No. ML15280A022), the NRC issued an interim staff response (ISR) letter for Palo Verde. The ISR letter discusses the reevaluated flood hazard mechanism that exceeded the CDB for Palo Verde and parameters that are a suitable input for the MSA. As stated in the ISR letter, because the local intense precipitation (LIP) flood-causing mechanism at Palo Verde is not bounded by the plant’s CDB, additional assessments of the LIP event is necessary. The NRC staff conducted an audit of the information in the FHRR and issued an audit report dated May 18, 2016 (ADAMS Accession No. ML16112A021). The NRC staff issued a final staff assessment of the FHRR in a letter dated November 14, 2016 (ADAMS Accession No. ML16306A444). The NRC staff’s conclusion regarding LIP exceeding the Palo Verde CDB remained unchanged from the information provided in the ISR letter.

Mitigation Strategies Assessment

By letter dated December 8, 2016 (ADAMS Accession No. ML16343B070), the licensee submitted the MSA for Palo Verde for review by the NRC staff. The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigation strategies for beyond-design-basis external events. By letter dated March 27, 2017 (ADAMS Accession No. ML17069A092), the NRC issued its assessment of the Palo Verde MSA. The NRC staff has concluded that the Palo Verde MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute (NEI) 12-06, Revision 2, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide” (ADAMS Accession No. ML16005A625). The NRC’s endorsement of NEI 12-06, Revision 2, is described in JLD-ISG-2012-01, Revision 1, “Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” (ADAMS Accession No. ML15357A163). The NRC staff further concluded that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazard conditions for beyond-design-basis external events.

Focused Evaluation

By letter dated June 29, 2017 (ADAMS Accession No. ML17181A515), the licensee submitted the FE for Palo Verde. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood

mechanism is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation. These 3 options associated with performing an FE are referred to as Path 1, 2, or 3, as described in NEI 16-05, Revision 1. The purpose of this staff assessment is to provide the results of the NRC's evaluation of the Palo Verde FE.

3.0 TECHNICAL EVALUATION

The licensee stated that its FE followed Path 2 of NEI 16-05, Revision 1, and utilized Appendix B for guidance on evaluating the site strategy. The Palo Verde FE addresses the LIP flooding mechanism, which had been found to exceed the plant's CDB as described in the FHRR and ISR letter. The licensee's modeling of the LIP event was previously reviewed and found acceptable by the NRC staff in the final staff assessment of the FHRR, in a letter dated November 14, 2016 (ADAMS Accession No. ML16306A444). This technical evaluation will address the following topics: characterization of flood parameters; evaluation of flood impact assessments; evaluation of available physical margin, reliability of flood protection features; and overall site response.

3.1 Characterization of Flood Parameters

Associated effects (AE) and flood event duration (FED) parameters were assessed by the licensee in its MSA for flooding. These parameters have already been reviewed by the NRC, as summarized by the NRC assessment letter dated March 27, 2017. The licensee used the AE and FED parameters as input to the Palo Verde FE and concluded that the site's flood strategy is effective in protecting structures, systems, and components (SSCs) that support key safety functions (KSFs). The licensee supported its conclusion of adequate flood protection by demonstrating adequate available physical margin (APM) and reliable flood protection features for LIP. In its MSA and FE for Palo Verde, the licensee indicated that the site does not require manual actions by plant personnel to protect key SSCs; therefore, an evaluation of the overall site response was not necessary.

All elevations in this document use the National Geodetic Vertical Datum of 1929 (NGVD29), which is approximately the height above mean sea level. The elevations for the reevaluated flood mechanism (LIP) are in the following table. For the LIP condition, the licensee relies on permanent passive flooding protection features and doors to demonstrate that adequate protection is available.

Table 1: Reevaluated LIP Flood Hazard Elevations (NGVD29)

	Grade Level of Powerblock (UFSAR Figure 2.4-4)	CDB LIP Flood Height (ISR letter)	Reevaluated LIP Flood Height (ISR Letter)
Unit 1	957.5 feet (ft.)	955.5 ft.	957.7 ft.
Unit 2	954.5 ft.	952.5 ft.	955.0 ft.
Unit 3	951.5 ft.	949.5 ft.	952.4 ft.

