



UNITED STATES
NUCLEAR REGULATORY COMMISSION
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April 24, 2020

Mr. James Barstow
Vice President, Nuclear Regulatory
Affairs and Support Services
Tennessee Valley Authority
1101 Market Street, LP 4A-C
Chattanooga, TN 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNITS 1 & 2 – STAFF ASSESSMENT OF
FLOODING FOCUSED EVALUATION (EPID NO. L-2019-JLD-0011)

Dear Mr. Barstow:

The purpose of this letter is to document the staff's evaluation of the Watts Bar Nuclear Plant, Units 1 & 2 (Watts Bar) flooding focused evaluation (FE) which was submitted in response to Near-Term Task Force (NTTF) Recommendation 2.1 "Flooding." The U.S. Nuclear Regulatory Commission (NRC) has concluded that based on the licensee's evaluation and the staff's independent assessment, no further response or regulatory actions are required to address the reevaluated flood hazard at the site.

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the NRC issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's NTTF report (ADAMS Accession No. ML111861807). Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A048).

By letter dated March 12, 2015 (ADAMS Accession No. ML15071A262), Tennessee Valley Authority (TVA, the licensee) responded to this request for Watts Bar by providing its flood hazard reevaluation report (FHRR). By letter dated June 16, 2015 (ADAMS Accession No. ML20037A072), TVA submitted a revision to the FHRR. Any reference to the "original FHRR" in this letter or the enclosures is intended to refer to Revision 1 of the FHRR. By letter dated September 3, 2015 (ADAMS Accession No. ML15239B292), the NRC issued an interim staff response (ISR) letter for Watts Bar. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Watts Bar that are a suitable input for further assessments as the site's response to the 50.54(f) letter. As stated in the ISR

Enclosure 1 transmitted herewith contains Security-Related Information and Critical Electric Infrastructure Information (CEII). When separated from Enclosure 1, this document is decontrolled.

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letter, because the local intense precipitation (LIP) and streams and rivers flood-causing mechanisms at Watts Bar are not bounded by the plant's CDB, additional assessments of those flood hazard mechanisms are expected to be performed by the licensee.

By letter dated October 11, 2019 (ADAMS Accession No. ML19284F763, non-public, CEII, security-related information), the licensee submitted an FE for Watts Bar. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded by the CDB based on a reevaluation of the flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is LIP. The purpose of this letter is to provide the NRC's assessment of the Watts Bar FE.

The licensee provided an FHRR analysis update as Attachment A to the FE. The updated analysis utilizes a new site-specific probable maximum precipitation (PMP). In addition to the use of a site-specific PMP, the following key changes were made in the FHRR analysis update:

1. Updated the channel geometry and/or the overbank storage volumes of the stream course model consistent with recommendations from the U.S. Army Corps of Engineers.
2. Updated the dam stability analysis to account for a modification at Douglas dam.
3. Updated the rainfall distribution methodology to be consistent with the gridded rainfall data format used to develop the new PMP and to apply TVA's antecedent precipitation index.

By letter dated June 22, 2016 (ADAMS Accession No. ML16175A518), TVA provided the NRC with dates for several project deliverables associated with the ongoing Hydrologic Engineering Center - River Analysis System (HEC-RAS) external flood modeling project. In a letter to the NRC dated January 14, 2020 (ADAMS Accession No. ML20016A396), TVA submitted a License Amendment Request (LAR) to revise the Sequoyah Nuclear Plant, Units 1 & 2 (Sequoyah), updated final safety analysis report regarding changes to the hydrologic analysis. As part of the HEC-RAS project deliverables, TVA will submit a similar LAR for Watts Bar. The same methodologies are expected to be used in the LAR and the FHRR analysis update provided with the FE.

The staff did not perform a detailed evaluation of the methodology associated with the FHRR analysis update to complete the FE assessment. The staff will evaluate the methodology associated with the FHRR analysis update and associated flood levels as part of the LAR review. Since the same methodologies are expected to be used in the LAR and the FHRR analysis update in the FE, a detailed review of the methodologies is not required for the staff to complete its assessment of the FE.

In addition to the FHRR analysis update, TVA also provided an updated warning time analysis in Attachment B to the FE. The staff did not perform a detailed evaluation of the methodology associated with the updated warning time analysis. The only significant change in the results of the analysis of warning time is the use of revised "rain on the ground" thresholds where Stage I and Stage II actions are required to begin. Use of these revised Stage I and Stage II action levels does not reduce the effectiveness of the warning plan, as the CDB minimum time to prepare for operation in the flood mode is retained. The staff will evaluate the updated warning time analysis as part of the LAR process and a separate evaluation for purposes of the licensee's response to the 50.54(f) letter is not needed.

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The NRC staff performed its review of the Watts Bar FE in accordance with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). Guidance document NEI 16-05, Revision 1, has been endorsed by the NRC in Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16090A140). The NRC staff concludes that, if implemented as described, the licensee has effective flood protection for the beyond-design-basis LIP and streams and rivers flood-causing mechanisms at Watts Bar. This closes out the licensee's response for Watts Bar for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with EPID No. L-2019-JLD-011.

If you have any questions, please contact me at 301-415-2621 or by email at Robert.Bernardo@nrc.gov.

