From: RILEY, Jim
To: Marshall, Michael; Shams, Mohamed
Cc: BAUER, Scott; Bill Webster (william.webster@dom.com); Bradley, Jeff (Nuclear); Dave Schupp; Dean Hubbard (dmhubbard@duke-energy.com); Diane Aitken (diane.aitken@dom.com); Don Bentley (DBENTLE@entergy.com); GASPER, JOSEPH K; Geiger, Charlotte; George Attarian; Giddens, John; greenrt@firstenergycorp.com; joe.bellini@aterrasolutions.com; Lingle, Ronnie; Lyter, Jay W:(GenCo-Nuc); Powell, Michael; RILEY, Jim; Spink, Thomas E <tespink@tva.gov> (tespink@tva.gov); TSCHILTZ, Michael; ZACHARIAH, Thomas
Subject: [External_Sender] MSA Examples
Date: Tuesday, February 02, 2016 11:30:12 AM
Attachments: NEI 12-06 Appendix G Rev 1 - G.3B Example.docx
NEI 12-06 Appendix G Rev 1 - G.3A Example.docx
G 4 3 MSA Example (DMH 1-27-16 Rev 1) .docx

Mo, Mike;

During our call last week I promised to send you our examples for G.3 (MSFHI<FLEX DB) and G.4.3 (AMS). These documents are attached for your review.

As we discussed last week, we are continuing to work on the other examples and finalize our response to your comments on the template.

Mike,
Let's catch up and come up with some options for our next call.

Jim Riley
NEI
W: (202) 739-8137
C: [redacted]
jhr@nei.org

10 CFR 50.54(f)

RS-__-____

December 31, 2016

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

Example Power Station, Unit 1
Facility Operating License No. ___
NRC Docket No. ___

Subject: Example Generation Company, LLC Mitigating Strategies Assessment (MSA) Report Submittal

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. Example Generation Company, LLC Letter to USNRC, Response to March 12, 2012 Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, Flooding Hazard Reevaluation Report, dated _______.

3. Example Generation Company, LLC Letter to USNRC, Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated _______.

4. Example Generation Company, LLC Letter to USNRC, Response to NRC Audit Review Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated _______.

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.

6. Nuclear Energy Institute (NEI), Report NEI 12-06 [Rev 2], Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, dated December 2015.

7. 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 ________.

8. NRC Letter, Example Power Station, Unit No. 1 – Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (TAC NO. MF 3654), dated _______.

9. NRC Letter, 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, dated March 1, 2013.

10. Example Power Station, Compliance Letter and Final Integrated Plan in Response to the March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated _______.

On March 12, 2012, the NRC issued Reference 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for Flooding. One of the Required Responses in Reference 1 directed licensees to submit a Flood Hazard Reevaluation Report (FHRR). For Example Power Station, the FHRR was submitted on _________ (Reference 2). The reevaluated flood hazard was further developed in response to requests for additional information (References 3 and 4). Per Reference 9, the NRC considers the reevaluated flood hazard to be “beyond the current design/licensing basis of operating plants”.

Concurrent to the flood hazard reevaluation, Example Power Station developed and implemented mitigating strategies in accordance with NRC Order EA-12-049, "Requirements for Mitigation Strategies for Beyond-Design-Basis External Events". In Reference 5, the Commission affirmed that licensees need to address the reevaluated flooding hazards within their mitigating strategies for BDB external events, including the reevaluated flood hazards. Guidance for performing mitigating strategies assessments (MSAs) is contained in Appendix G of Reference 6, endorsed by the NRC (with conditions) in Reference 7. For the purpose of the MSAs, the NRC has termed the reevaluated flood hazard, summarized in Reference 8, as the “Mitigating Strategies Flood Hazard Information” (MSFHI). Reference 6, Appendix G, describes the MSA for flooding as containing the following elements:

- Section G.2 – Characterization of the MSFHI
- Section G.3 – Comparison of the MSFHI and FLEX DB Flood
- Section G.4.1 – Assessment of Current FLEX Strategies (if necessary)
- Section G.4.2 – Assessment for Modifying FLEX Strategies (if necessary)
- Section G.4.3 – Assessment of Alternative Mitigating Strategies (if necessary)
- Section G.4.4 – Assessment of Targeted Hazard Mitigating Strategies (if necessary)

The following provides the MSA results for the Example Power Station.

<u>Reference 6, Section G.2 – Characterization of the MSFHI</u>

Characterization of the Mitigating Strategies Flood Hazard Information (MSFHI) is summarized in Table 1 of Reference 8; the NRC’s interim response to the flood hazard reevaluation submittal (Reference 2) and amended submittals (References 3 and 4). A more detailed description of the MSFHI, along with the basis for inputs, assumptions, methodologies, and models, is provided in the following references:

- Local Intense Precipitation (LIP): See Section 3.1 of Reference 2, Enclosure 1.
- Flooding in Streams and Rivers: See Section 3.2 of Reference 2, Enclosure 1.
- Dam Breaches and Failures: See Section 3.4 of Reference 2, Enclosure 1.
- Storm Surge: See Section 3.3 of Reference 2, Enclosure 1.
- Seiche: See Section 3.3 of Reference 2, Enclosure 1.
- Tsunami: See Section 3.8 of Reference 2, Enclosure 1.
- Ice-Induced Flooding: See Section 3.6 of Reference 2, Enclosure 1.
- Channel Migration or Diversion: See Section 3.7 of Reference 2, Enclosure 1.
- Combined Effects (including wind-waves and runup effects): See Section 3.5 of Reference 2, Enclosure 1, and References 3 and 4.
- Other Associated Effects (i.e. hydrodynamic loading, including debris; effects caused by sediment deposition and erosion; concurrent site conditions; and groundwater ingress): See Sections 3.10 and 4 of Reference 2, Enclosure 1, and References 3 and 4.
- Flood Event Duration Parameters (i.e. warning time, period of site preparation, period of inundation, and period of recession): See Sections 3.10 and 4 of Reference 2, Enclosure 1, and References 3 and 4.

At Example Power Station, the seiche, tsunami, ice-induced flooding, channel migration or diversion, and NUREG/CR-7046, Appendix H combined-effect floods H.2 (seismically-induced dam failure) and H.4.1 (floods along the shores of enclosed bodies of water, shore location) flood-causing mechanisms were either determined to be implausible or completely bounded by other mechanisms. Some individual flood-causing mechanisms (i.e. flooding in streams and rivers, dam breaches and failures, and surge) are addressed in one or more of the combined-effect floods. Only LIP and the NUREG/CR-7046, Appendix H, H.1 combined-effect flood (floods caused by precipitation events, including hydrologic dam failure) for Example River where determined to be applicable flood-causing mechanisms at Example Power Station.

In Reference 8, the NRC concluded that the "reevaluated flood hazards information [i.e. MSFHI], as summarized in the Enclosure [Summary Table of the Reevaluated Flood Hazard Levels], is suitable for the assessment of mitigating strategies developed in response to Order EA-12-049" for Example Power Station.

<u>Reference 6, Section G.3 – Basis for Mitigating Strategies Assessment (FLEX Design Basis Comparison)</u>

For Example Power Station, the FLEX design basis (FLEX DB) flood, described in Reference 10, is equivalent to the plant's current design basis (CDB) flood. A complete comparison of the CDB and reevaluated flood hazards is provided in Section 4 of Reference 2, Enclosure 1. As described in References 2, 3, and 4 and summarized below, the CDB and, by relationship, FLEX DB floods bound the reevaluated flood (i.e. MSFHI) for all applicable flood-causing mechanisms, including associated effects and flood event duration parameters.

The NRC further affirms in Reference 8 that "the reevaluated flood hazard mechanisms are bounded by the CDB" and "it is unnecessary for the licensee [Example Power Station] to perform an integrated assessment or focused evaluation".

Therefore, since the MSFHI is bounded by the FLEX DB (equivalent to the CDB), as affirmed by the NRC, Example Power Station considers the requirement to address the reevaluated flooding hazards within its BDB mitigating strategies as being satisfied with no further action required.

This letter contains no new regulatory commitments and no revision to existing regulatory commitments.

If you have any questions regarding this submittal, please contact _____ at ______.

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

Respectfully submitted,

____

____
Director - Licensing & Regulatory Affairs
Example Generation Company, LLC

10 CFR 50.54(f)

RS-__-____

December 31, 2016

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

Example Power Station, Unit 1
Facility Operating License No. ___
NRC Docket No. ___

Subject: Example Generation Company, LLC Mitigating Strategies Assessment (MSA) Report Submittal

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. Example Generation Company, LLC Letter to USNRC, Response to March 12, 2012 Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, Flooding Hazard Reevaluation Report, dated _______.

3. Example Generation Company, LLC Letter to USNRC, Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated _______.

4. Example Generation Company, LLC Letter to USNRC, Response to NRC Audit Review Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated _______.

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.

6. Nuclear Energy Institute (NEI), Report NEI 12-06 [Rev 2], Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, dated December 2015.

7. 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 ________.

8. NRC Letter, Example Power Station, Unit No. 1 – Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (TAC NO. MF 3654), dated _______.

9. NRC Letter, 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, dated March 1, 2013.

10. Example Power Station, Compliance Letter and Final Integrated Plan in Response to the March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated _______.

On March 12, 2012, the NRC issued Reference 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for Flooding. One of the Required Responses in Reference 1 directed licensees to submit a Flood Hazard Reevaluation Report (FHRR). For Example Power Station, the FHRR was submitted on _________ (Reference 2). The reevaluated flood hazard was further developed in response to requests for additional information (References 3 and 4). Per Reference 9, the NRC considers the reevaluated flood hazard to be "beyond the current design/licensing basis of operating plants".

