Enclosure A
L-21-002

Evaluation of Proposed Change
(53 pages follow)

Subject: Request to Revise the Methodology Used for Flooding Hazard Analysis and Revise the Flood Hazard Protection Scheme

1.0 SUMMARY DESCRIPTION

Pursuant to 10 CFR 50.90, Energy Harbor Nuclear Corp. is submitting a request for an amendment to Facility Operating License No. NPF-58 for Perry Nuclear Power Plant, Unit No. 1 (PNPP). The proposed amendment revises the PNPP Updated Safety Analysis Report (USAR) to include a change in methodology used for analysis of flooding hazards and drainage within the local intense precipitation (LIP) domain at the site and to reflect the results from the new analysis. Based on the new analysis, a new flood hazard protection scheme is also proposed for PNPP. Energy Harbor Nuclear Corp. has determined that the proposed changes to the PNPP USAR require prior Nuclear Regulatory Commission (NRC) approval. There are no technical specification changes associated with this request.

Pursuant to 10 CFR 50.12, Energy Harbor Nuclear Corp. is submitting requests for specific exemptions to credit non-safety related protection features, including permanent (passive) and temporary (deployable), as flood barriers and to credit the plant storm drain system in mitigation of flood levels during a LIP event.

Energy Harbor Nuclear Corp. proposes this license amendment and associated exemptions as part of a reconstitution effort for the design basis of the original probable maximum flood (PMF) event (small stream flood) and LIP domain analyses.

2.0 DETAILED DESCRIPTION

Effective February 27, 2020, the facility operating license for PNPP was transferred from FirstEnergy Nuclear Generation, LLC (owner) and FirstEnergy Nuclear Operating Company (operator) to Energy Harbor Nuclear Generation LLC (owner) and Energy Harbor Nuclear Corp. (operator) (ADAMS Accession No. ML20030A440). Upon completion of this license transfer, Energy Harbor Nuclear Corp. assumed the responsibility for all licensing actions under NRC review at the time of the transfer and requested that the NRC continue its review of these actions (ADAMS Accession No. ML20054B733). Some actions described within this license amendment request occurred prior to the license transfer, while some occurred after. For consistency and simplicity, Energy Harbor Nuclear Corp. is used throughout this license amendment request to indicate the operator of PNPP.

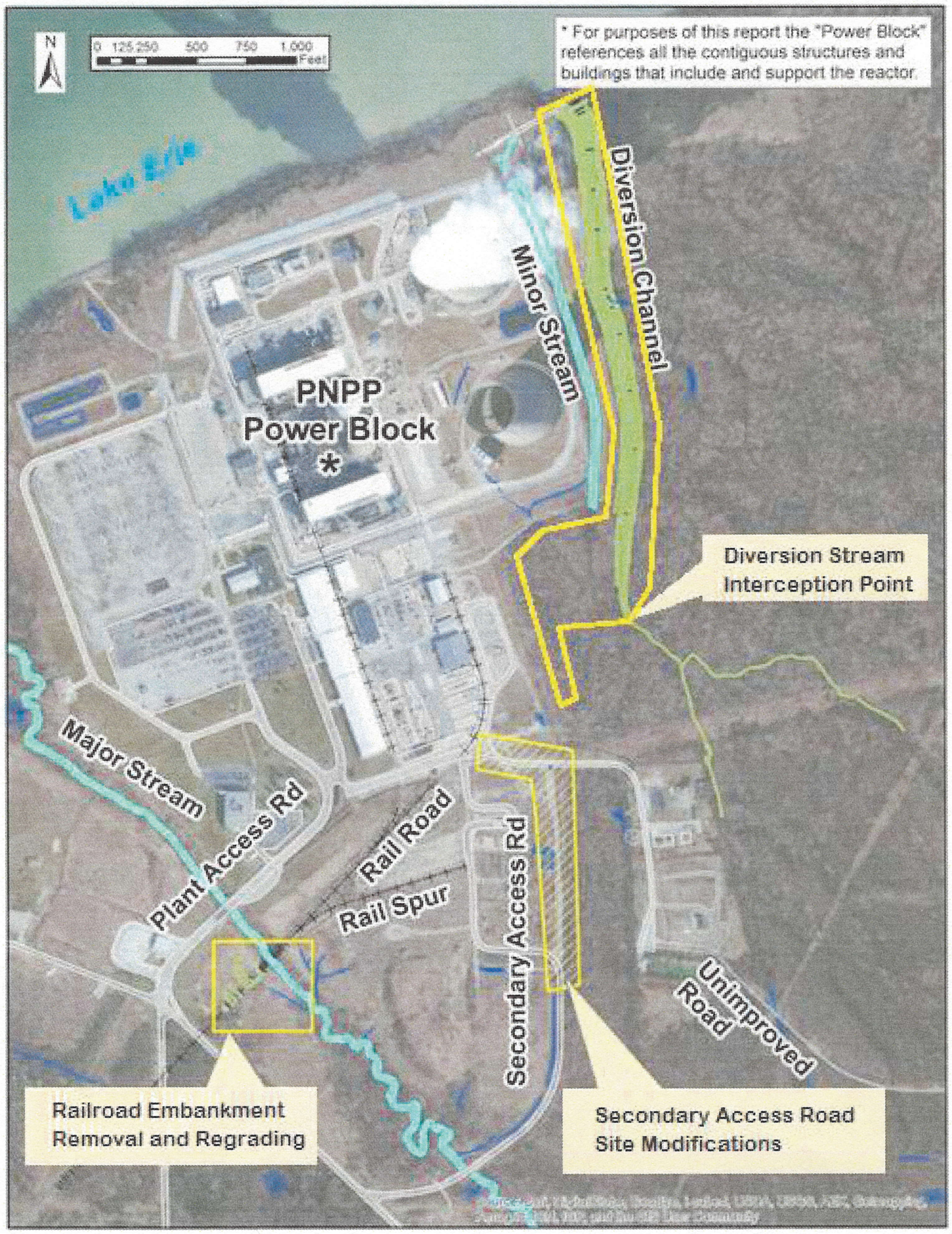
2.1 Plant Site

The PNPP is located within Lake County, Ohio, approximately seven miles northeast of Painesville. Lake Erie borders the site to the north with the mean lake level in excess of 40 feet (ft) below plant grade. The southern plant site boundary line is 3,100 ft from the shoreline of Lake Erie on the west side of the site and 8,000 ft on the east side. Lake Erie is the major hydrological feature of the location. A barge slip was constructed northwest of the plant along the southern shoreline of Lake Erie to accommodate barge deliveries. Including and surrounding the PNPP, there is a coastal watershed that drains into Lake Erie via several small streams. These streams have deep channels as they approach the lake in the otherwise flat terrain of this region. Two parallel streams run adjacent to the plant area. The larger stream (referred to as the Major Stream) has

a drainage basin of approximately 7.2 square miles and runs northwestward within 1,000 ft of the southwest corner of the plant property. The smaller stream (referred to as the Minor Stream) has a drainage area of approximately 0.8 square miles, runs northward, and is located to the east of the plant. The trapezoidal section of the Minor Stream adjacent to and east of the plant was installed during the original plant construction; the engineered channel intercepted the natural stream course and diverted the runoff northward to Lake Erie (the natural watercourse of the Minor Stream originally discharged to Lake Erie at the location of the barge slip). The trapezoidal section of the Major Stream was also installed during the original plant construction. The watershed and streams, discussed in the PNPP USAR, are designed to divert coastal watershed flood waters such that there is no potential for flood waters to reach safety-related plant structures, systems, and components (SSCs).

The safety-related structures of the plant are located within an isolated drainage area and within the drainage basin of the Minor Stream. Final grade elevations in the immediate plant area vary from 617 ft to 620 ft U.S. Geological Survey (USGS). The floors at plant grade are nominally set at Elevation (EL) 620 ft 6 inches USGS. The present-day site layout is shown in Figure 2-1 below.

Figure 2-1: Present-Day Site Layout



2.2 Original Flood Design Considerations

The PNPP USAR Section 2.4, “Hydrologic Engineering,” describes site characteristics related to flooding events. With the mean lake level of Lake Erie in excess of 40 ft below plant grade, no problems of site flooding exist owing to the nature of the site. In NUREG-0887, *Safety Evaluation Report related to the operation of Perry Nuclear Power Plant, Units 1 and 2*, Section 3.4.1, “Flood Protection” states, in part:

> The staff’s review for flood protection is concerned not with the criteria for determining flood level; but rather, once the flood level is established, with evaluating safety-related structures, systems, and components to ensure that they are protected from flooding.
>
> To ensure conformance with the requirements of GDC 2, the staff’s review of the overall plant flood protection design included all systems and components whose failure due to flooding could prevent safe shutdown of the plant, or result in uncontrolled release of significant radioactivity.
>
> The applicant has sited the plant (at elevation 620 ft mean sea level [msl]) on a bluff on the shore of Lake Erie approximately 48 ft above the mean lake elevation (572 ft msl), thus providing a “dry site” as defined in Regulatory Guide 1.102, “Flood Protection for Nuclear Power Plants,” Position C.1. In addition, the applicant has provided a seismic Category I pressure relief underdrain system to control the level of the water table at elevation 590 ft msl without pumping. Calculations show that the maximum surge flood (setup plus wave runup) elevation of Lake Erie is 608 ft msl. Calculations of flooding resulting from a probable maximum precipitation show that the water level on plant grade does not exceed the floor level of the buildings. Flooding from streams or rivers is not possible because of the nature of the plant site as discussed in Section 2.4. Thus, the guidelines of Regulatory Guide 1.59, “Design Basis Floods for Nuclear Power Plants,” Positions C.1 and C.2, are met.

The NRC staff conclusion was stated as follows:

> Based on this review of the design criteria and bases and safety classification of safety-related systems, structures, and components necessary for a safe plant shutdown during and following flood conditions, the staff concludes that the design of the facility for flood protection conforms to the requirements of GDC 2 with respect to protection against natural phenomena and the guidelines of Regulatory Guides 1.59, Positions C.1 and C.2, and 1.102, Position C.1, concerning design-basis floods and flood protection and is, therefore, acceptable. The design of the facility for flood protection meets the acceptance criteria of Section 3.4.1 of NUREG-0800.

Table 1.8-1 of the PNPP USAR identifies the specific revision of the Regulatory Guides to which PNPP conforms: (1) Regulatory Guide 1.59, Revision 2, August 1977; and (2) Regulatory Guide 1.102, Revision 1, September 1976.

The Major Stream, Minor Stream, and Lake Erie, as described in the previous section of this evaluation, are three of the four prospective sources of flooding that exist at the PNPP site. With Lake Erie being the major hydrological feature, a permanent slope protection system, described in PNPP USAR Section 2.4.5.5.3, is to provide protective measures if the toe of the bluff of the Lake Erie shoreline erodes to a point 250 ft away from the closest safety class structure (emergency service water pumphouse). Construction of the permanent slope protection system is to be completed before the toe of the bluff recedes to approximately 204 ft of the emergency service water pumphouse.

The fourth prospective source of flooding at PNPP is LIP. The controlling flood and associated water levels impacting the PNPP site are a result of the surface drainage capabilities during the LIP. Plant flooding by LIP was prevented by the design of the storm drainage and roof drainage systems. In case of complete blockage of the storm drainage system, the plant site has been graded so that overland drainage will occur away from the plant site buildings and will not allow the accumulated storm water to exceed EL 620 ft 6 inches, which is 6 inches above the finished plant grade.

Protection was provided thereby for safety-related structures, exterior systems, and access equipment against flooding from Lake Erie, surface runoff, and LIP.

2.3 Current Flood Hazard Protection Scheme

Because PNPP is a dry site, the flood hazard protection scheme is passive. The watershed and streams are designed to divert coastal watershed flood waters such that there is no potential for flood waters to reach safety-related plant SSCs.

2.4 Current Technical Specifications Requirements

As described in PNPP USAR Section 2.4.14, “Technical Specification and Emergency Operation Requirements,” safety-related facilities at PNPP are protected for flooding. Therefore, emergency protective measures and attendant technical specifications are not required.

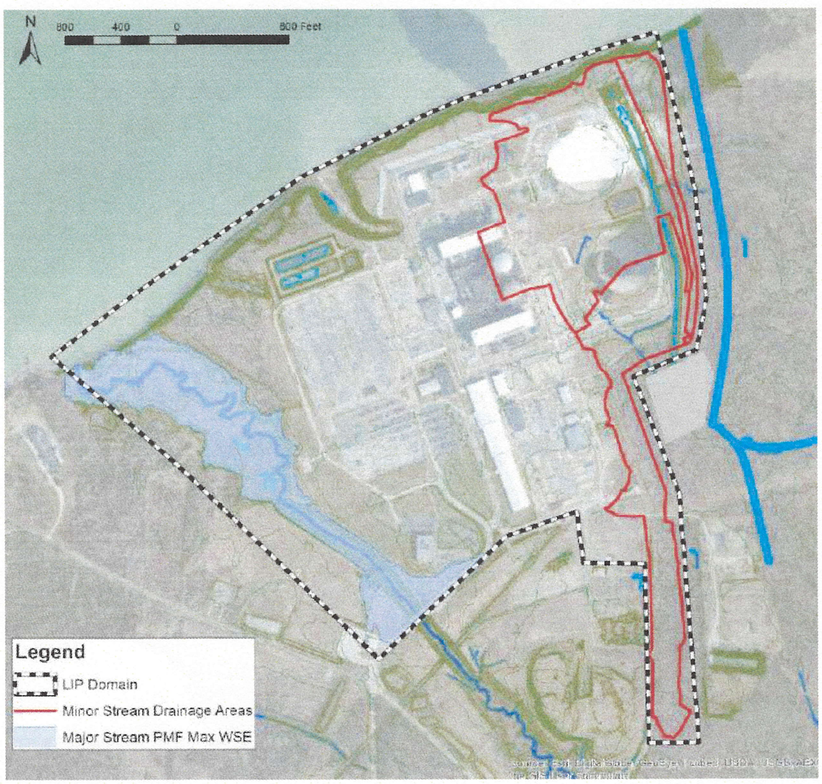
2.5 Current Local Intense Precipitation (LIP) Domain and Analysis

The LIP domain is shown in Figure 2-2 below. The PNPP USAR presents the probable maximum precipitation (PMP) event as being a 48-hour rainfall event with a cumulative rainfall of 33.9 inches over this period with the peak hourly intensity of 13.1 inches per hour. For LIP considerations, a front-loaded storm temporal distribution is postulated, using a 6-hour subset of the 48-hour PMP event. The rain event used for LIP considerations is based on the guidance of Hydrometeorological Report (HMR) 33 with hourly distribution taken from the Bureau of Reclamation’s Design of Small Dams (Second Edition).