Sincerely,

/RA/

Robert J. Bernardo, Project Manager
Integrated Program Management
and BDB Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Enclosures:

1. Staff Assessment Related to the
Flooding Focused Evaluation for Watts Bar
(Non-public, Security-Related)
2. Staff Assessment Related to the
Flooding Focused Evaluation for Watts Bar
(Public)

Docket Nos. 50-390 and 50-391

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FOCUSED EVALUATION FOR

WATTS BAR NUCLEAR PLANT, UNITS 1 & 2

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

RECOMMENDATION 2.1 - FLOODING

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 of the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). If the reevaluated hazard for any flood-causing mechanism is not bounded by the plant's design basis flood hazard, an additional assessment of plant response would be necessary. Specifically, the 50.54(f) letter stated that an integrated assessment (IA) should be submitted and described the information that the IA should contain. By letter dated November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Project Directorate¹ (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015 (ADAMS Accession No. ML15153A104), the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants. The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682). COMSECY-15-0019 outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's design basis. The revised process describes a graded approach in which certain licensees with hazards exceeding their design basis flood will not be required to complete an IA, but instead will perform a focused evaluation (FE). As part of the FE, these licensees will assess the impact of the hazard(s) on their site and then evaluate and implement any necessary programmatic, procedural, or plant modifications to address the hazard exceedance.

Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), has been endorsed by the NRC as an appropriate methodology for licensees to perform the FE in response to the 50.54(f) letter.

¹ The Japan Lessons-Learned Project Directorate was subsequently replaced by the Japan Lessons-Learned Division, which uses the same initials (JLD). No distinction is made between the two organizations in this evaluation.

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The NRC's endorsement of NEI 16-05, including exceptions, clarifications, and additions, is described in NRC JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301).

In the flood hazard reevaluation report (FHRR) submittal for Watts Bar Nuclear Plant, Units 1 & 2 (Watts Bar), Tennessee Valley Authority (TVA, the licensee) committed to submit an IA to address the required flood hazard impact assessments. By letter dated March 10, 2017 (ADAMS Accession No. ML17069A380), TVA informed the NRC of its intent to submit an FE, consistent with the changes discussed above, in lieu of an IA.

By letter dated October 11, 2019 (ADAMS Accession No. ML19284F763, non-public), the licensee submitted an FE for Watts Bar. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms, that: 1) a flood mechanism is bounded by the current design basis (CDB) based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation (LIP). The purpose of this staff assessment is to provide the results of the NRC's evaluation of the Watts Bar FE.

2.0 BACKGROUND

This NRC staff assessment is the last staff assessment associated with the information that the licensee provided in response to the reevaluated flooding hazard portion of the 50.54(f) letter. Therefore, the background section includes a discussion of the reevaluated flood information provided by the licensee and the associated staff assessments. The reevaluated flood information includes: 1) the FHRR; 2) the mitigation strategies assessment (MSA); and 3) the FE.

Flood Hazard Reevaluation Report

By letter dated March 12, 2015 (ADAMS Accession No. ML15071A262), TVA responded to the 50.54(f) letter for Watts Bar and submitted the FHRR. By letter dated June 16, 2015 (ADAMS Accession No. ML20037A072), TVA submitted Revision 1 to the FHRR. In its FHRR, TVA identified that the reevaluation results for LIP, streams and rivers, and flooding from the combined effects of a probable maximum flood (PMF) and wind are not bounded by the CDB for Watts Bar. Both the streams and rivers and combined effect flood-causing mechanisms elevations are reduced, but still exceed the CDB when credit is taken for an interim emergency action plan (EAP) installation of temporary engineered barriers []

[]. The licensee planned to submit an IA to assess the site impact from LIP and to review the long-term options for addressing []

[]. By letter dated March 10, 2017 (ADAMS Accession No. ML17069A380), TVA informed the NRC of its intent to submit an FE, consistent with the changes discussed in Section 1.0 above, in lieu of the IA.

By letter dated September 3, 2015 (ADAMS Accession No. ML15239B292), the NRC issued an interim staff response (ISR) letter for Watts Bar. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the CDB for Watts Bar and parameters that are a suitable input for the MSA and other assessments associated with NTTF Recommendation 2.1 "Flooding." The ISR letter is sometimes referred to as the Mitigating Strategies Flood Hazard

Information (MSFHI) letter. The ISR letter identified that LIP and streams and rivers flood-causing mechanisms exceed the CDB.

By letter dated December 1, 2015 (ADAMS Accession No. ML15310A085), the NRC issued its assessment of the licensee's FHRR. The staff assessment provides the documentation supporting the NRC staff's conclusions summarized in the ISR letter. The staff's conclusions regarding the LIP and streams and rivers flood-causing mechanisms remained unchanged from the information provided in the ISR letter.

Because the LIP and streams and rivers flood-causing mechanisms at Watts Bar are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are expected to be performed by the licensee. The licensee is expected to submit an IA or an FE, as appropriate, to address these reevaluated flood hazards, as described in a letter from the NRC dated September 1, 2015, letter (ADAMS Accession No. ML15174A257).

Mitigation Strategies Assessment

By letter dated December 27, 2016 (ADAMS Accession No. ML16363A381, non-public, security-related information), the licensee submitted its MSA for Watts Bar. The MSAs were intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events. The mitigation strategies have been put in place to meet NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events." The NRC staff's safety evaluation (SE) for the licensee's compliance plans for Order EA-12-049 was issued on March 27, 2015 (ADAMS Accession No. ML15078A193). By letter dated August 22, 2017 (ADAMS Accession No. ML17200C933), the NRC issued its assessment of the Watts Bar MSA.