Concurrent to the flood hazard reevaluation, Example Power Station developed and implemented mitigating strategies in accordance with NRC Order EA-12-049, "Requirements for Mitigation Strategies for Beyond-Design-Basis External Events". In Reference 5, the Commission affirmed that licensees need to address the reevaluated flooding hazards within their mitigating strategies for BDB external events, including the reevaluated flood hazards. Guidance for performing mitigating strategies assessments (MSAs) is contained in Appendix G of Reference 6, endorsed by the NRC (with conditions) in Reference 7. For the purpose of the MSAs, the NRC has termed the reevaluated flood hazard, summarized in Reference 8, as the "Mitigating Strategies Flood Hazard Information" (MSFHI). Reference 6, Appendix G, describes the MSA for flooding as containing the following elements:

- Section G.2 – Characterization of the MSFHI
- Section G.3 – Comparison of the MSFHI and FLEX DB Flood
- Section G.4.1 – Assessment of Current FLEX Strategies (if necessary)
- Section G.4.2 – Assessment for Modifying FLEX Strategies (if necessary)
- Section G.4.3 – Assessment of Alternative Mitigating Strategies (if necessary)
- Section G.4.4 – Assessment of Targeted Hazard Mitigating Strategies (if necessary)

The following provides the MSA results for the Example Power Station.

<u>Reference 6, Section G.2 – Characterization of the MSFHI</u>

Characterization of the Mitigating Strategies Flood Hazard Information (MSFHI) is summarized in Table 1 of Reference 8; the NRC's interim response to the flood hazard reevaluation submittal (Reference 2) and amended submittals (References 3 and 4). A more detailed description of the MSFHI, along with the basis for inputs, assumptions, methodologies, and models, is provided in the following references:

- Local Intense Precipitation (LIP): See Section 3.1 of Reference 2, Enclosure 1.
- Flooding in Streams and Rivers: See Section 3.2 of Reference 2, Enclosure 1.
- Dam Breaches and Failures: See Section 3.4 of Reference 2, Enclosure 1.
- Storm Surge: See Section 3.3 of Reference 2, Enclosure 1.
- Seiche: See Section 3.3 of Reference 2, Enclosure 1.
- Tsunami: See Section 3.8 of Reference 2, Enclosure 1.
- Ice-Induced Flooding: See Section 3.6 of Reference 2, Enclosure 1.
- Channel Migration or Diversion: See Section 3.7 of Reference 2, Enclosure 1.
- Combined Effects (including wind-waves and runup effects): See Section 3.5 of Reference 2, Enclosure 1, and References 3 and 4.
- Other Associated Effects (i.e. hydrodynamic loading, including debris; effects caused by sediment deposition and erosion; concurrent site conditions; and groundwater ingress): See Sections 3.10 and 4 of Reference 2, Enclosure 1, and References 3 and 4.
- Flood Event Duration Parameters (i.e. warning time, period of site preparation, period of inundation, and period of recession): See Sections 3.10 and 4 of Reference 2, Enclosure 1, and References 3 and 4.

As discussed in Reference 2, the flood hazard reevaluation showed that the seiche, tsunami, ice-induced flooding, channel migration or diversion, and NUREG/CR-7046, Appendix H combined-effect floods H.2 (seismically-induced dam failure) and H.4.1 (floods along the shores of enclosed bodies of water, shore location) flood-causing mechanisms were either determined to be implausible or completely bounded by other mechanisms. Some individual flood-causing mechanisms (i.e. flooding in streams and rivers, dam breaches and failures, and surge) are addressed in one or more of the combined-effect floods. Only LIP and the NUREG/CR-7046, Appendix H, H.1 combined-effect flood (floods caused by precipitation events plus hydrologic dam failure) for Example River where determined to be applicable flood-causing mechanisms at Example Power Station. Parameters for these flood-causing mechanisms, including associated effects and flood event duration parameters, are described in detail in Reference 2 and summarized in the enclosure. [Note that Example Power Station elected to provide a bounding set of MSFHI parameters, instead of individual parameters, in the enclosure.]

In Reference 8, the NRC concluded that the "reevaluated flood hazards information [i.e. MSFHI], as summarized in the Enclosure [Summary Table of the Reevaluated Flood Hazard Levels], is suitable for the assessment of mitigating strategies developed in response to Order EA-12-049" for Example Power Station.

<u>Reference 6, Section G.3 – Basis for Mitigating Strategies Assessment (FLEX Design Basis Comparison)</u>

At Example Power Station, the FLEX design basis (FLEX DB) flood, described in Reference 10, is primarily based on the plant's current design basis (CDB) flood but also incorporated aspects of the reevaluated flood hazard (i.e. MSFHI), including [describe which reevaluated flood-causing mechanisms and parameters were incorporated into the FLEX DB flood].

A complete comparison of the FLEX DB and reevaluated flood hazards (i.e. MSFHI), provided in the enclosure, shows that the FLEX DB flood bound the MSFHI for all applicable flood-causing mechanisms, including associated effects and flood event duration parameters. Therefore, Example Power Station considers the requirement to address the reevaluated flooding hazards within its BDB mitigating strategies as being satisfied with no further action required.

This letter contains no new regulatory commitments and no revision to existing regulatory commitments.

If you have any questions regarding this submittal, please contact _____ at ______.