The plant site is drained by three separate storm drainage systems, two draining to the west and the third draining to the east. The entire site area is subdivided into discrete sub-basins, each having storm water inlets referred to as catch basins. Storm water flows overland for no more than 300 ft before it reaches a catch basin. Peak flows to all catch basins are based on the Rational Formula, which does not account for complications in the runoff processes, neglects the advantages of storage, and assumes a steady-state flow condition.

The Rational Formula is the simplest of the deterministic flood prediction models and estimates the peak rate of runoff at a specific location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity for a duration equal to the time of concentration.

Figure 2-2: LIP Domain



As a result of the site grading, overland flow of storm water will begin once ponding has reached EL 620 ft 4 inches. Assuming the worst case (that is, complete blockage of the site storm drain system and using peak discharge from the most intense hour of the PMP), the resulting increase in surface elevation of water flowing over the surrounding roads and railroads (acting as weirs) on site would not exceed one inch. Therefore, the ponding level of EL 620 ft 5 inches provides a one-inch margin over the nominal floor levels at plant grade of EL 620 ft 6 inches.

2.6 Change to Watershed

Throughout the life of the facility, various changes to the immediate (local) plant area have occurred that have influenced the LIP watershed. Changes such as installation of various security features (vehicle barrier system and jersey barriers, as well as the multi-layered perimeter fence) have affected the runoff characteristics of overland flow within and out of the LIP domain. In addition, by comparison of USAR figures to more recent aerial imagery, several plant buildings have been erected since license issuance, including the Administration Building, Service Building Annex, security access structures and portions of the Warehouse. Site improvement initiatives, mainly the paving of previously grass and gravel areas, have resulted in changes to drainage patterns and runoff coefficients. To accommodate the various changes and evolving drainage characteristics, extensions or additions to the storm drain system have occurred. Based on the simplistic nature of the USAR-described LIP evaluation methodology, some of these changes, individually, would not appreciably influence the analytical results of drainage of the site. In contrast to the effects of some of the individual changes, the cumulative effect of the changes, when combined with the limited margin available at plant doorways relative to the grade elevation, have resulted in less effective drainage characteristics.

This condition was discovered during development of the response to the letter issued by the Nuclear Regulatory Commission (NRC) on March 12, 2012 titled, “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” (hereafter referred to as the “10 CFR 50.54(f) letter”). Energy Harbor Nuclear Corp. was unable to locate certain analyses supporting the PNPP USAR discussions regarding external flooding hazards. When the re-evaluated LIP hazard calculations were completed, the conditions predicted showed the change in watershed.

A prompt functionality assessment was completed, and compensatory measures were established. Compensatory measures include installation or staging of flood barriers (sandbags or equivalent) at certain doors such that if a weather alert for rainfall at a rate of 6 inches or higher over a three hour period is received, the pre-staged barriers are put in place. To allow defense-in-depth capabilities, the measures are implemented at locations that allow gross inleakage paths into PNPP Unit 1 or PNPP Unit 2 structures. Automated weather alerts provide ample warning time for the site to invoke compensatory measures prior to the point when the site flood level would exceed the building thresholds. Implementation of the compensatory measures ensures functionality of plant equipment as flood water due to an external event will not adversely affect the plant. With the compensatory measures in place, prevention of water into the buildings ensures that the plant will still operate as designed. The compensatory measures provide protection to maintain margin and the capability for achieving and maintaining cold shutdown resulting from the most severe flood conditions.

Additional modifications to the plant site (shown on Figure 2-1 above) were made as a result of the re-evaluated external flooding hazards in response to the 10 CFR 50.54(f)

letter. Modifications were made to the Major Stream and Minor Stream, establishing the Diversion Stream to reroute the south reaches of the Minor Stream.

With respect to the Major Stream, a portion of the existing rail line embankment to the southwest of the rail line bridge crossing the Major Stream was removed. Removal of the embankment allows greater conveyance of flow in the southern overbanks of the Major Stream, preventing flow from overtopping the rail line. Furthermore, the secondary (contractor) access road was raised to prevent any remaining backwater from overtopping the road. This modification resulted in the concentration of Major Stream runoff to be carried downstream to Lake Erie, rather than contributing to runoff to other areas of the site.

With respect to the Minor Stream, the stream no longer functions as a stream or river due to the installation of a new Diversion Stream, which intercepts the previous Minor Stream and its watershed and diverts runoff flow directly to Lake Erie. A portion of the originally engineered Minor Stream remains located between the plant area and the Diversion Stream. This section of the stream no longer functions as a traditional stream. The Remnant Minor Stream, as it is now referred to, is a drainage swale located entirely within the LIP computational domain. Also, an engineered earthen embankment (termed the Diversion Stream berm) was installed to separate the LIP domain from the Diversion Stream and the original Minor Stream watershed.

2.7 Reason for the Proposed Change

During development of the response to the 10 CFR 50.54(f) letter, Energy Harbor Nuclear Corp. was unable to locate analyses supporting the PNPP USAR discussions regarding external flooding hazards. Specifically, the original Minor Stream PMF analysis that supports the evaluation in the PNPP USAR Section 2.4.3 could not be located. A study calculation was used to re-assess the Minor Stream PMF. Calculation 50:51, “Minor Stream PMF Flow Rate and Water Surface Elevations given Site-Specific Probable Maximum Precipitation,” concluded that flooding of the Minor Stream approaches (and in one case equals) but does not exceed the ground floor elevation of any of the Unit 1 or Unit 2 buildings. It was subsequently identified that the topographic survey utilized in the calculation had been incorrectly converted to plant datum. The resulting discrepancy was accounted for by increasing the flood water surface elevations determined in the study calculation by 2.52 inches, making the flood water surface elevation higher than building ground floor elevation. To verify water levels over the LIP domain based on as-found site configuration, another study calculation was prepared. Calculation 50:87.000, “PNPP Local Intense Precipitation Study Calculation,” identified water levels at critical points of interest at the site and found that water levels at various locations around the power block exceed EL 620 ft 6 inches. Compensatory measures for these locations are currently in place.

The cumulative change in overland water discharge paths has resulted in inefficient site drainage for the LIP. In addition, the USAR-described analysis to determine the effects of LIP is a simplistic approach in how the maximum water surface elevation (WSE) near the power block is determined as compared to present-day methodology. This

approach relies solely on the broad crested weir computation and engineering judgment.

To address these changes related to external flooding events at the PNPP, Energy Harbor Nuclear Corp. has elected to reconstitute the design basis analyses for the LIP domain using a more appropriate methodology (a two-dimensional unsteady state model, FLO-2D Pro software computer program) and implement site modifications to alleviate the reconstituted flood hazards. Also, in response to the reconstituted hydrologic analysis, Energy Harbor Nuclear Corp. plans to revise the flood hazard protection scheme for the site.

2.8 Description of the Proposed Change

The proposed amendment includes a change to the PNPP USAR in the form of a change in methodology used for analysis of flooding hazards and drainage within the LIP domain at the site and a revision of the USAR to incorporate the results from the new analysis. The FLO-2D Pro (Build 16.06.16) software computer program (hereafter referred to as FLO-2D) provides a two-dimensional unsteady state modeling technique to evaluate the flooding effects of the LIP domain, including applied water sources. FLO-2D is a dynamic flood routing model that simulates channel flow, unconfined overland flow, and street flow. It can simulate a flood over complex topography and roughness while reporting on volume conservation. This program is used to reconstitute the LIP domain analyses and revise PNPP USAR Section 2.4, “Hydrologic Engineering.” Additional sections of the USAR are affected as a result of the changes made to Section 2.4. Attachment 1 of this evaluation provides the existing USAR text pages marked up to show the proposed changes. Attachment 2 provides affected tables and figures marked up to show the proposed changes, with the current figure provided first and the proposed change to that figure following. Attachment 3 provides the clean typed text pages with the proposed changes incorporated for reviewer convenience.

Under the reconstituted LIP flood hazard results, a new methodology is also used to address flood-borne missiles. The guidance of Federal Emergency Management Agency (FEMA) P-259, “Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures,” is used to demonstrate the capability of the temporary flood mitigation panels and permanent protection features (closure plates, ramps) to withstand the hydrostatic and hydrodynamic forces resulting from the reconstituted LIP domain flood hazards. Flood waters are sufficiently deep and of sufficient velocity to produce flood-borne missiles, where previously these missiles were not a consideration. The revised PNPP USAR Section 3.5.1.4, “Missiles Generated by Natural Phenomena,” adds a discussion of flood-borne missiles.

In response to the reconstituted hydrologic analysis, a change to the PNPP USAR in the form of a new flood hazard protection scheme for the site is included in the proposed amendment. The new flood hazard protection scheme takes exceptions to the guidance of Regulatory Guide 1.59 and Regulatory Guide 1.102, where previously none were taken.

The PNPP site is affected by flooding and, therefore, is no longer a dry site. Exterior barriers and incorporated barriers, as defined in Regulatory Guide 1.102, are part of the revised flood hazard protection scheme. These flood protection barriers include passive (permanent or normally installed) barriers and temporary incorporated barriers.

An alternative to hardened protection, as defined in Regulatory Guide 1.59, is added to the revised flood hazard protection scheme. A meteorological forecast is used to provide a warning time for deployment of protection features. If features are not deployed in the timeframe allotted, sufficient warning time is available such that a plant shutdown can occur.

For off-site flood hazards, PNPP is fully passively protected by topography and exterior barriers, including an earthen berm credited for maintaining floodwaters within the off-site Diversion Stream drainage basin. To ensure that the plant is protected against possible degradation, a berm failure consideration is conservatively incorporated into the LIP model used in the reconstituted analysis. To size the breach profile, guidance in U.S. Army Corps of Engineers (USACE) RD-13, “Flood Emergency Plans – Guidelines for Corps Dams,” and USACE RD-5, “Guidelines for Calculating and Routing a Dam-Break Flood,” is used.

For the LIP event, which represents the bounding external flood hazard for PNPP, protection is provided via a combination of permanent and temporary incorporated barriers. Structures, systems, and components (SSCs) required to achieve and maintain cold shutdown are only passively protected up to and including the effects of the Standard Project Storm (SPS). For hazards exceeding the SPS, up to and including the PMP event of the LIP domain, operator action is required to deploy protection features. Operator action is limited to the deployment of removable incorporated barriers in the form of flooding stop logs. The requirements and guidance for this action is incorporated into plant off-normal instructions.

Entry into the plant off-normal instructions is initiated by a meteorological forecast warning. This action is required by the PNPP Operations Requirement Manual (a site procedure) in lieu of placing a limiting condition of operation into the technical specifications. If barriers are not deployed in the timeframe allotted, a plant shutdown is initiated.

The changes proposed in USAR sections add information derived from the new flooding analysis results, modify existing information to align with the results, revise the flood hazard protection scheme, or delete outdated information to reflect the changes. These proposed changes are described in more detail below but include the following:

- Modify descriptions of onsite streams to reflect recent site modifications
- Delete outdated effects of LIP from previous analysis
- Add updated effects of LIP based on new flooding analysis results
- Add discussion of Non-LIP precipitation events
- Modify discussion based on revised flood hazard protection scheme
- Add new reference documents that include new flooding analysis results

The PNPP USAR presents elevations using a USGS datum that is equivalent to the National Geodetic Vertical Datum of 1929 (NGVD 29). A plant-specific datum for PNPP, referred to as Perry Local Datum (PLD), was established to provide NGVD 29 data corrected to local monument markers. For reference, conversion for the North American Vertical Datum of 1988 (NAVD 88), for the International Great Lakes Datum of 1985 (IGLD 85), and for PLD are provided in Table 2-1 below.

Table 2-1: General Datum Conversions

Datum Conversions (feet)			
NGVD 29	NAVD 88	IGLD 85	PLD
0.00	-0.72	-0.94	+0.21

The following sections of this evaluation discuss the corresponding USAR changes based on the new analysis results. The section numbers correspond to the USAR sections in Attachment 1.

SECTION 2.2, NEARBY INDUSTRIAL, TRANSPORTATION AND MILITARY FACILITIES

A reference (Reference 88) is added to the description of lake low water datum in Section 2.2.2.4, “Waterways,” and to the list of references. The reference is to U.S. Geological Survey quadrangle maps of Perry and Madison, Ohio, depicted on PNPP drawing 736-0201-00000. This clarifies the source of the low water datum.

The description of onsite streams is updated to reflect recent site modifications. The Remnant Minor Stream Channel replaces the generic “diverted creek east of the plant” in Section 2.2.3.1.3.1, “Oil Storage Tank.”

