DUANE
ARNOLD

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U. S. Nuclear Regulatory Commission
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Duane Arnold Energy Center
Docket No. 50-331
Renewed Facility Operating License No. DPR-49

Flooding Focused Evaluation Summary

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 (ML12073A348)
2) NG-14-0076, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendations 2.1, Flooding, of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident: Flood Hazard Reevaluation Report, dated March 10, 2014 (ML14072A019, ML14072A020)
3) NRC Letter, Duane Arnold Energy Center – Staff Assessment of Response to Request for Information Pursuant to 10 CFR 50.54(f) Information Request–Flood-Causing Mechanisms Reevaluation (CAC NO. MF3686), dated April 3, 2017 (ML17076A193)
4) NRC Letter, Correction to Duane Arnold Energy Center-Staff Assessment of Response to 10CFR 50.54(f) Information Request-Flood Causing Mechanism Reevaluation (CAC NO. MF3686), dated April 14, 2017 (ML17103A440)
5) NRC Letter, Duane Arnold Energy Center-Flood Hazard Mitigating Strategies Assessment, dated May 24, 2017 (ML17135A041)

On March 12, 2012, the NRC issued Reference 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for flooding. Reference 1 requested that licensees reevaluate flood hazards using present-day methods and regulatory guidance and submit a Flood Hazard Reevaluation Report (FHRR). NextEra Energy Duane Arnold, LLC submitted the FHRR for the Duane Arnold Energy Center

(DAEC) on March 10, 2014 (Reference 2), as supplemented by letters dated June 26, 2014 (ML14182A424) and August 12, 2016 (ML16229A159). The NRC issued a final Staff Assessment of the DAEC Flood-Causing Mechanism Reevaluation on April 3, 2017 (Reference 3), as supplemented on April 14, 2017 (Reference 4). Additionally, the NRC Staff documented an assessment of DAEC flood mitigating strategies required by NRC Order EA-12-049 (ML12054A736) in Reference 5.

Following the Commission's directive to NRC Staff on March 30, 2015 (ML15089A236), the NRC issued a letter to the industry (ML15175A257) indicating that new guidance was being prepared to replace existing instruction 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, which was endorsed by the NRC on July 11, 2016 (ML16162A301). NEI 16-05 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 Focused Evaluation (FE) to complete the actions related to external flooding required by the March 12, 2012, 10 CFR 50.54(f) letter (Reference 1). Mechanisms in Paths 4 or 5 require an Integrated Assessment. In Reference 3, the NRC staff indicated that DAEC should perform an FE for Local Intense Precipitation and for River and Stream flood events. The Enclosed report documents the final DAEC FE for these two flood causing mechanisms.

There are no regulatory commitments made in this letter. Should you have any questions regarding this matter, please contact Michael Davis at (319) 851-7032.

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

Executed on January 19, 2018

Dean Curtland

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Enclosure

Enclosure to NG-18-0008

<u>Flooding Focused Evaluation Summary for the Duane Arnold Energy Center</u>

18 pages follow

DUANE ARNOLD ENERGY CENTER
FLOODING FOCUSED EVALUATION REPORT

November 2017

NextEra Energy Duane Arnold, LLC
3277 DAEC Road
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DUANE ARNOLD ENERGY CENTER
FLOODING FOCUSED EVALUATION REPORT

1 EXECUTIVE SUMMARY

Duane Arnold Energy Center (DAEC) 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 NRC in a Flood Hazard Reevaluation Report (FHRR) on March 10, 2014 (Reference 2). The NRC staff review of the FHRR resulted in requests for additional information that are documented in References 3 and 4. Reference 4 contains the results of modeling sensitivity cases requested by the NRC during their review and the results are provided in the Mitigating Strategies Flood Hazard Information (MSFHI) documented in NRC's "Interim Staff Response to Reevaluated Flood Hazards" letter dated March 31, 2016 (Reference 11). Subsequently, the NRC issued a final Staff Assessment of the DAEC Flood-Causing Mechanism Reevaluation (References 12 and 13). The DAEC documented a Mitigating Strategies Assessment evaluating the capability of DAEC to mitigate an extended loss of AC power (ELAP) and loss of access to the ultimate heat sink (LUHS) as required by NRC Order EA-12-049 (Reference 22), under conditions including flooding consistent with the MSFHI in Reference 14. The NRC issued a Staff Assessment of the DAEC Mitigating Strategies in Reference 16. No changes to the flooding analysis have been performed since the issuance of the MSFHI letter and this flooding analysis will serve as the input to this Focused Evaluation (FE). There are two mechanisms that were found to exceed the design basis flood level at DAEC in Reference 12. These mechanisms are listed below and included in this FE:

- Local Intense Precipitation

  Associated effects (AE) and flood event duration (FED) parameters for Local Intense Precipitation (LIP) were assessed and submitted as a part of the Mitigating Strategies Assessment (MSA) (Reference 14). The FE concludes that water will not reach key safety systems and components (Key SSC) due to plant configuration. This FE followed Path 2 of NEI 16-05, Rev. 1 (Reference 6) and utilized Appendix B, Evaluation of Passive and Active Features, for guidance on evaluating the site strategy.

- Stream and River Flooding (including wind-wave run-up) for the Cedar River

  AE and FED parameters for the Cedar River were assessed and submitted as a part of the MSA. The FE concludes that the new flood effects and duration remain within the Available Physical Margin (APM) of existing flood protection features. This FE followed Path 2 of NEI 16-05, Rev. 1 and utilized Appendix B, Evaluation of Passive and Active Features as well as Appendix C, Evaluation of Site Response, for guidance on evaluating the site strategy.

This submittal completes the actions related to External Flooding required by the March 12, 2012 10 CFR 50.54(f) letter (Reference 1) and as requested in Reference 12.

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 Flood Hazard Reevaluation Report (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 DAEC, the FHRR was submitted on March 10, 2014 (Reference 2). Additional information was provided with References 3 and 4. Reference 4 contains the results of modeling sensitivity cases requested by the NRC during their review and the results are provided in the Mitigating Strategies Flood Hazard Information (MSFHI) documented in NRC's "Interim Staff Response to Reevaluated Flood Hazards" letter dated March 31, 2016 (Reference 11). Subsequently, the NRC issued a final Staff Assessment of the DAEC Flood-Causing Mechanism Reevaluation (References 12 and 13). In addition, the DAEC documented an evaluation of the capability of DAEC to implement strategies for mitigating an ELAP and LUHS as required by NRC Order EA-12-049 (Reference 22) under conditions including flooding consistent with the MSFHI in Reference 14. The NRC Staff documented an assessment of these DAEC flood mitigating strategies in Reference 16.

Following the Commission's directive to NRC Staff in Reference 5, the NRC issued a letter to industry (Reference 8) indicating that new guidance is being prepared to replace instructions in Reference 17 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 6), which was endorsed by the NRC in Reference 7. NEI 16-05 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 an FE to complete the actions related to external flooding required by the March 12, 2012, 10 CFR 50.54(f) letter (Reference 1). Mechanisms in Paths 4 or 5 require an Integrated Assessment. In Reference 12, the NRC staff indicated that DAEC should perform an FE for Local Intense Precipitation and for River and Stream flood events. This report documents the final DAEC FE for these two flood causing mechanisms.

3 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 (ML12073A348)
2. NG-14-0076, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendations 2.1, Flooding, of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident; Flood Hazard Reevaluation Report dated March 10, 2014 (ML14072A019, ML14072A020)
3. NG-14-0162, Nextera Energy Duane Arnold, LLC's Response to NRC Staff Request for Additional Information Related to Flood Hazard Reevaluation Report, dated June 26, 2014 (ML14182A424)
4. NG-16-0153, Response to Request for Information Supporting Flood Hazard Reevaluation Report Audit dated August 12, 2016 (ML16229A159)
5. 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 (ML15089A236)
6. Nuclear Energy Institute (NEI), Report NEI 16-05 [Revision 1], External Flooding Assessment Guidelines, dated June 2016 (ML16165A178)
7. U.S. Nuclear Regulatory Commission, JLD-ISG-2016-01, Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation; Focused Evaluation and Integrated Assessment, Revision 0, dated July 11, 2016 (ML16162A301)
8. NRC Letter, Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events, dated September 1, 2015 (ML15175A257)
9. Nuclear Energy Institute (NEI), Report NEI 12-06 [Revision 2], Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, dated December 2015 (ML16005A625)
10. U.S. Nuclear Regulatory Commission, JLD-ISG-2012-01, Revision 1, Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events, dated January 22, 2016 (ML15357A163)
11. NRC Letter, Duane Arnold Energy Center-Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request Flood-Causing Mechanism Reevaluation, dated March 31, 2016 (ML16084A788)
12. NRC Letter, Duane Arnold Energy Center – Staff Assessment of Response to Request for Information Pursuant to 10 CFR 50.54(f) Information Request– Flood-Causing Mechanisms Reevaluation (CAC NO. MF3686), dated April 3, 2017 (ML17076A193)

