WOLF CREEK
NUCLEAR OPERATING CORPORATION

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Vice President Engineering

June 28, 2017

ET 17-0012

U. S. Nuclear Regulatory Commission
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References:

1) Letter dated March 12, 2012, from E. J. Leeds and M. R. Johnson, USNRC, to M. W. Sunseri, WCNOC, "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"

2) NRC Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012

3) Letter dated March 1, 2013, from E. J. Leeds, USNRC, to M. W. Sunseri, WCNOC, "Supplemental Information Related to Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) regarding Flooding Hazard Reevaluations for Recommendation 2.1 of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident"

4) Letter ET 14-0012, dated March 10, 2014, from J. P. Broschak, WCNOC, to USNRC

5) NRC Staff Requirements Memorandum SRM-COMSECY-14-0037, "Staff Requirements – COMSECY-14-0037 – Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," dated March 30, 2015

6) Letter ET 15-0012, dated May 20, 2015, from J. H. McCoy, WCNOC, to USNRC

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7) Letter dated December 24, 2015, from A. J. Minarik, USNRC, to A. C. Heflin, WCNOC, "Wolf Creek 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. MF3648)"

8) Letter ET 16-0003, dated January 19, 2016 from J. H. McCoy, WCNOC, to USNRC

9) Letter ET 16-0009, dated February 23, 2016 from J. H. McCoy, WCNOC, to USNRC

10) Nuclear Energy Institute (NEI) Report NEI 16-05, "External Flooding Assessment Guidelines," Revision 1, June 2016

11) NRC Interim Staff Guidance JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment," Revision 0, July 11, 2016

12) Letter ET 16-0029, dated November 8, 2016, from J. H. McCoy, WCNOC, to USNRC

Subject: Docket No. 50-482: Wolf Creek Nuclear Operating Corporation's Flooding Focused Evaluation Summary Submittal

To Whom It May Concern:

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Reference 1 to request information associated with Near-Term Task Force Recommendation 2.1 for Flooding. One of the Required Responses in Reference 1 directed licensees to submit a Flood Hazard Reevaluation Report (FHRR). Wolf Creek Nuclear Operating Corporation (WCNOC) submitted the FHRR for Wolf Creek Generating Station (WCGS) on March 10, 2014 (Reference 4). The FHRR was further developed in response to requests for additional information (RAIs) (Reference 6), subsequent submittal of Revision 1 of the FHRR (Reference 8) and responses to RAIs regarding Revision 1 of the FHRR (Reference 9). Herein, References 8 and 9 are referred to as the FHRR. Per Reference 3, the NRC considers the FHRR to be beyond the current design/licensing basis of operating plants.

Concurrent to the FHRR, WCNOC developed and implemented mitigating strategies in accordance with NRC Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Reference 2). In NRC SRM-COMSECY-14-0037 (Reference 5), the Commission affirmed that licensees need to address the reevaluated flooding hazards within their mitigating strategies for Beyond Design Basis External Events (BDBEE), including the reevaluated flood hazards. Letter ET 16-0029 (Reference 12) submitted the Mitigating Strategies Assessment (MSA) for New Flood Hazard Information using the Mitigating Strategies Flood Hazard Information (MSFHI) summarized in Reference 7 and the reevaluated flood hazard in the FHRR. Subsequently, a Flood Impact Assessment was to be performed in accordance with NEI 16-05 Revision 1 (Reference 10) and JLD-ISG-2016-01 (Reference 11) to demonstrate the adequacy of the existing plant design and mitigating strategies for responding to the reevaluated flooding hazards that exceed a facility's design basis flood level. The attachment to this letter provides a summary to the Wolf Creek Generating Station Flooding Focused Evaluation.

This letter contains no commitments. If you have any questions concerning this matter, please contact me at (620) 364-4156, or Cynthia R. Hafenstine (620) 364-4204.

