Exelon Generation®

RS-16-100 Order No. EA-12-049

June 30, 2016

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

Dresden Nuclear Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-19 and DPR-25
NRC Docket Nos. 50-237 and 50-249

Subject: Mitigating Strategies Flood Hazard Assessment (MSFHA) 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. Exelon 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 May 10, 2013 (RS-13-110)

3. Exelon Generation Company, LLC Letter to USNRC, Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated May 19, 2014 (RS-14-122)

4. Exelon Generation Company, LLC Letter to USNRC, Supplemental Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated August 28, 2013 (RS-13-210)

5. 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

6. 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

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

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

9. U.S. Nuclear Regulatory Commission, JLD-ISG-2012-01, Revision 1, Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events, dated January 22, 2016

10. NRC Letter, Dresden Nuclear Power Station, Units 2 and 3 – Supplement to Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (TAC Nos. MF1795 and MF1796), dated November 4, 2015

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 Dresden Nuclear Power Station, Units 2 and 3, the FHRR was submitted on May 10, 2013 (Reference 2). Additional information was provided with References 3 and 4. Per Reference 5, the NRC considers the reevaluated flood hazard to be "beyond the current design/licensing basis of operating plants".

Concurrent to the flood hazard reevaluation, Dresden Nuclear Power Station, Units 2 and 3 developed and implemented mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events". In Reference 6, the NRC affirmed that licensees need to address the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis (BDB) external events, including the reevaluated flood hazards. This requirement was confirmed by the NRC in Reference 7. Guidance for performing mitigating strategies flood hazard assessments (MSFHAs) is contained in Appendix G of Reference 8, endorsed by the NRC in Reference 9. For the purpose of the MSFHAs and in Reference 7, the NRC termed the reevaluated flood hazard, summarized in Reference 10, as the "Mitigating Strategies Flood Hazard Information" (MSFHI). Reference 8, Appendix G, describes the MSFHA 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)

In Reference 10, the NRC concluded that the "reevaluated flood hazards information, as summarized in the Enclosure [to Reference 10], is suitable for the assessment of mitigating

strategies developed in response to Order EA-12-049" for Dresden Nuclear Power Station, Units 2 and 3.

The enclosure to this letter provides the Mitigating Strategies Assessment for Flooding for the Dresden Nuclear Power Station, Units 2 and 3.

The current FLEX strategies can be successfully implemented for both flooding scenarios applicable to Dresden Station: a) River flood (River Probable Maximum Flood (PMF) plus upstream dam failure, and b) Local Intense Precipitation (LIP) event. It was determined that no safety related equipment or FLEX equipment was adversely impacted by the water ingress.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact David P. Helker at (610) 765-5525.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 30th day of June 2016.

Respectfully submitted,

Glen T. Kaegi

Glen T. Kaegi
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosure: Dresden Nuclear Power Station, Units 2 and 3, Mitigating Strategies Assessments for Flooding, dated June 30, 2016

cc: Director, Office of Nuclear Reactor Regulation
NRC Regional Administrator - Region III
NRC Senior Resident Inspector – Dresden Station
NRC Project Manager, NRR – Dresden Station
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Mr. John P. Boska, NRR/JLD/JOMB, NRC
Illinois Emergency Management Agency - Division of Nuclear Safety

Enclosure

Dresden Nuclear Power Station, Units 2 and 3

Mitigating Strategies Assessments for Flooding

dated June 30, 2016

(16 Pages)

Mitigating Strategies Assessments for Flooding

Dresden Nuclear Power Station, Units 2 and 3

Exelon.

June 30, 2016

Contents

1 Executive Summary

The Dresden FLEX design basis (DB) flood is an event principally caused by precipitation across the Des Plaines River and Kankakee River watersheds as determined by the Flood Hazard Reevaluation Report (FHRR) (i.e. Mitigating Strategies Flood Hazard Information (MSFHI)). The MSFHI for the river flood is based on a combined-effects Probable Maximum Flood (PMF) level, including upstream dam failure, of 525 ft Mean Sea Level (MSL) for stillwater and an additional 4 ft of wind-wave runup. The Dresden site grade is at elevation 517 ft MSL. The MSFHI for the river flood (producing 8 feet stillwater depth and 12 feet total depth above site grade) is not bounded by the Current Licensing Basis (CLB) flood, which consists of a stillwater elevation of 525 ft MSL plus 3 ft of waves. However, the FLEX DB flood parameters were set equivalent to, and are therefore bound, the MSFHI. Therefore, a Mitigating Strategies Assessment (MSA) for the MSFHI river flood is not required.