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

Respectfully submitted,

____

____
Director - Licensing & Regulatory Affairs
Example Generation Company, LLC

Enclosure:

- FLEX DB and MSFHI – Flood Parameter Comparison Tables

ENCLOSURE

FLEX DB AND MSFHI – FLOOD PARAMETER COMPARISON TABLES

Table 1 – Local Intense Precipitation Flood Parameter Comparison

	Flood Scenario Parameter	Plant's Current Design Basis	FLEX Design Basis	MSFHI	Bounded (B) or Not Bounded (NB)
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft. [datum])	536.8	536.8	536.6	B
	2. Max Wave Run-up Elevation (ft. [datum])	N/A	N/A	N/A	N/A
	3. Max Hydrodynamic (lb/ft)/Debris Loading (lb)	N/I	See note	2.0 lb/ft	B
	4. Effects of Sediment Deposition/Erosion	N/I	See note	See note	B
	5. Other associated effects (identify each effect)	N/A	N/A	N/A	N/A
	6. Concurrent Site Conditions	N/I	See note	See note	B
	7. Effects on Groundwater	N/I	See note	See note	N/A
Flood Event Duration	8. Warning Time (hours)	N/A	See note	See note	N/A
	9. Period of Site Preparation (hours)	N/A	N/A	N/A	N/A
	10. Period of Inundation (hours)	N/A	N/A	N/A	N/A
	11. Period of Recession (hours)	N/A	N/A	N/A	N/A
Other	12. Plant Mode of Operations	Any	Any	Any	B
	13. Other Factors	N/A	N/A	N/A	N/A

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

Additional notes, 'N/A' justifications (why a particular parameter is judged not to affect the site), and explanations regarding the bounded/non-bounded determination.

1. [Use Mean Sea Level or other applicable datum.] Elevation may vary around the site; represents the maximum flood elevation.
2. [Use Mean Sea Level or other applicable datum.] Consideration of wind-wave action for the LIP event is not explicitly required by NUREG/CR-7046 and is judged to be a negligible because of limited fetch lengths and flow depths.
3. [Discuss the loads on flood barriers caused by flowing water and associated debris as identified in the FHRR.] The hydrodynamic and hydrostatic loads are determined as force per unit length of structure (lb/ft). To determine the force for the entire structure the loads need to be multiplied by the structure length. The hydrodynamic and hydrostatic loads are bounded by the design basis maximum tornado wind load. The debris load for the LIP event is assumed to be negligible due to the absence of heavy objects at the plant site and due to low flow velocity, the factors combination of which could lead to a hazard due to debris load. Additionally, the water depth around the buildings due to LIP are relatively shallow.
4. [Discuss velocity and scour results and provide comparisons with CDB, permissible velocities, presence of scour resistant material, etc.] The flow velocities due to the LIP event are determined to be below the suggested velocities (USACE 1984) for the ground cover type (concrete and gravel) at the plant area. Therefore, significant erosion is not expected for the LIP flood. Similarly, the relatively low velocities and flow depths are not expect to have the power to transport sediment and cause significant deposition during the LIP flood.
5. [Discuss any other significant detrimental effects associated with the flood hazard that are not otherwise listed in the table, such as soil deposition.]
6. [Discuss conditions that could exist concurrent with this flood-causing mechanism or combined-effect flood (e.g. high winds, ice formation, etc.)] High winds could be generated concurrent to a LIP event. However, manual actions are not required to protect the plant from LIP flooding so this concurrent condition is not applicable.
7. [Discuss if and how this flood-causing mechanism or combined-effect flood could cause a surcharge to groundwater, considering flood duration and soil conditions.] The majority of the plant area is paved or gravel. Also, the soil in the site area is generally characterized by the Natural Resources Conservation Service (NRCS) as sandy clay loam (Hydrologic Soil Group C). These land use and soil type features

would limit the volume of rainfall infiltrated during a short-duration (1-hour) LIP event and groundwater seepage would likely be minimal.

8. [Discuss warning time; may include information from relevant forecasting methods (e.g., products from local, regional, or national weather forecasting centers) and ascension time of the flood hydrograph to a point (e.g. intermediate water surface elevations) triggering entry into flood procedures and actions by plant personnel. Reference NEI 15-05 for LIP.] SSC's important to safety are currently protected by means of permanent/passive measures. Therefore, warning time is not applicable to the LIP flood.
9. [Discuss period of site preparation (after entry into flood procedures and before flood waters reach site grade).] SSC's important to safety are currently protected by means of permanent/passive measures. Therefore, period of site preparation is not applicable to the LIP flood.
10. [Discuss period of inundation.] SSC's important to safety are currently protected by means of permanent/passive measures. Therefore, period of inundation is not applicable to the LIP flood.
11. [Discuss period of recession, when flood waters completely recede from site and plant continues to be in a safe and stable state that can be maintained indefinitely. Also discuss the timing of loss and restoration of site access if the site is not accessible due to flooding for some period during the MSFHI.] SSC's important to safety are currently protected by means of permanent/passive measures. Therefore, period of recession is not applicable to the LIP flood.
12. [Additional notes regarding plant mode of operations.]
13. [Discuss other plant-specific factors (e.g. waterborne projectiles).]

