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January 25, 2018
GO2-18-010

10 CFR 50.54(f)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: **COLUMBIA GENERATING STATION, DOCKET NO. 50-397 ENERGY NORTHWEST'S SUBMITTAL OF THE MITIGATING STRATEGIES ASSESSMENT (MSA) AND FOCUSED EVALUATION (FE) FOR THE REEVALUATED FLOODING HAZARD**

References
1. Letter from E. J. Leeds (NRC) and M. R. Johnson (NRC) to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," dated March 12, 2012 (ADAMS No. ML12053A340)
2. Letter GO2-16-143 from A. L. Javorik (Energy Northwest) to the NRC, "Flooding Hazard Reevaluation Report, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident," dated October 6, 2016 (ADAMS ML16286A309)
3. Letter from L. K. Gibson (NRC) to M. E. Reddemann (Energy Northwest), "Interim Staff Response to Reevaluated Flood Hazards Submitted I-in Response to 10 CFR 50.54(f) Information Request - Flood-Causing Mechanism Reevaluation," dated December 7, 2016 (ADAMS ML16337A109) (Package ADAMS ML16337A111)

Dear Sir or Madam:

On March 12, 2012, the NRC requested information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for Flooding (Reference 1). One of the Required Responses in Reference 1 directed licensees to submit a Flood Hazard Reevaluation Report (FHRR). The Columbia Generating Station (Columbia) FHRR was submitted on October 6, 2016 (Reference 2). The staff completed its review of the FHRR as documented in Reference 3 and summarized the results in Table 1. Table 2 of Reference 3 describes the reevaluated flood hazards that exceed the current design basis. Reference 3 required Columbia to perform a mitigating strategies assessment (MSA) of the reevaluated flood hazards that exceed the current design basis and stated that based on the guidance provided in Revision 2 of NEI 12-06, flood event duration parameters and applicable flood associated effects should be considered as part of the MSA. Reference 3 stated that Columbia is also expected to submit an integrated assessment (IA) or a focused evaluation (FE), as appropriate, to address the reevaluated flood hazards identified in Table 2.

Enclosure 1 of this letter provides Columbia's flooding MSA and Enclosure 2 of this letter provides Columbia's FE. Both were performed using the using the guidance identified in Reference 3.

No new commitments are identified in this letter.

If you have any questions or require additional information, please contact Ms. L. L. Williams at (509) 377-8148.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on the 25th day of January, 2018

Respectfully,

A. L. Javorik
Vice President, Engineering

Enclosures As stated

cc: NRC RIV Regional Administrator
NRC NRR Project Manager
NRC Senior Resident Inspector/988C
CD Sonoda – BPA/1399 (email)
WA Horin – Winston & Strawn

Columbia Mitigating Strategies Assessment for Flooding

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Title:	MITIGATING STRATEGIES ASSESSMENT FOR FLOODING DOCUMENTATION REQUIREMENTS AT COLUMBIA GENERATING STATION	REPORT NO.: ENGNW~00460-REPT-002
		REVISION: 0
		Client: Energy Northwest
		Project Identifier: ENGNW~00460

Item	Cover Sheet Items	Yes	No
1	Does this Project Report contain any open assumptions, including preliminary information that require confirmation? (If **YES**, identify the assumptions.)	☐	☒
2	Does this Project Report supersede an existing Project Report? (If **YES**, identify the superseded Project Report.) **Superseded Project Report No.** ______________	☐	☒

Scope of Revision:
Initial Issue

Revision Impact on Results:
N/A

Safety-Related ☐ **Non-Safety-Related** ☒

Originator: **Brian Froese**

Design Verifier [1] (Reviewer for Non-Safety-Related): **Dora Garcia**

SME Reviewer: Anu Gaur

Digitally signed by Anu Gaur
DN: cn=Anu Gaur, o=Enercon Services Inc., ou=Project Manager, email=agaur@enercon.com, c=US
Date: 2017.11.28 09:18:40 -06'00'

Approver: **Jared Monroe** **Date:** **11/29/2017**

Note 1: Design Verification is required for all safety-related Project Reports. A review is adequate for non-safety-related Project Reports.