13. NRC Letter, Correction to Duane Arnold Energy Center-Staff Assessment of Response to 10CFR 50.54(f) Information Request-Flood Causing Mechanism Reevaluation (CAC NO. MF3686), dated April 14, 2017 (ML17103A440)

14. NG-16-0216, Flood Mitigating Strategies Assessment (MSA) Report Submittal, dated January 25, 2017 (ML17026A415)

15. NG-16-0217, NextEra Energy Duane Arnold, LLC's Notification of Full Compliance with Order EA-12-049 Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Bases External Events and Submittal of Final Integrated Plan, dated December 7, 2016 (ML16347A010)

16. NRC Letter, Duane Arnold Energy Center-Flood Mitigating Strategies Assessment (CAC NO. MF7923), dated May 24, 2017 (ML17135A041)

17. NRC Letter, Trigger Conditions for Performing an Integrated Assessment and Due Date for Response, December 3, 2012 (ML12326A912)

18. Updated Final Safety Analysis Report, Chapter 3.4, Revision 24, Water level (Flood) Design

19. Updated Final Safety Analysis Report, Chapter 10.4, Revision 24, Other Features of Steam and Power Conversion System

20. NG-12-0461, Response to NRC 10 CFR 50.54(f) Request for Information Regarding Near-Term Task Force Recommendation 2.3, Flooding, dated November 27, 2012 (ML12342A004)

21. NRC Letter, Duane Arnold Energy Center-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, dated June 17, 2014 (ML14162A176)

22. Order EA-12-049, Order Modifying the Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, March 12, 2012 (ML12054A736)

23. NS13F002, Revision 35, Fire Door and Frame Inspection

24. AOP 902, Revision 60, Abnormal Operating Procedure-Flood

25. AOP 903, Revision 59, Abnormal Operating Procedure-Severe Weather

26. Engineering Change 280489, Revision 16, FLEX RPV Injection, Refuel Floor Vent, and Other Mechanical Modifications

4 TERMS AND DEFINITIONS

- MSFHI – Mitigating Strategies Flood Hazard Information
- FHRR – Flood Hazard Reevaluation Report
- ELAP – Extended Loss of ac Power
- LUHS – Loss of Normal Access to the Ultimate Heat Sink
- AIMs – Assumptions, Inputs, and Methods
- LIP – Local Intense Precipitation
- NTTF – Near Term Task Force commissioned by the NRC to recommend actions following the Fukushima Dai-ichi accidents
- FLEX – Diverse and flexible coping strategies covered by NRC order EA-12-049
- Key SSC – A system Structure or Component relied upon to fulfill a KSF
- KSF – Key Safety function, i.e. core cooling, spent fuel pool cooling, or containment function.
- APM – Available Physical Margin
- TSA – Time Sensitive Action, as described in NEI 16-05 Appendix C
- MSA – Mitigating Strategies Assessment as described in NEI 12-06 Rev 2, App G
- RFI – Request for Information
- PMP – Probable Maximum Precipitation
- DAEC – Duane Arnold Energy Center
- AOP – Abnormal Operating Procedure

5 FLOOD HAZARD PARAMETERS FOR UNBOUNDED MECHANISMS

The NRC completed the Staff Assessment of the DAEC FHRR and NTTF Recommendation 2.1, "Flooding" in References 12 and 13. In Table 2.2-1 of Enclosure 2 to Reference 12, the NRC lists the following flood-causing mechanisms for the design basis flood:

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

In Table 3.1-1 of Enclosure 2 to Reference 12 the NRC lists the current design basis flood hazard elevations at Duane Arnold. In Table 3.0-1 of Enclosure 2 to Reference 12 the NRC lists the following flood-causing mechanisms that are not bounded by the design bases of the DAEC:

- Local Intense Precipitation and Associated Drainage (Turbine Building)
- Streams and Rivers (Cool-Season PMP)