Sincerely,

Jaime H. McCoy

Jaime H. McCoy

JHM/rlt

Attachment: Wolf Creek Generating Station Flooding Focused Evaluation Summary

cc: L. K. Gibson (NRC), w/a
K. M. Kennedy (NRC), w/a
B. K. Singal (NRC), w/a
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WOLF CREEK GENERATING STATION FLOODING FOCUSED EVALUATION SUMMARY

1. Executive Summary

The Wolf Creek Nuclear Operating Corporation (WCNOC) has reevaluated the Wolf Creek Generating Station (WCGS) flooding hazard in accordance with Near-Term Task Force (NTTF) Recommendation 2.1 and the Nuclear Regulatory Commission's (NRC) 10 CFR 50.54(f) request for information. This information was submitted to the NRC on January 19, 2016[1] in the Flood Hazard Reevaluation Report (FHRR) and is outlined in the NRC Mitigating Strategies Flood Hazard Information (MSFHI) letter to WCNOC dated December 24, 2015. No changes to the flooding analysis have been performed since the issuance of the NRC MSFHI letter, and the FHRR and MSFHI letter serve as the input to this Focused Evaluation (FE). There are two mechanisms that were found to exceed the design basis flood level of WCGS. These mechanisms are listed below and are included in this FE:

1. Local Intense Precipitation (LIP)
2. Failure of Dams and Onsite Water Control/Storage Structures

The FHRR screened out Dam Failure using methods that are more conservative than the current design basis and yielded a flood level that did not reach site grade. Consistent with the WCNOC Mitigating Strategies Assessment (MSA) Report for New Flood Hazard Information, Dam Failure is not considered a credible hazard and was not further evaluated as part of the FE. The assessment of LIP concluded that the strategy for maintaining key safety functions (KSFs) during a LIP event has effective flood protection through the demonstration of adequate Available Physical Margin (APM), reliable flood protection features, and an adequate overall site response. All key Structures, Systems, and Components (SSCs) are adequately protected from flooding due to LIP. This FE followed Path 2 of Nuclear Energy Institute (NEI) Report 16-05, Revision 1, and utilized Appendices B and C 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 without the need for the NRC staff to perform Phase 2 decision making per NRC Interim Staff Guidance (ISG) JLD-ISG-2016-01 and NEI 16-05.

[1] The January 19, 2016 submittal (ET 16-0003) was a re-submittal of information that was originally submitted on October 27, 2015 (ET 15-0027) that did not conform to the NRC's electronic information exchange.

2. Background

On March 12, 2012, the NRC issued Reference 1 to request information associated with NTTF Recommendation 2.1 for Flooding. One of the Required Responses in Reference 1 directed licensees to submit a FHRR. WCNOC submitted the FHRR for WCGS on March 10, 2014 (Reference 2). The Flood Hazard Reevaluation was further developed in response to requests for additional information (Reference 3), subsequent submittal of Revision 1 of the FHRR (Reference 4) and a response to requests for additional information regarding Revision 1 of the FHRR (Reference 5).

Following the Commission's approval of the NRC staff's recommendation in Reference 6, the NRC issued a letter to the industry (Reference 7) indicating that new guidance is being prepared to replace instructions in Reference 8 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 provided the External Flooding Assessment Guidelines in NEI 16-05 (Reference 9), which was endorsed by the NRC in Reference 10. Reference 9 indicates that each flood-causing mechanism not bounded by the design basis flood (using only stillwater and/or wind-wave runup level) should follow one of the following five assessment paths:

- Path 1: Demonstrate Flood Mechanism is Bounded
- 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 to complete the actions related to external flooding required by Reference 1 without the need for the NRC staff to perform Phase 2 decision making per References 9 and 10. Mechanisms in Paths 4 or 5 require an Integrated Assessment.

3. Flood Hazard Parameters for Unbounded Mechanisms

The NRC has completed the Interim Staff Response to Reevaluated Flood Hazards (Reference 11) related to WCGS's Flood Hazard Reevaluation Report (Reference 4). In Reference 11, the NRC states that the "...staff has concluded that the licensee's reevaluated flood hazards information, as summarized in this Enclosure, is suitable for the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and NRC staff) for Wolf Creek. Further, the NRC staff has concluded that the licensee's reevaluated flood hazard information is suitable input for other assessments associated with Near-Term Task Force Recommendation 2.1 'Flooding.'" The enclosure to Reference 11 includes a summary of the current design basis and reevaluated flood hazard parameters, respectively. In Table 1 of the enclosure to Reference 11, 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 Flooding
- Channel Migrations/Diversions

In Table 2 of the enclosure to Reference 11, the NRC lists flood hazard information for the following flood-causing mechanisms that are not bounded by the design basis hazard flood level:

- Local Intense Precipitation
- Failure of Dams and Onsite Water Control/Storage Structures

These are the reevaluated flood-causing mechanisms that should be addressed in the external flooding assessment. The two unbounded flood mechanisms for WCGS are described in detail in the FHRR (References 4 and 5). Table 1 summarizes how each of these unbounded mechanisms are addressed in this external flooding assessment. Table 2, Note 1 of the enclosure to Reference 11 stated "The licensee is expected to develop flood event duration parameters and applicable flood associated effects..." Table 2 below provides the parameters used for the LIP FE. These parameters are based on the FHRR and responses to requests for additional information (RAI) submittals.