The MSFHI also included the Local Intense Precipitation (LIP) flood-causing mechanism. For Dresden, the LIP event results in a maximum flood at elevation 518.1 ft (0.6 ft above the reactor building floor level of elevation 517.5 ft for a time period of 1.75 hours). This results in potential water ingress through the reactor building interlocks at ground level. All elevations for river flooding and LIP flooding are taken from References 2, 4 and 6.

The primary water ingress path is through a U2 Trackway interlock door threshold. An evaluation was performed to quantify the water ingress. The LIP water ingress causes less than 10 inches of flooding in the reactor basement. The LIP flood-causing mechanism was not included in the FLEX flood mitigation strategy thus the MSFHI parameters for the LIP event were unbounded by the FLEX DB. Section 6 of this document summarizes the impact of LIP parameters on FLEX flood mitigation strategy. The evaluation determined that there is no adverse impact on the SSCs or FLEX equipment.

The MSA for Dresden concludes that the existing FLEX strategies, procedures and equipment are not adversely impacted by the Mitigating Strategies Flood Hazard Information (MSFHI) under both PMF and LIP events.

2 List of Acronyms

- AMS – Alternate Mitigating Strategies
- AOP – Abnormal Event Operating Procedures
- BDB – Beyond Design Basis
- BDBEE – Beyond Design Basis External Events
- CDB – Current Design Basis
- CLB – Current Licensing Basis
- DB – Design Basis
- DG – Diesel Generator
- DGA - Dresden General Abnormal Procedure
- DGP - Dresden General Procedure
- DOA – Dresden Operating Abnormal
- DOP – Dresden Operating Procedure
- EDG – Emergency Diesel Generator
- ELAP – Extended Loss of A/C Power
- EOP – Emergency Operating Procedures
- FHRR – Flood Hazard Reevaluation Report
- FLEX – Strategy response to an ELAP and LUHS, postulated from a BDBEE
- FLEX DB – FLEX Design Basis (flood hazard); the controlling flood parameters used to develop the FLEX flood strategies
- FSG – FLEX Support Guidelines

- HCVS – Hardened Containment Vent System
- IA – Integrated Assessment
- ISPH – Intake Screen and Pump House
- LIP – Local Intense Precipitation
- LUHS – Loss of Ultimate Heat Sink
- MSA – Mitigation Strategy Assessment
- MSFHA – Mitigating Strategies Flood Hazard Assessment
- MSFHI – Mitigating Strategies Flood Hazard Information
- MSL – Mean Sea Level datum
- NRC – Nuclear Regulatory Commission
- NGVD-29 – National Geodetic Vertical Datum of 1929
- NTTF – Near-Term Task Force
- OCC – Outage Control Center
- PMF – Probable Maximum Flood
- PMP – Probable Maximum Precipitation
- RAI – Request for Additional Information
- SAR – Staff Assessment Report
- TPDU – Temporary Power Distribution Unit
- TSA – Time Sensitive Action
- USACE – US Army Corps of Engineers

3 Background

3.1 Purpose

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). The Dresden FHRR was submitted on May 10, 2013 (Reference 2). NRC requested additional information (RAI) on the FHRR on April 9, 2014 (Reference 3). On May 19, 2014, Dresden submitted responses to the NRC's RAIs (Reference 4). On March 31, 2015, NRC provided Staff Assessment of the FHRR (Reference 5) and determined that Dresden has provided sufficient information in response to the 50.54(f) letter (Reference 1). On November 4, 2015, the NRC provided a Supplement to the Staff Assessment (Reference 6) for Dresden and concluded that (a) the reevaluated flood hazards results for LIP and upstream dam failure are not bounded by the current design-basis flood hazard, (b) additional assessments of plant response will be performed for the local intense precipitation and upstream dam failure flood-causing mechanisms, and (c) the reevaluated flood-causing mechanism information is appropriate input to additional assessments of evaluations of plant response, as described in the 50.54(f) letter and COMSECY-15-0019, including the assessment of mitigation strategies developed in response to Order EA-12-049.

Concurrent to the flood hazard reevaluation, Dresden developed and implemented mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events". In Reference 7, the Commission affirmed that licensees need to address the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis (BDB) external events, including the reevaluated flood hazards. This requirement was confirmed by the NRC in Reference 8. The NRC has determined that the reevaluated flood hazard is "beyond the current design/licensing basis of operating plants" (Reference 8).