Table 2 – NUREG/CR-7046, Appendix H, H.1 Combined-Effect Flood (floods caused by precipitation events plus hydrologic dam failure) Parameter Comparison for Example River

	Flood Scenario Parameter	Plant's Current Design Basis	FLEX Design Basis	MSFHI	Bounded (B) or Not Bounded (NB)
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft. [datum])	540.3	540.3	538.9	B
	2. Max Wave Run-up Elevation (ft. [datum])	N/I	544.0	542.8	B
	3. Max Hydrodynamic (lb/ft)/Debris Loading (lb)	See note	See note	1800/8100	B
	4. Effects of Sediment Deposition/Erosion	N/I	See note	See note	B
	5. Other associated effects (identify each effect)	N/A	N/A	N/A	N/A
	6. Concurrent Site Conditions	N/I	See note	See note	B
	7. Effects on Groundwater	See note	See note	See note	B
Flood Event Duration	8. Warning Time (hours)	N/I	96	105.5	B
	9. Period of Site Preparation (hours)	30.0	30.0	37.1	B
	10. Period of Inundation (hours)	50.0	50.0	37.5	B
	11. Period of Recession (hours)	7.0	9.0	8.0	B
Other	12. Plant Mode of Operations	All	All	All	B
	13. Other Factors	N/A	N/A	N/A	N/A

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

Additional notes, 'N/A' justifications (why a particular parameter is judged not to affect the site), and explanations regarding the bounded/non-bounded determination.

1. Use Mean Sea Level or other applicable datum.
2. Use Mean Sea Level or other applicable datum
3. [Discuss the loads on flood barriers caused by flowing water and associated debris as identified in the FHRR.] The original structural design criteria (tornado missile loads) for safety-related structures bound the MSFHI loads. FLEX equipment is elevated above the MSFHI wind-wave runup elevation and, as a result, are not subject to flooding loads.
4. [Discuss velocity and scour results and provide comparisons with CDB, permissible velocities, presence of scour resistant material, etc.] The flow velocities due to a river flood are determined to be below the suggested velocities (USACE 1984) for the ground cover type (concrete and gravel) at the plant area. Therefore, significant erosion is not expected for the LIP flood. 2D models do not show abrupt changes in direction and magnitude of velocity vectors that would cause significant deposition during the river flood.
5. [Discuss any other significant detrimental effects associated with the flood hazard that are not otherwise listed in the table, such as soil deposition.]
6. [Discuss conditions that could exist concurrent with this flood-causing mechanism or combined-effect flood (e.g. high winds, ice formation, etc.)] High winds could be generated concurrent to a LIP event. However, the FLEX design considered 1-minute sustained wind-speeds of 45 mph (equivalent to a 100-year 1-minute sustained wind).
7. [Discuss if and how this flood-causing mechanism or combined-effect flood could cause a surcharge to groundwater, considering flood duration and soil conditions.] The CLB assumes that safety-related structures below site grade are protected from ingress to plant grade. Therefore, the river flood is not expected to surcharge groundwater and cause ingress below grade during a river flood. The MSFHI stillwater flood elevation is less than the CDB flood elevation so no additional pressure head will be applied beyond the CDB flood.
8. [Discuss warning time; may include information from relevant forecasting methods (e.g., products from local, regional, or national weather forecasting centers) and ascension time of the flood hydrograph to a point (e.g. intermediate water surface elevations) triggering entry into flood procedures and actions by plant personnel. Reference NEI 15-05 for LIP.]
9. [Discuss period of site preparation (after entry into flood procedures and before flood waters reach site grade).]

10. [Discuss period of inundation.]
11. [Discuss period of recession, when flood waters completely recede from site and plant continues to be in a safe and stable state that can be maintained indefinitely. Also discuss the timing of loss and restoration of site access if the site is not accessible due to flooding for some period during the MSFHI.]
12. [Additional notes regarding plant mode of operations.]
13. [Discuss other plant-specific factors (e.g. waterborne projectiles).]

Table 1 – Bounding Set of MSFHI Flood Parameters

Flood Scenario Parameter		Associated Flood-Causing Mechanism	Plant's Current Design Basis	FLEX Design Basis	MSFHI	Bounded (B) or Not Bounded (NB)
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft. [datum])					
	2. Max Wave Run-up Elevation (ft. [datum])					
	3. Max Hydrodynamic/Debris Loading (psf)					
	4. Effects of Sediment Deposition/Erosion					
	5. Other associated effects (identify each effect)					
	6. Concurrent Site Conditions					
	7. Effects on Groundwater					
Flood Event Duration	8. Warning Time (hours)					
	9. Period of Site Preparation (hours)					
	10. Period of Inundation (hours)					
	11. Period of Recession (hours)					
Other	12. Plant Mode of Operations					
	13. Other Factors					

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

Additional notes, 'N/A' justifications (why a particular parameter is judged not to affect the site), and explanations regarding the bounded/non-bounded determination.