In SECY-16-0142, "Draft Final Rule – Mitigation of Beyond-Design-Basis Events [MBDBE] (RIN 3150-AJ49)," (ADAMS Accession No. ML16291A186) provisions were proposed that would have required the mitigation strategies to address the reevaluated flood hazard information on a generic basis. As reflected in the Affirmation Notice and Staff Requirements Memorandum (SRM) dated January 24, 2019 (ADAMS Accession No. ML19023A038), associated with SECY-16-0142, the Commission determined that addressing the reevaluated hazards in the mitigation strategies on a generic basis was not needed for adequate protection of public health and safety but should instead be assessed on a plant-specific, case-by-case basis under the requirements of 10 CFR Section 50.109, "Backfitting," and Section 52.98, "Finality of combined licenses; information requests."

The January 24, 2019, Affirmation Notice and SRM directed the staff to continue to use the 50.54(f) process to ensure that the NRC and its licensees will take the needed actions, if any, to ensure there is no undue risk to public health and safety due to the potential effects of the reevaluated flood hazards. The SRM further directed that the staff should continue these efforts, utilizing existing agency processes, to determine whether an operating power reactor license should be modified, suspended, or revoked considering the reevaluated hazard.

In a letter dated August 20, 2019 (ADAMS Accession No. ML19067A247), the NRC staff provided a path forward to treat the reevaluation of flood hazards in light of the Commission's direction in the Affirmation Notice and SRM dated January 24, 2019. The staff assessment documented herein was performed in accordance with the information in the August 20, 2019,

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letter, including a plant-specific determination on whether additional regulatory actions are warranted to address the reevaluated hazard.

In the MSA staff assessment, the staff concluded that the licensee demonstrated the capability to implement FLEX strategies against the reevaluated hazards described in the ISR letter. The NRC staff made its determination based on:

- Consideration that a reevaluated LIP hazard is not expected to impact the storage, deployment and/or staging areas of FLEX equipment given the estimated floodwaters present during the deployment trigger and the physical characteristics of the haul paths and staging areas;
- Consideration that other time sensitive deployment activities occurring prior to 1 hour occur inside or on the roof of the Auxiliary Building and are not affected by the LIP event;
- All Phase 1 and 2 strategies, as currently designed, contain sufficient margin to allow local floodwaters to recede prior to any established FLEX actions or equipment deployment. As a result, implementation timelines should not be impacted; and
- The availability of warning time for streams and rivers, which was determined using accepted methodology, and its incorporation into plant procedures. This warning time allows for additional staging of FLEX equipment for the streams and rivers combined effects event.

In its FE, the licensee revised the LIP and streams and rivers analyses (see Attachment A to the FE) from that provided in the FHRR. In addition, other flood-causing mechanisms that were bound by the CDB were revised and remain bounded. The FE LIP and streams and rivers is used to support the licensee's assessment of structures, systems, and components (SSCs) to provide key safety functions (KSFs) of core cooling, containment integrity, and spent fuel pool cooling. The changes to the LIP flood elevations, associated effects (AE), and flood event duration (FED) were minimal and do not affect the results submitted in the original FHRR and MSA. The revised streams and rivers flood elevations in the FE decreased, are now bound by the CDB, and do not affect the conclusions reached in the staff's assessment of the FHRR or MSA.

The staff continues to conclude that FLEX strategies can be implemented assuming a flooding event of the magnitude described in the ISR letter and bounds the revised flood elevations provided in the FE. In its MSA, TVA concluded that the results from the licensee's original FHRR did not change the overall strategies and timelines for the staging and deployment of FLEX equipment. The mitigation strategies at Watts Bar can be implemented as designed. The staff concludes that implementation of FLEX strategies, assuming the ISR flood conditions, provide an important defense-in-depth function should the installed SSCs be unable to maintain the KSFs during the conditions associated with the flood levels found in the ISR letter.

Focused Evaluation

As noted in the ISR letter, the LIP and streams and rivers flood-causing mechanisms at Watts Bar are not bounded by the plant's CDB. Additional assessments of those flood hazard mechanisms are expected to be performed by the licensee.

By letter dated October 11, 2019 (ADAMS Accession No. ML19284F763, non-public, security-related information, critical energy infrastructure information (CEII)), TVA submitted the FE for

Watts Bar. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded by the CDB based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is LIP. These options associated with performing an FE are referred to as Paths 1, 2, or 3, as described in NEI 16-05, Revision 1.

In November 2015, TVA Corporate Engineering identified a potential error in the Watts Bar FHRR Hydrologic Engineering Center-River Analysis System (HEC-RAS) hydrologic flooding simulation model (TVA Condition Report 1101784). This potential error could result in an overestimation of flood storage capacity in reservoirs within the HEC-RAS model and an underestimation of flooding levels at critical dams and at the Watts Bar plant site. This issue and the proposed changes to address the issue were discussed in detail with the NRC in a public meeting with TVA concerning the Sequoyah Nuclear Plant, Units 1 & 2 (Sequoyah) on April 4, 2016 (ADAMS Accession No. ML16117A551).