Table 1 – Summary of Flood Impact Assessment

	Flood Mechanism	Summary of Assessment
1	Local Intense Precipitation	Path 2 was determined to be pursued for WCGS since use of flood protection features and implementation of a response procedure is the site strategy to maintain KSFs [see Flooding Impact Assessment Process (FIAP) Path Determination Table, Section 6.3.3 of NEI 16-05]. The parameters listed in Table 2 are based on the FHRR and MSFHI and were not revised as part of the FIAP.
2	Failure of Dams and Onsite Water Control/Storage Structures	A separate assessment for this hazard was not performed. The evaluation performed in ET 16-0029 (Reference 12) is valid for the FIAP and provides the basis for screening out this hazard as a beyond design basis challenge; in that, the dam breaches and failures flood hazard mechanism in the FHRR used a conservative screening method. The FHRR concluded that dam failure yielded a flood level that did not reach site grade. Consistent with the Flooding MSA (Reference 12), dam failure is not considered a credible hazard. The methods used in the FHRR are not comparable to the design basis methods. The FHRR screened out dam failure.

Table 2 – Flood Mechanism Parameters for LIP

Parameter Description	Values/Discussion	
1. Maximum Stillwater Elevation (ft Mean Sea Level (MSL)) - Areas Around the Powerblock - Areas Away from the Powerblock	 1,100.5 1,099.9	 (Note 1) (Note 1)
2. Maximum Wave Run-up Elevation (ft MSL)	Screened Out	(Note 2)
3. Maximum Hydrodynamic/Debris Loading (psf)	Screened Out	(Note 3)
4. Effects of Sediment Deposition/Erosion	Screened Out	(Note 4)
5. Other associated effects - Maximum Flow Velocity (fps)	 Screened Out	 (Note 5)
6. Concurrent Site Conditions - Winds (mph)	 38.65	 (Note 6)
7. Effects on Groundwater (ft MSL)	1,100.5	(Note 7)
8. Warning Time (hours)	1.0	(Note 8)
9. Period of Site Preparation (hours)	0.65	(Note 8)
10. Period of Inundation (hours)	1.24	(Note 9)
11. Period of Recession (hours)	8.76	(Note 9)
12. Plant Mode of Operations	All	
13. Other Factors	None	

Notes:

1. Table 2 shows the most bounding values around the site and does not represent the flood levels at pathways to key SSCs. Various locations around the site have different flooding depths. As noted in the FHRR, 11 doors have flood waters that exceed elevation 1,100 ft MSL. These are the only locations that require analysis in this Focused Evaluation. This is consistent with the MSA submittal (Reference 12).
2. Wind waves coincident with a LIP event were screened out as a potential hazard at the WCGS site in the FHRR based on the following factors: the shallow water depths near buildings, the direction of the flow velocities (generally away from buildings), and the height of the buildings in the powerblock that would tend to block wind and shorten fetch lengths. This is consistent with the MSA submittal.
3. The evaluation presented in the MSA submittal concluded that the key safety functions will not be challenged by hydrodynamic loads or associated flow velocities. The potential debris generation caused by the LIP event will be from unsecured materials located inside the plant powerblock. Procedurally controlled housekeeping practices minimize the amount of material/debris that can be moved by LIP runoff. The flow velocities inside the powerblock are low, minimizing debris transport and the ability for waterborne projectiles to adversely affect key SSCs. Therefore, hydrodynamic or debris loading due to LIP will not impact KSFs, consistent with the MSA submittal. The suction source for essential service water is Coffey County Lake. The potential for debris impact from LIP on essential service water suction in Coffey County Lake is bounded by the flooding in streams and rivers evaluation from Section 3.3.2.2.6.3 of the FHRR, which screened out debris clogging due to baffle dikes and the essential service water pump house trash racks.