MITIGATING STRATEGIES ASSESSMENT FOR FLOODING DOCUMENTATION REQUIREMENTS AT COLUMBIA GENERATING STATION	REPORT NO.: ENGNW~00460-REPT-002
	REVISION: 0

PROJECT REPORT REVISION STATUS

REVISION	DATE	DESCRIPTION
0	11/29/2017	Initial Issue

ATTACHMENT REVISION STATUS

APPENDIX NO.	NO. OF PAGES	REVISION	ATTACHMENT NO.	NO. OF PAGES	REVISION
N/A			N/A		

Mitigating Strategies Assessment
Flooding Documentation Requirements
Columbia Generating Station

Acronyms:

- CDB – Current Design Basis
- CGS – Columbia Generating Station
- ELAP – Extended Loss of AC Power
- FHRR – Flood Hazard Reevaluation Report
- FLEX – Diverse and Flexible Coping Strategies covered by NRC order EA-12-049
- FLEX DB – FLEX Design Basis (flood hazard)
- ISR – Interim Staff Response
- LIP – Local Intense Precipitation
- MSFHI – Mitigating Strategies Flood Hazard Information (from the FHRR and MSFHI letter)
- MSL – Mean Sea Level
- PMF – Probable Maximum Flood

Definitions:

FLEX Design Basis: the flood hazard for which FLEX was designed.

1. Summary

The MSFHI provided in the CGS FHRR (Ref. 1) evaluates the eight flood-causing mechanisms and combined effect flood, identified in Attachment 1 to Enclosure 2 of the NRC information request (Ref. 3). The ISR provided by the NRC (Ref. 2) identified the flood mechanisms listed below as not bounded by the CDB:

(1) LIP

(2) Flooding in Streams and Rivers (PMF in the local drainage basin)

For both mechanisms, the overall FLEX strategies can be implemented as designed. The primary storage location for a full “N” set of FLEX equipment (Building 82) is protected and deployable after all external flooding events. The “N+1” storage building (Building 600) is also protected from all events, however certain sections of the deployment route may become inundated. If necessary, a portion of the vehicle barrier system can be removed to access equipment from the “N+1” building. Therefore, the current FLEX strategies can be deployed fully with no additional operator actions or pre-staging additional equipment. Further details of the FLEX strategies along with the reevaluated flood levels will be discussed later in this document.

2. Documentation

2.1. NEI 12-06, Rev. 2, Section G.2 – Characterization of the MSFHI

Characterization of the MSFHI is summarized in Table 2 of the NRC’s ISR (Ref. 2) to the FHRR (Ref. 1). A more detailed description of the flood mechanisms identified in the ISR, along with the basis for inputs, assumptions, methodologies, and models, is provided in the following references:

- LIP: Reference 1, Section 3.1.
- Flooding in Streams and Rivers: Reference 1, Section 3.2.
- Dam Breaches and Failures: Reference 1, Section 3.3.
- Probable Maximum Storm Surge: Reference 1, Section 3.4.
- Seiche: Reference 1, Section 3.5.
- Tsunami: Reference 1, Section 3.6.
- Ice-Induced Flooding: Reference 1, Section 3.7.
- Channel Migration or Diversion: Reference 1, Section 3.8.
- Combined-Effect Flood: Reference 1, Section 3.9.

Based on the results of the FHRR, the ISR issued by the NRC (Ref. 2) identified that the flood mechanisms described below are not bounded by the CGS CDB. Therefore, these mechanisms are included in this MSA developed in response to Order EA-12-049. All other mechanisms evaluated in the MSFHI (i.e.: tsunami, seiche, channel migrations/diversions, etc.) are not applicable, are bounded by design basis flood level, or have available topographic relief and have no impact on the site.

Local Intense Precipitation

The LIP is not included in the CDB and thus does not bound the MSFHI. Flooding depths range from 0.03 to 0.79 ft. (Ref. 1, Table 1). The calculated maximum water surface elevation of local ponding is 443.3 ft. MSL (Ref. 2, Table 2).

Flooding in Streams and Rivers

The PMF in the local drainage basin maximum flood height elevation is 432 ft. MSL and is bounded by the highest CDB PMF flood height of 433.3 ft. MSL (Ref. 2, Table 1). However, the CDB flood height is based on a slightly lower stillwater elevation of 431.1 ft. MSL and wave runup of 2.2 ft.

2.2. NEI 12-06, Rev. 2, Section G.3 – Comparison of the MSFHI and FLEX DB Flood Hazard

A complete comparison of the CDB, the FLEX DB and reevaluated flood hazards is provided in the tables listed below:

- Table 1 reflects data from the MSFHI for the LIP.
- Table 2 reflects data from the MSFHI for the bounding PMF in the local drainage basin.

