



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

March 28, 2018

Mr. Mark E. Reddemann  
Chief Executive Officer  
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Richland, WA 99352

SUBJECT: COLUMBIA GENERATING STATION – STAFF ASSESSMENT OF FLOODING  
FOCUSED EVALUATION (EPID NO. 000495/05000397/L-2018-JLD-0000)

Dear Mr. Reddemann:

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, under 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 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 October 6, 2016 (ADAMS Accession No. ML16286A309, non-public), Energy Northwest (the licensee) responded to this request for Columbia Generating Station (Columbia).

After its review of the licensee’s response, on December 7, 2016 (ADAMS Accession No. ML16337A111), the NRC issued an interim staff response (ISR) letter for Columbia. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Columbia and parameters that are suitable for other assessments associated with NTTF Recommendation 2.1, “Flooding.” As stated in the letter, because the local intense precipitation (LIP) and streams and rivers flood-causing mechanisms at Columbia are not bounded by the plant’s CDB, additional assessments of these flood hazard mechanisms are necessary.

By letter dated January 25, 2018 (ADAMS Accession No. ML18025B515), the licensee submitted the focused evaluation (FE) for Columbia. 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. The purpose of this letter is to provide the NRC’s assessment of the Columbia FE.

As set forth in the attached staff assessment, the NRC staff has concluded that the Columbia 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). Guidance document 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 and streams and rivers flood mechanisms during a beyond-design-basis external flooding event at Columbia. This closes out the licensee's response for Columbia for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with EPID NO. 000495/05000397/L-2018-JLD-0000.

If you have any questions, please contact me at 301-415-1617 or by via e-mail at Frankie.Vega@nrc.gov.

Sincerely,



Frankie Vega, Project Manager  
Beyond-Design-Basis Management Branch  
Division of Licensing Projects  
Office of Nuclear Reactor Regulation

Docket No: 50-397

Enclosure:  
Staff Assessment Related to the  
Flooding Focused Evaluation for Columbia

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FOCUSED EVALUATION FOR

COLUMBIA GENERATING STATION

AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE

RECOMMENDATION 2.1 - FLOODING

EPID NO. 000495/05000397/L-2018-JLD-0000

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, under 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 stated 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 Directorate (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015 (ADAMS Accession No. ML15153A104), the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants. 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).

## 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.

### Flood Hazard Reevaluation Report

By letter dated October 6, 2016 (ADAMS Accession No. ML16286A309, non-public), Energy Northwest (the licensee) submitted its FHRR for Columbia. After reviewing the licensee's response, on December 7, 2016 (ADAMS Accession No. ML16337A111), the NRC issued an interim staff response (ISR) letter for Columbia. The ISR letter discusses the reevaluated flood hazard mechanisms that exceeded the CDB for Columbia and parameters that are a suitable input for the MSA and the FE. As stated in the ISR letter, because the local intense precipitation (LIP) and streams and rivers (PMF in the local drainage basin) flood-causing mechanisms at Columbia are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are necessary. The NRC staff issued a final staff assessment of the FHRR in a letter dated February 21, 2018 (ADAMS Accession No. ML18051A332, non-public). The NRC staff's conclusions regarding LIP and streams and rivers exceeding the Columbia CDB remained unchanged from the information provided in the ISR letter.

### Mitigation Strategies Assessment

By letter dated January 25, 2018 (ADAMS Accession No. ML18025B515), the licensee submitted its MSA for Columbia 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 23, 2018 (ADAMS Accession No. ML18074A077), the NRC issued its assessment of the Columbia MSA. The NRC staff concluded that the Columbia MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 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 hazards conditions for beyond-design-basis external events.

### Focused Evaluation

By letter dated January 25, 2018 (ADAMS Accession No. ML18025B515), the licensee submitted the FE for Columbia. 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 Columbia 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 Columbia FE addresses the LIP and streams and rivers flooding mechanisms, which were found to exceed the plant's CDB as described in the FHRR and ISR letter. This technical evaluation will address the following topics: characterization of flood parameters; evaluation of flood impact assessments; evaluation of available physical margin (APM); reliability of flood protection features; and overall site response.