4. Section 3.3.1.3 of the FHRR explains that sedimentation due to a LIP event (i.e., deposition and erosion of sediment) was screened out as a potential hazard for the WCGS site. Therefore, sedimentation due to LIP will not impact key safety functions, consistent with the MSA submittal.
5. The evaluation presented in the MSA submittal concluded that the flow velocities in and around site structures should not be of sufficient depth or velocity to impair the performance of human actions related to the protection of key safety functions. Therefore, consistent with the MSA submittal, flow velocities due to LIP will not impact key safety functions.
6. The value of 38.65 mph for the MSFHI is the 10-minute, two-year maximum sustained overland wind speed calculated in the FHRR for the flooding in rivers and streams hazard and was determined using the methods in the U.S. Army Corps of Engineers Coastal Engineering Manual. Placing quick dam flood barriers at eleven powerblock doorways is the only protective action that may be required to keep the buildings that contain key SSCs dry during a LIP event. With the exception of three deployment locations that require exterior access, the barriers are stored in the same buildings in which they need to be deployed and are deployed without going outside. The margin between deployment and available warning time shows that key safety functions can be maintained. Therefore, any slowdown in deployment of the barriers due to a wind of 38.65 mph occurring coincidentally with the LIP rainfall will not affect protection of key SSCs during a LIP event. Furthermore, if barriers are not placed prior to onset of LIP, this FE has shown that key SSCs are not impacted. Refer to Section 5.3 for further discussion.
7. Penetrations that limit water intrusion into the powerblock are credited flood protection features. The structures monitoring program is used to monitor water inleakage at joints and penetrations with an inspection interval of once every 5 years. Any seals determined to be deficient will be addressed by the site corrective action program. The APM of penetrations was evaluated and found to be acceptable. This will ensure key safety functions are not challenged. Safety-related buildings and structures are designed to Seismic Category I standards. The additional hydrostatic head considered by the MSFHI, as detailed in Tables 3-2 and 3-3 of the FHRR, is small and will not inhibit the design function of the safety-related structures. Therefore, the hydrostatic loads and groundwater levels due to LIP will not prohibit the implementation of key safety functions.
8. The evaluation presented in the MSA submittal shows that warning time is expected to be available such that required actions specific to flooding in Procedure, OFN SG-048, "Flash Flood Warning" (Reference 13) may be performed.
9. Information developed for the FHRR and the information used to respond to RAI 10 in Reference 5 are used as the basis for the development of the bounding flood event duration information. Based upon this information, the flood water exceeds the floor elevation of 11 doorways that are pathways to key SSCs. These pathways are protected by quick dam flood barriers that are deployed using Reference 13. The peak flood depths are either directly tied to the peak precipitation intensity (i.e., the peak ponding level occurs at the start of the storm when the peak intensity occurs) or lags the peak intensity by up to 30 minutes (i.e., flood levels begin to recede at these locations after 30 minutes) (Reference 14). Water begins to recede below the floor elevation at the critical doorways by approximately 30 minutes after the start of the LIP rainfall at most locations with the most rapid reduction beginning one hour after the start of the LIP rainfall. Time history plots from an FHRR input calculation show that standing ponding around the site occurs ten hours after the start of the event but by seven to eight hours into the event, a steady state ponding level is reached at most locations; this level is typically less than one inch of water. Flood levels have receded below the 11 entryway elevations as early as six minutes to as late as 1.24 hours into a LIP event. The timing information provided herein is based on model output files from an FHRR input calculation and is considered a refinement of the information presented in the MSA submittal.

4. <u>Overall Site Flooding Response</u>

4.1 Description of Overall Site Flooding Response

Key SSCs at WCGS that support core cooling, Spent Fuel Pool (SFP) cooling, and containment integrity are located in the Auxiliary Building (AB), Control Building (CB), Emergency Diesel Generator Building (DG), Fuel Building (FB), Reactor Building (RB), and Refueling Water

Storage Tank (RWST) Valvehouse. A conservative list of key SSCs was developed based on site internal flooding calculations, which evaluated the lowest safety-related SSC susceptible to flooding in each room. This list includes more SSCs than would be required by the definition of key SSCs. As discussed in Section 5.1, the main locations of concern are grade elevation of the FB and the basements of the AB and CB. The lowest SSCs included in the key SSC list for the FB at grade include spent fuel pool pump room coolers. The lowest SSCs included in the key SSC list for the AB basement include equipment and instrumentation for reactivity control, and pumps and associated electrical for charging, safety injection, residual heat removal, and containment spray. The lowest SSCs included in the key SSC list for the CB basement include equipment and electrical for essential service water (Reference 14).