Table 1 – Local Intense Precipitation

Flood Scenario Parameter		Plant CDB Flood Hazard	FLEX Design Basis Flood Hazard	MSFHI LIP	Bounded (B) / Not Bounded (NB) by FLEX DB
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft. MSL)	N/I	433.3	See Note 1	NB
	2. Max Wave Run-up Elevation (ft. MSL)	N/I	433.3	See Note 2	B
	3. Max Hydrodynamic/Debris Loading (psf)	N/I	See Note 3	See Note 3	B
	4. Effects of Sediment Deposition/Erosion	N/I	See Note 4	See Note 4	B
	5. Other Associated effects (identify each effect)	N/A	N/A	N/A	B
	6. Concurrent Site Conditions	N/A	N/A	N/A	B
	7. Effects on Groundwater	N/I	See Note 5	See Note 5	B
Flood Event	8. Warning Time (hours)	N/I	See Note 6	See Note 6	B
	9. Period of Site Preparation (hours)	N/I	See Note 7	See Note 7	B
	10. Period of Inundation (hours)	N/A	See Note 8	See Note 8	B
	11. Period of Recession (hours)	N/A	See Note 8	See Note 8	B
Other	12. Plant Mode of Operations	Normal Operations	Normal Operations	Normal Operations	B
	13. Other Factors	N/A	N/A	N/A	N/A

N/A = Not Applicable N/I = Not Included

Additional notes and explanations regarding the bounded/non-bounded determination:

1. The elevation of local ponding around the site due to the LIP varies from 435.1 ft. MSL to 443.3 ft. MSL at the points of interest evaluated. Site grade is 441 ft. MSL. The FLEX storage buildings are constructed above the FLEX DB flood elevation of 433.3 ft. MSL, closer to site grade. The resulting flood depths are generally low and vary between 0.03 ft. and 0.79 ft. (Ref. 5). Since the maximum elevation of ponding is above the FLEX DB, this is considered NB.
2. Consideration of wind-wave action for the LIP event is not explicitly required by NUREG/CR-7046 and is judged to be negligible because of the flow depths.
3. Hydrodynamic and debris loading are considered negligible for LIP given there is no wave run-up, the velocities are relatively low, and there are limited debris sources within the protected area.
4. The potential for erosion was evaluated and is not anticipated to cause any sediment deposition or erosion at CGS. Therefore, this is considered bounded.
5. The LIP is a short duration event and is not expected to result in changes to the groundwater level. However, all piping and electric conduit penetrations credited to perform a flood protection function that are below grade are waterproof sealed.
6. Warning time for the beyond design basis flood events postulated in the FHRR is not credited or deemed necessary for the CGS FLEX strategies because the FLEX strategies can be implemented following a LIP induced flooding event.
7. Significant plant preparation for the beyond design basis flood events postulated in the FHRR is not credited or deemed necessary at CGS for the FLEX strategies.

8. As discussed in the Order EA-12-049 Compliance Letter (Reference 4), certain areas along the deployment path from the “N+1” storage building (Building 600) may become inundated. The equipment stored in this building is not the primary equipment for a flood-induced BDBEE and only serves as a backup capability to the “N” set of equipment. The primary storage location for a full “N” set of FLEX equipment (Building 82) is protected and deployable after an external flooding event. Furthermore, the alternate equipment is still accessible by removing a portion of the vehicle barrier system if required. Therefore, this is considered bounded.

Table 2 – PMF in the Local Basin

Flood Scenario Parameter		Plant CDB Flood Hazard	FLEX Design Basis Flood Hazard	MSFHI PMF on the Local Basin	Bounded (B) / Not Bounded (NB) by FLEX DB
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft. MSL)	431.1	433.3	432.0	B
	2. Max Wave Run-up Elevation (ft. MSL)	433.3	433.3	432.0	B
	3. Max Hydrodynamic/Debris Loading (psf)	N/I	See Note 1	See Note 1	B
	4. Effects of Sediment Deposition/Erosion	N/I	See Note 2	See Note 2	B
	5. Other Associated effects (identify each effect)	N/A	N/A	N/A	B
	6. Concurrent Site Conditions	N/A	N/A	N/A	B
	7. Effects on Groundwater	N/I	See Note 3	See Note 3	B
Flood Event	8. Warning Time (hours)	N/I	See Note 4	See Note 4	B
	9. Period of Site Preparation (hours)	N/I	See Note 5	See Note 5	B
	10. Period of Inundation (hours)	N/I	See Note 6	See Note 6	B
	11. Period of Recession (hours)	N/I	See Note 6	See Note 6	B
Other	12. Plant Mode of Operations	Normal Operations	Normal Operations	Normal Operations	B
	13. Other Factors	N/A	N/A	N/A	N/A