Guidance for performing mitigating strategies flood hazard assessments (MSFHAs) is contained in Appendix G of Reference 10, endorsed by the NRC in Reference 9. For the purpose of the MSFHAs and in Reference 6, the NRC termed the reevaluated flood hazard,

summarized in References 9, as the "Mitigating Strategies Flood Hazard Information" (MSFHI). Reference 10, Appendix G, describes the MSFHA for flooding as containing the following elements:

- Section G.2 – Characterization of the MSFHI
- Section G.3 – Basis for Mitigating Strategy Assessment (MSFHI-FLEX DB Comparison)
- 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)

3.2 Site Description

The Dresden site is located at the confluence of the Des Plaines and Kankakee Rivers that forms the Illinois River. The site is also located just upstream of the Dresden Island Lock and Dam, which is owned and operated by the USACE. The nominal ground elevation of the Dresden site is about elevation 516 feet MSL at the location of the principal structures of Units 2 and 3, and the design plant grade is elevation 517 feet MSL. The finished floor elevation of the plant structure is 517.5 feet MSL. Safe shutdown of the plant during the CLB PMF is accomplished via implementation of flood emergency procedures (Dresden UFSAR). CLB flood emergency procedures available to mitigate the impact of an external river flood event are described below.

The existing procedure DOA 0010-04 "Floods" makes optimum use of the onsite equipment to achieve a safe shutdown of the reactor under PMF conditions. The procedure utilizes several methods to discharge decay heat throughout the PMF event. During early phases when the power is available, the reactor is shutdown and cooled down per existing procedures. Once the river level reaches elevation 513 feet MSL, the reactor cooling is switched to the isolation condensers. Initially, multiple water sources are available for the shell side of the isolation condensers. Once the site is inundated with a flood, the barge mounted flood pumps will be used to pump flood waters to remove the decay heat. One flood pump is sized to meet all makeup requirements for both units. A second flood pump on the barge serves as a back-up pump.

Essential to the implementation of the flood procedure is the availability of reliable monitoring and the forecast of data pertaining to regional precipitation and water level rise. This information is provided by rainfall monitoring stations located throughout the Kankakee and Illinois River basins as well as by the National Weather Service and the firm of Murray and Trettle, Exelon's meteorological consultants. The information provided from these sources, in conjunction with the computed PMF hydrograph, provides advance warning in the event of a PMF. The PMF flood procedure is implemented upon a forecast of river levels exceeding elevation 506.5 feet MSL. Operators then maintain a close watch on the Unit 2/3 intake canal water level, which, if predicted to exceed elevation 509 feet MSL, will trigger further operator actions. When the water level reaches elevation 509 feet MSL all reactors are shutdown, the drywells are deinerted, and the vessels are flooded. The reactors are cooled to the lowest temperature as quickly as possible per Tech Specs. If the water level reaches elevation 513 feet MSL at the plant site, cooling of the reactors will be transferred to the isolation condensers, which will thereafter maintain the primary system in a safe shutdown condition until the flood waters have receded and flood recovery actions can be initiated.

If forecasted flood levels exceed elevation 517.0 MSL, concurrent with the operations described for core cooling, the following procedural steps are implemented. Motors and other electrical equipment, located at elevation 517.0 MSL, below the PMF crest level, are de-energized. In addition, all above-ground water tanks are filled to a level of 10 feet above grade, and all below-ground water tanks are filled with demineralized water. Also, vents to below-ground diesel oil storage tanks will be sealed for U2 and U3. For U2/3

underground tank, the vent will be extended up to 25 feet (using multiple sections as needed) above ground. A battery operated pump will be used to retrieve diesel fuel through the extended vent line. A barge mounted diesel-driven emergency flood pump staged in U3 Turbine building is connected by hoses to a fire system header in each unit. Other auxiliary equipment obtained upon prediction of a PMF includes portable generators and motorized boats to facilitate operations in and around the site subsequent to de-energizing transformers at the time the water level reaches plant grade.

3.3 Overview of FLEX Strategy

Dresden's FLEX strategy only considers the river PMF (with upstream dam failure) flood causing mechanism, reevaluated and documented in the FHRR and RAI submittals (References 2 and 4, respectively). The Local Intense Precipitation (LIP) flood-causing mechanism was not considered.

The FLEX strategy is implemented by FLEX Support Guides (FSGs) in conjunction with other site emergency procedures. FSG-01 provides a Flowchart of actions to be performed under Extended Loss of AC Power/Loss of Ultimate Heat Sink conditions for all FLEX events including flooding. The entry condition for FSG-01 is "Station Blackout". As soon as this event occurs, DGA-22, Station Blackout is entered. As directed by DGA-22, the FSG-01 Flowchart actions are initiated. Pertinent to the flooding conditions, three FSGs are invoked: FSG-60, FLEX Flood Pump Deployment/Operation, FSG-61, FLEX Fire System Isolation and FSG-62, FLEX Generator Deployment during a flood. These three FSGs provide guidance in conjunction with the Floods procedure DOA 0010-04 that provides step by step actions to be performed under flooding conditions. If a Station Blackout does not occur and a flooding event is in a forecast, DOA 0010-04 is entered based on river flood levels.