The key SSCs are protected from the effects of LIP by incorporated passive and active flood protection features as well as through the deployment of temporary passive flood protection. Passive incorporated flood protection features include topography, walls, roofs, floor, and penetration seals. Incorporated active flood protection features include below grade pressure doors in the AB, watertight doors in the AB and CB, and sump pumps in the AB, CB, DG, and FB. The temporary passive flood protection features are commercial grade quick dam flood barriers that are deployed at select doorways when Reference 13 is implemented.

Without installation of the quick dam flood barriers, water may enter through eleven doorways that are pathways to key SSCs and were identified in the FHRR to have maximum transient ponding levels that exceed the entryway elevation of 1,100 ft MSL (2,000 ft Standardized Nuclear Unit Power Plant System (SNUPPS)). The water would accumulate in the FB and the basements of AB and CB. The barriers are to be deployed upon receipt of a flash flood warning. The barriers are stored in the Operations Storage Area of the Turbine Building at elevation 1,133 ft MSL (2,033 ft SNUPPS) for doors not in the radiation controlled area (RCA). Flood barriers to be used at doors within the RCA can be retrieved from either Area 5 Sump Storage Area of the Auxiliary Building at elevation 1,074 ft MSL (1,974 ft SNUPPS) or the Operations Storage Area of the Turbine Building. The deployment of barriers can be done concurrently, which allows more than one operator to perform actions, if available. With the deployment of the barriers, all KSFs and key SSCs will remain available during a LIP event. Though not credited in this evaluation, additional defense-in-depth is provided by FLEX as shown in the Flooding MSA addressing the potential for an extended loss of power occurring coincidently with a LIP event (Reference 12).

4.2 Summary of Plant Modifications and Changes

There are no remaining actions necessary to implement the flood strategy described above. The site has initiated site modifications that would provide added flood protection for the site. These modifications were not credited in the LIP FE.

5. Flood Impact Assessment

5.1 Description of Flood Impact

Table 2 in Reference 11 identifies the maximum LIP ponding elevation in areas around the powerblock as 1,100.5 ft MSL and 1,099.9 ft MSL for areas away from the powerblock. Potential inleakage due to the flood is protected against by the deployment of the quick dam flood barriers at the eleven locations where the FHRR determined that flood levels will exceed entryway elevations. Five of these doors are direct paths to key SSCs (i.e., they are doors that breach safety related buildings). The other six doors are indirect pathways through attached buildings and structures. Available Physical Margin was evaluated for the case where flood barriers are installed to prevent inleakage. For this case, APM was defined as the difference between the elevation at the top of the barrier and the maximum flood elevation at the barrier. The doorway with the lowest APM where barriers would be installed has an APM of 1.1 inches. Some doorways are pathways to key SSCs but do not require flood protection because the FHRR determined peak ponding levels lower than the entryway elevation; the lowest APM for these locations is 0.6 inches. Additionally, penetration seal APM was evaluated per References 9 and 15, and found to be adequate (Reference 14).

The potential case where quick dam flood barriers may not get installed was also evaluated. The evaluation found that water accumulation in areas containing key SSCs would be in the FB and the basements of AB and CB. The APM between key SSC height and LIP water accumulation inside buildings was determined to be 43 inches for the most vulnerable or lowest key SSC located in the AB basement, the boric acid tank instrumentation. The most vulnerable key SSC located in the basement of the CB, the electrical contacts for essential service water isolation valves, had an APM of 32.9 inches. The lowest key SSC located at grade elevation in the FB, 'A' train SFP pump room cooler, had an APM of 9.9 inches. This is due to site topographic features combined with the short duration of the LIP event preventing significant water accumulation from occurring that could impact key SSCs and does not even account for internal barriers (i.e., doors) that would limit water inundation. The evaluation also found that the accumulated water depths would be bounded by the site internal flooding design basis. LIP flood waters would not intrude into DG, RB, and RWST Valvehouse (Reference 14).

Since the maximum flood elevation does not impact any key SSCs, there are no consequential flood conditions. Therefore, there was no need to determine the consequential flood. In this context, the external flood mitigation strategies provided added margin to protect against the LIP hazard.