N/A = Not Applicable N/I = Not Included

Additional notes and explanations regarding the bounded/non-bounded determination:

1. Hydrodynamic and debris loading were not formally evaluated as wave runup was calculated to be minimal and does not reach the site.
2. Sediment deposition/erosion effects do not impact CGS because flooding due to the PMF on the local basin does not encroach the site. No washouts or significant areas of erosion were found during walkdowns. Concrete, asphalt, and gravel paved areas are well maintained and no degraded areas were observed. Therefore, this is considered bounded.
3. All piping and electric conduit penetrations credited to perform a flood protection function that are below grade (441 ft. MSL) are waterproof sealed. Therefore, this is considered bounded.
4. Warning time for the beyond design basis flood events postulated in the FHRR is not credited or deemed necessary for the CGS FLEX strategies because the FLEX strategies can be implemented following a PMF event.
5. Significant plant preparation for the beyond design basis flood events postulated in the FHRR is not credited or deemed necessary at CGS for the FLEX strategies.
6. The power block and FLEX storage buildings are built above the plant design basis flood plain of 433.3 ft. MSL. As discussed in the Order EA-12-049 Compliance Letter (Reference 4), certain areas along the deployment path from the “N+1” storage building (Building 600) may become inundated. The equipment stored in the “N+1” storage building is not the primary equipment for a flood-induced BDBEE and only serves as a backup capability to the “N” set of equipment. The primary storage location for a full “N” set of FLEX equipment (Building 82) is protected and deployable after an external flooding event. Furthermore, the alternate equipment is still accessible by removing a portion of the vehicle barrier system if required. Therefore, this is considered bounded.

2.3. NEI 12-06, Rev. 2, Section G.4 – Evaluation of Mitigating Strategies for the MSFHI

2.3.1. NEI 12-06, Rev. 2, Section G.4.1 – Assessment of Current FLEX Strategies

2.3.1.1. LIP

There is only one flooding scenario parameter for the LIP that is not bounded by the FLEX DB. This is the Max Stillwater Elevation, where several areas of local ponding are above the FLEX DB elevation of 433.3 ft. MSL. Maximum flood depths around the power block, FLEX storage buildings, and deployment route from the "N" storage building (Building 82) are low in general (<0.8 ft.) and have relatively short durations (Ref. 5). This level of ponding will not affect the FLEX strategies given the equipment is trailer mounted. The FHRR also determined that any local ponding in areas above the site grade elevation of 441 ft. MSL do not flood any safety-related SSCs. As discussed in the FLEX Compliance Letter (Ref. 4), certain areas along the deployment path from the "N+1" storage building (Building 600) may become inundated due to the low elevation of the path. The equipment stored in the "N+1" storage building is not the primary equipment for a flood-induced BDBEE and only serves as a backup capability to the "N" set of equipment. The primary storage location for a full "N" set of FLEX equipment (Building 82) is protected and deployable after an external flooding event. Furthermore, the alternate equipment is still accessible by removing a portion of the vehicle barrier system if required.

2.3.1.2. Streams and Rivers

Since the maximum reevaluated hazard elevation of 432 ft. MSL is less than the designed FLEX elevation of 433.3 ft. MSL, the FLEX strategies can be implemented as intended and all flooding scenarios are bounded by the FLEX DB.

2.4. References

1. GO2-16-143, Columbia Generating Station, Docket No. 50-397 Flooding Hazard Reevaluation Report, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident, dated October 6, 2016 (ADAMS Accession No. ML16286A309).
2. Columbia Generating Station – Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (CAC No. MF3039), dated December 7, 2016 (ADAMS Accession No. ML16337A111).
3. Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident, U.S. Nuclear Regulatory Commission, March 2012 (ADAMS Accession No. ML12053A340).
4. GO2-17-147, Columbia Generating Station, Docket No. 50-397 Energy Northwest's Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses With Regard to Requirements for Mitigation For Beyond Design Basis External Events", dated August 17, 2017.
5. CE-02-13-22, Rev. 0, Effects of Local Intense Probable Maximum Precipitation Analysis for Columbia Generating Station (CGS).