The river flooding scenario is based on rainfall forecast. A close coordination with the Dresden Lock Master of the USACE will be maintained when river levels are rising. Additionally, Unit 2/3 Cribhouse Intake Canal level will be measured at specified frequencies. Note that the Unit 2/3 Cribhouse is the same as the Intake Screen and Pump House (ISPH).

Based on predictions/information, the following actions are taken.

1. If rainfall forecast exceeds two (2) inches/hour, or the river level exceeds elevation 507 ft MSL, Attachment A of DOA 0010-04 provides guidance for river monitoring and rainfall forecasting. Additionally, communications with the Dresden Lock Master or the US Army Corps of Engineering are initiated and maintained to obtain information on the operability status and intentions of Dresden Lock and Dam gates. The U2/3 Crib House water level monitoring is initiated at specified frequencies.
2. If the Crib House levels are "predicted" to reach > elevation 507 ft MSL, then the Duty station manager is notified to staff the OCC. Additionally OCC is notified to initiate actions in Attachment K, FLEX Flood Preparatory Actions. Major actions include deployment of barge mounted FLEX Flood Pumps in the U3 Turbine Building Trackway and filling all the diesel fuel barrels on the barge. The U2/3 EDG Fuel Oil Tank vent line extension pipe(s) are installed. The HL130, B.5.b/Flex Pump, Dam Failure Submersible pumps/power packs, Portable Isolation Condenser Diesel Driven Make-up pump and hoses are relocated to an offsite location above elevation 529 ft MSL so they are available during the period when flood waters recede to the plant grade level. The FLEX Diesel Generator and associated power distribution unit are staged on top of the U2 Trackway interlock. Dresden is in the process of changing the location of the FLEX DG equipment to the turbine deck at EL 561' due to Hardened Vent routing above the U2 Trackway interlock. A boat with necessary supplies and fuel is also staged near the barge. Dresden has 5 boats available for use.

3. In addition to the Attachment K preparations discussed above, OCC will initiate actions to install flood barriers per station procedure MA-DR-MM-6-00101. The plate type flood barriers are designed to cover all reactor building openings and EDG rooms for PMF conditions (Reference 14). Note that the turbine building is not protected from the flood waters. Access to the reactor building will be made through an interlock on turbine deck at elevation 561 ft MSL. The interlock is at elevation 570 ft MSL on the reactor side (Drawing M-2).
4. If the Crib House intake canal level is "predicted" to exceed EL 509' anytime within the next 72 hours, then both U2 and U3 are shut down per DGP 02-01. The reactor systems are cooled down as quickly as possible per Tech. Spec 3.4.9 to the lowest temperature possible in the time available before U2 and U3 Service Water Systems are secured at elevation 513 ft MSL.
5. U2 and U3 reactor vessels are filled to aid in cool down if time is available before Service Water Systems are secured at elevation 513 ft MSL.
6. OCC is notified to coordinate installation of the Isolation Condenser Make-Up Pump Building Flood Barriers or construction of a flood protection berm to protect the building to at least a level elevation 519' 6" MSL.
7. If the Crib House level reaches elevation 508 ft MSL, the Duty Station Manager is notified to staff the OCC and to initiate the FLEX Flood Preparatory Actions described above.
8. If the Cribhouse level reaches elevation 509 ft MSL and is predicted to continue to rise then both units are scrammed per DGP 02-03 and the reactor systems are cooled down as quickly as possible. FSG-61, FLEX Fire System Isolation actions are also initiated.
9. If the Crib House level reaches elevation 513 ft MSL, U2 and U3 Service Water Systems are secured, and DOA 1000-01, Residual Heat Removal Alternatives is entered. The reactor level is restored between +55" and +60". The reactor cooling is transferred to the Isolation Condensers (DOP 1300-03), and contingency plans are initiated to address loss of fuel pool cooling (DOA 1900-01).
10. If the Crib House level is "predicted" to exceed elevation 517 ft MSL, then all above-ground storage tanks level will be raised to ≥ 10 ft and the below-ground water storage tanks will be filled.
11. When the Crib House level reaches elevation 517 ft MSL, then power will be removed from transformers and MCCs on elevation 517 ft MSL.
12. When the Crib House Level reaches elevation 518 ft MSL, the barge mounted FLEX Flood Pump is aligned and started. The pump takes flood water suction from the Test boiler pit and delivers to the fire header at elevation 538 ft MSL. The flood pump provides make-up water to the isolation condensers, spent fuel pools and the reactor vessel until flood waters recede and recovery and cleanup activities start. The barge mounted flood pump will be started at flood level of elevation 518 ft MSL. Note that the Isolation Condenser Make-Up Pump Building is protected to a flood level of at least elevation 519' 6" MSL (EC 391096). This provides sufficient time to transition from the Make-Up pumps to the barge mounted FLEX Flood Pumps. One Flood Pump will provide make up for the Isolation Condensers, Spent fuel Pools and Reactor Pressure Vessels for both the units. The second Flood Pump on the barge provides redundancy.
13. When the Crib House level recedes to below elevation 509 ft MSL, the Service Water System is made operational so that it may be used to control reactor temperature.
14. FLEX equipment is returned to the storage after recovery from the flooding event.