5.2 Adequate APM Justification and Reliability Flood Protection

The design basis for exterior penetration seals is to be leak tight. The structures monitoring program is used to monitor water inleakage at joints and penetrations with an inspection interval of once every 5 years. As discussed in Reference 5, penetrations with a history of leakage will be reworked or repaired. Any non-conforming conditions will be entered into the site corrective action program. Assuming an increase in the hydrostatic load attributed to the LIP peak ponding elevation to 1,100.5 ft MSL (the MSFHI flood elevation), the peak transient groundwater hydrostatic pressure on the lowest safety related building elevation (being 1,074 ft MSL, top of floor elevation) would increase by the ratio of (1,100.5-1,099.5) / (1,099.5-1,074) = 3.9%. Design margins for structures are well above this value. Therefore, it is not feasible that this transient increase in maximum ponding level would cause a sustained increase in the groundwater level of 1 foot of additional head not included in the current design basis. In addition, it is not feasible that this incremental head would cause sufficient penetration inleakage to affect the lowest potentially susceptible key SSC or accumulate to a depth that exceeds the design basis internal flooding analyses.

The evaluation for the case where barriers do not get installed shows that there is significant APM to the lowest potentially affected key SSC. Furthermore, the reevaluated LIP hazard was calculated with the following implicit conservatisms in the determination of flood levels (Reference 14):

- The rainfall distribution used was based on Hydrometeorological Report No. 52, as opposed to using a site-specific probable maximum precipitation study that would refine the rainfall analysis to be more representative of the local and regional conditions.
- The reevaluated LIP calculations applied a 1-hour, 1-sq-mi rainfall event that produces 19 inches of rainfall, which was nested into a 6-hr, 10-sq-mi probable maximum precipitation (PMP) event with a total rainfall of 28.59 inches, to the site drainage area that is less than 1-sq-mi.
- Roofs were modeled as flat; whereas, site roofs were sloped away from roof perimeters. Inclusion of the additional detail would increase the storage capability of the roofs and reduce ponding levels at grade.
- Flow routing through culverts, drainage ditches, and swales was not credited. The model grid cell size used effectively considers drainage features as blocked and only allowed overland flow. Discrete modeling of these features, as well as planned plant modifications, should reduce flood levels around the site.
- Underground drainage piping was not credited.

The site installs temporary flood barriers prior to the onset of LIP, using procedural controls. The APM associated with the top elevations of the barrier locations is considered adequate because all of these barriers are placed on the inside of doorways, except at the two rollup doors, with the main function being the prevention of leakage around door gaps. Furthermore, many of the barrier locations are at pressure or missile doors that are designed to be loaded with a differential pressure. Successful simulations of barrier installation have been performed. Additionally, site features not credited in the determination of APM for the case where barriers are not installed, include the operation of sump pumps in below grade rooms, and the capacity of floor drains and sumps. These would provide additional margin. In all cases, the internal flooding design basis flood levels bounded potential flood levels in rooms containing key SSCs that could be potentially impacted.

Therefore, APM is considered adequate and reliable (Reference 14).

5.3 Adequate Overall Site Response

This evaluation, performed in accordance with NEI 16-05, Appendix C, has demonstrated that the overall site response to LIP is adequate.