Section 2.2.3.1.3.3, “Forest Fires,” is modified to align with recent site modifications and clarify that the presence of “greater than” 350 feet of clear space between “forested areas and powerblock structures” reduces the potential hazard of forest fire to a minimum.

SECTION 2.3, METEOROLOGY

A reference (Reference 55) is added to the description of mean low water datum in Section 2.3.1.2.2, “Tornadoes and Waterspouts,” and to the list of references. The reference is to U.S. Geological Survey quadrangle maps of Perry and Madison, Ohio, depicted on PNPP drawing 736-0201-00000. This clarifies the source of the low water datum.

The reference used in the discussion of the probable maximum winter precipitation (PMWP) for the PNPP region in Section 2.3.1.2.5, “Frozen Precipitation,” is modified to point to the updated flooding analysis results determined in PNPP Calculation 50:79.000, “Probable Maximum Winter Precipitation (PMWP, Cool-Season PMP) and

Snowmelt Contribution (Design Basis)." This calculation is a new reference in USAR Section 2.4.

<u>SECTION 2.4, HYDROLOGIC ENGINEERING</u>

As mentioned previously, the changes proposed in UFSAR Section 2.4 add information derived from the new flooding analysis results, modify existing information to align with the results, revise the flood hazard protection scheme, or delete outdated information to reflect the changes.

2.4.1 HYDROLOGIC DESCRIPTION

<u>2.4.1.1, Site and Facilities</u>

- A new reference (Reference 61) is added for the maximum monthly average level for Lake Erie. PNPP Calculation 50:74.000, "Lake Erie Water Levels," reconstitutes the design basis analysis for the ambient high water and low water levels for Lake Erie historically reported in the PNPP USAR.
- General descriptions of site drainage are updated to reflect recent site modifications to the onsite streams and addition of flood protection features resulting from the new flood hazard protection scheme.
- The figure used to show final topography is changed to Figure 2.4-3, "Topography and Storm Drain Composite." Figure 2.4-3 is revised in its entirety to provide updated information.

<u>2.4.1.2, Hydrosphere</u>

- Descriptions of site drainage are updated to reflect recent site modifications to onsite streams, including the resulting change in drainage basin sizes and base flow estimates.
- An editorial change is made to the Lake Survey Center (NOAA) starting date for maintaining lake level records. The period of record shown on current Figure 2.4.2, "Lake Erie Water Levels," is 1860 to 1973.
- An updated Figure 2.4-2 provides vertical datum conversion values and is titled "Lake Erie Water Levels and Datum Conversion Values."
- Reference 61 (previously described) is also added to this section.
- A new reference (Reference 70) is added to the description of the Major Stream. PNPP Calculation 50:72.000, "Design Basis Major Stream Probable Maximum Flood (PMF)," develops the design basis PMF for the modified Major Stream.
- A new reference (Reference 71) is added to the description of the Diversion Stream. PNPP Calculation 50:73.000, "Design Basis Diversion Stream Probable Maximum Flood (PMF)," develops the design basis PMF for the Diversion Stream.
- A new reference (Reference 75) is added to identify the specific site modification, PNPP Engineering Change Package 13-0802, "Major/Minor Stream Modification," that altered the onsite streams.

2.4.2, FLOODS

2.4.2.1, Flood History

- Minor editorial changes are made for clarification.

2.4.2.2, Flood Design Considerations

- General descriptions of site drainage are updated to reflect recent site modifications to the onsite streams and addition of flood protection features resulting from the new flood hazard protection scheme.
- Reference 61 (previously described) is also added to this section.
- A reference (Reference 65) is added to the description of lake runup. The reference is to PNPP Calculation DX-1.5.1, “Lake Erie Surge Study – Surge Analysis.” This clarifies the original source of the water surface elevation.
- A discussion of the controlling flood hazard (LIP) is added. This discussion provides pointers to other applicable revised USAR sections.
- A discussion of external flood hazards and protection is added to summarize the regulatory guidance to which PNPP complies. Exceptions are taken to the guidance in Regulatory Guide 1.59, “Design Basis Floods for Nuclear Power Plants,” and Regulatory Guide 1.102, “Flood Protection for Nuclear Power Plants,” as part of the revised flood hazard protection scheme. This discussion clarifies that for off-site flood hazards, PNPP is fully passively protected by topography and exterior barriers. For the LIP hazard, the new flood protection scheme is employed. Protection for the LIP hazard is provided via a combination of permanent and temporary incorporated barriers. This discussion also provides pointers to other applicable revised USAR sections.
- A reference (Reference 81) is added to the external flood protection discussion. The reference is to American National Standards Institute (ANSI) Standard ANS-N170-1976-ANS-2.8, “American National Standards for Determining Design Basis Flooding at Power Reactor Sites.” This clarifies the original source document.
- A new reference (Reference 72) is added to the discussion of external flood hazards. The new reference is to PNPP Calculation 50.75.000, “Design Basis Standard Project Storm (SPS) Determination.” This calculation derives the SPS based on updated site drainage basin data.
- A new reference (Reference 82) is added to the discussion of external flood hazards. The new reference is to PNPP Calculation 50:76.000, “PNPP Design Basis Standard Project Storm (SPS) Rainfall Effects.” This calculation determines the effects of SPS using the new methodology, FLO-2D.
- Figure 2.4-82, “Local Intense Precipitation Computational Domain” is a new figure that shows the LIP domain.

2.4.2.3, Effects of Local Intense Precipitation

- This section is updated in its entirety to describe the LIP domain shown in Figure 2.4-82 and to describe LIP event surface drainage and roof drainage analysis results based on the new methodology.
- A discussion of the flood protection is added due to drainage limitations. This discussion provides a pointer to the new flood hazard protection scheme in USAR Section 2.4.10.
- Figure 2.4-3 (previously described) is also added to this section.
- A new reference (Reference 66) is added to the discussion of surface drainage. The new reference is to PNPP Calculation 50:64.000, "PNPP Site Modifications Local Intense Precipitation (Design Basis)." This calculation determines the effects of LIP using the new methodology, FLO-2D.
- A new reference (Reference 67) is added to the discussion of building roof drainage. The new reference is to PNPP Calculation 50:65.000, "Evaluation of Structural Roof Capacity for USAR Described PMP Event." This calculation determines the maximum water levels on the roofs of both safety and non-safety plant structures that occur during a PMP.
- A new reference (Reference 68) is added to identify the source of PMP values. The new reference is to PNPP Calculation 50:71.000, "Design Basis Probable Maximum Precipitation (PMP) Determination." This calculation determines the design basis rainfall event for PNPP for use in subsequent probable maximum flooding (PMF) calculations.
- New subsection 2.4.2.3.1, "Non-LIP Precipitation Events," is added to discuss less significant precipitation events, including the SPS and PMWP. Effects of SPS are determined in Reference 82 (previously described). Effects of PMWP are determined in a new reference (Reference 78) added to this subsection. The new reference is to PNPP Calculation 50:80.000, "Effects of Cool-Season Probable Maximum Winter Precipitation (PMWP) Event." This calculation determines the effects of PMWP with attendant snowmelt contribution using the new methodology, FLO-2D.

2.4.3, PROBABLE MAXIMUM FLOOD (PMF) ON STREAMS AND RIVERS

The description of onsite streams is updated to reflect recent site modifications. The calculated PMFs for the Major Stream and Diversion Stream are updated, with the source calculation identified for each (Reference 70 and Reference 71).

Figure 2.4-4a, "Plan – Major Stream Inundation Area," and Figure 2.4.5a, "Plan – Diversion Stream Inundation Area," are two new figures added to show inundation profiles.

2.4.3.1, Probable Maximum Precipitation

- An editorial change was made to identify Reference 4.
- Reference 68 (previously described) is added to this section.

- PMP values for the 6-hour, 12-hour, 24-hour, and 48-hour storms are updated based on Reference 68 results and tables showing PMP incremental rainfall and cumulative rainfall for LIP and for rivers and streams are added.
- A discussion of PMWP and snowmelt is added with a table showing incremental rainfall and snowmelt and cumulative rainfall and snowmelt.
- A new reference (Reference 69) is added to the PMWP discussion. The new reference is to PNPP Calculation 50:79.000, "Probable Maximum Winter Precipitation (PMWP, Cool-Season PMP) and Snowmelt Contribution (Design Basis)." This calculation determines the PMWP event for PNPP for use in subsequent PMF calculations.
- A new reference (Reference 83) is added to the PMWP discussion. Reference 83 is the U.S. Army Corps of Engineers' "Snow Hydrology," which provides guidance for determining snowmelt rates.
- A discussion of SPS precipitation is added with a table showing incremental rainfall and cumulative rainfall based on Reference 72 (previously described) results.

<u>2.4.3.2, Precipitation Losses</u>

- An editorial clarification is added.

<u>2.4.3.3, Runoff and Stream Course Models</u>

- The description of onsite streams is updated to reflect recent site modifications and to provide a better description of the modeling methods used for PMF peak runoff. (There is no change in methodology.)
- Reference 70 and Reference 71 (previously described) are added to this section.
- Figure 2.4.4, "Hydrograph of PMF Discharge Into Lake Erie-Major Stream," is revised in its entirety.
- Figure 2.4.5, "Hydrograph of PMF Discharge Into lake Erie-Minor Stream," is revised in its entirety and is now titled "Hydrograph of PMF Discharge Into Lake Erie-Diversion Stream."

<u>2.4.3.4, Probable Maximum Flood Flow</u>

- The description of onsite streams is updated to reflect recent site modifications.
- Editorial clarifications are added.

<u>2.4.3.5, Water Level Determinations</u>

- The description of onsite streams is updated to reflect recent site modifications, including updated bed elevation and PMF surface profile information. The section is updated to provide a better description of the computational method used. (There is no change in methodology.)

- Figure 2.4-6, “Probable Maximum Flood Profiles – Major Stream,” is revised in its entirety.
- Figure 2.4-8, “Profile and Typical Cross Sections – Minor Stream,” is revised in its entirety and is now titled “Profile and Typical Cross Section – Diversion Stream.”
- Figure 2.4-8a, “Diversion Stream Typical Cross Section,” is a new figure depicting an updated cross section.
- Reference 70 and Reference 71 (previously described) are added to this section.
- A new reference (Reference 73) is added to the discussion of PMF flow elevation related to the railroad bridge. The new reference is to PNPP Calculation 21:02.000, “Misc. Yard Structures – Railroad Bridge,” which updates the evaluation of the structural integrity of an existing pier supporting the railroad bridge and girder superstructure spanning the Major Stream.

2.4.4, POTENTIAL DAM FAILURES, SEISMICALLY INDUCED

An editorial clarification is added to the first paragraph to show seismically-induced dam failure is not included as a design condition.

2.4.5, PROBABLE MAXIMUM SURGE FLOODING

<u>2.4.5.2, Surge and Seiche Water Levels</u>

- Reference 61 (previously described) is added to Section 2.4.5.2.2, “Brief Description of Numerical Method of Setup Prediction.”

<u>2.4.5.5, Protective Structures</u>

- A reference (Reference 74) is added to the summary of shoreline recession. Reference 74 is for PNPP Procedure EMARP-0005, “Monitoring of Shoreline Recession and Bluff Erosion.” This procedure is used to monitor the Lake Erie shoreline where it forms the northern boundary of the plant site and assure that any ongoing shoreline recession will not threaten the integrity or function of the emergency service water pump house.
- An editorial change is made to Section 2.4.5.5.1.5, “Wind, Littoral Drift and Beaches,” to remove an unnecessary sentence and clarify that the nearest off-site structure is located on the former Neff Perkins property.
- The 1973 mean level of Lake Erie is changed in Section 2.4.5.5.1.6, “Lake Levels,” to “five” feet as a result of the reconstitution of the design basis analysis determined in Reference 61. Reference 61 (previously described) is also added in this section.
- Reference 61 is added to Section 2.4.5.5.1.8, “Shoreline Changes.”
- Section 2.4.5.5.1.10, “Man Made Effects of Erosion,” is updated to provide a pointer to the discussion of interim shore protection, reflect recent site modifications of onsite streams, and identify protection for each. Reference 74 (previously described) is also added to this section.

- Reference 61 (previously described) is added to Section 2.4.5.5.3.1, "Protective Measures Description," in the discussion of protective revetment. This discussion is also updated to reflect recent site modifications of onsite streams.
- An editorial change is made to Section 2.4.5.5.6, "Barge Slip," to reflect the name of the stream and to clarify the original entry to the Lake was prior to plant construction.
- Section 2.4.5.5.8, "Minor Stream Diversion Channel Outlet," is updated to reflect recent site modifications to onsite streams. The title of the section is also updated to "Remnant Minor Stream and Diversion Stream Outlets." Reference 75 (previously described) is added to this section.
- Section 2.4.5.5.9, "Interim Shore Protection," is updated to reflect recent site modifications to onsite streams. A revetment was installed at the outfall of the Diversion Stream and is depicted in new Figure 2.4-39B, "Interim Shore Protection – Diversion Stream Outfall." Two new references (Reference 76 and Reference 77) are added to the Diversion Stream revetment discussion. Reference 76 is to PNPP Calculation 50:68.000, "Perry Nuclear Power Plant (PNPP) Diversion Stream Design Basis Shore Protection Analysis." This calculation determines the size and thickness of the riprap for use as shore protection. Reference 77 is to PNPP Drawing 744-0177-00012, "Stream Relocation Outfall Profile – Stream Outfall."

2.4.7, ICE EFFECTS

2.4.7.4, Ice Flooding

- A discussion of ice-induced flooding from adjacent streams is added with pointers to applicable USAR sections.