These are the reevaluated flood-causing mechanisms that are to be addressed in the focused evaluation of external flooding. The two non-bounding flood mechanisms for DAEC are described in detail in References 2 and 4, the FHRR submittal and associated RFI responding to the NRC audit. All other flood causing mechanisms are either bounded or not applicable to the DAEC site. The flood event durations (FED) are discussed in the MSA (Reference 14) and were reviewed by the NRC staff in the subsequent staff assessment (Reference 16). The following summarizes how each of these unbounded mechanisms is addressed in this external flooding assessment:

	Flood Mechanism	Summary of Assessment
1	Local Intense Precipitation	The assessment of the effects of Local Intense Precipitation on DAEC utilized Path 2 of NEI 16-05 (Reference 6). The existing plant configuration including turbine building doors provide adequate APM to ensure Key SSCs are not adversely affected by the projected water ingress.
2	Streams and Rivers	The assessment of the effects of unbounded Stream and River Flooding at DAEC utilized Path 2 of NEI 16-05 (Reference 6). The Available Physical Margin (APM) of features already credited in the design and licensing bases for flood protection are sufficient to ensure Key SSCs are not adversely affected by the projected water level including wind-wave runup.

6 OVERALL SITE FLOODING RESPONSE

6.1 DESCRIPTION OF OVERALL SITE FLOODING RESPONSE

6.1.1 Site Response to Flooding from LIP

A site specific evaluation of the most intense rainfall anticipated on site at DAEC was performed in Reference 2. The analyzed rainfall was 14.1 inches of precipitation in a 60 minute period. As documented in Reference 2, detailed modeling of the resulting water accumulation on site associated with this extreme rainfall event concluded the maximum water depth external to buildings containing Key SSCs would be approximately 0.8 feet above the lowest ingress thresholds for the Turbine Building. Four external doors on the Turbine Building are potential water ingress paths to buildings containing Key SSCs. The Turbine Building design includes open gratings that assure any water entering through the doors would readily flow to lower elevations of the building.

Evaluation of the resulting volume of water potentially entering the Turbine Building from the LIP concluded the accumulation would be less than 8 inches deep in the Turbine Building basement and this would have no impact on Key SSCs. As documented in the existing UFSAR Section 10.4.5.3 (Reference 19), water accumulations of as much as 8 feet in the turbine building would not adversely affect safe shutdown due to the location of key equipment. While some warning time may be available for the LIP event, no credit was taken for flood mitigation actions beyond normal plant configuration. A LIP event will not result in significant ingress of water to buildings other than the Turbine Building as documented in the FHRR due to the absence of ingress paths below the level of water accumulation. The plant procedure for severe weather response (Reference 25) does provide operators with direction for increased monitoring of areas containing Key SSCs for signs of water intrusion in association with heavy rainfall events, but no time sensitive operator actions (TSA) exist.

6.1.2 Site Response to Streams and Rivers Flooding

DAEC is located adjacent to the Cedar River. In the FHRR (Reference 2) the DAEC evaluated the potential flooding associated with combined events of a 100 year snowpack plus a snow season maximum rainfall event centered over the Cedar River Basin plus waves associated with a 2-year wind event occurring at the time of peak still water level. In Reference 4 DAEC provided additional information requested by the NRC staff related to the effects of different modeling assumptions for the extreme rainfall assumed in the analysis. The FED and warning times associated with flooding on the Cedar River are discussed further in Reference 14. Several days warning time is available for site preparations as documented in Reference 14. The existing site flood protection activities discussed in References 2, 14 and 18 include a combination of permanent plant structures and temporary features such as stop logs in doors and openings of plant buildings to ensure that buildings containing Key SSCs are protected to elevations with sufficient physical margin to prevent adverse impacts on Key SSCs from the maximum water level including wind-wave run-up from the revised flood hazard evaluation. The maximum water elevation projected including wind wave run-up is 767.8 feet Mean Sea Level (MSL)

(Reference 12 Table 3.3-2) on the south side of DAEC key structures. As documented in UFSAR Chapter 3.4 (Reference 18), DAEC flood protection features, including temporary protection for openings in the exterior walls, ensure flood protection to elevation 770.5 feet MSL on the northerly side, 773.7 feet MSL on the southerly side and 769 feet MSL on all other sides of safety related structures. This physical configuration was verified and the reasonable timing of installation of temporary features was validated under Reference 20. The available physical margin of the protective features exceeds the reevaluated maximum water level including wind-wave runup. This ensures no significant ingress of water that could affect Key SSCs.