The FLEX strategy is fully integrated within the emergency procedure architecture. The EOP provides the primary direction for mitigation of the ELAP. The Emergency Support Procedures provide specific guidance for tasks needed to implement the mitigation strategy. The AOP provide event specific guidance for floods, earthquake, tornado, etc.

Note that the existing strategy includes placement of FLEX diesel generators on top of U2 trackway as part of flood preparations. Note also that the U2 trackway is near the middle of the reactor building south wall (Drawing M-1D). Dresden has recently completed the design of Hardened Containment Vent System (HCVS) and the vent lines for both units exit the reactor building south wall above the U2 Trackway. During a potential venting operation, area around the south wall may not be accessible due to the shine from the vent lines. In view of this, Dresden is in the process of changing the location of the FLEX diesel generator to the Turbine Deck at elevation 561 feet MSL on the north side of the reactor building.

4 Characterization of MSFHI (NEI 12-06, Rev 2, Section G.2)

NRC has completed the "Staff Assessment" (Reference 5) and "Supplement to Staff Assessment" (Reference 6), related to Dresden's FHRR (References 2 and 4). In Reference 6, the NRC concluded that, "as documented in the NRC staff assessment and the enclosed supplement, the NRC staff has concluded that the licensee's reevaluated flood hazard information is suitable for the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and NRC staff) for Dresden". The enclosure to Reference 6 includes a summary of the current design basis and reevaluated flood hazard parameters. In Table 3.1.2-1 of the enclosure to Reference 6, the NRC lists the following flood-causing mechanisms for the current design basis flood:

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

In Tables 4.0-1 through 4.0-3 of the enclosure to Reference 6, the NRC lists flood hazard information (specifically stillwater elevation, wind-wave runup elevation, other associated effects, and flood duration parameters) for the following flood-causing mechanisms that are not bounded by the current design basis hazard:

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

It should be noted that the "Failure of Dams and Onsite Water Control/Storage Structures" flood-causing mechanism for Dresden represents the hydrologic dam failure scenario. That is, it's the combination of a precipitation-induced Probable Maximum Flood and upstream dam failure (Section H.1 combinations in Reference 12.) These are the reevaluated flood-causing mechanisms that should be addressed in the mitigating strategies assessment. The following summarizes these hazards for Dresden:

- **Local Intense Precipitation:** The LIP event for Dresden is characterized by 1-hour, 1 square mile PMP event distribution using Hydrometerological Reports (HMRs) 51 and 52 (National Oceanic and Atmospheric Administration (NOAA), 1978 and

1982). Using this, Dresden computed a cumulative depth of the 1-hour, 1-square mile PMP of 17.97 inches. Based on this rainfall model, flooding depths were computed for several openings around the reactor and turbine building by a FLO-2D model. The maximum flood elevation of 518.1 feet MSL occurs at several Category 1 structures. The flooding depths range between 0.1 foot (Reactor Building, U3) to 1.7 feet (Turbine Building U2). The CDB LIP flood has a maximum flood elevation of 517.45 feet MSL; whereas, the plant floor level is elevation 517.5 feet MSL so the LIP water does not enter any structures at the CDB 517.5 ft MSL elevation. The maximum reevaluated LIP flood elevation is 518.1 feet MSL (Reference 2, Table 4). The maximum flood inundation time above elevation 517.5 feet MSL is 1.75 hours (Reference 2, Table 5). The largest leak path for water ingress to the reactor building is due to U2 Trackway interlock where the maximum flood height is 0.54 feet for 1.35 hour (Reference 2, Table 5).

- **Combined-Effects (River Flooding from PMP + Dam Failure + Wind-Wave Runup):** The CDB combined-effects flood elevation is 528 ft MSL. The maximum reevaluated combined-effects flood elevation is 529.0 ft MSL (Reference 2). This difference is attributed to a higher reevaluated wind-wave runup height of 4 ft, instead of 3 feet in the CDB. The stillwater flood level remains at elevation 525 ft MSL in both cases.

In Reference 5, the NRC staff identified two Integrated Assessment (IA) Open Items related to the LIP FLO-2D model, LIP durations, and LIP flood parameters comparison between the site specific PMP and HMR-based models. In the supplement, these two IA items were deleted (Reference 6, Table 5.0-1).