Columbia Focused Evaluation for Flooding

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Title:		
	COLUMBIA GENERATING STATION FLOODING FOCUSED EVALUATION SUMMARY	**REPORT NO.:** ENGNW~00460-REPT-001
		REVISION: 0
		Client: Energy Northwest
		Project Identifier: ENGNW~00460

Item	Cover Sheet Items	Yes	No
1	Does this Project Report contain any open assumptions, including preliminary information that require confirmation? (If **YES**, identify the assumptions.)	☐	☒
2	Does this Project Report supersede an existing Project Report? (If **YES**, identify the superseded Project Report.) **Superseded Project Report No.** ____________	☐	☒

Scope of Revision:
Initial Issue

Revision Impact on Results:
N/A

Safety-Related ☐ **Non-Safety-Related** ☒

Originator: **Brian Froese**

Design Verifier [1] (Reviewer for Non-Safety-Related): **Mickey Hamby**

SME Reviewer: Freddy Dahmash

Approver: **Jared Monroe** | **Date:** 11/29/2017

Note 1: Design Verification is required for all safety-related Project Reports. A review is adequate for non-safety-related Project Reports.

COLUMBIA GENERATING STATION FLOODING FOCUSED EVALUATION SUMMARY	REPORT NO.: ENGNW~00460-REPT-001
	REVISION: 0

PROJECT REPORT REVISION STATUS

REVISION	DATE	DESCRIPTION
0	11/29/2017	Initial Issue

ATTACHMENT REVISION STATUS

APPENDIX NO.	NO. OF PAGES	REVISION	ATTACHMENT NO.	NO. OF PAGES	REVISION
N/A			N/A		

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COLUMBIA GENERATING STATION
FLOODING FOCUSED EVALUATION SUMMARY

1 EXECUTIVE SUMMARY

Columbia Generating Station (CGS) has reevaluated its flooding hazard in accordance with the NRC's March 12, 2012, 10 CFR 50.54(f) request for information (RFI) (Reference 1). The RFI was issued as part of implementing lessons learned from the Fukushima Dai-ichi accident; specifically, to address Recommendation 2.1 of the NRC's Near-Term Task Force report. This information was submitted to the NRC in a flood hazard re-evaluation report (FHRR) (Reference 2) and is summarized in the Mitigating Strategies Flood Hazard Information (MSFHI) documented in the NRC's "Interim Staff Response to Reevaluated Flood Hazards" letter dated December 7, 2016 (Reference 7). No changes to the flooding analysis have been performed since the issuance of the MSFHI letter and this flooding analysis will serve as input to this Focused Evaluation (FE). There are two (2) flood-causing mechanisms that were found to exceed the design basis flood level at CGS. These mechanisms are listed below and are included in this FE:

1. Local Intense Precipitation (LIP)
2. Streams and Rivers (Probable Maximum Flood (PMF))

Associated effects (AE) and flood event duration (FED) parameters for the LIP flood-causing mechanism are assessed and submitted as a part of the Mitigating Strategies Assessment (MSA). These parameters were not developed for the PMF since the maximum flood elevation is considerably below normal site grade and flood protection elevation of 441 feet (ft) Mean Sea Level (MSL).

This FE concludes there is effective flood protection for maintaining key safety functions (KSFs) during both mechanisms through the demonstration of adequate Available Physical Margin (APM) and reliability of flood protection features. This FE followed Path 2 of NEI 16-05, Rev. 1 (Reference 4) and utilized Appendix B to that document for guidance on evaluating the site flood protection features. This report documents completion of the actions related to External Flooding required by the March 12, 2012 10 CFR 50.54(f) letter.

2 BACKGROUND

On March 12, 2012, the NRC issued Reference 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for Flooding. The RFI (Reference 1) directed licensees, in part, to submit a FHRR to reevaluate the flood hazards for their sites using present-day methods and guidance used for early site permits and combined operating licenses. For CGS, the FHRR was submitted on October 6, 2016 (Reference 2).

Following the Commission's directive to NRC Staff in Reference 3, the NRC issued a letter to the industry (Reference 6) indicating that new guidance is being prepared to replace instructions in Reference 11 and provide for a "graded approach to flooding reevaluations" and "more focused evaluations of local intense precipitation and available physical margin in lieu of proceeding to an integrated assessment." NEI prepared the new "External Flooding Assessment Guidelines" in NEI 16-05 (Reference 4), which was endorsed by the NRC in Reference 5. NEI 16-05 Rev. 1 indicates that each flood-causing mechanism not bounded by the design basis flood (using only stillwater and/or wind-wave run-up level) should follow one of the following five assessment paths:

- Path 1: Demonstrate Flood Mechanism is Bounded Through Improved Realism
- Path 2: Demonstrate Effective Flood Protection
- Path 3: Demonstrate a Feasible Response to LIP
- Path 4: Demonstrate Effective Mitigation
- Path 5: Scenario Based Approach

Non-bounded flood-causing mechanisms in Paths 1, 2, or 3 would only require a FE to complete the actions related to external flooding required by the March 12, 2012 10 CFR 50.54(f) letter. Mechanisms in Paths 4 or 5 require an Integrated Assessment.