As a result of the HEC-RAS error, TVA has updated the FHRR flooding simulation models. The following key changes were made:

1. Probable Maximum Precipitation (PMP): updated to a Watts Bar site-specific PMP based on an NRC reviewed Topical Report (TR) TVA-NPG-AWA16-A, "TVA Overall Basin Probable Maximum Precipitation and Local Intense Precipitation Analysis, Calculation CDQ0000002016000041, Revision 1" (ADAMS Accession No. ML19155A047). The NRC safety evaluation associated with the TR, dated March 18, 2019, can be found at ADAMS Accession No. ML19010A212.
2. Channel Geometry and Overbank Storage in Stream Course Model: updated the channel geometry and/or the overbank storage volumes of the stream course model consistent with recommendations from the United States Army Corps of Engineers.
3. Dam Modifications: updated dam stability analysis to account for a modification at Douglas dam.
4. PMP Areal Application and Loss Methods: updated the rainfall distribution methodology to be consistent with the gridded rainfall data format in TR TVA-NPG-AWA16-A and to apply TVAs antecedent precipitation index (API) rainfall runoff method.

(CEII) The licensee provided an FHRR analysis update as Attachment A to the FE. Table A-4 of the FE tabulates the FHRR analysis update results. Except for the LIP flood-causing mechanism, the FHRR analysis update results are bounded by the CDB. The staff did not perform a detailed evaluation of the methodology associated with the FHRR analysis update for purposes of the FE. For the LIP flood-causing mechanism, the FHRR analysis update change was minor (decrease by 0.2 feet (ft.)) and remains bounded by the licensee's evaluation in the original FHRR. This minor change does not affect the staff's review of the FE. For the streams and rivers flood-causing mechanism, the original FHRR hazard levels are above the CDB (when dam modifications are completed and an EAP for [] is in place). The streams and rivers flood-causing mechanism in the FHRR analysis update is bounded by the CDB. The FHRR analysis update also addresses the long-term actions associated with the EAP []. The EAP remains in place until the hydrology license amendment request (LAR) review (discussed below) is complete and a determination that the EAP is no longer required is made. All other FHRR flood-causing mechanism hazard levels were bounded by the CDB and remain bound in the FHRR analysis update.

(CEII) In addition to the FHRR analysis update, TVA provided a warning time analysis in Attachment B to the FE. The only significant change in the results of the analysis of warning time is the use of revised “rain on the ground” thresholds where Stage I and Stage II actions are required to begin. Use of these revised Stage I and Stage II action levels does not reduce the effectiveness of the warning plan, as there is still a minimum of [] to prepare for operation in the flood mode, which is equal to the CDB warning time. In its MSA, the licensee noted that mitigation of the LIP event requires no site protective actions to occur prior to the start of the LIP event rainfall or before the site is inundated. Therefore, a warning time for the LIP event is not required. The FHRR analysis update notes that the streams and rivers flood-causing mechanism is bound by the CDB.

In a letter to the NRC dated January 14, 2020 (ADAMS Accession No. ML20016A396), TVA applied to revise the Sequoyah, updated final safety analysis report (UFSAR) regarding changes to the hydrologic analysis. As noted in a HEC-RAS project status letter dated October 28, 2019 (ADAMS Accession No. ML19302D601), TVA intends to submit a similar LAR for Watts Bar in the near future. The same methodologies are expected to be used in the LAR and the FHRR analysis update provided with the FE. The original FHRR results bound the FHRR analysis update in the FE and a detailed review of the FHRR analysis update is not required to complete the review of the FE. The staff will evaluate the methodology associated with the updated flood levels and warning times as part of the LAR review. A separate, detailed evaluation for purposes of the licensee’s response to the 50.54(f) letter is not needed.

The licensee’s FE provides a “Path 2” LIP evaluation (i.e., the licensee has effective flood protection for this event), and a “Path 1” streams and rivers evaluation (i.e., the FHRR analysis update flood levels for this event are bound by the current design basis for the plant).

3.0 TECHNICAL EVALUATION

As described in the ISR letter, the LIP and the streams and rivers flood-causing mechanisms exceeds the CDB. The Watts Bar FE addresses both flood-causing mechanisms. This technical evaluation characterizes flood parameters and evaluates the following flood impact assessment topics for the LIP unbounded flood-causing mechanism: a description of the impact of the unbounded hazard; an evaluation of available physical margin (APM) and reliability of flood protection features; and the overall site response.

3.1 Characterization of Flood Parameters

The flood parameters that are used as inputs to the Watts Bar FE staff’s assessment are based on the FHRR analysis update provided as attachment A to the FE. Table 3.1-1 presents a comparison of the design basis flood elevations to the Table 11-1 from the original FHRR and the FHRR analysis update provided as Attachment A to the FE. The FHRR analysis update incorporates the changes to the FHRR simulation models as discussed in Section 2.0. The FHRR analysis update flood elevations are bounded by the CDB flood elevations except for LIP.

For the LIP flood-causing mechanism, the staff’s assessment credits passive protection features to demonstrate that SSCs and the associated KSFs are protected from the LIP flooding mechanism.

For the streams and rivers flood-causing mechanism, the staff reviewed the peak flooding elevations reported by the licensee in Attachment A and notes that the reported values are

bound by the CDB. Therefore, no additional flood protection strategy beyond the existing design basis is needed to address the updated streams and rivers flood-causing mechanism and key SSCs remain protected.