5 Basis for Mitigating Strategy Assessment (NEI 12-06, Rev 2, Section G.3)

Dresden's FLEX DB flood is based on the FHRR (Reference 2) and response to the NRC's request for additional information dated April 9, 2014 (Reference 4) (i.e. MSFHI) for the river flood per CC-DR-118 (Reference 13). As shown in Table 1, all aspects of the FLEX DB river flood hazard are equal to the MSFHI flood parameters. Therefore, the FLEX DB completely bounds the MSFHI and no further assessment of FLEX for the river flood is required or included. LIP flooding was not considered in the FLEX flood strategy. Therefore, the FLEX DB flood does not bound the MSFHI for LIP and further assessment of FLEX for the LIP flood is required. (See Section 6.)

Table 1 – Failure of Dams and Onsite Water Control/Storage Structures (Precipitation-Induced PMF Combined with Upstream Dam Failure) Parameter Comparison (i.e. River Flood)

Flood Scenario Parameter		Plant's CLB Flood	FLEX Design Basis Flood Hazard	MSFHI	MSFHI Bounded (B) or Not Bounded (NB) by FLEX DB
Flood Level and Associated Effects	1. Max Stillwater Elevation (ft-MSL)	525.0	524.8	524.8	B
	2. Max Wave Run-up Elevation (ft-MSL)	528.0	529.0	529.0	B
	3. Max Hydrodynamic/Debris Loading	Not described in UFSAR	117.2 psf/3,387 lbs	117.2 psf/3,387 lbs	B
	4. Effects of Sediment Deposition/Erosion	Not Determined	See Note 1	See Note 1	B
	5. Concurrent Site Conditions	Not determined	Hail, strong winds and tornado	Hail, strong winds and tornado	B
	6. Effects on Groundwater	See Note 2	See Note 2	See Note 2	B
Flood Event Duration	7. Warning Time (hours)	33	23 hr 25 min	23 hr 25 min	B
	8. Period of Site Preparation (hours)	24	20 hr 40 min	20 hr 40 min	B
	9. Period of Inundation (hours)	57	159	159	B
	10. Period of Recession (hours)	29	165	165	B
Other	11. Plant Mode of Operations	All Modes	All Modes	All Modes	B

Notes:

1. In response to RAI 8, dated May 19, 2014 (Reference 4), Dresden performed an analysis to evaluate sediment transport near the site. The licensee used methods and equations to estimate for natural sediments the shear velocity, sediment setting velocity, and its ratio. The results indicate that the primary mode of sediment transport is in suspension at most of representative locations throughout the power block area and, therefore, sedimentation at the site during the controlling PMF is limited. NRC staff verified that the equations and reference tables were from accepted sources, and concluded they produced reasonable results.

2. All critical structures essential to a safe shutdown of the reactor are flood protected to plant finished floor (elevation 517.5 feet MSL). Therefore, Dresden is not subject to effects associated with groundwater ingress.

6 Assessment of Current Flex Strategy (NEI 12-06, Rev 2, Section G.4.1)

6.1 Assessment Methodology and Process

This assessment reviews the effect of a LIP event and concurrent ELAP/LUHS on the FLEX strategy. For this assessment of the FLEX strategy:

- The LIP flood level is equal to the MSFHI (elevation 518.1 feet MSL). The maximum flood time above elevation 517.5 feet MSL is 1.75 hours (Reference 2). The ELAP/LUHS is assumed to occur at the initiation of rainfall for the LIP event. BASIS: This is a non-mechanistic conservative assumption. There is no technical basis for how the LIP would cause an ELAP/LUHS. Assuming the ELAP/LUHS at the beginning of rainfall is the most conservative approach.
- Access to outside of plant structures such as FLEX Buildings A, B and C is assumed to be prevented for one hour during the LIP event. These three buildings were constructed specifically for FLEX equipment and implementation of FLEX strategies. Buildings A and B are robust structures inside the protected area. Building C is a commercial building primarily for storage of equipment. Note that, as a result of the LIP event, the flooding level remains above elevation 517.5 feet MSL for 1.75 hours. However, after one hour, the outside activities can start although the plant grade can have about one foot of flooding.
- FLEX Building A is not flooded by LIP event since its floor level is at elevation 518.5 feet MSL.
- Section 4.1.3 of Dresden document CC-DR-118 Rev. 00 "Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program" (Reference 13) provides TSAs related to FLEX strategies. TSA-ELAP1 through TSA-ELAP5 are required to be performed in less than 2.5 hours. The remaining actions are not required to be complete in less than 6 hours and are not impacted by a LIP event. TSA-ELAP1 through TSA-ELAP5 actions are described below in Table 2.