#### 3.1 Characterization of Flood Parameters

The LIP and streams and rivers flood elevations, associated effects (AE) and flood event duration (FED) parameters that are used as input to the FE are the same as those that were used for the MSA. These parameters were assessed by Energy Northwest and have already been reviewed by the NRC, as summarized by letter dated March 23, 2018 (ADAMS Accession No. ML18074A077).

For LIP, the maximum reevaluated flood elevations are not bounded by the CDB elevation of 433.3 feet (ft.) mean sea level (MSL) at multiple locations throughout the site. Table 2 of the staff ISR letter identifies 23 points of interest (POIs) as having reevaluated hazard elevation values that were representative of several buildings located in the protected area. These reevaluated flood levels range from 435.1 ft. MSL to 443.3 ft. MSL. Site grade and flood protection elevation for Columbia is at an approximate elevation of 441 ft. MSL. The corresponding calculated maximum water depths at these POIs vary between 0.03 ft. and 0.79 ft. FHRR Table 1 provides the complete list of POI elevations and the maximum flooding depths estimated at each POI.

The FE credits passive permanent flooding protection features to demonstrate that key structures, systems, and components (SSCs) are protected from the LIP flooding mechanism. The licensee indicated that the site does not require additional manual actions by plant personnel to protect key SSCs; therefore, an evaluation of the overall site response was not necessary for LIP.

For streams and rivers, the maximum reevaluated flood elevation is 432.0 ft. MSL. This elevation is bounded by the CDB flood hazard elevation of 433.3 ft. MSL. In addition, normal site grade and flood protection elevation is at an approximate elevation of 441 ft. MSL.

The FE credits passive permanent flooding protection features to demonstrate that key SSCs are protected from the streams and rivers flooding mechanism. The licensee indicated that the site does not require additional manual actions by plant personnel to protect key SSCs; therefore, an evaluation of the overall site response was not necessary for streams and rivers.

The NRC staff reviewed the LIP and streams and rivers parameters listed in the licensee's FE and confirmed that they were consistent with the parameters that were presented in the MSA. Based on the review that was previously performed for the FHRR and MSA, the staff concludes

that the licensee's characterization of the LIP and streams and rivers events in the FE is appropriate.

### 3.2 Evaluation of Flood Impact Assessment for Local Intense Precipitation

#### 3.2.1 Description of Impact of Unbounded Hazard

The Columbia FE identified the potential impacts on key SSCs as a result of water ingress due to LIP. The 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 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 licensee's evaluation indicated that maximum reevaluated flood elevations exceeded the site protection elevation of 441 ft. MSL at several POIs throughout the site. The maximum water depths at these POIs vary between 0.03 ft. and 0.05 ft. In the FHRR, Table 1 provides the complete list of POI elevations and the maximum flooding depths estimated at each POI. The POIs where the estimated water surface elevation results exceeded the site protection elevation of 441 ft. MSL are shown below:

- Reactor Building railroad bay door (POI 3)
- Diesel Generator Tank access (POI 20)
- Service water B pump house personnel door (4)
- Radwaste Building truck ramp (POI 1)
- ISFSI Pad North (PASP No. 17)
- ISFSI Pad South (PASP No. 18)

The complete evaluation of the potential impacts of the LIP flood hazard was provided in the FHRR and in Energy Northwest calculation CE-02-13-22 "Effects of Local Intense Probable Maximum Precipitation Analysis for Columbia Generating Station." The licensee assumed that a limited amount of water would ingress the locations mentioned above and verified the location and elevation of key SSCs in each of these locations. Based on this evaluation, the licensee concluded that internal flooding from a LIP event would not affect any key safety functions (KSFs).

The NRC staff reviewed the information provided by the licensee in order to assure that adequate flood parameters were used for the calculation of water ingress and water accumulation. The NRC staff confirmed the flood parameters used for the calculation of water ingress and water accumulation were consistent with previous information reviewed by the staff for the Columbia FHRR and MSA.