2.4.10, FLOODING PROTECTION REQUIREMENTS

The description of flooding protection requirements is updated to reflect recent site modifications of onsite streams, the new flood hazard protection scheme, and new analysis results. The discussion is divided into new subsections that address each flood hazard and associated protection requirements.

2.4.10.1, Lake Erie Flood Hazards

- A discussion of wave runup is added to the previous information for Lake Erie based on updated analysis results. Peak water surface elevation (WSE), including wave runup, is added for enhancement.
- The focus of the discussion is changed to Lake Erie flood hazards because new sections are added for discussion of other flood hazards.
- No emergency procedures are required for Lake Erie flood hazards.

2.4.10.2, Major Stream Flood Hazards

- A discussion of the Major Stream PMF is added based on updated drainage basin information from recent site modifications to the stream.
- Figure 2.4-4a (previously described) is also added to this section.
- No emergency procedures are required for Major Stream flood hazards.

2.4.10.3, Diversion Stream Flood Hazards

- A discussion of the Diversion Stream PMF is added based on updated drainage basin information from recent site modifications to the stream.
- Figure 2.4-5a (previously described) is also added to this section.
- Reference 66 (previously described) is also added to this section.
- Two references (Reference 84 and Reference 85) were added to the Diversion Stream berm discussion. Reference 84 is the U.S. Army Corps of Engineers' "Guidelines for Calculating and Routing a Dam-Break Flood," RD-5. Reference 85 is the U.S. Army Corps of Engineers' "Guidelines for Corps Dams," RD-13.
- No emergency procedures are required for Diversion Stream flood hazards.

2.4.10.4, Local Intense Precipitation Domain Flood Hazards

- A discussion of LIP, the controlling flood event for the site, is added based on the updated LIP domain. Flood protection is provided by incorporated barriers, both permanent and temporary (removable). Temporary incorporated barriers are provided in the form of removable flood panels (flood stop logs).
- Figure 2.4-77, "External Flooding Protection Plan," is added to depict the buildings protected by the flood protection features described in this section.
- Figure 2.4-78, "Exterior Flood Protection – Concrete Walls Typical Details," is added to depict typical concrete flood walls.
- Figure 2.4-79, "Exterior Flood Protection – Aluminum Walls Typical Details," is added to depict typical aluminum flood walls.
- Figure 2.4-80, "Exterior Flood Protection – Door Barriers – Multispan Typical Details," is added to provide a typical example of removable incorporated barriers for wider door openings.
- Figure 2.4-81, "Exterior Flood Protection – Door Barriers – Single Span Typical Details," is added to provide a typical example of removable incorporated barriers door openings.
- A new reference (Reference 79) is added. The reference is to PNPP Calculation 50:77.000, "Evaluation of Flood Barriers," that demonstrates that the incorporated flood barriers relied upon as part of the flooding design basis reconstitution can withstand the hydrostatic and hydrodynamic loads associated with a postulated PMP event, using the new methodology of FEMA P-259.
- Deployment of the temporary flood protection features for the LIP hazard is incorporated into plant off-normal instructions.

2.4.10.5, Meteorological Forecast Warning

- A discussion of the two-tier meteorological alert used to initiate deployment of temporary flood barriers is added based on the updated LIP analysis. The first-tier alert of 2.1 inches of precipitation in a 24-hour period initiates heightened awareness for plant personnel. The second-tier alert of 1.9 inches of precipitation in a one-hour period serves as the initial condition for entry into plant off-normal instructions, which includes deployment of temporary flood barriers.
- A new reference (Reference 88) is added to identify the guidance document used in the development of this forecast warning. The new reference is the industry white paper issued by Nuclear Energy Institute (NEI), NEI 15-05, “Warning Time for Local Intense Precipitation Events.” Revision 6 of the white paper was endorsed by the Nuclear Regulatory Commission in 2015 for beyond-design-basis purposes.
- A new reference (Reference 89) is added to this discussion. The new reference is to PNPP Calculation 50:85.000, “Precipitation Hazard Alert Evaluation.” This calculation determines the alert tier thresholds based on inputs from updated SPS analysis using the new methodology, FLO-2D.

2.4.11, LOW WATER CONSIDERATIONS

2.4.11.2, Low Water Resulting From Surges, Seiches or Tsunami

- A reference (Reference 90) is added to the maximum lake level setdown discussion in Section 2.4.11.2.2.2, “Probable Maximum Setdown,” and Section 2.4.11.2.2.3, “One-Dimensional Model for Setdown Surge.” The reference is to PNPP Calculation DX-1.5.0, “Lake Erie Surge Levels – Lake Level Studies – PMS.” This clarifies the original source of the reported values.
- An editorial change in the maximum setdown value is made in Section 2.4.11.2.2.2 to be consistent with the value in Section 2.4.11.2.2.3.
- Reference 61 (previously described) is also added to this section.

2.4.11.3, Historical Low Water

- An editorial change is made to correct the recorded date of the minimum monthly mean level of record at Cleveland. This error appears to be the result of misreading the original graph figure. Figure 2.4-2 is revised in its entirety and displays the values in a different format.

2.4.11.4, Future Controls

- The description of onsite streams is updated to reflect recent site modifications.

2.4.11.5, Plant Requirements

- A reference (Reference 91) is added to the discussion of the emergency service water pumphouse. The reference is to PNPP Calculation DX-1.1.2, “Emergency Service Water Pumphouse Water Levels.” This clarifies the original source of the reported values.

2.4.11.6, Heat Sink Dependability Requirements

- The description of onsite streams is updated to reflect recent site modifications.
- Figure 2.4-3 (previously described) is used for illustration in place of Figure 2.4.8 (previously discussed in 2.4.3.5 above)
- A new reference (Reference 86) is added to the water flow path discussion. The new reference is to PNPP Calculation 50:82.000, “ESW Swale Discharge Flooding Evaluation.” This calculation uses the new methodology, FLO-2D, to determine the hydraulic effects, on critical points of interest, of an accident event onsite in which the emergency service water (ESW) lines are simultaneously discharged into the ESW Swale during a sustained period of use.

2.4.13, GROUNDWATER

2.4.13.3, Accident Effects

- The description of onsite streams is updated to reflect recent site modifications.

2.4.13.5, Design Bases for Subsurface Hydrostatic Loadings

- An editorial correction is made to the discussion of the underdrain system, changing “insure” to “ensure” in Section 2.4.13.5.4, “Maintenance and Testing.”
- The discussion of the underdrain system in Section 2.4.13.5.5, “Safety Evaluation,” is updated to reflect the changes to onsite streams and drainage as a result of recent site modifications. Concrete is added as a ground surface. Editorial changes are made to clarify that the discussion of mean high water level for Lake Erie is the mean “monthly” high water level, and the water level is consistently listed as Elevation 575.4 feet.
- The discussion of the underdrain system manholes was changed to credit the covers as providing the inleakage mitigation function, rather than relying on the topography.
- Reference 61 (previously discussed) is added to this section.

2.4.14, TECHNICAL SPECIFICATION AND EMERGENCY OPERATION REQUIREMENTS

This section is updated to summarize the new flood hazard protection scheme based on changes to the site surface drainage and updated analyses using the new methodology, FLO-2D. Reference 66 (previously described) is added to this section.

The bounding external flood hazard event is LIP. The LIP event requires operator action for precipitation hazards that exceed the SPS. The operator action is required by the PNPP Operations Requirement Manual (a site procedure) and is limited to the deployment of removable incorporated barriers. Guidance for the operator action is incorporated into plant off-normal instructions. Entry into the off-normal instructions is initiated by a meteorological forecast alert. If barriers are not deployed in the allotted timeframe, a plant shutdown is initiated.

2.4.16, REFERENCES FOR SECTION 2.4

The new references are repeated below for convenience.

- Reference 61, PNPP Calculation 50:74.000, "Lake Erie Water Levels"
- Reference 62, Not Used
- Reference 63, Not Used
- Reference 64, Not Used
- Reference 65, PNPP Calculation DX-1.5.1, "Lake Erie Surge Study – Surge Analysis"
- Reference 66, PNPP Calculation 50:64.000, "PNPP Site Modifications Local Intense Precipitation (Design Basis)"
- Reference 67, PNPP Calculation 50:65.000, "Evaluation of Structural Roof Capacity for USAR Described PMP Event"
- Reference 68, PNPP Calculation 50:71.000, "Design Basis Probable Maximum Precipitation (PMP) Determination"
- Reference 69, PNPP Calculation 50:79.000, "Probable Maximum Winter Precipitation (PMWP, Cool-Season PMP) and Snowmelt Contribution (Design Basis)"
- Reference 70, PNPP Calculation 50:72.000, "Design Basis Major Stream Probable Maximum Flood (PMF)"
- Reference 71, PNPP Calculation 50:73.000, "Design Basis Diversion Stream Probable Maximum Flood (PMF)"
- Reference 72, PNPP Calculation 50:75.000, "Design Basis Standard Project Storm (SPS) Determination"
- Reference 73, PNPP Calculation 21:02.000, "Misc. Yard Structures – Railroad Bridge"
- Reference 74, PNPP Procedure EMARP-0005, "Monitoring of Shoreline Recession and Bluff Erosion"
- Reference 75, PNPP Engineering Change Package 13-0802, "Major/Minor Stream Modification"

- Reference 76, PNPP Calculation 50:68.000, “Perry Nuclear Power Plant (PNPP) Diversion Stream Design Basis Shore Protection Analysis”
- Reference 77, PNPP Drawing 744-0177-00012, “Stream Relocation Outfall Profile – Stream Outfall”
- Reference 78, PNPP Calculation 50:80.000, “Effects of Cool-Season Probable Maximum Winter Precipitation (PMWP) Event”
- Reference 79, PNPP Calculation 50:77.000, “Evaluation of Flood Barriers”
- Reference 80, PNPP Calculation 21:21.000, “Hydrogen Water Chemistry Tank Foundations and Miscellaneous Equipment Foundations”
- Reference 81, ANSI Standard ANS-N170-1976-ANS-2.8, “American National Standards for Determining Design Basis Flooding at Power Reactor Sites”
- Reference 82, PNPP Calculation 50:76.000, “PNPP Design Basis Standard Project Storm (SPS) Rainfall Effects”
- Reference 83, U.S. Army Corps of Engineers’ “Snow Hydrology,” June 1956
- Reference 84, U.S. Army Corps of Engineers’ “Guidelines for Calculating and Routing a Dam-Break Flood,” RD-5, Hydrologic Engineering Center, January 1977
- Reference 85, U.S. Army Corps of Engineers’ “Guidelines for Corps Dams,” RD-13, Hydrologic Engineering Center, June 1980
- Reference 86, PNPP Calculation 50:82.000, “ESW Swale Discharge Flooding Evaluation”
- Reference 87, PNPP Calculation 50:83.000, “Mixed Bed Tank Discharge Evaluation”
- Reference 88, NEI 15-05, “Warning Time for Local Intense Precipitation Events,” Revision 6, April 2015, Nuclear Energy Institute
- Reference 89, PNPP Calculation 50:85.000, “Precipitation Hazard Alert Evaluation”
- Reference 90, PNPP Calculation DX-1.5.0, “Lake Erie Surge Levels – Lake Level Studies – PMS”
- Reference 91, PNPP Calculation DX 1.1.2, “Emergency Service Water Pumphouse Water Levels”

SECTION 2.5, GEOLOGY, SEISMOLOGY AND GEOTECHNICAL ENGINEERING

2.5.1, BASIC GEOLOGIC AND SEISMIC INFORMATION

2.5.1.2, Site Geology

- Discussion in Section 2.5.1.2.1.1, “Topography,” and Section 2.5.1.2.1.2, “Site Drainage,” is updated to describe post-construction changes, including the recent site modifications of onsite streams.
- Figure 2.4-7, “Plan Minor Stream,” is revised in its entirety and is now titled “Plan Diversion Stream.”
- Figure 2.4-84, “Topography Surrounding Powerblock,” is added to provide updated information.

2.5.5, STABILITY OF SLOPES

With the site modifications to onsite streams, man-made slopes exist at the plant. This section is updated to reflect the existence of man-made slopes, such as the Diversion Stream.

2.5.6, EMBANKMENTS AND DAMS

This section is updated in its entirety to discuss the existence of the Diversion Stream berm, an earthen embankment installed between the Remnant Minor Stream Channel and the Diversion Stream. This berm is part of the recent site modifications to onsite streams. Figure 2.4-8a and Reference 66 of Section 2.4 (both previously described) are added to this section.

SECTION 3.4, WATER LEVEL (FLOOD) DESIGN

3.4.1, FLOOD PROTECTION

3.4.1.1, Flood Protection Measures for Seismic Category I Structures

- This section is updated to reflect the new flood hazard protection scheme described in USAR Section 2.4 above.

3.4.1.2, Permanent Dewatering System

- The discussion related to flood elevation, plant grading, and storm drainage system is updated to reflect recent site modifications to onsite streams and updated LIP analysis using the new methodology, FLO-2D. Clarification is added that external flooding from the LIP event does not affect the underdrain system.
- An editorial change is made to the descriptive term “maximum recorded Lake Erie” elevation. This is changed to “mean monthly high water” elevation for consistency with other USAR sections.

3.4.2, ANALYTICAL AND TEST PROCEDURES

This section is updated to reflect results of the LIP analysis using the new methodology, FLO-2D and FEMA P-259. Safety Class I structures are subjected to flood forces as a result of the LIP event. These forces are evaluated and shown to be bounded by other design basis forces. A new reference (Reference 79 of Section 2.4) is added. The reference is to PNPP Calculation 50:77.000, “Evaluation of Flood Barriers.” This calculation demonstrates that the incorporated barriers relied upon as part of the flooding design basis reconstitution can withstand the hydrostatic and hydrodynamic loads associated with a postulated PMP event.