Table 2: LIP Evaluation for FLEX Time Sensitive Actions

Time Sensitive Actions (TSA)	Action Description	Time Required	Effect of a LIP Event
TSA-ELAP1	125 and 250 VDC Load Shed	30 minutes	This activity is not impacted by the LIP ever performed inside.
TSA-ELAP2	Establish natural circulation air flow to HPCI room by opening doors (FSG-31)	2 hours	The LIP flood remains above the RB floor le FSG-31, several doors are opened to provid HPCI room. Only the 2/3 EDG interlock doo The remaining doors are either inside or at During a LIP event, all FSG-31 actions can b for the interlock and this will be the last one the flood waters recede after 1.75 hours. O will provide ventilation prior to opening the
TSA-ELAP3	Supply power to a FLEX Makeup Pump (FSG-03)	2.5 hours	This activity involves running temporary cal the selected FLEX Makeup Pump. In order to deployment time, Dresden has installed mis receptacles on the west (primary) and south the reactor building where connections can sides. Cables from the DG in FLEX A buildin the outside of the wall receptacles. Inside th cables will be routed from the wall receptac FLEX pump. During a LIP event, the inside c completed without any impact. The outside made in the remaining 45 minutes. The cab water proof however any cable connections level higher than the 1 foot LIP flood.
TSA-ELAP4	FLEX Pump supply Isolation Condenser shell-side makeup (FSG-04)	2.5 hours	This action involves valve lineup inside the not impacted by the LIP flooding event.

Time Sensitive Actions (TSA)	Action Description	Time Required	Effect of a LIP Event
TSA-ELAP5	Isolation Condenser initiated for RPV pressure control (FSG-05)	2.5 hours	This action involves actions inside the reactor building. It is not impacted by the LIP flooding event.

- <u>Deployment of FLEX Equipment (Section 6.2.3.2 of NEI 12-06, Rev 2)</u>
  - There are two possible impacts of this short term flooding. One impact is the ingress of water into the reactor building through the interlock doors. The other impact is on the FLEX equipment and its deployment under LIP flooding. Both impacts are evaluated below.
    - LIP Flood Water Ingress:

      The reactor building secondary containment interlock door seals are quarterly inspected for any in-leakage. The allowable leakage margin is 94.57 square inches Per EC 398329 (Reference 15) for all the interlock seal leakage areas. The actual leak area is measured by quarterly surveillance and verified that it is less than 94.57 square inches. Conservatively, it is assumed that all this area is available for water ingress under LIP flooding. The largest leak path is due to the U2 Trackway interlock. From the results of FLO-2D analysis, the maximum LIP flood height at this location is 0.54 foot (above the plant floor level of elevation 517.5 feet MSL) for duration of 1.35 hours. A recent evaluation (EC 405127) quantified the total amount of water ingress into the reactor building during this time. Conservatively, it was assumed that all the LIP flood water will accumulate in one unit's torus basement through large pipe annular openings at elevation 517.5 feet MSL near the south wall. Note that the corner rooms are isolated from the torus basement by submarine type doors with thresholds higher than 10-inches and berms around stairways at 517.5 feet MSL floor elevation. For each unit, one FLEX pump is installed in the torus basement where LIP can cause 9.78 inches of flooding. The other pump for each unit is in the corner room that does not receive any flood water. The FLEX pumps are on 12-inch high pedestals. None of the FLEX pumps or safety related equipment are adversely impacted by LIP flooding. Note that each reactor basement has two sump pumps (50 gpm each) and the flooding level will be less if the pumps are operational. Two additional pumps were later installed to provide redundancy (UFSAR 3.4.1.2.2). However, 9.78 inches of flooding was calculated without taking any credit for these sump pumps. If power becomes available for the sump pumps, the level of LIP flooding will be reduced.

    - Impact on FLEX Equipment and Deployment:

      The second impact of LIP flooding is on the FLEX equipment outside the reactor building and implementation of FLEX strategy. The general plant grade level is elevation 517 feet MSL. Thus during a LIP event, the plant grade will experience an average flood depth of about 1.1 feet. The maximum flooding duration above elevation 517.5 feet MSL is 1.75 hours.

      Most time-critical equipment is staged in a robust FLEX Building A, that is located about 50 feet from the southwest corner of the reactor building. This building houses a FLEX diesel generator, Temporary Power Distribution Unit (TPDU) and cables. The floor level of FLEX Building A is at elevation 518.5 feet MSL (Sketch C-SK-013-1). The maximum water surface elevation during MSFHI LIP event is 518.1 feet MSL. Thus, no LIP water enters the FLEX Building A. The wall penetrations for cable routing from FLEX Building A to the west wall of the reactor building are at least 3.5 feet above the plant grade level. Thus, deployment of the temporary power cables over a short distance is not impacted by the LIP flooding of maximum 1 foot depth. The alternate penetrations to the reactor building are on the south wall and this route is longer than the primary path. Any cable connections along this travel path will

be secured to a higher point to avoid submergence of the connections. The cables are water proof and can be submerged in water for this short lived LIP event.