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

The licensee relies on existing doors to justify that there is available margin. The licensee evaluated the potential water depths at several POIs across the site, evaluated the potential effects of water ingress at these locations and verified the elevation of key SSCs. The licensee concluded the key SSCs will not be impacted by the LIP flooding. As a result, the licensee concluded that adequate APM exits. Furthermore, the licensee stated that several conservative assumptions were made in the estimation of water surface elevation and water ingress, such as

not crediting storm drains and ignoring water stored on roofs or diversion away from the site in the roof drains that might result in higher calculated water surface elevations.

The NRC staff concludes, based on the information provided by Energy Northwest, that adequate margin exists for the reevaluated LIP mechanism. The NRC staff agrees that the licensee's estimation of water ingress and accumulation is reasonable. Therefore, the NRC staff concludes that the licensee has demonstrated that there is sufficient APM, as described in Appendix B of NEI 16-05, Revision 1.

### Evaluation of Reliability of Protection Features

Columbia relies on permanent passive flood protection features such as exterior doors to provide protection from LIP flooding.

The licensee stated that water could accumulate outside several doors of buildings housing key SSCs. The FHRR shows doorways that could potentially serve as pathways into structures containing key SSCs and provides the estimated maximum flood depth at such doorways. The FHRR also provides a summary of the calculated hydrostatic and hydrodynamic loads on the doors due to the LIP flood. The staff verified the information provided in the FHRR regarding these loads and, as stated in the FHRR and FE, agrees with the licensee in that the resultant loads are expected to be insignificant due to the shallow depth and low velocity resulting from the LIP.

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 under 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 NRC staff further expects that 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 Columbia flood protection features described above are reliable to maintain KSFs as defined in Appendix B of NEI 16-05, Revision 1.

### 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 LIP event. As described above, the licensee's evaluation relied on passive existing flood protection features to demonstrate adequate flood protection; therefore, there is no need to review overall site response.

### 3.3 Evaluation of Flood Impact Assessment for Streams and Rivers

#### 3.3.1 Description of Impact of Unbounded Hazard

As described in the FE, the maximum flood elevation from the streams and rivers flooding mechanism is 432.0 ft. MSL. Since the site grade elevation is 441 ft. MSL, no impacts were identified to key SSCs.

The NRC staff confirmed the flood parameters used for the calculation of water ingress and water accumulation were consistent with previous information reviewed by the staff for the Columbia FHRR and MSA

#### 3.3.2 Evaluation of Available Physical Margin and Reliability of Flood Protection Features

Columbia relies on the passive protection of the natural topography around the site to provide protection from the streams and rivers conditions. The APM for the streams and rivers was estimated at 9.0 ft. in relation to the plant grade of 441 ft. MSL. The staff concludes that this APM is acceptable because it meets the guidance found in NEI 16-05, Revision 1. Section B.1, which states that a standard used to support Federal Emergency Management Agency flood insurance studies can be used to define "adequate APM" for the river flood as 2.5 ft.

Since the site's natural topography is already credited as part of the Columbia's design-basis flood protection, the NRC staff concludes that a reliability analysis of these features is not necessary in accordance with the guidance found in NEI 16-05, Revision.

#### 3.3.3 Overall Site Response

The licensee does not rely on any personnel actions or new modifications to the plant in order to respond to the streams and rivers flooding event. As described above, the licensee's evaluation relied on the site's natural topography to demonstrate adequate flood protection. Therefore, there is no need to review overall site response for this mechanism.

## 4.0 AUDIT REPORT

The July 18, 2017, generic audit plan (ADAMS Accession No. ML17192A452) describes the NRC staff's intention to issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's FE. The NRC staff's Columbia audit was limited to the review of the calculations and procedures described above. Because this staff assessment appropriately summarizes the results of the audit, the NRC staff concludes that a separate audit report is not necessary, and that this document serves as the audit report described in the staff's July 18, 2017, letter.

## 5.0 CONCLUSION

The NRC staff concludes that Energy Northwest performed the Columbia 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, if appropriately implemented, exists for the reevaluated flood hazards. Furthermore, the NRC staff concludes that Columbia 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 following



completion of the licensee's regulatory commitments, are not warranted. The licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

**SUBJECT: COLUMBIA GENERATING STATION – STAFF ASSESSMENT OF FLOODING  
FOCUSED EVALUATION DATED March 28, 2018**

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