Reference 61 of Section 2.4 (previously described) is also added to this section.

3.4.3, FLOOD FORCE APPLICATION

This section is updated to reflect that the land safety class structures are evaluated and shown to be bounded by other design basis forces. Reference 79 of Section 2.4 is added.

SECTION 3.5, MISSILE PROTECTION

3.5.1, MISSILE SELECTION AND DESCRIPTION

3.5.1.4, Missiles Generated by Natural Phenomena

- This section is updated to describe two sources of externally generated missiles due to natural phenomena, tornado missiles and flood-borne missiles. Pre-existing Section 3.5.1.4.1, “Missile Selection,” and Section 3.5.1.4.2, “Missile Protection Methods,” are renamed to focus on tornado missiles. New sections are added to address flood-borne missiles.
- Section 3.5.1.4.1 is titled “Tornado Missile Selection,” and a pointer to the new section for flood-borne missiles is added.
- Section 3.5.1.4.2 is titled “Tornado Missile Protection Methods.”
- Discussion of flood-borne missiles is added in Section 3.5.1.4.3, “Flood-borne Missiles,” Section 3.5.1.4.3.1, “Flood-borne Missile Selection,” and Section 3.5.1.4.3.2, “Flood-borne Missile Protection.”
- A new reference (Reference 15) is added. The reference is to PNPP Calculation 50:77.000, “Evaluation of Flood Barriers.” This calculation demonstrates that the incorporated barriers relied upon as part of the flooding design basis reconstitution can withstand the hydrostatic and hydrodynamic loads associated with a postulated PMP event, using new methodology FEMA P-259.
- Figures 2.4-77, 2.4-78, 2.4-79, 2.4-80, and 2.4-81 (previously described in Section 2.4 above) are added.
- Three new references (Reference 16, Reference 17 and Reference 18) were added to identify guidance documents used. Reference 16 is FEMA P-259, “Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures.” Reference 17 is American Society of Civil Engineers (ASCE) 7, “Minimum Design Loads for Buildings and Other Structures.” Reference 18 is ANSI A58.1, “Building Code Requirements for Minimum Design Loads in Building and Other Structures.”

3.5.4, REFERENCES FOR SECTION 3.5

The new references are repeated below for convenience.

- Reference 15, PNPP Calculation 50:77.000, “Evaluation of Flood Barriers”
- Reference 16, FEMA P-259, “Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures,” 3rd Edition, January 2012

- Reference 17, ASCE 7, "Minimum Design Loads for Buildings and Other Structures," 2010 Ed.
- Reference 18, ANSI A58.1, "Building Code Requirements for Minimum Design Loads in Building and Other Structures," 1972

SECTION 3.6, PROTECTION AGAINST DYNAMIC EFFECTS ASSOCIATED WITH THE POSTULATED RUPTURE OF PIPING

3.6.2, DETERMINATION OF BREAK LOCATIONS AND DYNAMIC EFFECTS ASSOCIATED WITH THE POSTULATED RUPTURE OF PIPING

3.6.2.3, Dynamic Analysis Methods to Verify Integrity and Operability

- The flooding analysis discussion for the Unit 2 Transformer Alley is updated to reflect that the passive protection features are adequate to prevent floodwater ingress due to a tornado missile strike.
- Two new references (Reference 11 and Reference 12) are added to the discussion. Reference 11 is PNPP Calculation 50:86.000, "Service Water Line Break in Unit 2 Transformer Alley." The calculation uses the new methodology, FLO-2D, to determine the hydraulic effects, on critical points of interest, of an accident event onsite in which the service water line (above ground), located in the Unit 2 Transformer Alley, is ruptured due to a tornado missile and service water is discharged onto the site. Reference 12 identifies the specific site modification, PNPP Engineering Change 19-0155, "Installation of Flood Barriers at Plant Doors," that installs flood barriers at affected plant doors.

3.6.3, REFERENCES FOR SECTION 3.6

The new references are repeated below for convenience.

- Reference 11, PNPP Calculation 50:86.000, "Service Water Line Break in Unit 2 Transformer Alley"
- Reference 12, PNPP Engineering Change 19-0155

SECTION 3.8, DESIGN OF CATEGORY I STRUCTURES

3.8.1, CONCRETE CONTAINMENT

This section is updated to clarify that weather and exterior missile protection for the containment vessel includes the effects of external flood hazards.

3.8.4, OTHER SEISMIC CATEGORY I STRUCTURES

3.8.4.1, Description of the Structures

- Section 3.8.4.1.2, "Auxiliary Building," is updated to clarify that exterior walls and the roof of the building also provide protection of safety class equipment from effects of the environment.
- Section 3.8.4.1.6, "Radwaste Building," is updated to add pointers to previous discussion of external flood protection features and effects of flood-borne missiles.
- Section 3.4.1.7, "Diesel Generator Building," is updated to clarify that the walls and roof provide protection against other natural phenomena, including external flooding.
- Section 3.8.1.8, "Offgas Building," is updated to clarify that exterior walls resist external flood hazards as previously discussed.
- Section 3.8.4.1.9, "Emergency Service Water Pumphouse," is updated to reflect that the structure provides protection from external natural phenomena, including external flood hazards and associated external missiles.

SECTION 7.2, REACTOR TRIP SYSTEM – REACTOR PROTECTION SYSTEM (RPS)

7.2.1, DESCRIPTION

7.2.1.2, Design Basis Information

- The discussion of floods for buildings containing RPS components is updated to reflect the provision of flood protection features and to point to the discussion in USAR Section 2.4.

SECTION 7.3, ENGINEERED SAFETY FEATURE SYSTEMS

7.3.1, DESCRIPTION

7.3.1.2, Design Basis

- The discussion of floods for buildings containing engineered safety feature systems components is updated to reflect the provision of flood protection features and to point to the discussion in USAR Section 2.4.

SECTION 7.4, SYSTEMS REQUIRED FOR SAFE SHUTDOWN

7.4.1, DESCRIPTION

7.4.1.5, Design Basis

- The discussion of floods for buildings containing safe shutdown system components is updated to reflect the provision of flood protection features and to point to the discussion in USAR Section 2.4.

SECTION 7.6, ALL OTHER INSTRUMENTATION SYSTEMS REQUIRED FOR SAFETY

7.6.1, DESCRIPTION

7.6.1.13, Design Basis

- The discussion of floods for buildings containing safety-related components is updated to reflect the provision of flood protection features and to point to the discussion in USAR Section 2.4.

SECTION 9.1, FUEL STORAGE AND HANDLING

9.1.2, SPENT FUEL STORAGE

9.1.2.1, Design Bases

- The reference made to Regulatory Guide 1.102 in Section 9.1.2.1.1, “Structural – GE [General Electric] Racks,” and Section 9.1.2.1.2, “Structural – PAR [Programmed and Remote Systems, Inc.] Racks,” is updated to point to USAR Section 2.4.

SECTION 9.3, PROCESS AUXILIARIES

9.3.8, HYDROGEN WATER CHEMISTRY SYSTEM

9.3.8.2, System Description

- A new reference (Reference 80 of Section 2.4) is added to the discussion of storage tank foundations. The reference is to PNPP Calculation 21:21.000, “Hydrogen Water Chemistry Tank Foundations and Miscellaneous Equipment Foundations.” Addendum A-01 of this calculation confirms the Hydrogen Water Chemistry storage tanks (Liquid Hydrogen Storage Tank, Liquid Oxygen Storage Tank, and High Pressure Gaseous Hydrogen Storage Vessel) are still capable of withstanding the effects of flooding.

SECTION 9.5, OTHER AUXILIARY SYSTEMS

9.5.4, DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM

9.5.4.3, Safety Evaluation

- Discussion of PMF and tank openings is updated to include passive protection utilized as part of the new flood hazard protection scheme.

9.5.8, DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM

9.5.8.1, Design Bases

- The reference made to Regulatory Guide 1.102 is updated to point to USAR Section 2.4.

9.5.8.3, Safety Evaluation

- The discussion of system elevation as it relates to flood water level is updated to reflect the new flood hazard protection scheme and to point to the discussion in USAR Section 2.4.

SECTION 15.7, RADIOACTIVE RELEASE FROM SUBSYSTEMS AND COMPONENTS

15.7.3, POSTULATED RADIOACTIVE RELEASES DUE TO LIQUID-CONTAINING TANK FAILURES

15.7.3.5, Radiological Consequences

- The description of onsite streams is updated to reflect recent site modifications.

USAR TABLES

In support of the proposed methodology change and to reflect the revise flood hazard protection scheme, the associated tables are proposed to be revised as follows:

- Table 1.8-1, “Conformance to NRC Regulatory Guides,” is updated to indicate that exceptions are taken to Regulatory Guide 1.59 and Regulatory Guide 1.102 as described in USAR Section 2.4, and that Regulatory Guide 1.135 is not applicable as it was not issued and the draft was withdrawn.
- Table 2.4-12, “Major Onsite Storage Facilities,” is updated to reflect a new evaluation of tank failure for demineralized water storage tanks using the new methodology, FLO-2D, for the LIP computational domain. A new reference (Reference 87) is added. The reference is to PNPP Calculation 50:83.000, “Mixed Bed Tank Discharge Evaluation,” which confirms that water levels at

the previously defined critical points of interest do not exceed existing thresholds.

- Table 3.5-6, “Existing Openings Without Unique Missile Shields,” is updated to change the title to “Existing Openings Without Unique Tornado Missile Shields,” to be consistent with the text changes in Section 3.5.1.

USAR FIGURES

In support of the proposed methodology change and to reflect the revised flood protection scheme, the associated figures are proposed to be revised as follows:

Figures Revised to Designate Historical Information (such as Plant Grade Elevation, Topographical information):

- Figure 1.2-5, “Final Plant Layout, Plan C Above Elevs. 620’-6”, 623’-6” and 624’-6”, Plant Complex”
- Figure 1.2-11, “Final Plant Layout, Section A-A”
- Figure 1.2-12, “Final Plant Layout, Section B-B”
- Figure 1.2-13, “Final Plant Layout, Section C-C”
- Figure 1.2-14 (Sheet 1 of 2), “Final Plant Layout, Circulating Water Pumphouse, Plans and Elevations”
- Figure 1.2-14 (Sheet 2 of 2), “Final Plant Layout, Circulating Water Pumphouse, Plans and Elevations”
- Figure 1.2-15, “Final Plant Layout, Service Water Pumphouse”
- Figure 1.2-16, “Final Plant Layout, Emergency Service Water Pumphouse Plans and Elevations”
- Figure 1.2-17, “Final Plant Layout, Discharge Tunnel Entrance Structures”
- Figure 1.2-18, “Final Plant Layout, Plot Plan Release Point Designation”
- Figure 2.1-3, “Topograph Within the Plant Site Boundary”
- Figure 2.2-3, “Natural Gas Pipelines Within the Immediate Environs of the Plant”
- Figure 2.3-15, “Plant Site and Meteorological Tower Location”
- Figure 2.3-17, “Region Topographic Map 5 Mile Radius”
- Figure 2.4-32, “Plan – Location of Lake Erie Shoreline and Bluff Recession Survey Lines”
- Figure 2.4-35, “1937, 1957, 1964, 1972 Top of Bluff Lines”
- Figure 2.4-36, “1876 Top of Bluff”
- Figure 2.4-37, “1798, 1829-30, 1852-1858, 1965-67, 1876, 1917, 1975 Shorelines”
- Figure 2.4-39, “Shoreline Protection”
- Figure 2.4-39A, “Shore Protection Breakwall” (Title changes to “Interim Shore Protection – General Plant Area”)
- Figure 2.4-66, “Well Location Map”
- Figure 2.5-33, “Final Grading Plan for the Perry Nuclear Power Plant”
- Figure 2.5-34, “Site Surficial Deposits Map (Prior to Construction)”
- Figure 2.5-48, “Tunnel Intersecting Faulting”

- Figure 2.5-53, “Site Exploration Plot Plan”
- Figure 2.5-144, “Site Seismic Survey”
- Figure 2D-1, “Location Map Perry Nuclear Power Plant”
- Figure 2D-3, “Tunneling Plan”
- Figure 2D-11, “TX-Series Boring Plant”
- Figure 2D-12, “Map of Shoreline Survey”
- Figure 2E-1, “Site Exploration Plot Plan”
- Figure 3.8-81, “Foundation Details of Safety Class Structures”
- Figure 9.5-22 (Sheet 1 of 3), “Plant Backfill and Excavation Showing Diesel Generator Piping and Fuel Oil Tanks”
- Figure 12.3-9, “Radiation Zone, Section A-A”
- Figure 12.3-10, “Radiation Zone, Section B-B”
- Figure 12.3-11, “Radiation Zone, Section C-C”

<u>Figures Revised to Update Building Elevations, Roof Depictions and Elevations, and Reflect Current Configuration:</u>