3.2 Evaluation of Flood Impact Assessment for LIP

3.2.1 Description of Impact of Unbounded Hazard

The Palo Verde FE identified the potential impacts on key SSCs as a result of water ingress due to LIP. The beyond-design-basis (BDB) LIP event leads to flood water surface elevations above the plant floor elevations at some locations. In order to assess the impacts of the unbounded flood levels, the licensee identified the maximum water surface elevations at the exterior door openings, maximum flood depths above the door threshold, and duration of when the flood levels are above the door threshold. With this information, the licensee assessed the impacts of water ingress and potential for accumulation into rooms housing key SSCs. The assessment was documented in Study 13-MS-A135, "Evaluation of Internal Flooding in Safety Related Structures as a Result of Localized Ponding at the Power Block During a LIP Event in Support of NRC 50.54(f) letter and the PVNGS Flood Hazard Reevaluation Report," Revision 0, dated December 11, 2014. Using the audit process, performed in accordance with a generic audit plan dated July 18, 2017 (ADAMS Accession No. ML17192A452), the NRC staff reviewed this report and determined that the report's conclusion that safety-related equipment needed for safe shutdown would remain functional during a LIP event without operator action was reasonable based on the evaluation.

The NRC staff reviewed the information provided by the licensee in order to ensure that adequate flood parameters were used for the calculation of water ingress and water accumulation. The NRC staff verified that the assumed duration of flooding above threshold elevation was consistent with previous information reviewed by the staff for the Palo Verde FHRR (ADAMS Accession No. ML14350A466).

3.2.2 Evaluation of Available Physical Margin and Reliability of Flood Protection Features

The licensee relies on passive features and existing doors and hatches to justify that there is available margin using a deterministic approach. Therefore, the licensee evaluated the key SSC elevations when compared to water ingress accumulation through exterior doors and hatches, and evaluated the hydrostatic and hydrodynamic loads on exterior doors.

Hydrostatic Loads on Exterior Doors

In its FHRR, the licensee stated that the maximum water height next to safety-related buildings was 0.63 feet above grade. The licensee also stated that the maximum hydrostatic load from this water is 10.2 pounds-force per foot (lbf/ft.) and the maximum hydrodynamic load is 3.2 lbf/ft, and that both are considered to be conservative numbers as the direction of flow is typically parallel to or away from the building, resulting in a reduction in the force. The licensee reported that there was no current licensing basis for hydrostatic and hydrodynamic loads, as the plant was initially licensed as a dry site (flood waters did not reach the safety-related buildings). Exterior doors open out, so the force from the water would push the door into the door frame rather than applying force to the latch. The licensee analyzed the doors in Study 13-CS-A039 and calculation 13-CC-ZZ-0313 and concluded that the doors will maintain their structural integrity with considerable margin, as the water level is low.

Water Ingress through Exterior Doors and Hatches

The licensee reviewed the rooms which contain key SSCs and determined the height of water which might affect the equipment needed for safe shutdown. The licensee then calculated how

much water could potentially leak into these rooms during the LIP event. This information was documented in Study 13-MS-A135 as noted above and summarized in Table 2 of the FE. All rooms with key SSCs had available margin before key SSCs would be affected. The staff notes that in general, floor drains were credited at a reduced capacity. The room with the lowest margin was the B Train 4160 volt Class 1E switchgear room (Room J-114), where the water level was 0.96 inches and the available margin was 0.54 inches. However, this was calculated with the assumption that the floor drains in this room were completely blocked. Appendix B of NEI 16-05 states that "Negligible or zero APM [available physical margin] can be justified as acceptable if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established." The NRC staff finds that the licensee followed the guidance of Appendix B, and that this low margin is acceptable. It is expected that the floor drains in the switchgear rooms will function during this event, as there is no mechanism present which would cause them to fail.