No additional flood protection strategy beyond the existing design basis strategy is needed.

6.2 Summary of Plant Modifications and Changes

No plant modifications or changes are required as a result of this FE of the flooding hazard for the DAEC. To simplify plant response to conditions defined in NRC Order EA-12-049 (Reference 22), DAEC did modify the plant to install a water tight door to provide protection at Door 124 in the Turbine Building (Reference 26). This water tight door is normally closed, providing additional conservatism with respect to the potential water ingress to the Turbine Building as evaluated in Reference 2.

7 FLOOD IMPACT ASSESSMENT

7.1 Flood Mechanism-Local Intense Precipitation

7.1.1 Comparison of LIP Flood Levels to the Design Basis

Flood Mechanism Parameters-LIP				
	Parameter Description	Plant Design or Licensing Basis Flood Levels[1]	Revised Levels[1]	Bounded (B) or Not Bounded (NB)
1	Max Stillwater Elevation	Not Addressed	758.2 feet MSL[2]	NB[3]
2	Max Wave Run-up Elevation	Not Addressed	758.2 feet MSL[2]	NB[3]
3	Flood Event Duration	Not Addressed	1 Hour[4]	NB[3]

1) Elevations are listed to local datum for MSL consistent with site design drawings. The offset between the local datum and the standard North American Vertical Datum of 1988 is -0.38 feet.
2) The reported depth is for the location of Doors 136 and 137 of the DAEC Turbine Building. Doors 124 and 154 are affected by a slightly lower depth at 758.0 feet MSL. The depth of water above the affected door sills ranges from 0.5 feet to 0.8 feet and is used in calculations of expected water ingress to the Turbine Building to demonstrate Key SSCs are not impacted.
3) As noted in Reference 2, the effects of Local Intense Precipitation had been previously evaluated for DAEC in association with the DAEC Individual Plant Examination of External Events (IPEEE) for conditions that bounded the values determined by the FHRR, however, the IPEEE analysis is not considered part of the design bases of the plant and therefore this parameter is listed as "Not Bounded".
4) Calculation of water ingress conservatively assumed ponding adjacent to the Turbine Building doors for 1 hour. Calculations of water inflow to the Turbine building conservatively assumed the maximum depth for the full duration. This resulted in an accumulation of less than 8 inches of water in the Turbine Building basement.

7.1.2 Description of LIP Flood Impact

As documented in the FHRR (Reference 2), the only key structures with openings vulnerable to significant water ingress during a beyond-design-basis LIP event are exterior doors on the Turbine Building. In order to assess the impacts of the unbounded LIP flood event, DAEC 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. The NRC review of these evaluations are documented in References 12, 13 and 16. The impacts of water ingress and potential for

accumulation into rooms housing Key SSCs were evaluated in Reference 2. The configuration of the Turbine Building ensures that any water entering the building under the affected doors will readily flow to the lower elevation of the Turbine Building where Key SSCs are not affected. As noted in the FHRR (Reference 2), the calculated depth of water accumulating in the lower elevation of the Turbine Building was less than 8 inches. Flood water ingress due to the LIP would not impact the plant's key safety functions (KSF) because the estimated water accumulation would not reach the elevation of Key SSCs. UFSAR Section 10.4.5.3 documents that accumulations of 8 feet of water in this location from other events (internal flooding) would not adversely affect plant safety.

The potential for debris impacts of the unbounded flood levels from a LIP event on the exterior walls and doors of the plant buildings, including hydrostatic and hydrodynamic loading was judged to be negligible. (Reference 14 and 16).

7.1.3 Adequate APM and Reliability

During a LIP event doors on the Turbine Building are exposed to flood water up to a height equal to the maximum flood elevation. Since the doors are not water tight, leakage is assumed to occur into the building. Per NEI 16-05 Appendix B Section B.1 (Reference 6) negligible or zero APM can be justified as acceptable if the use of conservative assumptions, inputs and/or methods (AIM) are used. The following are examples of conservatisms used in the LIP flood analysis (Reference 2):

1. All site surfaces are considered impervious so no infiltration is credited.
2. The plant drainage system including roof drainage is assumed to be non-functional.
3. No credit is taken for sump pumps in the Turbine Building.
4. No credit is taken for operator actions to minimize ingress of water.
5. The maximum depth of water is assumed to be continuously present for calculation of the inflow to the Turbine Building.