Table 3.1-1 - Summary of Hazard Refinement Changes in Water Surface Elevations for Unbounded Mechanisms

Flood Mechanism	CDB	FHRR/ISR		MSA		Update in FE	
Local Intense Precipitation	728.9	729.2		729.2		729.0	
Streams and Rivers (Stillwater)	739.2	[[]]	[[]]	[[]]
Streams and Rivers (Wind wave)	741.7	[[]]	[[]]	[[]]

In the FE, Watts Bar followed Path 1 of NEI 16-05, Revision 1 to address the streams and rivers flood-causing mechanism. As noted, TVA discovered an issue with the HEC-RAS stream course model used to determine the FHRR streams and rivers flood-causing mechanism. The overbank storage error was discussed with the U. S. Army Corps of Engineers (USACE), which confirmed the original method used by TVA was in error. As discussed with the NRC in the public meeting held on April 4, 2016 (ADAMS Accession No. ML16117A551), TVA has corrected the HEC-RAS storage volume modeling issue. The modifications made, along with the updated channel geometry, are consistent with the recommendations from the USACE. In addition, the FHRR analysis update included application of the NRC-approved site-specific PMP. In addition, modifications at Douglas dam have been completed and the dam stability analysis was updated to account for the completed modifications. No credit is taken for the EAP at [[]]. With these changes, the updated flood elevations of [[]] (stillwater) and [[]] (wind wave) are bound by the CDB. The NRC staff finds this approach to be reasonable, that the streams and rivers flood-causing mechanism flood elevation is bound by the CDB (using the flood elevations from the FHRR analysis update), and concludes that Path 1 from NEI 16-05, Revision 1, is appropriate. No additional flood protection strategy beyond the existing design basis is needed.

The FHRR analysis update addresses the long-term actions associated with the EAP [[]]. The FHRR analysis update states that the EAP is no longer required. The EAP will remain in place until the hydrology LAR review (discussed below) is complete.

For the LIP flood-causing mechanism, Watts Bar followed Path 2 of NEI 16-05, Revision 1. The staff reviewed the FE considering the flooding elevations provided in the FHRR analysis update. The critical flood height is the floor elevation of the exterior doors leading to the Auxiliary Building, which is equal to 729.0 ft. The CDB value of 728.9 ft. is based on ensuring that the LIP flood level at the site that will not exceed the critical elevation. Since the peak flooding elevation of 729.0 ft. equals the safety-related building entry elevations of 729.0 ft., and exceeds the CDB of 728.9 ft., the staff assessed the applicable buildings regarding the lowest key SSC elevation and determined that the key SSCs remain protected during the LIP event. The staff also notes that the key SSCs remain protected even in the case where the ISR level of 729.2 is used. An evaluation of the potential impacts of the 729.2 ft. LIP flooding elevation was documented in Section 12.1 of the FHRR and in Section 3.1 of the MSA.

The staff did not perform a detailed evaluation of the methodology associated with the FHRR analysis update provided in Attachment A of the FE.

For the LIP flood-causing mechanism, the FHRR analysis update change was minor (decrease by 0.2 ft.) and remains bounded by the licensee's evaluation in the original FHRR. Both the original and updated analysis are not bound by the CDB. The staff's assessment credits passive protection features to demonstrate that SSCs and the associated KSFs are protected from the LIP flooding mechanism, even at the slightly higher ISR level. The methodology used to determine the new LIP hazard level has no effect on the conclusions reached by the staff.

(CEII) **[[** For the streams and rivers flood-causing mechanisms, the original FHRR hazard levels exceed the CDB by less than 1 ft., assuming that dam modifications are completed and an EAP for **]]** is in place. The licensee reported in its FE that the revised streams and rivers flood-causing mechanism is bounded by the CDB and the dam modifications are complete. The EAP is not credited in the FHRR analysis update and is no longer needed. The EAP will remain in place until the hydrology LAR review (discussed below) is complete. An inspection of the interim actions noted in the FHRR by the licensee was completed by the NRC and documented in Inspection Report 05000390/2015003 (ADAMS Accession No. ML15310A360). Thus, it is reasonable to conclude that the plant remains capable, using the interim actions noted in the FHRR, of completing a safe shutdown up to the reevaluated streams and rivers flood hazard level described in the ISR. All other FHRR flood-causing mechanism hazard levels were bound by the CDB and remain bound in the FHRR analysis update. In addition, the licensee's MSA determined that the mitigation strategies remain effective under the reevaluated flood hazard conditions up to the ISR flood levels, providing an important defense-in-depth function.

The new flood hazard analysis detailed methodologies will be reviewed as part of an upcoming LAR review. In a letter to the NRC dated January 14, 2020 (ADAMS Accession No. ML20016A396), TVA provided an application (license amendment request, or LAR) to revise the Sequoyah UFSAR regarding changes to the hydrologic analysis. As noted in a HEC-RAS project status letter dated October 28, 2019 (ADAMS Accession No. ML19302D601), TVA has committed to provide a similar LAR in the near future for Watts Bar. Given that essentially the same methodologies are expected to be used in both the FHRR analysis update and the LAR, in the interest of efficiency, the staff has determined that a detailed review of the methodologies will be done during the LAR review. An identical, detailed evaluation for purposes of the licensee's response to the 50.54(f) letter is not needed. The staff considers this reasonable for the following reasons:

- The topical report used to provide input to the site-specific PMP has been approved for use by the NRC.
- The stream course model updates are consistent with recommendations from the US Army Corps of Engineers.
- Dam modifications discussed in the FHRR have been completed and are used to update the dam stability analysis.
- The same methodologies are expected to be used in both the FHRR analysis update and the LAR.
- The LIP flood-causing mechanism change was minor.
- The warning time analysis retains the design basis warning time.
- The staff considers it reasonable that the conclusions reached in the FE assessment will not be affected, up to the flood levels noted in the original ISR levels, for LIP.
- Using the interim actions described in the FHRR and inspected by the NRC, the plant remains capable of completing a safe shutdown up to the reevaluated streams and rivers flood hazard level described in the ISR.