- Figure 1.2-6, “Final Plant Layout, Plan D Above Elevs. 638’-6”, 642’-0” and 647’-6”, Plant Complex”
- Figure 1.2-7, “Plant Layout Plan E Above Elevs. 652’-0” and El. 654’-6”, Plant Complex”
- Figure 1.2-8, “Final Plant Layout, Plan F Above Elevs. 664’-7”, 665’-0”, and 670’-6”, Plant Complex”
- Figure 1.2-9, “Final Plant Layout, Plan G Above Elevs. 689’-6”, Plant Complex”
- Figure 1.2-10, “Final Plant Layout, Plan H Roof Plan”
- Figure 2.4-69, “Plot Plan – Gravity Discharge System”
- Figure 2.4-76, “Plant Underdrain System Nuclear Island Piezometer Locations”
- Figure 2.5-197, “Shale Heave Gauge Location Plan”
- Figure 2.5-203, “Settlement Monument Location Plan”
- Figure 3.11-42, “Environmental Zone Map Plan “C” Above Elevs. 620’-6”, 623’-6”, and 624’-6”, Plant Complex”
- Figure 3.11-43, “Environmental Zone Map Plan “D” Above Elevs. 638’-6”, 642’-0” and 647’-6”, Plant Complex”
- Figure 3.11-44, “Environmental Zone Map Plan “E” Above Elevs. 652’-0” and 654’-6”, Plant Complex”
- Figure 3.11-45, “Environmental Zone Map Plan ‘F’ Above Elevs. 664’-6”, 665’-0”, and 670’-6”, Plant Complex”
- Figure 3.11-46, “Environmental Zone Map Plan ‘G’ Above Elev. 689’-6”, Plant Complex”
- Figure 12.3-3, “Radiation Zones, Plan C Above Elevs. 620’-6”, 623’-6”, and 624’-6””
- Figure 12.3-4, “Radiation Zones, Plan D Above 638’-6”, 642’-0”, and 647’-6””
- Figure 12.3-5, “Radiation Zones, Plan E Above Elev. 652’-0” and 654’-6” Plant Complex”

- Figure 12.3-6, “Radiation Zones, Plan F Above Elev. 664’-7”, 665’-0” and 670’-6” Plant Complex”
- Figure 12.3-7, “Radiation Zone, Plan G Above Elev. 689’-6””
- Figure 12.3-8, “Radiation Zone, Plan H Roof Plan”
- Figure 12.6-3, “Post Accident Radiation Zones, Plan C Above Elev. 620’-6”, 623’-6”, and 624’6”, Plant Complex”
- Figure 12.6-4, “Post Accident Radiation Zones, Plan D Above Elev. 638’-6”, 642’-0”, and 647’-0”, In Plant Complex”
- Figure 12.6-5, “Post-Accident Radiation Zones, Plan E Above Elev. 652’-0” and 654’-6” Plant Complex”
- Figure 12.6-6, “Post-Accident Radiation Zones, Plan F Above Elev. 664’-7”, 665’-0” and 670’-6” Plant Complex”
- Figure 12.6-7, “Postaccident Radiation Zones, Plan G Above Elev. 689’-6”, Plant Complex”

Figures Revised in Their Entirety to Reflect Current Hydrological Information:

- Figure 2.4-1, “Plan – Drainage Area of 2 Streams Close to Plant Site”
- Figure 2.4-2, “Lake Erie Water Levels” (Title changes to “Lake Erie Water Levels and Datum Conversion Values”)
- Figure 2.4-3, “Topography and Storm Drain Composite”
- Figure 2.4-4, “Hydrograph of PMF Discharge Into Lake Erie-Major Stream”
- Figure 2.4-5, “Hydrograph of PMF Discharge Into Lake Erie-Minor Stream” (Title changes to “Hydrograph of PMF Discharge Into Lake Erie-Diversion Stream”)
- Figure 2.4-6, “Probable Maximum Flood Profiles – Major Stream”
- Figure 2.4-7, “Plan – Minor Stream” (Title changes to “Plan – Diversion Stream”)
- Figure 2.4-8, “Profile and Typical Cross Sections – Minor Stream” (Title changes to “Profile and Typical Cross Section – Diversion Stream”)
- Figure 2.4-9, “Plan – Major Stream”

New Figures Added to Reflect Current Hydrological Information:

- Figure 2.4-4a, “Plan – Major Stream Inundation Area”
- Figure 2.4-5a, “Plan – Diversion Stream Inundation Area”
- Figure 2.4-8a, “Diversion Stream Typical Cross Section”
- Figure 2.4-39B, “Interim Shore Protection – Diversion Stream Outfall”
- Figure 2.4-77, “External Flooding Protection Plan”
- Figure 2.4-78, “Exterior Flood Protection – Concrete Walls Typical Details”
- Figure 2.4-79, “Exterior Flood Protection – Aluminum Walls Typical Details”
- Figure 2.4-80, “Exterior Flood Protection – Door Barriers – Multispan Typical Details”
- Figure 2.4-81, “Exterior Flood Protection – Door Barriers – Single Span Typical Details”
- Figure 2.4-82, “Local Intense Precipitation Computational Domain”

- Figure 2.4-83, “Plant Area Regional Topography”
- Figure 2.4-84, “Topography Surrounding Powerblock”

3.0 TECHNICAL EVALUATION

The proposed changes are part of a reconstitution effort for the design basis of the original probable maximum flood (PMF) event (small stream flood) and LIP domain analyses (using new methodology) and part of an effort to update the flood hazard protection scheme due to changes in the watershed over time at the PNPP site.

3.1 Proposed Change in Analysis Methodology

Current LIP analysis methodology is described in Section 2.5 of this evaluation. The collective methodology used to evaluate the effects of LIP as currently described in PNPP USAR Section 2.4.2.3 is a simplified approach that is not optimum in the characterization of the complexities of the site flood drainage. The proposed change in analysis methodology is to use FLO-2D, a two-dimensional unsteady state model, to evaluate the effects of precipitation events on the LIP domain, including applied water sources. In addition to evaluating the site with an applied water source that is uniformly distributed, the use of FLO-2D is intended to account for point discharges. One key capability of FLO-2D is the ability to perform storage routing functions. Storage routing is referenced in the current PNPP USAR in that the USAR credits the topographic storage of six inches of precipitation for LIP domain analyses.

FLO-2D is a commercial product developed by FLO-2D Software, Inc. FLO-2D is a dynamic flood routing model that simulates channel flow, unconfined overland flow, and street flow. It can simulate a flood over complex topography and roughness while reporting on volume conservation, which is the key to accurate flood distribution. The main intended use of FLO-2D at PNPP is for calculating stillwater elevations and inundation extents for a flood caused by a LIP and floods caused by lesser precipitation events.

FLO-2D is a volume conservation model that simulates open channel flow through a numerical approximation of the shallow water equations (also known as Saint-Venant’s Equation). The program uses input prescribed by the user from the various informational sources described throughout the calculations. A set of partial differential equations (Saint-Venant’s Equation) is solved within the program using estimated depths within the second-order Newton-Raphson tangent finite difference method to approximate a solution (velocity) from the Saint-Venant’s Equation. The approximated solution, a velocity, is then used to determine a flow depth. The depth is then used to evaluate numerical stability based on volume conservation to determine if it either meets acceptability requirements or if another iteration is required with adjusted depths. The program attempts three iterations to converge to a solution before the algorithm defaults to the diffusive wave equation. Within FLO-2D, the solution domain is discretized into uniform, square grid elements, where the discharge is computed in eight different flow directions across the grid element. Essentially, the program is two-dimensional in nature, but the base algorithm discretizes flow into one dimension in eight directions (quasi-two-dimensional model) for each time step. Therefore, the model

is capable of translating precipitation excess over a watershed to its resultant time variant rate of flow (unsteady flow).

The FLO-2D two-dimensional model is the host model that also includes a subsurface storm drain system module, Storm Water Management Model 5.0 (hereafter referred to as SWMM), developed by the U.S. Environmental Protection Agency. SWMM utilizes Hazen-Williams or Darcy-Weisbach equations to calculate hydraulic parameters for the full-pipe flow under pressure (surcharge) conditions. While both methods are acceptable to calculate flow under pressure, Darcy-Weisbach is utilized for the proposed PNPP LIP calculations. SWMM provides discharge analyses for both the roof drain network as well as the storm drain system. The conduits modeled in SWMM are analyzed using the Manning Equation for gravity flow conditions and transitions to the Darcy-Weisbach Equation when pressurized flow conditions exist. The SWMM module runs concurrently with the two-dimensional model, with the host model providing the surface water routing functions and the storm drain module addressing all below-ground storm water and roof drain routing. The programs exchange precipitation runoff at defined nodes representing storm drain inlets (catch basins and roof drains) and outlets (storm drain system headwalls). SWMM uses input prescribed by the user from the various informational sources reflecting site conditions and equations and methods described in *Open-Channel Hydraulics* by V.T. Chow (Reference 6 of ANSI N170-1976 Section 5.4.2.1) to obtain solutions to the modeled situation.

The FLO-2D topography feature uses the ArcGIS software program for pre-processing of input data for use in FLO-2D. ArcGIS is an Environmental Systems Research Institute Geographic Information System (GIS) software package. Topographic data, representing the ground surface, is developed in ArcGIS as a digital surface in the form of an American Standard Code for Information Interchange (ASCII) text file. The ASCII file represents the topographical surface in the form of multiple points with x, y, and z coordinates. The ASCII file is used as an input to build a topographic surface in FLO-2D. For PNPP, this topographic data was modified to incorporate changes to the LIP domain based on aerial survey information obtained in 2012 and supplemental, more recent, aerial imagery of the site. ArcGIS is also used to display the output from FLO-2D.

Energy Harbor Nuclear Corp. has identified the FLO-2D features that are critical software functions for use at PNPP (not all FLO-2D features are proposed for use). Table 3.1-1 provides a summary of FLO-2D features and proposed use at PNPP.

Table 3.1-1: FLO-2D Features

FLO-2D Feature	Proposed PNPP Use
Overland Flow Simulation including Multiple Channel Flow	Critical software function
Channel Flow Simulation	Critical software function
Channel-Floodplain Interface	Critical software function
Floodplain Surface Storage, Area Modification and Flow Obstructions	Critical software function
Rainfall-Runoff Simulation	Critical software function
Hydraulic Structures	Critical software function
Levees	Critical software function
Green-Ampt Infiltration	Critical software function
EPA SWMM Model Interchange and Pipe Flow	Critical software function
Inflow and Outflow Elements	Critical software function
Multiple Channels	Critical software function
Topography [developed in ArcGIS]	Critical software function
MODFLOW Interface	None
Coastal flooding	None
Levee and dam failure	None
Evaporation	None
Sediment transport	None
Mud and debris flow	None
RAINARF Parameter	Critical software function

Energy Harbor Nuclear Corp. maintains FLO-2D on a designated computer as an executable file to prevent unauthorized editing. Access to the computer is password protected to restrict access.

Framework for an acceptance process for commercial-grade items is established under the definition for “dedication” in 10 CFR 21, Reporting of Defects and Noncompliance. This acceptance process is undertaken to provide reasonable assurance that a commercial grade item to be used as a basic component will perform its intended safety function and, in this respect, is deemed equivalent to an item designed and manufactured under a 10 CFR 50, Appendix B, quality assurance program. This assurance is achieved by identifying the critical characteristics of the item and verifying their acceptability. The dedication process must be conducted in accordance with the applicable provisions of 10 CFR 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants.

Criterion III, “Design Control,” of 10 CFR 50, Appendix B, includes the provisions for quality assurance and quality control, which are applicable to the acceptance and dedication process for commercial-grade design and analysis computer programs. For design and analysis computer programs, acceptance of commercial-grade software in accordance with the requirements in Criterion III fulfills the requirements of dedication in

10 CFR 21. Criterion III design control measures are required, in part, for the selection and the review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems, and components. These measures are applicable to a commercial-grade design and analysis computer program associated with basic components.

The dedication of FLO-2D, SWMM, and ArcGIS software was performed by Enercon Services, Inc. (ENERCON) under the ENERCON quality assurance (QA) program. The ENERCON QA program is comprised of the Quality Assurance Manual and the associated implementing procedures. The QA program meets the following requirements:

- Title 10 Part 50 Appendix B and Title 10 Part 21 of the Code of Federal Regulations: QA requirements of the U.S. Nuclear Regulatory Commission for safety applications

- ANSI N45.2-1977 and NQA-1-2008 / NQA-1a-2009: QA program standards endorsed by the Nuclear Regulatory Commission as acceptable methods for meeting the requirements of 10 CFR 50 Appendix B.

The ENERCON QA program has been audited and accepted by Energy Harbor Nuclear Corp. and is on the Energy Harbor Nuclear Corp. Approved Supplier List (ASL). The software validation and testing report is provided in Attachments 4 and 5. The conclusion of the report is that FLO-2D is acceptable and accurate for its intended use in modeling a flood due to a LIP and lesser flood elevations. Testing of critical characteristics was deemed to be acceptable, and it is concluded that the FLO-2D software is acceptable and accurate.

Subsequent to the software dedication performed by ENERCON, Energy Harbor Nuclear Corp. identified an additional parameter of FLO-2D to be used in site calculations. The RAINARF parameter is applied to the model and serves as a depth reduction factor to the applied grid element(s), thus reducing the rainfall on that grid by a factor specified by the user. This parameter is used at PNPP to model variations in snowmelt rate within the modeled domain. Because this feature was not included in the ENERCON report, Energy Harbor Nuclear Corp. performed a separate validation and testing under its own QA program, which meets the requirements of ANSI N18.7-1976, "Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants." The software validation and testing report for RAINARF is provided in Attachment 6 and supplements the ENERCON report. The conclusion of the report is that the FLO-2D RAINARF parameter is acceptable and accurate for its intended use.

In addition, Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants," Revision 2, describes acceptable methods for determining the design basis flood conditions that nuclear power plants located on sites along streams must withstand without loss of safety-related functions. Regulatory Position C.1. states that the PMF on streams, as defined in Appendix A and based on the analytical techniques summarized in Appendices A and B of the guide, provides an acceptable level of conservatism for estimating flood levels caused by severe hydrometeorological conditions.