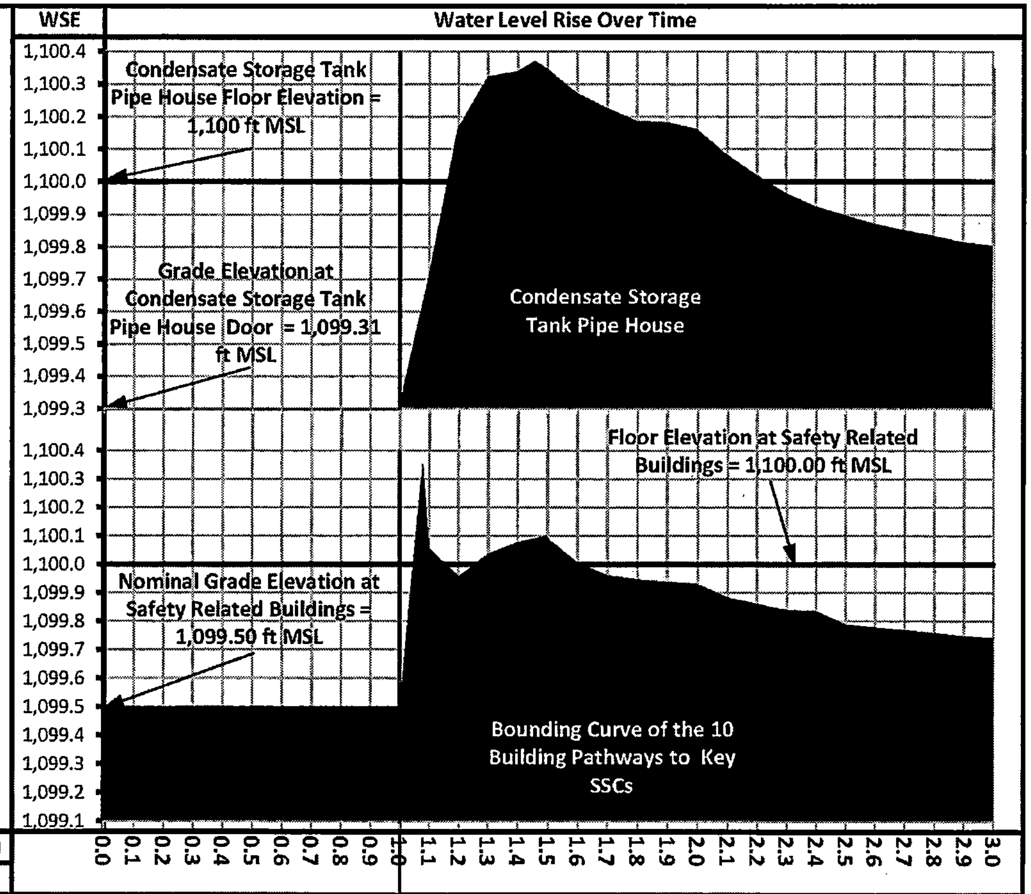
When a flash flood warning for Coffey County, Kansas is received from the National Weather Service, operations implements Reference 13 to install quick dam flood barriers. As evaluated in the MSA (Reference 12), there is at least one hour of warning time associated with the event. The procedure contains no timing requirements or critical path actions. The deployment of the barriers can be performed in any order, based on the number of available operators and weather conditions. However, weather conditions only impact the installation of barriers at three locations where exterior access is required to install the barriers. Barriers can be installed at other locations that do not require exterior access if immediate weather conditions do not allow for exterior access (Reference 14).

Figure 1 provides an evaluation of the timeline for the site response. The figure includes two water level plots based on the FHRR, one for the ten building doors that must be protected and one for the condensate storage tank valvehouse door that must be protected. The evaluation considers a delay of 15 minutes between the issuance of the flash flood warning by the National Weather Service and the time for the control room to receive the warning and initiate the procedural response. The 15 minute delay is more than the eight minutes required to initiate the procedure to respond to the issuance of a flash flood warning for Coffey County, KS in 2016. The 15 minute delay is consistent with the timing evaluation performed for the MSA. With one field operator performing the installation, there is more than six minutes of margin based on the timing simulation performed and validated for the Flooding MSA. Adding an additional field operator increases the margin to 25 minutes based on the timing simulation performed and validated for the Flooding MSA. This is consistent with documented timing information for response to an actual flash flood warning in 2016, where it took 19 minutes to complete installation of the barriers after receipt of the warning by the control room. Generally, there are five field operators that may be available to perform installation of the barriers, and during outages additional field operators are placed on each shift (Reference 14).

Operators are trained to the procedure as part of initial operator qualification. Procedure refresher training is held at the same frequency as refresher training for FLEX strategy response. The barriers are stored in accessible locations. The procedure requires the reordering of barriers that become wetted during the response such that proper inventory is maintained (Reference 14).

Therefore, the site response to LIP has been demonstrated to be adequate by meeting the guidelines in NEI 16-05 Appendix C. It is further noted that there are no time sensitive critical actions required by the procedural response. The time margin calculated was at least six minutes, given an available warning time of 60 minutes; and a time required for one operator to execute of 39 minutes. The evaluation presented in Reference 14 shows that there is adequate APM even if barriers do not get installed prior to the onset of LIP, such that delay in installation of barriers requiring exterior access will not impact key SSCs.