The NRC staff concludes, based on the information provided by the licensee, that adequate margin exists for the reevaluated LIP mechanism. The NRC staff concurs with the licensee's statement that conservative methods were used to estimate the water accumulation in plant rooms. No credit was given to active components, such as sump pumps, that could alleviate the water accumulation if power is available. Therefore, the NRC staff concludes that the licensee has demonstrated that adequate passive features exist to provide flood protection of key SSCs.

Evaluation of Reliability of Protection Features

Palo Verde relies on permanent passive flooding protection features, such as sealed hatches, exterior doors and walls, and man-made topography changes, to provide protection for flooding from LIP. The licensee evaluated the ability of these passive engineering features to withstand the flood conditions and the results are summarized above in the assessment of hydrostatic and hydrodynamic loads on exterior doors and water ingress through exterior doors and hatches. As noted in Study 13-MS-A135, the licensee evaluated the gap at the bottom of the doors and used that in the leakage calculation. Except for doors that were designed to be watertight, the licensee did not credit door seals. For watertight doors in critical locations, such as doors to the main steam support structure (MSSS) building that are below grade, repetitive maintenance is performed every refueling cycle to inspect the door seals. For hatches in the MSSS that are designed to be watertight and are credited for LIP, repetitive maintenance to inspect the sealant is performed every two refueling outages. For other credited hatches, such as those to the diesel generator fuel storage pits, the essential pipe density tunnels, the condensate storage tank tunnels, and the refueling water tank valve pits, Equipment Reliability Engineering Template ERET-3324300 is used to inspect the seals. The NRC staff concludes that these measures provide a basis to conclude that the above-mentioned passive features are evaluated by an appropriate maintenance and inspection regime to ensure they will continue to be available to perform their intended flood protection function.

Because increased focus has been placed on flood protection since the accident at Fukushima, licensees and NRC inspectors have identified deficiencies with equipment, procedures, and analyses relied on to either prevent or mitigate the effects of external flooding at a number of licensed facilities. Recent examples include those found in Information Notice 2015-01, "Degraded Ability to Mitigate Flooding Events" (ADAMS Accession No. ML14279A268). In addition, the NRC is cooperatively performing research with the Electric Power Research Institute to develop flood protection systems guidance that focuses on flood protection feature descriptions, design criteria, inspections, and available testing methods in accordance with a

memorandum of understanding dated September 28, 2016 (ADAMS Accession No. ML16223A495). The NRC staff expects that licensees will continue to maintain flood protection features in accordance with their current licensing basis. The staff also expects that licensees will use the site corrective action program to disposition flood-related maintenance, operations, and design issues, consistent with the provisions of NEI 16-05 and NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features," as endorsed by the NRC, where appropriate. Continued research involving flood protection systems will be performed and shared with licensees in accordance with the guidance provided in Management Directive 8.7, "Reactor Operating Experience Program," (ADAMS Accession No. ML122750292) as appropriate.

The NRC staff concludes that the Palo Verde flood protection features described above meet the definition of being reliable as discussed in Appendix B of NEI 16-05, Rev 1, in order to maintain key safety functions.

3.2.3 Overall Site Response

The licensee does not rely on any personnel actions or new modifications to the plant in order to respond to the BDB LIP event. As described above, the licensee's evaluation relies on passive existing flood protection features to demonstrate adequate flood protection; therefore, there is no need to review overall site response.

4.0 AUDIT REPORT

The generic audit plan dated July 18, 2017 (ADAMS Accession No. ML17192A452), describes the NRC staff's intention to conduct audits related to focused evaluations and issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's FE. Staff activities have been limited to performing the reviews described above. Because this staff assessment appropriately summarizes the results of those reviews, the NRC staff concludes that an audit report is not necessary, and that this document serves as the final audit report described in the July 18, 2017, letter.

5.0 CONCLUSION

The NRC staff concludes that the licensee performed the Palo Verde FE in accordance with the guidance described in NEI 16-05, Revision 1, as endorsed by JLD-ISG-2016-01, and that the licensee has demonstrated that effective flood protection exists from the reevaluated flood hazard. Furthermore, the NRC staff concludes that Palo Verde screens out of performing an integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard are not warranted. The licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 – STAFF
 ASSESSMENT OF FLOODING FOCUSED EVALUATION DATED November 17, 2017

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