1. Use Mean Sea Level or other applicable datum.
2. Use Mean Sea Level or other applicable datum
3. [Discuss the loads on flood barriers caused by flowing water and associated debris as identified in the FHRR.]
4. [Discuss velocity and scour results and provide comparisons with CDB, permissible velocities, presence of scour resistant material, etc.]
5. [Discuss any other significant detrimental effects associated with the flood hazard that are not otherwise listed in the table, such as soil deposition.]
6. [Discuss conditions that could exist concurrent with this flood-causing mechanism or combined-effect flood (e.g. high winds, ice formation, etc.)]
7. [Discuss if and how this flood-causing mechanism or combined-effect flood could cause a surcharge to groundwater, considering flood duration and soil conditions.]
8. [Discuss warning time; may include information from relevant forecasting methods (e.g., products from local, regional, or national weather forecasting centers) and ascension time of the flood hydrograph to a point (e.g. intermediate water surface elevations) triggering entry into flood procedures and actions by plant personnel. Reference NEI 15-05 for LIP.]
9. [Discuss period of site preparation (after entry into flood procedures and before flood waters reach site grade).]
10. [Discuss period of inundation.]
11. [Discuss period of recession, when flood waters completely recede from site and plant continues to be in a safe and stable state that can be maintained indefinitely. Also discuss the timing of loss

and restoration of site access if the site is not accessible due to flooding for some period during the MSFHI.]

12. [Additional notes regarding plant mode of operations.]
13. [Discuss other plant-specific factors (e.g. waterborne projectiles).]

2016 Mitigating Strategies Assessment for Flooding Documentation Requirements G.4.3 Example

Acronyms:

- MSFHI – Mitigating Strategies Flood Hazard Information (from the FHRR and MSFHI letter)
- FHRR – Flood Hazard Reevaluation Report
- DB – Design Basis
- AMS – Alternative Hazard Mitigating Strategies
- THMS – Targeted Hazard Mitigating Strategies
- FLEX DB – FLEX Design Basis (flood hazard)

Definitions:

FLEX Design Basis Flood Hazard: the controlling flood parameters used to develop the FLEX flood strategies.

1. **Summary**

The site is a single unit 700 MWe Westinghouse PWR located on an inland reservoir that provides cooling water for the site.The Flooding Hazard Reevaluation Report (FHRR) for the site includes a reevaluated flood hazard that exceeds both the plant design basis and FLEX design basis. The maximum reevaluated flood hazard for Flood-Causing Mechanisms for use in the MSA (MSFHI) is the Combined-effect River Probable Maximum Flood (PMF). Impacts of the Combined-effects River PMF include flooding on the first level of the Reactor Auxiliary Building and a loss of all AC power due to flooding of the switchyard and the emergency diesels. Additionally, the PMF event results in a loss of the ultimate heat sink upon failure of the reservoir dam.

Due to a loss of the ultimate heat sink an Alternate Mitigating Strategy (AMS) is required.

2. **Documentation**

2.1. NEI 12-06, Rev. 2, Section G.2 – Characterization of the MSFHI (all licensees need to complete)

The bounding external flood-causing mechanism based on the FHRR (Section 3.9) for the site is a Combined-effects River PMF with a maximum water level of 233.8 ft msl. This PMF results from the combination of a 500 year antecedent storm with a subsequent PMP with wave runup induced by 2-year wind speed and a subsequent dam breach on the reservoir adjoining the site.

<u>Combined-effect River PMF</u>

Combined-effect floods events were evaluated for the site in the FHRR. Recommended combinations of events are discussed in ANSI/ANS 2.8 1992 Section 9.2, and also in NUREG/CR-7046 Appendix H. The site is bounded by the lake on the east and a railroad on the west. The 171.5 square mile drainage basin feeds the reservoir that borders the site and is subject to a PMF resulting from an 500 year antecedent storm followed by the PMP over the watershed. The reservoir is subject to wind-generated setup and wave runup. The controlling combined-effect applicable to the site is a PMF that results from the combination of a 500 year antecedent storm with a subsequent PMP that includes wave runup induced by 2-year wind speed and a subsequent dam breach on the reservoir adjoining the site. With a stillwater elevation of 231.8 feet msl, the maximum wave runup is 2.0 feet with a total maximum water level of 233.8 ft msl. This elevation is higher than the site grade of 225 ft msl.

2.2. NEI 12-06, Rev. 2, Section G.3 – Comparison of the MSFHI and FLEX DB Flood (all licensees need to complete)

A Combined-effect River PMF is the only flooding event not bounded for all applicable flood-causing mechanisms. The set of parameters for the flooding event are included in Table 1 below.

Table 1 – Flood Causing Mechanisms Set of Parameters

Combined-effect River PMF

Flood Scenario Parameter		Plant DB Flood	FLEX Design Basis Flood Hazard	MSFHI	Bounded (B) or Not Bounded (NB)
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft. msl)	Dry Site	Dry Site	231.3 ft	NB
	2. Max Wave Run-up Elevation (ft. msl)	Dry Site	Dry Site	2.5 ft	NB
	3. Max Hydrodynamic/Debris Loading (psf)	Dry Site	Dry Site	Note 1	N/A
	4. Effects of Sediment Deposition/Erosion	Dry Site	Dry Site	Note 2	N/A
	5. Other associated effects (identify each effect)	Dry Site	Dry Site	None	N/A
	6. Concurrent Site Conditions	Dry Site	Dry Site	2-yr wind speed	NB
	7. Effects on Groundwater	Dry Site	Dry Site	Note 3	N/A
Flood Event Duration	8. Warning Time (hours)	Dry Site	Dry Site	12 hrs	NB
	9. Period of Site Preparation (hours)	Dry Site	Dry Site	6 hrs	NB
	10. Period of Inundation (hours)	Dry Site	Dry Site	9.5 hrs	NB
	11. Period of Recession (hours)	Dry Site	Dry Site	Note 4	N/A
Other	12. Plant Mode of Operations	Dry Site	Dry Site	All modes	N/A
	13. Other Factors	Dry Site	Dry Site	None	N/A