3 TERMS AND DEFINITIONS

- AE – Associated Effects
- AIMs – Assumptions, Inputs, and Methods
- APM – Available Physical Margin
- CDB – Current Design Basis
- CGS – Columbia Generating Station
- FE – Focused Evaluation
- FED – Flood Event Duration
- FHRR – Flood Hazard Re-evaluation Report
- FIAP – Flooding Impact Assessment Process
- FLEX – Diverse and Flexible Coping Strategies covered by NRC order EA-12-049
- HHA – Hierarchical Hazard Assessment
- HMR-57 – Hydrometeorological Report No. 57
- ISR – Interim Staff Response
- Key SSC – A System Structure or Component relied upon to fulfill a Key Safety Function
- KSF – Key Safety Function, i.e. core cooling, spent fuel pool cooling, or containment function
- LIP – Local Intense Precipitation
- MSA – Mitigating Strategies Assessment as described in NEI 12-06 Rev 2, App G
- MSFHI – Mitigating Strategies Flood Hazard Information
- MSL – Mean Sea Level (equivalent to NGVD 29 for CGS)
- NGVD 29 – National Geodetic Vertical Datum of 1929
- NRC – Nuclear Regulatory Commission
- NTTF – Near Term Task Force commissioned by the NRC to recommend actions following the Fukushima Dai-ichi accident
- PASP – Protected Area Survey Points
- PMF – Probable Maximum Flood
- RFI – Request for Information
- VBS – Vehicle Barrier System

4 FLOOD HAZARD PARAMETERS FOR UNBOUNDED MECHANISMS

The NRC has completed the "Interim Staff Response to Reevaluated Flood Hazards" (Reference 7) which contains the MSFHI related to the CGS FHRR (Reference 2). In Reference 7, the NRC states that the "staff has concluded that the licensee's reevaluated flood hazard information is a suitable input for other assessments associated with Near-Term Task Force Recommendation 2.1 'Flooding.'" The enclosure to Reference 7 includes a summary of the CDB and reevaluated flood hazard parameters. In Table 1 of the enclosure to Reference 7, the NRC lists the following flood-causing mechanisms for the current design basis flood:

- Local Intense Precipitation;
- Streams and Rivers;
- Failure of Dams and Onsite Water Control/Storage Structures;
- Combined Effect;
- Storm Surge;
- Seiche;
- Tsunami;
- Ice Induced Flooding; and
- Channel Migrations/Diversions.

In Table 2 of the enclosure to Reference 7, the NRC lists flood hazard information (specifically stillwater elevation and wind-wave run-up elevation) for the following flood-causing mechanisms that are not bounded by the design basis hazard flood level:

- Local Intense Precipitation
- Streams and Rivers

The two non-bounding flood mechanisms for CGS are described in detail in Reference 2, the FHRR submittal. Table 1 summarizes how these unbounded mechanisms were addressed in this Focused Evaluation:

Table 1 – Unbounded Flood Mechanisms

	Flood Mechanism	Summary of Assessment
1	Local Intense Precipitation	Path 2 was determined to be pursued for both mechanisms at CGS since all flooding vulnerabilities are addressed by flood protection features (see FIAP Path Determination Table, Section 6.3.3 of NEI 16-05). Adequate APM and reliability of flood protection features are all demonstrated.
2	Streams and Rivers	

5 OVERALL SITE FLOODING RESPONSE

5.1 DESCRIPTION OF OVERALL SITE FLOODING RESPONSE

The HHA approach described in NUREG/CR-7046 (Reference 8) was used for the evaluation of the LIP and PMF mechanisms' resultant water surface elevations at CGS. For these flood-causing mechanisms, two-dimensional hydrodynamic computer models were created using the FLO-2D software. These FLO-2D models were developed based on CGS site features including: topography, site location, structures, and VBS layout. The results of these FLO-2D evaluations are included in the FHRR. Potential pathways for water intrusion into below grade penetrations, walls, and floors in the Reactor Building and the Standby Service Water Pumphouses were also evaluated in the FHRR.