Figure 1 – LIP Response Strategy Timeline



No	Task	Dur. (hr)
	Control Room Receives Flash Flood Warning	-
1	Initiate OFN SG-048	0.25
2	Complete OFN SG-048 (2+ operators)	0.33
3	Complete OFN SG-048 (1 operator)	0.65
4	LIP 1-hr, 1-sq mi Rainfall	1
5	LIP Rainfall Recedes Below 1,100 ft MSL at Pathways to SSCs	1.24

6. Conclusion

The FHRR showed that two flooding mechanisms were not bounded by the current licensing basis (CLB) and were required to be evaluated in this FE. The first mechanism LIP was estimated to generate a water level that exceeds the floor elevation at 11 doorways that are pathways to key SSCs. Upon receipt of a flash flood warning, quick dam flood barriers are placed at these eleven doorways to preclude building inundation. This FE demonstrated that the site response is adequate by meeting the requirements of Appendix C in NEI 16-05. This FE also demonstrates that even without the barriers in place, the amount of flood water expected to flow into the AB, CB, and FB is an insufficient amount to impact key SSCs and that significant margin exists.

The second mechanism that was not bounded by the CLB is failure of dams and onsite water control/storage structures. The FHRR screened this hazard out using methods that are more conservative than the current design basis and yielded a flood level that did not reach site grade. Consistent with the Flooding MSA, Dam Failure is not considered a credible hazard and was not further evaluated as part of the FE.

Finally, the MSA demonstrated that mitigating strategies (FLEX) would be available to maintain/restore KSFs as a defense-in-depth measure if an extended loss of power occurred coincidently with a LIP event. Additional information can be found in the Flooding MSA (Reference 12).

This submittal completes the actions related to external flooding required by Reference 1, without the need for the NRC staff to perform Phase 2 decision making per Reference 9 and 10.

7. References

1. Letter from E. J. Leeds and M. R. Johnson, USNRC, to M. W. Sunseri, WCNOC, "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 Accession No. ML12053A340.

2. WCNOC Letter ET 14-0012, "Docket No. 50-482: Wolf Creek Nuclear Operating Corporation's Flood Hazard Reevaluation Report in Response to NRC Request for Information Regarding Recommendation 2.1, Flooding, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," dated March 10, 2014. ADAMS Accession No. ML14077A280.

3. WCNOC Letter ET 15-0012, "Docket No. 50-482: Response to Request for Additional Information Regarding Flood Hazard Reevaluation Report," dated May 20, 2015.

4. WCNOC Letter ET 16-0003, "Wolf Creek Nuclear Operating Corporation's Flood Hazard Reevaluation Report, Revision 1," dated January 19, 2016. ADAMS Accession No. ML16032A190.

5. WCNOC Letter ET 16-0009, "Docket No. 50-482: Response to Request for Additional Information Regarding Flood Hazard Reevaluation Report, Revision 1," dated February 23, 2016. ADAMS Accession No. ML16061A256.

6. NRC Staff Requirements Memoranda to COMSECY-14-0037, "Staff Requirements – COMSECY-14-0037 – Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," dated March 30, 2015. ADAMS Accession No. ML15089A236.

7. Letter from W. M. Dean, USNRC, to A. C. Heflin, WCNOC, "Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events," dated September 1, 2015. ADAMS Accession No. ML15174A257.

8. Letter from D. L. Skeen, USNRC, to J. E. Pollock, NEI, "Trigger Conditions for Performing an Integrated Assessment and Due Date for Response," dated December 3, 2012. ADAMS Accession No. ML12326A912.

9. NEI Report 16-05, Revision 1, "External Flooding Assessment Guidelines," dated June 2016. ADAMS Accession No. ML16165A178.

10. NRC Interim Staff Guidance JLD-ISG-2016-01, Revision 0, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment," dated July 11, 2016. ADAMS Accession No. ML16162A301.

11. Letter from A. J. Minarik, USNRC, to A. C. Heflin, WCNOC, "Wolf Creek 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. MF3648)," dated December 24, 2015. ADAMS Accession No. ML15357A179.

12. WCNOC Letter ET 16-0029, "Docket No. 50-482: Wolf Creek Nuclear Operating Corporation's Mitigating Strategies Assessment for New Flood Hazard Information Report Submittal," dated November 8, 2016.

13. WCNOC Procedure OFN SG-048, Revision 4, "Flash Flood Warning."

14. Westinghouse Report WCAP-18221-P, Revision 0, "Wolf Creek Nuclear Generating Station Flooding Focused Evaluation."

15. NEI Report 12-07, Revision 0-A, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features," dated May 2012.