The material previously contained in Regulatory Guide 1.59, Appendix A, "Probable Maximum and Seismically Induced Floods on Streams," has been replaced by ANSI Standard N170-1976, "Standards for Determining Design Basis Flooding at Power Reactor Sites." ANSI N170-1976 has been endorsed as acceptable by the NRC staff with the exception noted in Appendix A.

ANSI N170-1976, Section 5.8, "Plantsite Drainage," is the governing section for the determination of the effects of local probable maximum precipitation on the plant site (USAR Section 2.4.3.1). Section 5.8 also provides guidance with respect to what specific factors should be considered for flooding scenarios over the LIP domain. These factors include:

(1) Sheet flow over the areas immediately adjacent to safety-related facilities, including roof drainage,

(2) Side-hill drainage running toward the plant site,

(3) Temporary ponding in the plant area because of site topography as planned to be graded or man-caused hydraulic controls, and

(4) Natural watercourses or manmade drainage channels that run through the site, the drainage area of which may also include areas outside of the plant boundary.

The FLO-2D model considers each of these elements, including natural watercourses both inside and outside of the plant boundary.

ANSI N170-1976, Section 5.8.1.4, "Model," states that runoff and stream course models may be derived in accordance with the guidance of 5.4. Section 5.4, "Runoff and Streamcourse Models," begins with the following:

> A runoff model translates precipitation excess over a watershed to its resulting time variant rate of flow. It is often necessary to divide a watershed into subareas on the basis of size, drainage pattern, installed and proposed regulation facilities, vegetation, soil and cover type, and precipitation characteristics. These subarea runoff models are connected and combined by streamcourse modeling.

In accordance with Section 5.4.1, "Runoff Models," the model must be verifiable and conservative.

Section 5.4.2, "Streamcourse Model," states the following, in part:

> Flood water travel in open watercourses shall be modeled by transient flow (unsteady flow) techniques when rate of flow change is rapid, as in the case of surge from dam failure.

Transient flow is described in Section 5.4.2.1 as:

> The transient flow method, also referred to here as the hydraulic method, computes simultaneously the time sequence of both flow and water surface elevation over the full length of the stream. The solution requires knowledge of the lateral and longitudinal geometry of the stream, its frictional resistance, a discharge-elevation relationship at one boundary, and the time varying flow or elevation at the opposite boundary.

When considering the intensity of the estimated rainfall for PNPP LIP, the applied water point loadings, the limited model area, and the number of pathways for the floodwaters to travel, the rate of change for PNPP is rapid.

The elements described above are included in FLO-2D. The SWMM model incorporates roof drainage, man-caused hydraulic controls, and manmade drainage channels that run through the site while translating precipitation excess over the watershed to its resulting time variant rate of flow. Therefore, Energy Harbor Nuclear Corp. concludes that the two-dimensional modeling approach provided by FLO-2D complies with a transient flow unsteady state model described in the standard.

Under the reconstituted LIP flood hazard results, a new methodology is also used to address flood-borne missiles. Because the current licensing basis for PNPP does not include flood-borne missiles and staff-endorsed guidance was not located, Energy Harbor Nuclear Corp. selected the guidance of FEMA P-259, "Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures" (Third Edition, January 2012), to provide a methodology for determining floodwater loading and flood-borne missile effects. FEMA P-259 is a publicly available document. The methodology was used in a calculation at PNPP to demonstrate the capability of the temporary flood mitigation panels and permanent protection features (closure plates, ramps) to withstand the hydrostatic and hydrodynamic forces resulting from the reconstituted LIP domain flood hazards.

The calculation extracts peak floodwater depths and velocities for protected plant doorways (man doors and roll-up doors) and other relevant openings from reconstituted LIP analyses results. Using this information, the calculation employs typical fluid mechanics formulae to determine forces that act on the panels and other protection features (static and dynamic). These forces are determined using the guidance of FEMA P-259, which provides equations for calculating impact force from objects carried by moving water. Applicable flood-borne missiles are determined by review of the PNPP existing tornado missile spectrum. Screening of this spectrum is performed to determine which tornado missiles are also applicable to flood-borne missiles. The selected flood-borne missile is evaluated to ensure that it is bounding of any other expected flood-borne missile hazards. The selected flood-borne missile weight is then utilized in the FEMA P-259 methodology to determine the resultant equivalent load. These resulting forces are used to determine material stresses in the flood panels, other protection features and mounting hardware, using structural evaluation and strength of material formulae, which are then compared to allowable values. Allowable stresses are obtained from appropriate source documents, such as the American Institute of

Steel Construction (AISC) Steel Construction Manual. Energy Harbor Nuclear Corp. considers this an acceptable methodology for the application.

3.2 Proposed New Flood Hazard Protection Scheme

As described in Section 2.2 of this evaluation, the design of PNPP for flood protection conforms to the guidelines of Regulatory Guide 1.102, Position C.1, and Regulatory Guide 1.59, Positions C.1 and C.2. No exceptions to the guidance in these two regulatory guides have previously been taken.

Regulatory Guide 1.102 describes types of flood protection acceptable to the NRC staff for safety-related SSCs and methods of protecting nuclear power plants from the effects of PMP falling directly on the site. Position C.1 provides working definitions of various types of flood protection acceptable to the Nuclear Regulatory Commission (NRC) staff. As described in Section 2.2 of this evaluation, the definition applicable to PNPP has been “dry site.”

Regulatory Guide 1.59 describes acceptable methods of determining the design basis flood conditions that nuclear power plants located along streams must withstand without loss of safety-related functions. It also discusses the phenomena producing comparable design basis floods for coastal, estuary, and Great Lakes sites. Position C.1 states, in part, the conditions resulting from the worst site-related flood probable at a nuclear power plant with attendant wind-generated wave activity constitute the design basis flood conditions that SSCs must be designed to withstand and retain capability for cold shutdown and maintenance thereof. Position C.2 provides discussion of an alternative to designing hardened protection for all safety-related SSCs. Hardened protection is described as meaning structural provisions incorporated in the plant design that will protect SSCs from the static and dynamic effects of floods. Each component of the protection must be passive and in place, as it is to be used for flood protection, during normal plant operation. It is permissible not to provide hardened protection for some of these features if sufficient warning time is shown to be available to shut the plant down and implement adequate emergency procedures, while safe shutdown SSCs remain fully passively protected. The PNPP flood hazard protection scheme has been fully passive up to this point in time.

As previously described in this evaluation (Section 2.6), changes to the watershed have occurred such that the change in flow of water on site requires a change in flood hazard protection. In addition, the reconstituted LIP analysis using the new methodology, FLO-2D, results in a more conservative design basis flood level, compared to the previous analysis. As shown in Table 3.2-1 below, the reconstituted PMP has a maximum intensity of 13.19 inches per hour of rainfall over the postulated 48-hour duration. For the LIP event, this interval occurs at the start of the event, with progressively less intense intervals (“front-loaded” storm sequence). A cumulative rainfall of 34.73 inches occurs over the 48-hour storm duration. The reconstituted flood levels necessitate a fundamental change to the protection scheme for the LIP event at the PNPP site.

Table 3.2-1: Reconstituted PMP - LIP

Design Basis Probable Maximum Precipitation - Local Intense Precipitation									
Time	1 HR	2 HR	3 HR	4 HR	5 HR	6 HR	12 HR	24 HR	48 HR
Incremental Rainfall (inches)	13.19	4.03	2.96	2.42	2.16	2.15	2.30	3.22	2.30
Cumulative Rainfall (inches)	13.19	17.22	20.18	22.60	24.76	26.91	29.21	32.43	34.73

As previously described, four prospective external flooding hazards exist at the PNPP site: Lake Erie, Major Stream, Minor Stream, and LIP. Regulatory Guide 1.102 defines the design basis flooding level (DBFL) as the maximum water elevation attained by the controlling flood, including coincident wind-generated wave effects. Currently, the controlling external flood hazard at the PNPP is the LIP; however, that is due to the protection schemes provided for the other hazards. The existing flood protection scheme for the four hazards are summarized below.

With respect to Lake Erie, the existing protection requirement is that the plant is built above the high-water levels determined for the probable maximum setup and coincident wave action. Relative to this particular hazard, the current protection falls under the “dry site” category. It is recognized in the USAR that the impact of bluff erosion and the retreating of the shoreline can ultimately impact the flood protection requirements necessary to protect safety-related structures. The USAR outlines the required steps to monitor the shoreline to ensure that it remains a safe distance from safety-related structures. When it is identified that the shoreline has receded to a point 250 ft away from the closest safety class structure (emergency service water pumphouse), the site is required to initiate the design of a permanent revetment structure to protect the shoreline. Revetment structures are explicitly listed in Regulatory Guide 1.102, Section C, as an exterior barrier, which is an acceptable method of flood protection. For this hazard, PNPP is fully passively protected by topography and complies with Regulatory Guide 1.59, Position C.1.

Modifications were made to the two previously described streams, Major Stream and Minor Stream (see Figure 2-1 of this evaluation). A portion of the Major Stream was modified to an engineered trapezoidal channel designed to convey the peak flow rates caused by the PMP, resulting in the concentration of Major Stream runoff being carried downstream to Lake Erie, rather than contributing to runoff to other areas of the site. Effectively, the engineered channel falls within the category of exterior barrier, although not explicitly listed. The Minor Stream was diverted further to the east. The newly diverted stream (the Diversion Stream) also falls within the category of exterior barrier. The Diversion Stream includes a berm that extends above the stream forming its western bank. The berm provides flood protection as an exterior barrier containing the Diversion Stream flood levels from impacting the site. The berm effectively isolates the

Diversion Stream watershed from the LIP domain. A portion of the originally engineered Minor Stream (the Remnant Minor Stream) remains located between the plant area and the Diversion Stream. This section of the stream no longer functions as a traditional stream. The Remnant Minor Stream is limited to a drainage swale located entirely within the LIP domain. A mid-loaded event sequence is used for the Rivers and Streams analysis. As shown in Table 3.2-2 below, total precipitation values are the same, only the temporal distribution differs between this and the LIP analysis. For these hazards, PNPP is fully passively protected by topography and exterior barriers and complies with Regulatory 1.59, Position C.1.

Table 3.2-2: Reconstituted PMP – Rivers and Streams

Design Basis Probable Maximum Precipitation - Rivers and Streams									
Time	1 HR	2 HR	3 HR	4 HR	5 HR	6 HR	12 HR	24 HR	48 HR
Incremental Rainfall (inches)	2.15	2.42	2.96	13.19	4.03	2.16	2.30	3.22	2.30
Cumulative Rainfall (inches)	2.15	4.57	7.53	20.72	24.75	26.91	29.21	32.43	34.73

With respect to LIP, flood levels are being updated based on the reconstituted LIP levels derived from using the new methodology, FLO-2D. With the reconstituted LIP flood levels, PNPP structures required to reach and maintain cold shutdown are not fully passively protected. These structures, like safety-related structures and non-safety related structures that communicate with safety-related structures, are passively protected up to and including the effects of the SPS. For hazards exceeding the SPS, up to and including the PMP event of the LIP domain, protection features are deployed via operator action.

For the LIP event, Regulatory Guide 1.102 provides the following:

> Local PMP may produce flooding at sites otherwise considered immune from flooding. The intensity of this rainfall and the usual design of the drainage system may result in ponding in the plant yard that could produce the DBFL. Also, roofs may receive more precipitation than the roof drains are designed to discharge.
>
> Final plant grading is usually designed to cause ponded water to flow away from safety-related buildings. Even so, some temporary ponding is to be expected. Such ponding is generally accommodated by locating penetrations above the level of temporary ponding. Plant structures, systems, and components subject to ponding are also subject to the static and dynamic forces of the ponded water. These forces are usually less, however, then the forces from other design basis events.

All safety-related buildings are located within the LIP computational domain. The LIP domain is effectively an island bordered by three watersheds (Major Stream, Diversion Stream, and Lake Erie) because of the flood protection features in place for these hazards. All three of these waterbodies are capable of either storing or conveying the storm waters developed within their watershed to prevent flood water levels from impacting any safety-related facilities, systems, and equipment on the site. Therefore, the controlling flood and associated water levels impacting the site are a result of the limitations of the site drainage capabilities during the LIP event. To date, the site was protected from flooding during the LIP event by locating penetrations and doorways above the high-water level. In addition, plant SSCs subject to standing water were sufficiently protected for the static and dynamic forces of the ponded water.

The reconstituted LIP flood levels necessitate a fundamental change to the protection scheme for the LIP event at the PNPP site. Flood waters now exceed door thresholds of safety-related buildings and non-safety environmental interfaces, requiring deployable flood barriers for doorways to protect the structures from inundation. Prevention of water intrusion into the buildings ensures that the plant will still operate as designed, maintain margin, and the capability for achieving and maintaining cold shutdown resulting from the most severe flood conditions.

The resulting high-water surface elevations based on the LIP event are evaluated for safety-related buildings (structures) and non-safety buildings (structures) that function as an environmental interface to determine the flood protection requirements. A non-safety building (structure) is considered an environmental interface to a safety-related building if external floodwaters would enter the safety-related building if the existence of all or part of the non-safety building was removed. Where water levels exceed either door thresholds, wall penetrations, or rise above the first-floor grade of a building, flood protection is necessary to meet the requirements of incorporated barriers as defined in Regulatory Guide 1.102.

Regulatory Guide 1.102 explicitly allows for the use of incorporated barriers for all external flood hazards other than the LIP event. The guide also states that the LIP event is usually less severe than the other design basis events. Therefore, it is assumed that incorporated barriers are an effective means to protect SSCs from floodwaters regardless of the source of the flooding.