This FE credits passive protection features to demonstrate that Key SSCs are protected during the two (2) flooding mechanisms. All Key SSCs are flood protected up to a minimum elevation of 441 feet (ft) MSL per Section 2.4 of the FHRR (Reference 2). For the LIP, the maximum water surface elevation at CGS varies between 435.14 ft MSL and 443.27 ft MSL, with resulting maximum water depths between 0.03 ft and 0.79 ft. For the areas where the LIP local ponding water surface elevation is above the flood protection elevation of 441 ft MSL, the resulting flooding depth is minimal and due to the peak intensity rainfall. These occur only for a short duration with runoff and do not result in flooding of the CGS safety-related SSCs.

For the PMF in the local drainage basin, the maximum flood elevation of 432 ft MSL is below the protected elevation of 441 ft MSL and Key SSCs are not impacted.

No manual actions or active components are required by the site to protect Key SSCs for these events. Though not credited in this FE, additional defense-in-depth is provided by FLEX as confirmed in the flooding MSA (Reference 10).

5.2 SUMMARY OF PLANT MODIFICATIONS AND CHANGES

None.

6 FLOOD IMPACT ASSESSMENT

6.1 LOCAL INTENSE PRECIPITATION – PATH 2

6.1.1 Description of Flood Impact

The ISR identified the maximum LIP stillwater elevation varies between 435.1 ft MSL and 443.3 MSL. Per the FHRR (Reference 2), the reevaluated flood elevations are either below the flood protected elevation of Key SSCs at CGS of 441 ft MSL or do not impact any Key SSCs. These areas where the flooding heights are above 441 ft MSL were evaluated in the FHRR and are summarized in Section 6.1.2. There are no manual actions or active components credited in the FHRR.

6.1.2 Adequate APM Justification and Reliability of Flood Protection

The maximum flood depths at the twenty-three (23) PASP locations range between 0.03 and 0.79 ft (Reference 9). Of the twenty-three (23) PASP locations evaluated for LIP, seventeen (17) were below the flood protection elevation of 441 ft MSL and do not result in any impacts. The remaining six (6) were evaluated individually in the LIP calculation (Reference 9) as well as in the FHRR (Reference 2). In summary, PASPs 1, 3, 4, and 20 all result in 0.03 ft of ponding maximum, which is effectively negligible. However, leakage through access points at these PASPs was evaluated and determined to not impact any Key SSCs. Similarly, PASPs 17 and 18 result in 0.05 ft and 0.03 ft maximum of flooding, respectively, at the ISFSI pads, which are not adjacent to any safety related SSCs. Therefore, there is additional APM. However, for the purposes of determining adequacy in this FE, the APM is considered zero or negligible.

Per NEI 16-05 Appendix B Section B.1 "Negligible or zero APM can be justified as acceptable if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established." Since the AIMs used in the LIP analysis are conservative, this APM is adequate. The following are examples of conservatisms used in the LIP and PMP analyses (References 9 and 13, respectively):

1. It was conservatively assumed that all the drainage system components (e.g. gravity storm drain systems, culverts, and inlets) were non-functional or completely blocked during the LIP event.

2. All precipitation falling on the buildings was assumed to discharge onto the ground and contribute to ground surface runoff. This conservatively ignores storage on the roofs or diversion away from the site in the roof drains, which resulted in larger roof runoff volumes and higher calculated water surface elevations.

3. The HMR-57 (Reference 12) storm-based methodology was used, with the following conservative approaches:

a. Each storm was maximized in-place to produce a scenario representing how much larger the rainfall could have been had all atmospheric processes been combined in ideal conditions and transpositioned to CGS.

b. The greatest depth of the total adjusted rainfall of all transpositionable storms becomes the LIP depth for CGS at hourly increments up to 6 hours.

Per the discussion above, locations of ponding from a LIP above elevation 441 ft MSL were evaluated and do not result in flooding of CGS safety-related SSCs. Hydrodynamic and debris loading forces are not applicable to the LIP floods since, as discussed in the MSA (Reference 10), there is no wave run-up, the velocities are relatively low, and there are limited debris sources within the protected area. Therefore, this meets the criteria for reliability of doors in Section B.2.2.2 in NEI 16-05.

6.1.3 Adequate Overall Site Response

There are no required manual actions for this response to be successful and, therefore, an evaluation of the overall site response is not necessary.

6.2 STREAMS AND RIVERS – PATH 2

6.2.1 Description of Flood Impact

The PMF in the local drainage basin will not impact any structures that contain Key SSCs. Protection of all Key SSCs is provided by site grade, which is permanent and passive. There are no manual actions or active components credited in the FHRR.