- In the MSA staff assessment, the NRC staff concluded that the licensee demonstrated its capability to implement FLEX strategies, as designed, against the reevaluated hazards discussed in the ISR letter.
- Any results identified during the LAR review that may adversely impact the conclusions described in this staff assessment (i.e., an increase in the applicable FCM critical flood height or a decrease in the design basis warning time) will be reviewed and the impact on the site assessed as part of the LAR review.

3.2 Evaluation of Flood Impact Assessment for Local Intense Precipitation

3.2.1 Description of Impact of Unbounded Hazard

The LIP evaluation in the FE generated a maximum ponding level of 729.0 ft. on the east side of the plant. This elevation equals the safety-related building entry point levels of 729.0 ft. The time the flood water remains at this elevation prior to receding is minimal.

Figure 3-3 of the licensee's FHRR provides a site layout. Based on this potential for in-leakage, the licensee reviewed the key SSCs in each potentially affected building that could be affected by the original FHRR LIP elevation of 729.2 ft. on the east side of the plant. The LIP flood elevation at all other areas was below the CDB elevation.

The buildings that could be affected by the LIP flood levels have access at or below elevation equal to 729.0 ft. Access doors to buildings containing safety-related SSCs from ground elevation 729.0 ft. are highlighted in Figure 12-1 of the licensee's FHRR. The licensee identified that the safety-related buildings with exterior entry doors and potentially subject to LIP flooding are the Auxiliary Building and the north and south Main Steam Valve Vaults (MSVV) (FHRR, Section 12.1).

The potential for LIP flood water entry into buildings housing safety-related equipment required for safe shutdown was assessed by the licensee in the FHRR using a LIP flood level of 729.2 ft. This bounds the FHRR analysis update level of 729.0 ft. in the FE. In its FE, the licensee summarized the impact assessment conclusions from the original FHRR. Based on the FHRR impact assessment, the licensee states that key safety-related equipment is not affected by the LIP event described in the FE. In addition, the licensee states that LIP associated effects, such as debris loads, hydrodynamic loads, and hydrostatic loads, are expected to be negligible due to the low flow velocities and shallow water depths.

The plant structures that contain safety-related equipment and systems, as well as the major exterior accesses, are specified in the Watts Bar UFSAR. The site topography and geographical characteristics, site physical features and plant layout were reviewed by NRC staff as noted in the FHRR audit report dated October 30, 2015 (ADAMS Accession No. ML15294A203). The access doors, as well as any other openings at or below the LIP flood height, that could allow water into the safety-related buildings were reviewed by the licensee using site drawings and a licensee walkdown conducted in February 2015.

The licensee states in its FE that no LIP floodwater in-leakage is expected into the Auxiliary Building based on design of the personnel and equipment access entry locations. No LIP floodwater in-leakage is expected into the MSVV rooms based on the height of louvered or grilled openings and curbing around the personnel access doors, which provide protection to at least elevation 729.5 ft. No credit is taken for flood mitigation actions in the FE LIP event.

Nuclear Power Group (NPG) standard procedure NPG-SPP-07.1.8, "Severe Weather and Natural Disasters," states that in heavy rains, plant areas prone to ground water intrusion are inspected. In addition, plant conditions are reviewed to determine if any penetrations in an external flood barrier are open and the necessary actions are taken to seal penetrations. However, no time sensitive operator actions are required to protect the safety-related SSCs during a LIP event. Details of the licensee evaluations and staff review follow.

A potential LIP floodwater ingress point into the Auxiliary Building is through the railroad bay door A112. The railroad bay door, its embedded frames, seals, etc., are seismic Category 1 equipment and designed as Auxiliary Building Secondary Containment Envelope (ABSCE) closures, providing an essentially airtight closure. An exterior water height of 0.2 ft. is bound by the load case for which this door is designed. Two railroad bay doors (A113 and A114) communicate with the Auxiliary building. The railroad bay door A112 is interlocked with the two alternate ABSCE doors A113 and A114 such that, if door A112 is open, doors A113 and A114 will be closed. Both doors A113 and A114 have 1 ¼ inch thresholds. This interlock essentially provides an airlock and no LIP floodwater leakage is expected through this airlock. If the railroad bay door A112 is open, the doors within the railroad bay are interlocked closed. Door A111 on the north side of the railroad bay opens to the Waste Packing Area. There is no safety-related equipment housed in the railroad bay area or the waste packing area. There is no equipment required for safe shutdown in the rooms below the railroad bay. The water volume entering the adjacent waste packaging areas from the railroad bay will be minimal.