As noted above, the accumulation of water in the Turbine Building as a result of a LIP event of 8 inches is a small fraction of previously evaluated (8 feet) water accumulation events in the Turbine Building ensuring adequate APM. Flood protection from a LIP event does not rely on active features or operator actions. The potential for debris impacts of the unbounded flood levels from a LIP event on the exterior walls and doors of the plant buildings, including hydrostatic and hydrodynamic loading was judged to be negligible. The Turbine Building doors are routinely inspected under a plant procedure (Reference 23) thus ensuring reliability of the feature.

7.1.4 Adequate Overall Site Response

As noted above, the site response to a LIP event does not rely on any operator actions, and therefore no evaluation of the overall site response is necessary.

7.2 Flood Mechanism-Rivers and Streams

7.2.1 Comparison of Flood Levels to the Design Basis

Flood Mechanism Parameters-Rivers and Streams				
	Parameter Description	Plant Design or Licensing Basis Flood Levels[1]	Revised Levels[1]	Bounded (B) or Not Bounded (NB)
1	Max Stillwater Elevation	764.1 feet MSL	765.2 feet MSL	NB
2	Max Wave Run-up Elevation	767 feet MSL[2]	767.8 feet MSL	NB

1) Elevations are listed to local datum for MSL consistent with site design drawings. The offset between the local datum and the standard North American Vertical Datum of 1988 is -0.38 feet.
2) During initial plant licensing, the Atomic Energy Commission required DAEC to commit to providing additional protection beyond the design to elevation 770.5 feet MSL on the northerly side, 773.7 feet MSL on the southerly side and 769 feet MSL on all other sides of safety related structures (Reference 18).

7.2.2 Description of Rivers and Streams Flood Impact

The DAEC response to a design bases flood event is described in UFSAR Chapter 3.4 (Reference 18) as well as in the FHRR (Reference 2). For the beyond-design-bases Rivers and Streams Flood event, the projected combined events cool season flood for the Cedar River, including wind-wave run-up, would result in water reaching an elevation approximately 0.8 feet above that calculated for the design bases. As discussed in Reference 18, the original licensing bases of the facility, required that protection be provided to an elevation of at least 2 feet above the elevation calculated for the design basis with additional margin on the sides of the building most susceptible to wind-wave run-up. The DAEC procedure for flood response (Reference 24) currently implements that higher level of protection, and therefore, the higher postulated flood elevation has no impact on Key SSCs. The elevation of protective features was verified via plant walk-downs in Reference 20, and the results of this walk down were reviewed by the NRC staff in Reference 21. Hydrodynamic/debris loads, warning times, period of site preparation, period of inundation, period of recession and other factors associated with the beyond-design-basis rivers and streams flooding event were reviewed and found to be acceptable by DAEC in the MSA (Reference 14). The DAEC MSA was reviewed by the NRC staff in Reference 16.

7.2.3 Adequate APM and Reliability

The DAEC protective features relied upon for protection from the beyond-design-basis river and steam flood event are those described in the current design and licensing bases in UFSAR Chapter 3.4 (Reference 18). These features provide protection to an elevation

770.5 feet MSL on the northerly side, 773.7 feet MSL on the southerly side and 769 feet MSL on all other sides of safety related structures. The calculated elevations for the beyond-design-bases flood event (Reference 4) as reviewed by the NRC Staff (Reference 12) including the wind-wave run-up are 767.8 feet MSL on the Southerly side, 766.2 feet MSL on the West side, and 766.7 on the East side. The configuration of site and power block structures is such that wind-wave run-up was not considered critical on the north side. Thus, a minimum of 2.3 feet of margin is available.

APM-Rivers and Streams				
	Key Structures	**Revised Levels[1] Including Wind-Wave Run-up**	**Protected Levels[1]**	**APM**
1	South Side	767.8 feet MSL	773.7 feet MSL	5.9 feet
2	West Side	766.2 feet MSL	769.0 feet MSL	2.8 feet
3	East Side	766.7 feet MSL	769.0 feet MSL	2.3 feet
4	North Side	Not Critical	Not Critical	Not Critical

1) Elevations are listed to local datum for Mean Sea Level consistent with site design drawings. The offset between the local datum and the standard North American Vertical Datum of 1988 is -0.38 feet.