Notes

1. Debris from the upstream watershed will not translate to the site due to the low velocities in the lake and the constricted crossing of the State Road near the north end of the lake.
2. It is also assumed that topography will not change during the event due to sediment erosion/accretion due to the low water velocities on site and the event duration.
3. No below ground safety related structures exist on site.
4. Due to the site being a free flowing site with a small upstream watershed, no additional time is associated with recession of the flood waters beyond the period of inundation.

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 (all licensees need to complete)

Current FLEX Strategies assume a dry site based on the site design basis as required by NEI 12-06 Rev 0. For the new FHRR, site flooding occurs during the Combined-effect PMF. The site FLEX strategy would be impacted by flood waters that would prevent FLEX deployment during the event and also result in FLEX equipment being located below flood waters. Additional flooding impacts on the FLEX strategy include the loss of ultimate heat sink. The sites FLEX response currently includes only time zero events with no provision for warning time to support pre-deployment.

2.3.1.1. Assessment of FLEX Strategies (Reference Section G.4.1 in NEI 12-06 Rev 2). Responses to the bullets in Section G.4.1 are described below:

- **The boundary conditions and assumptions of the initial FLEX design are maintained.**

The boundary conditions and assumptions for the initial FLEX design do not include any external flooding events at the site. Initial FLEX design assumes a dry site and all events are time zero events without warning time. The FHRR Combined-effect PMF flooding scenarios result in flood waters significantly above site grade which inundates site equipment credited for FLEX and prevents access to deploy FLEX during the flooding event.

- **The sequence of events for the FLEX strategies is not affected by the impacts of the MSFHI (including impacts due to the environmental conditions created by the MSFHI) in such a way that the FLEX strategies cannot be implemented as currently developed.**

The sequence of events for the FLEX strategies are affected by the impacts of the MSFHI. Due to flooding levels and durations, time sensitive actions for FLEX to establish feed to the Steam Generators cannot be completed within the required 61 minutes. The ultimate heat sink is also lost when the dam for the reservoir fails. On-site inventories are exhausted 16 hours after reactor trip. The lake will not be available as a water source after dam failure on the adjoining reservoir.

- **The validation performed for the deployment of the FLEX strategies is not affected by the impacts of the MSFHI.**

FLEX strategies cannot be deployed during the flooding event. FLEX strategies for RCS cooling from the Steam Generators are defeated during the event due to a loss of all feedwater pumps and an inability to deploy the portable FLEX pump. Feedwater makeup is lost after the flooding event due to lack of a water source after site inventories are depleted.

2.3.1.2. Conclusions

The existing FLEX strategies cannot be implemented as designed. FLEX cannot be modified because alternate equipment and cooling water sources are required. Alternate Mitigating Strategies (AMS) are required.

2.3.1.3. NEI 12-06, Rev. 2, Section G.4.2 – Assessment for Modifying FLEX Strategies

Not applicable

2.3.1.4. Assessment of Alternate Mitigating Strategies (Reference Section G.4.3 in NEI 12-06 Rev 2). Responses to the bullets in this section are described below:

- **The sequence of events for the flood hazard(s);**

The Combined-effect PMF event is described in detail in Section 3.2 of FHRR. The entire storm event consists of an antecedent storm of 500-year probability that lasts for 72 hours, a dry period of 72 hours, and a 72-hour probable maximum precipitation (PMP) event with wave runup induced by 2-year wind speed. The antecedent storm delivers rainfall amounts included in the current licensing basis, and the PMP storm provides additional rainfall amounts that are beyond design basis. Water surface elevations at the reservoir overtop the dam causing dam failure.

No site flooding occurs during the antecedent storm and the following dry period. Site flooding begins approximately 40 hours after the start of the PMP event. Flood levels increase until the dam fails. Flooding starts and recedes to below site elevation over a duration of approximately 9.5 hours.

- **A detailed description of the mitigating strategies;**

1. Event Warning Time – If a storm system is approaching the site within 72 hours (Day 3) with a 24 hour NOAA Probabilistic Quantitative Precipitation Forecast (PQPF) total of 5 inches or more (95^{th} Percentile), the corporate meteorologist would then notify the site and monitoring each shift would be initiated at the site. If the PQPF for 24 hour rainfall is projected to be 5 inches or greater within 12 hours, a trigger would be activated to enter the Severe Weather Abnormal Procedure where pre-deployment of Alternate Mitigating Strategies (AMS) would be initiated.
2. Pre-deployment of AMS (and required FLEX) Equipment (6 hours required to complete actions assuming minimum staffing):
    a. Pre-deploy FLEX Auxiliary Feedwater Pump (diesel driven) to designated location where the pumps and motors are located above the maximum flood height. The discharge flexible piping would be connected to the FLEX AFW discharge piping connection, and the pump suction to the Condensate Storage Tank.
    b. Pre-stage the portable FLEX diesel generator above the flood level and connect the generator AC cable to power the B5b "D" Deepwell pump for Condensate Storage Tank makeup water.
    c. Connect cables from the pre-staged diesel generator (located in a 2^{nd} room above the flooding) to battery chargers with portable cabling (two complete sets).
3. ELAP Initiation
    a. Declare ELAP within 60 minutes of the loss of all AC power
    b. Actions taken within <u>first six hours</u> after ELAP:

    i. Start up the FLEX diesel (150 Kw) and provide AC power to the battery chargers within 60 minutes
    ii. Manually align valves and initiate feedwater using the FLEX Auxiliary Feedwater Pump to feed the S/Gs within 61 minutes of losing the Steam Driven AFW pump.
    iii. Start FLEX diesel and power-up the B5b “D” Deepwell pump to provide makeup as required for the Condensate Storage Tank.
    iv. Manually steam the Steam Generators using the Main Steam Bypass valves and initiate a cooldown of the RCS to ~425F: S/G’s to ~290 psig in 2 – 4 hours.
    v. Monitor Spent Fuel Pool (SFP) level from the Control Room.
    vi. Monitor Containment pressure
    vii. Provide notifications to state, counties, NRC, INPO, NSRC

c. Actions taken beyond six hours:
    i. Pre-job briefs for RCS boration/makeup
    ii. Makeup to Spent Fuel Pool
    iii. Track fuel oil consumption
        1. Equipment has average of 20 hours onboard supply
        2. Two 500 gallon trailered tanks with DC delivery pump in FLEX dome
        3. On-site fuel supply will last 5 days
    iv. Monitor SFP (23 hours to 10 feet above fuel)
    v. Monitor Containment (43 days to reach 42 psig)

- **A list of changes to the FLEX equipment necessary for the mitigating strategies. The level of detail in the list should be consistent with the equipment list in the OIP or FIP;**

Because of a loss of the ultimate heat sink the B5b “D” Deepwell pump would provide an alternate water source for Steam Generator feedwater by providing makeup (1320 gpm makeup to support maximum initial feedwater requirements of approximately 300 gpm) to the Condensate Storage tank. A modification would be required to provide a water sealed power connection above the maximum flood level to power the B5b “D” Deepwell pump from the FLEX diesel and a disconnect added to isolate the pump from the normal plant circuitry. One of the FLEX portable AC diesel generators would be deployed to a location above the flood level and to provide power for the B5b “D” Deepwell pump. A modification would also be required to provide FLEX standard hose connections from the B5b “D” Deepwell pump to the Condensate Storage Tank to provide makeup water.

- **A description of what elements of the strategy have changed as compared to the mitigating strategies design approved for compliance with EA-12-049, and the basis for the change.**

The majority of the AMS strategy relies on the existing FLEX strategy with the exception of using warning time for the flooding event to pre-stage equipment and the use of an alternate water source to supply feedwater after the loss of the ultimate heat sink due to dam failure. Warning time actually allows more time to perform FLEX time sensitive actions (eg charging for the batteries and set up for establishing the path for feed to the S/G’s).

After the ELAP occurs, the FLEX strategy is used to maintain core cooling, spent fuel pool cooling and containment integrity. Due to the flooding of the primary feedwater pumps used in the FLEX strategy, the backup FLEX diesel driven pump becomes the primary method for feeding the steam generators.

With the loss of the ultimate heat sink due to dam failure, the B5b "D" Deepwell pump can provide all make up water requirements indefinitely. The B5b "D" Deepwell pump is located in a concrete protected enclosure which provides protection from the floodwaters and any associated effects. To make this source available for AMS, the existing junction box must be raised above the maximum flood height. The cabling must be modified to include a separate FLEX plug for connection to the FLEX diesel generator, a disconnect to separate the pump from it's normal power source, and on/off circuitry to operate the pump. These modifications are not complex and will not impact continuing to meet the site B5b requirements.

- **A description and explanation of any changes to flood protection features:**

As a design basis dry site, the only flood protection features are the normal finished floor elevation of buildings and plant equipment above site grade (approximately 1 ft) to protect from rain events. No flood protection features would be added or modified.

- **A description of how the provisions in Sections 3, 6, and 11 of NEI 12-06, Rev. 2 have been addressed;**

The installed plant equipment being used beyond that required for the original implementation of FLEX comes from the B5b program and were designed, procured and maintained to meet the site requirements for B5b. This includes the B5b "D" Deepwell pump and associated piping and circuitry. The piping to supply water to the Condensate Storage tank is a combination of site permanent piping and flexible hoses and connections. The flex hoses and connections were purchased using the same specifications as FLEX hoses and include the same color coding system to aid in connecting up the flow path without the requirement for tools. All of the AMS portable equipment will be stored in the FLEX building and maintained to the same standards as the FLEX equipment.

- **Describe any validation items that will need to be performed based on the changes. Validation documentation does not need to be submitted and should be performed following any modifications or procedure revisions.**

Validation will be required for the actions taken in response to the warning time trigger to pre-stage equipment. Actions currently included in the FLEX response that are part of the AMS have already been validated as part of the FLEX implantation for Order EA 12-049.