- All FLEX equipment (n and n + 1) at Dresden is staged/stored in the Reactor Building and three external buildings (FLEX Buildings A – C), specifically designed and constructed for FLEX program. Attachment 2 of CC-DR-118 (Reference 13) provides a FLEX equipment list for each building.
- The 4 FLEX pumps are staged in the Reactor Building basement (2 in the corner rooms and 2 in the torus basement). Additionally, hoses and electrical cables are staged in reactor building. None of this equipment is impacted by the LIP flooding. The staged equipment in the reactor building allows minimizing deployment time for activities inside the reactor building.
- The FLEX Building A has a finished floor level at elevation 518.5 feet MSL (C-SK-013-1). The maximum LIP flood elevation is 518.1 feet MSL, thus no flood water enters this building. All wall penetrations are above the floor level. No equipment in this building is impacted by LIP.
- The FLEX Building B has a finished floor level at elevation 517.5 feet MSL (C-SK-014-1). All equipment in this building is either trailer mounted or elevated so that it is not impacted by LIP flood at elevation 518.8 feet.
- The FLEX Building C is a commercial building with a floor level at elevation 517.83 feet MSL. This building is outside the protected area in a parking lot on the southeast side of the reactor building. None of the equipment is needed during a LIP flooding event.
- The connection points for electrical cables are at least 3.5 feet above the plant grade and are not impacted by a LIP flood. The hose connections for FLEX pumps are in the corner rooms that are protected from the LIP flood waters.
- The flood barriers are designed to protect the reactor building under river flooding event that is based on rainfall forecasting and sufficient time is available for the deployment of flood barriers. Under a LIP flooding event, there is no advance warning and no barriers are deployed. Thus the deployment of temporary flood barriers is not impacted by MSFHI.

- <u>Procedural Interfaces (Section 6.2.3.3 of NEI 12-06, Rev 2)</u>
  - No procedural changes are required due to the MSFHI.
- <u>Utilization of Off-site Resources (Section 6.2.3.4 of NEI 12-06, Rev 2)</u>
  - The site access routes are not impacted by LIP MSFHI. The LIP flooding is a short lived event (a few hours) and access roads will be available shortly after the LIP event.
  - Under river flooding (PMF), the whole site will be inundated for several days and the onsite resources/supplies are adequate during this phase. After flood water recede from the site, offsite resources will be available as part of FLEX phase 3.

6.2 Results

- Dresden FLEX DB flood strategy is based on the FHRR (i.e. MSFHI) for river flooding and, thus, bounds the MSFHI.
- The MSFHI parameters for the LIP event were not included in the FLEX DB. This assessment shows that the reevaluated LIP parameters have no adverse impact on the equipment and deployment strategy.

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

6.3 Conclusions

The current FLEX strategies, as described above, can be successfully implemented for both flooding scenarios applicable to Dresden: a) River flood (River PMF plus upstream dam failure and b) LIP event. The reevaluated flood hazard parameters (i.e. MSFHI) for the river flood were used to develop FLEX implementation strategies. During a PMF event, all the required flood mitigation equipment is either deployed or staged at higher elevations due to sufficient advance warning time. For the LIP event, no warning time is assumed and the evaluation concluded that this event has no adverse impact on FLEX equipment or its deployment. An evaluation (Reference 11) quantified the water ingress and its impact on FLEX strategy during a LIP event. It was determined that no safety related equipment or FLEX equipment was adversely impacted by the water ingress.

6. 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. Exelon 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 May 10, 2013 (RS-13-110)
3. NRC Request for Additional Information Regarding Fukushima Lessons Learned-Flood Hazard Reevaluation Report, dated April 9, 2014
4. Exelon Generation Company, LLC Letter to USNRC, Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated May 19, 2014 (RS-14-122)
5. NRC Letter, Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (TAC Nos. MF1795 and MF1796) dated March 31, 2015
6. NRC Letter, Supplement to Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (TAC Nos. MF1795 and MF1796) dated November 4, 2015
7. 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
8. NRC Letter, Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events, dated September 1, 2015
9. U.S. Nuclear Regulatory Commission, JLD-ISG-2012-01, Revision 1, Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events, dated January 22, 2016 [Effective February 29, 2016 per Federal Register / Vol. 81, No. 39]

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

11. Technical Evaluation, EC 405127 Rev 1. Water Ingress During the Reevaluated LIP Flood Hazard

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

13. Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program (CC-DR-118, page 14)

14. EC 391644, Reactor and Diesel Building Flood Barriers

15. EC 398329, Determination of the Maximum Allowable Opening in a Secondary Containment Penetration that can be Induced During Refueling Op