The APM of 2.3 feet is adequate per NEI 16-05 Appendix B Section B.1 as the DAEC flood analysis (Reference 2 and 4) used conservative assumptions, inputs, and/or methods (AIM). Examples of conservatism in the AIM used for the DAEC analysis include:

1. The probable maximum precipitation (PMP) assumed is an extrapolation beyond the largest observed cool-season PMP.
2. The PMP is assumed to co-occur with a 100 year snow pack.
3. The location of the PMP is assumed to occur at the optimal location on the Cedar River basin to maximize flooding results.
4. The snow pack is assumed to be fully ripened at the time of the PMP to maximize the potential melting associated with the event.
5. The wind event generating the waves is a 2 year wind event and is assumed to occur at the time of peak still water elevation.

The features relied on for protection for the beyond-design-bases rivers and streams flood event are identical to those relied on for a design bases event and the reliability is judged to be equivalent given the small difference in assumed conditions.

7.2.4 Adequate Overall Site Response

This evaluation, performed in accordance with NEI 16-05 Appendix C, has demonstrated the overall site response to an event associated with rivers and streams flooding is adequate. The site response for the beyond-design-bases river and streams flood event is identical to the response to the design bases flood described in UFSAR Section 3.4 (Reference 18). No new actions or time constraints are associated with site response to the beyond-design-bases rivers and streams flood event.

7.2.4.1 Defining Critical Path and Identifying Time Critical Actions

The warning time available for flood preparation activities for the beyond-design-bases flood of rivers and streams for DAEC is 4 days and 17 hours (Reference 14). The time required to complete any individual tasks associated with site preparation is a fraction of the available time, and most tasks can be performed in any sequence. Therefore, there are no time critical actions or prescribed critical path. Appendix 4 of AOP 902 (Reference 24) provides a suggested timeline for efficient use of resources that ensures all flood preparation activities would be completed with at least 24 hours of margin (Reference 14).

7.2.4.2 Demonstration That All Time Critical Actions Are Feasible

In Reference 20, DAEC documented the performance of reasonable simulations that demonstrated the flood protections activities for the design bases flood are feasible. The NRC staff review of the DAEC flood response is documented in Reference 21. The DAEC response to the beyond-design-bases flood of rivers and streams is the same as the design bases flood and therefore no additional demonstration is warranted.

7.2.4.3 Establishing Unambiguous Procedural Triggers

AOP 902 (Reference 24) ensures actions are begun upon issuance of flood advisories from the National Weather Service or if meteorological conditions are occurring or forecast to cause river level to increase above a prescribed level. Clear procedural actions are tied to specific river levels.

7.2.4.4 Proceduralized and Clear Organizational Response to Flood

AOP 902 (Reference 24) provides clear direction on organizational responsibilities for flood preparation. The Shift Manager is ultimately responsible for all site actions taken. Attachment 1 to AOP 902 specifies flood prestaging activities with a checklist of associated personnel responsible for performance of each action. There are no manual actions required to be performed after flood waters reach plant grade, although actions may be taken to protect economic assets.

7.2.4.5 Detailed Response Timeline

Given the amount of time available for flood preparations (4 days 17 hours), a detailed flood response timeline is not required. AOP 902 Attachment 4 (Reference 24) provides a suggested sequence for efficient use of resources, but tasks do not need to be performed in a specific order.

7.2.4.6 Accounting for Expected Site Conditions

The beyond-design-bases flood event for rivers and streams for DAEC involves a rainfall event centered substantially upstream of the DAEC site several days prior to the flood reaching the DAEC site. There are no manual actions required after water level reaches plant grade from the beyond-design-bases river and stream flooding event, therefore, unique environmental conditions expected with the flood response are not applicable.

7.2.4.7 Demonstration of Adequate Site Response

The site response to rivers and streams flooding has been demonstrated as adequate by meeting NEI 16-05 Appendix C. All required actions occur prior to the flood reaching plant grade based on a 4 day 17 hour warning period which provides adequate time for all site preparations.

8 CONCLUSION

The DAEC FE of the unbounded flood event for LIP has concluded that no Key SSCs are impacted by a LIP event due to the adequate APM provided by the existing plant configuration.

The DAEC FE of unbounded rivers and streams flooding events has concluded there is adequate APM in the licensing bases flood response features to continue to protect all Key SSCs.

This submittal completes the actions related to External Flooding required by the March 12, 2012 10 CFR 50.54(f) letter (Reference 1) and as requested in the Staff Assessment dated April 3, 2017 (Reference 12).