Given the limited LIP flood height and duration, any minimal leakage through the railroad bay door will likely be contained within the railroad bay and will not impact the plant capability to perform a safe shutdown. Even if the railroad bay door is open, minimal to no leakage is expected through the internal airlock doors up to the ISR LIP flood height. Any minimal water ingress through the railroad bay door (or the interior ABSCE doors if the bay door is fully open) will not impact the ability to perform a safe shutdown. Any minimal leakage past doors A113 and A114 is bound by the moderate energy line break (MELB) flood heights in the affected rooms.

The staff reviewed the interlocked operation of the railroad bay doors. Considering the design characteristics of the doors, the physical size of the railroad bay, the operations of the internal airlock doors, and the minimal height and duration of any LIP flood waters at or above elevation 729.0 ft., the staff considers it reasonable that little to no leakage beyond the internal airlock doors is expected and that no safety-related SSCs will be affected.

The LIP flood water ingress could potentially occur at both the north and south MSVV. The LIP flood water level at this location is 729.0 ft. Both MSVV rooms have finished floor elevations of 729.0 ft.

The personnel access doors for the north MSVV have 6-inch concrete curbing with a top elevation of 729.5 ft., as noted in Section 12.1 of the licensee's FHRR. The curbing was verified during licensee walkdowns. The external louvers have a bottom elevation of 729.5 ft. Thus, each potential ingress path for the north MSVV is above the expected LIP floodwater level with a margin of 0.5 ft.

The personnel access doors for the south MSVV have 6-inch concrete curbing with a top elevation of 730.0 ft., as noted in Section 12.1 of the licensee's FHRR. The curbing was verified during licensee walkdowns. The grilled vent openings have a bottom elevation of 730.0 ft.

Thus, each potential ingress path for the north MSVV is above the expected LIP floodwater level with a margin of 1 ft.

The licensee concluded that, since the maximum LIP floodwater was 729.0 ft., the north and south MSVVs are protected by design and no LIP floodwater is expected to impact SSCs in the MSVV. An evaluation of the available physical margin is provided in Section 3.2.2.

The staff has reviewed the licensee's information. The staff concludes that safety-related equipment within the MSVVs is unlikely to be impacted by the LIP flood waters because of the physical protection up to an elevation of at least 729.5 ft. The staff's evaluation of the acceptability of the available physical margin is provided in the next section.

The licensee discussed three additional buildings that are potentially impacted by the reevaluated LIP flood heights in Section 12.1 of the FHRR. The Shield Building Vent Radiation Monitor room has a finished floor elevation of 729.5 ft. and is above the LIP flood height. The Upper Head Injection room, located on the plant east side (FHRR figure 7-3), has a finished floor elevation of 729.0 ft., and LIP water could potentially enter this room because the exterior door has no threshold or curbing. However, the MELB flood height in this room is 4 inches, which bounds any potential LIP floodwater in-leakage. The upper head injection room primarily contains equipment associated with the abandoned upper head injection equipment. Lastly, the turbine building has a finished floor elevation of 729.0 ft. However, the turbine building doors are located well south of channel Section 16 (FHRR figure 7-3), and the calculated LIP flood height in the FHRR (FHRR table 9-1.1) is below the finished floor elevation in this area. The FHRR analysis update calculated LIP flood height in this area (identified as WBN West in table A-2 in the FE) is 728.4 ft.

In its FE, the licensee states that the LIP associated effects, such as debris loads, hydrodynamic loads, and hydrostatic loads are expected to be negligible, as well as the flood event duration. The licensee states in its MSA that the AE and FED parameters for both LIP and riverine flooding are minimal. In its assessment of the licensee's MSA, the NRC staff concluded that the licensee's justifications and methods related to the AE and FED parameters are appropriate and reasonable. Since the FHRR analysis update water levels are below those used in the MSA, the staff considers it reasonable to conclude that the associated effects due to LIP will be negligible.

Based on the discussions above, the staff concludes that key SSCs and their associated key safety functions are effectively protected against the LIP flood levels identified in the FE because:

- Exterior doors and hatches would prevent/minimize water intrusion into safety-related areas of the plant.
- Doors leading to safety-related areas that are subject to LIP floodwater ingress are designed water-tight, pressure-tight, or essentially air-tight. Any leakage through these doors will be minimal and does not impact any safety-related SSCs.
- Curbing around non-leak tight exterior doors to the MSVV provide protection to a level above the expected LIP flood level.
- Potential in-leakage water depths are bounded by MELB flood heights.
- The FHRR analysis update LIP flood height elevation of 729.0 ft. is equal to the exterior thresholds and finished floor heights and any water intrusion would be minimal.
- The time for LIP flood waters to recede from the site is minimal (MSA staff assessment, Table 3.3.1-1).
- The debris loads, hydrodynamic loads, and hydrostatic loads due to the LIP flood levels are minimal.

Therefore, the staff concludes that the licensee has met the guidance in NEI 16-05, Revision 1, as endorsed by the NRC, of a Path 2 evaluation (i.e., "effective flood protection") for the FE LIP event. Key safety functions, without reliance on FLEX, can reasonably be expected to be met with installed plant equipment.

Defense-in-Depth

In addition to the staff concluding that Watts Bar meets the Path 2 guidance in NEI 16-05, Revision 1, for the LIP event, the staff also concludes that Watts Bar would meet Path 3 guidance for this event by demonstrating a feasible flood response for LIP. The feasible flood response for the higher ISR LIP event was evaluated by the staff and found to be acceptable as documented in the MSA staff assessment dated August 22, 2017 (ADAMS Accession No. ML17200C933). No changes to the mitigation strategies described in the licensee's final integrated plan were necessary to address the ISR LIP flood elevation. Mitigation of the LIP event does not require any protective actions to occur before the site is inundated. The information in the FE does not change the conclusions in the MSA staff assessment regarding the LIP flood event.