Table 2 – Local Drainage Basin PMF APM

PMF Maximum Reevaluated Elevation	Site Flood Protection Height	APM
432.0 ft MSL	441.0 ft MSL	9.0 ft

6.2.2 Adequate APM Justification and Reliability of Flood Protection

Protection of all Key SSCs is provided by site topography which is inherently permanently installed and passive. Per NEI 16-05 Appendix B Section B.1, the APM of 9 ft is adequate since it meets the established criteria for uncertainties in the hydraulic model used to estimate flood levels. Per NEI 16-05 Appendix B Section B.1, "The minimum freeboard (e.g. margin) requirement, specified in 44 CFR 65.10(b)(1)(i) to account for uncertainty in the estimated flood level, is 3 feet overall and 4 feet within 100 feet on either side of a flow constriction (e.g. bridge)." Since the freeboard was calculated to be 9.0 ft (Reference 2), this APM is considered acceptable.

Site topography is a Type 1 feature that is already credited as part of the CGS design basis flood protection, and therefore per Appendix B of NEI 16-05, a reliability analysis to reconstitute all aspects of the original barrier design is not required. There are no active components credited.

6.2.3 Adequate Overall Site Response

There are no required manual actions for this response to be successful and, therefore, an evaluation of the overall site response is not necessary.

7 CONCLUSION

The FHRR concluded that there is no site response required to ensure the plant's Key SSCs will perform their KSFs. No additional actions or interim evaluations are planned to be taken at this time. The LIP and PMF flood mechanisms were not bounded by the site CDB as indicated in the ISR. For the LIP, the maximum flood elevation ranged between 435.1 ft MSL and 443.3 MSL. Several areas of local ponding were above the flood protected elevation of 441 ft MSL. These were evaluated in the FHRR (Reference 2) and determined that no Key SSCs are impacted. This was due primarily to the small resulting flood height that ranged between 0.03 and 0.05 ft as well as the short duration (<1 hour). The PMF maximum elevation of 432.0 ft MSL is below the site flood protection elevation and site grade of 441 ft MSL. Key SSCs are not impacted by this flood mechanism.

The site determined that all vulnerabilities due to the LIP and PMF mechanisms are addressed by existing site protection features and APM was demonstrated to be adequate to protect Key SSCs. This FE verified the reliability of the flood protection features using Appendix B of NEI 16-05. This places CGS in Path 2 to address these unbounded flooding mechanisms. Finally, for both flood mechanisms, the Flooding MSA has demonstrated that mitigating strategies developed within FLEX will be available to maintain/restore KSFs as a defense-in-depth measure. Additional information can be found in the Flooding MSA (Reference 10).

This submittal completes the actions related to External Flooding Response required by the March 12, 2012, 10 CFR 50.54(f) RFI. It is not anticipated that Phase 2 decision making will be necessary based on the information provided in this FE.

8 REFERENCES

1. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012.

2. GO2-16-143, Columbia Generating Station, Docket No. 50-397 Flooding Hazard Reevaluation Report, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident, Dated October 6, 2016.

3. NRC Staff Requirements Memoranda to COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards", dated March 30, 2015.

4. Nuclear Energy Institute (NEI), Report NEI 16-05, Rev. 1, External Flooding Assessment Guidelines.

5. U.S. Nuclear Regulatory Commission, JLD-ISG-2016-01, Rev. 0, Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation; Focused Evaluation and Integrated Assessment.

6. NRC Letter, Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events, dated September 1, 2015.

7. Columbia Generating Station – Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (CAC No. MF3039), dated December 7, 2016.

8. NUREG/CR-7046, Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America, November 2011.

9. CE-02-13-22, Rev. 0, Effects of Local Intense Probable Maximum Precipitation Analysis for Columbia Generating Station (CGS).

10. ENGNW~00460-REPT-002, Rev. 0, Mitigating Strategies Assessment for Flooding Documentation Requirements at Columbia Generating Station.

11. Letter from David L. Skeen, U.S. Nuclear Regulatory Commission, to Joseph E. Pollock, Nuclear Energy Institute – Trigger Conditions for Performing an Integrated Assessment and Due Date for Response, dated December 3, 2012.

12. Hydrometeorological Report No. 57, Probable Maximum Precipitation – Pacific Northwest States, October 1994.

13. CE-02-14-10, Rev. 0, Site-Specific Local Intense Probable (LIP) Determination for Columbia Generating Station.