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

Watts Bar flood protection from a LIP event does not rely on active features or operator actions. Flood protection in the LIP event is provided by passive civil/structural and architectural design features. These features are periodically inspected under the Watts Bar Structures Monitoring program, Technical Instruction 0-TI-445, R2, "Examination of Structures for Maintenance Rule."

During a LIP event, flood water leaking into the Auxiliary Buildings is minimized or prevented by the design of the Auxiliary Building access doors and hatches. For example:

1. Doors are designed as airtight, watertight, or pressure containing and minimal or no leakage is expected
2. Interlocks prevent opening internal railroad bay doors and the external bay door simultaneously
3. Doors are Auxiliary Building Secondary Containment Enclosure doors and are designed watertight
4. The railroad bay door, its embedded frames, seals, etc., are seismic Category 1 equipment.

The only access to a room containing safety-related SSCs with non-sealed doors and external openings that are near the LIP flood height are the north and south the MSVVs. During a LIP event with a maximum flood elevation of 729.0 ft., leakage into the MSVVs is prevented by the elevation of the installed entry curbs and the height of the lowest vent louver opening. External doors are protected by concrete curbs to at least elevation 729.5 ft. The external ventilation louver opening has a lower elevation of 729.5 ft. This provides a minimum available physical margin of 0.5 ft. above the LIP level of 729.0 ft.

Per NEI 16-05 Appendix B, Section B.1, negligible or zero APM can be justified as acceptable if the use of conservative assumptions, inputs, and/or methods are used. The following are examples of conservatisms used in the licensee's LIP flood analysis:

1. All site surfaces are considered impervious, so no infiltration is credited.
2. All catch basins and storm culverts are assumed to be blocked and unavailable for drainage.
3. The plant drainage channels are postulated to experience partial, although severe, blockage that significantly reduces the conveyance capacity of the channels.
4. No credit is taken for operator actions to minimize ingress of water.

The NRC staff reviewed the licensee's assumptions, inputs and methods used for the LIP analysis in the original FHRR. These conservatisms were retained for the FHRR analysis update values provided in the FE. Based on these conservatisms, the NRC staff concludes that adequate APM is available for the LIP event described in the FE. The minor difference between the original FHRR LIP flood height and the flood height used in the FE does not affect the staff's conclusion.

Based on the above evaluation, the NRC staff concludes that existing margins are adequate and protective features are reasonably reliable to provide effective flood protection from the LIP event to maintain KSFs for the LIP event, consistent with Appendix B of NEI 16-05, Revision 1.

3.2.3 Overall Site Response

The licensee stated in its FE that site response to a LIP event relies on normal passive/civil structural and architectural design features. No specific operator actions are required to respond to a LIP event. Mitigation of the LIP event requires no site protective actions to occur prior to the start of the LIP rainfall or before the site is inundated. A minimum of **[[]]** is provided by the stage I/stage II warning system as described in the UFSAR, and those times are not changed in the updated warning time analysis in Attachment B to the FE.

(CEII)

(CEII) The licensee also stated in Attachment B to the FE that calculations were performed to determine the appropriate weather monitoring thresholds for a LIP event. These thresholds will be used by TVA's River Operations Group to provide flood warnings to the Watts Bar Operations group. These warnings, together with river flood modeling by TVA's River Operations, assure adequate time is provided for Watts Bar to perform the required design-basis flood mode operations activities before site flooding begins. In addition, regardless of the rain on the ground values or other conditions, a Stage II shutdown warning is given when plant grade is projected to be reached in or less. The rain on the ground values will be evaluated as part of the upcoming Watts Bar hydrology LAR. If these thresholds are used as described, the site procedures will have updated weather monitoring triggers based on the latest hazard information and methodologies.

In addition, as outlined in the MSA, the licensee demonstrated the capability to deploy its FLEX strategies against a postulated beyond-design-basis flooding event up to the ISR flood levels and that the FLEX strategies are reasonably protected against the reevaluated flooding hazard. If implemented and maintained as described in the MSA, the FLEX strategies are expected to provide an additional layer of protection against the reevaluated LIP flooding hazard.

4.0 AUDIT REPORT

The July 18, 2017 (ADAMS Accession No. ML17192A452), generic audit plan describes the NRC staff's intention to issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's FE. An audit was not required for the NRC staff to complete this staff assessment.

5.0 CONCLUSION

Based on the staff's review that was performed in accordance with the guidance described in NEI 16-05, Revision 1, as endorsed by JLD-ISG-2016-01, the staff concludes that Watts Bar has effective flood protection for the LIP event as described in the FE and that the streams and rivers water levels are bound by the CDB. The staff concludes that, because the licensee meets Path 2 FE guidance for the LIP flood event, and Path 1 FE guidance for the streams and rivers flood event, an integrated assessment is not needed to support NRC Phase 2 decisionmaking. Watts Bar screens out for an integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, the staff concludes that, in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard are not warranted. The staff further concludes that the licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

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J. Barstow

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FLOODING FOCUSED EVALUATION (EPID NO. L-2019-JLD-0011) DATED
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