Although the proposed use of incorporated barriers for the PNPP LIP flood protection is not explicitly discussed within Regulatory Guide 1.102, plant structures subject to ponding during a LIP event are also subject to the static and dynamic forces of the ponded water. This implies that such structures meet the definition of incorporated barriers in that the structures are protected from inundation, and static and dynamic effects by engineered features in the structure and environmental interface. The current PNPP USAR Section 2.4.3.1 notes that ponding in the LIP domain, particularly to the area within the perimeter road, reaches EL 620 ft 5 inches. Based on this water surface elevation, there are plant buildings that experience standing water against them during the LIP event. Structures considered to be incorporated barriers at the PNPP site have been analyzed and designed to protect against the static and dynamic forces, and where applicable, the missiles generated during the postulated event.

Temporary ponding is to be expected, according to Regulatory Guide 1.102, during the LIP event and such ponding is generally accommodated by locating the penetrations above the maximum water surface elevation. The current flood protection scheme described in the PNPP USAR aligns with this as doorways and other penetrations are located above EL 620 ft 6 inches, the LIP flood level. The reconstituted LIP analysis using the new methodology, FLO-2D, results in conservatively higher flood levels that exceed the location of the current doorway thresholds. Therefore, alternative protection is necessary. The guide states that penetrations are generally located above flood levels but does not explicitly discuss other recourse for LIP protection. Flood panels (stop logs) are to be used at the PNPP site to provide flood protection at doorways where flood levels exceed their thresholds. The stop logs used as flood barriers provide protection from flood waters up to approximately 2 ft in height. This is adequate to prevent water intrusion into the door with the maximum water depth (approximately 1.625 ft). Incorporated barriers are an effective means to protect SSCs from floodwaters, and the source of the flooding has no impact to the effectiveness of such barriers. The design of the PNPP flood panels is such that it protects plant structures from inundation of external flood water hazards. All flood panels and door threshold ramps that are considered incorporated barriers have been analyzed and designed to protect against the static and dynamic forces, and where applicable, the missiles generated during the postulated event.

Section C.1.c of Regulatory Guide 1.102 also requires the hydraulic and seismic design bases for all types of closures be the same as for the wall that encompasses the closure. There are no external flooding hazards associated with a seismic event (that is, dam failure or tsunamis); therefore, seismic qualifications of the walls and flood panels for the purposes of flood protection are not required.

Regulatory Guide 1.102 describes various protection measures the NRC staff finds acceptable for protection against flood effects at nuclear power plants. The use of incorporated barriers is explicitly allowed for all external flood hazards other than the LIP event because local flooding induced by severe local precipitation was to be discussed later. The barriers to be used at the PNPP will withstand the static and dynamic forces associated with the LIP event, as is the intent for any flood hazard to which incorporated barriers would provide protection. Therefore, the use of incorporated barriers to prevent floodwaters from entering SSCs during a LIP event meets the intent of Regulatory Guide 1.102.

An inspection plan will require periodic inspections of the material condition of the flood barriers, including the gasketed sealing surfaces. The inspection plan will also ensure the channels are free of any material that could interfere with barrier deployment or mating surfaces. Furthermore, the barriers are to be added to the Plant Operator Rounds or other applicable periodic activity. In this way, the barriers are confirmed to be staged at the designated locations, thus ensuring deployment readiness.

Temporary incorporated barriers are required to be located at the exterior doors of plant buildings that, in some locations, function as normal ingress and egress paths. For all man doors and some rollup doors, the doors function as emergency exits for plant

personnel and may function as emergency entrances (such as for medical first responders or fire brigade members). Using permanent incorporated barriers (that is, leaving the flood panels in place during normal operation) would result in a safety hazard for plant personnel. Therefore, for these instances, an advance warning time is incorporated into the flood hazard protection scheme.

Safety-related features located within the plant site will be protected up to and including the SPS using passive (permanent or normally installed) flood protection barriers. Protection is provided at all environmental interfaces, including both safety and non-safety structures. The SPS estimates the most severe flood-producing rainfall depth-area-duration relationship and isohyetal pattern of a storm that is considered reasonably characteristic of the PNPP region. For any precipitation event larger than the SPS, including the PMP event, permanent barriers and removable flood panels are to be used at the PNPP. The removable flood panels will be either normally installed or stored in a central location to be deployed per site operational procedure(s). As shown in Table 3.2-3 below, the peak intensity of the SPS for the LIP domain is 3.747 inches per hour and the 24-hour total is 13 inches.

Table 3.2-3: Reconstituted Standard Project Storm for LIP Domain

Standard Project Storm									
Time	6 HR	12 HR	13 HR	14 HR	15 HR	16 HR	17 HR	18 HR	24 HR
Incremental Rainfall (inches)	0.560	1.600	0.986	1.183	1.479	3.747	1.380	1.085	0.980
Cumulative Rainfall (inches)	0.560	2.160	3.146	4.329	5.808	9.555	10.935	12.020	13.000

Regulatory Guide 1.59, Position C.2.b, requires that safety-related structures be designed for the effects of the SPS. The Standard Project Flood (SPF), resulting from the SPS, is analyzed in PNPP Calculation 50:76.000, “PNPP Design Basis Standard Project Storm (SPS) Rainfall Effects.” The results of this calculation were used as input to a site modification that installs hardened protection features for power block grade level penetrations. These protection features function as incorporated barriers as defined in Regulatory Guide 1.102 and passively protect the plant from water intrusion during the SPS. These protection features are provided not only for safety-related building exterior openings, but for non-safety related buildings that communicate with safety-related buildings. This ensures the SPS event does not provide any indirect paths for floodwater ingress, which could potentially challenge SSCs required for reaching cold shutdown.

Regulatory Guide 1.59, Position C.2.c, requires reasonable combinations of less-severe events be considered so that a consistent level of conservatism is achieved. For the PNPP, the only probable maximum hazard that is not passively protected is the PMP event over the LIP domain. Other hazards, such as the probable maximum flood (PMF)

of the adjacent streams, and probable maximum storm surge (PMSS) are addressed by the design of the engineered channels (maximized boundary conditions are assumed in the LIP domain models) and elevation difference between lake water surface elevation (WSE) and bluff elevation. This renders any combined event postulation inconsequential.

Regulatory Guide 1.59, Position C.2.d, requires that in addition to Position C.2.b, at least those SSCs necessary for cold shutdown and maintenance thereof are designed with hardened protective features to remain functional while withstanding the entire range of flood conditions up to the PMP. "Hardened protection" is a structural provision that is passive and in place during normal plant operation, intended to protect SSCs from the static and dynamic effects of floods. As described above, the proposed PNPP flood hazard protection scheme includes the use of passive flood protection barriers to mitigate the effects of all storms up to and including the SPS. While not entirely permanent, the barriers are normally installed at the required location.

For flood protection in response to storms in excess of the SPS, up to and including the PMP, temporary incorporated barriers are deployed. Because the barriers are not in place during normal plant operation, they are not considered hardened protection. The concept of using an advanced warning alert in response to flood protection, where sufficient warning time is available to bring the plant to a safe shutdown condition, is considered within Regulatory Guide 1.102. For PNPP, the new flood hazard protection scheme includes a two-tier meteorological alert used to initiate deployment of temporary flood barriers. The first-tier alert of 2.1 inches of precipitation in a 24-hour period is used to initiate heightened awareness of plant personnel. The second-tier alert of 1.9 inches of precipitation in a one-hour period serves as the initial condition for entry into plant off-normal instructions, which includes deployment of temporary flood barriers.

Due to the changes in watershed discussed in this evaluation and the unusual circumstances leading to this issue at PNPP, this use of temporary flood barriers is incorporated in the proposed PNPP USAR changes as an exception to Regulatory Guide 1.102. This use of the barriers provides a reasonable approach to mitigate the effects of the LIP event while maintaining plant personal safety by providing unobstructed exits during emergency situations.

For the LIP hazard, PNPP is protected by a combination of permanent and temporary incorporated barriers.

To summarize, Energy Harbor Nuclear Corp. proposes to transition from an all-passive flood hazard protection scheme to a combination of passive and operator action-based flood hazard protection scheme. For off-site hazards (Lake Erie and streams adjacent to the site), PNPP is protected by topographic features, such as the Lake Erie bluff, and exterior barriers in the form of engineered channels and the recently installed berm. For the LIP domain, passive (permanent or normally installed) flood protection features protect the site up to and including the SPS. For a precipitation event larger than the SPS, temporary flood protection features will be utilized, specifically removable flood panels (stop logs). These flood panels are either normally installed or stored in a central location to be deployed in accordance with operational procedures. In some

cases, where there is minimal impact on normal plant activities and no impact on personnel egress, these temporary barriers may be pre-deployed and validated when necessary per procedure.

The flood panels meet the definition of incorporated barriers described in Regulatory Guide 1.102, Position C.1. With the change in flow of water and drainage on site since original plant construction, these features are credited in the new flood hazard protection scheme. PNPP is no longer a dry site in which building exterior penetrations are located above the DBFL. By extension, the reconstituted flood hazards subject the exterior of all plant structures to external forces not previously considered in the plant design. As a result, both safety-related building exteriors and non-safety related building exteriors of buildings that can potentially communicate with safety-related buildings are required to prevent external flood water intrusion. Non-safety related buildings are provided with new flood protection features at or near the environmental interface to prevent floodwater intrusion into these areas.

Energy Harbor Nuclear Corp. has elected to credit the plant storm drain system in mitigating the effects of the LIP event as well as lesser (non-PMP) precipitation events. The storm drain system is non-safety related. In addition, the plant roof drain system is being incorporated. The roof drain system is hydraulically coupled to the storm drain system; therefore, the roof drain system is considered part of the storm drain system for purposes of the reconstitution effort.

4.0 REGULATORY EVALUATION

4.1 <u>Applicable Regulatory Requirements/Criteria</u>

<u>10 CFR 100 Subpart A – Evaluation Factors for Stationary Power Reactor Site Applications Before January 10, 1997 and for Testing Reactors</u>

10 CFR 100.10 – Factors to be considered when evaluating sites.

(c) Physical characteristics of the site, including seismology, meteorology, geology, and hydrology.

<u>10 CFR 21 – Reporting of Defects and Noncompliance</u>

Framework for an acceptance process for commercial grade items is established under the definition for “dedication” in 10 CFR 21.3, Definitions.

> *Dedication*. (1) When applied to nuclear power plants licensed pursuant to 10 CFR Part 30, 40, 50, 60, dedication is an acceptance process undertaken to provide reasonable assurance that a commercial grade item to be used as a basic component will perform its intended safety function and, in this respect, is deemed equivalent to an item designed and manufactured under a 10 CFR Part 50, appendix B, quality assurance program. This assurance is achieved by identifying the critical characteristics of the item and verifying their acceptability by inspections,

> tests, or analyses performed by the purchaser or third-party dedicating entity after delivery, supplemented as necessary by one or more of the following: commercial grade surveys; product inspections or witness at holdpoints at the manufacturer's facility, and analysis of historical records for acceptable performance. In all cases, the dedication process must be conducted in accordance with the applicable provisions of 10 CFR Part 50, appendix B. The process is considered complete when the item is designated for use as a basic component.

<u>10 CFR 50, Appendix A – General Design Criteria for Nuclear Power Plants</u>

Criterion 1 – Quality standards and records. Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. A quality assurance program shall be established and implemented in order to provide adequate assurance that these structures, systems, and components will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

Criterion 2 – Design bases for protection against natural phenomena. Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena and (3) the importance of the safety functions to be performed.

<u>10 CFR 50, Appendix B – Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants</u>

Criterion III, "Design Control," includes the provisions for quality assurance and quality control, which are applicable to the acceptance and dedication process for commercial-grade design and analysis computer programs. For design and analysis computer programs, acceptance of commercial-grade software in accordance with the requirements in Criterion III fulfills the requirements of dedication in 10 CFR 21. Criterion III design control measures are required, in part, for the selection and the review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems, and components, and are applicable to a commercial-grade design and analysis computer program associated with basic components.

<u>Regulatory Guide 1.59, Revision 2, August 1977 – Design Basis Floods for Nuclear Power Plants</u>

This regulatory guide describes acceptable methods for determining the design basis flood conditions that nuclear power plants located on sites along streams must withstand without loss of safety-related functions.

Regulatory Position C.1 states, in part, the conditions resulting from the worst site-related flood probable at a nuclear power plant with attendant wind-generated wave activity constitute the design basis flood conditions that safety-related SSCs identified in Regulatory Guide 1.29, "Seismic Design Classification for Nuclear Power Plants," must be designed to withstand and retain capability for cold shutdown and maintenance thereof.

The PMF, as defined in Appendix A, is the hypothetical flood (peak discharge, volume, and hydrograph shape) that is considered to be the most severe reasonably possible, based on comprehensive hydrometeorological application of probable maximum precipitation and other hydrologic factors favorable for maximum flood runoff, such as sequential storms and snowmelt.

The PMF on streams, based on the analytical techniques summarized in Appendices A and B of the guide, provides an acceptable level of conservatism for estimating flood levels caused by severe hydrometeorological conditions. [The material previously contained in RG 1.59, Appendix A, "Probable Maximum and Seismically Induced Floods on Streams," has been replaced by American National Standards Institute (ANSI) Standard N170-1976, "Standards for Determining Design Basis Flooding at Power Reactor Sites." ANSI N170-1976 has been endorsed as acceptable by the NRC staff with the exception noted in Appendix A.]

Regulatory Position C.2 provides discussion of an alternative to designing hardened protection for all safety-related SSCs. Hardened protection is described as meaning structural provisions incorporated in the plant design that will protect SSCs from the static and dynamic effects of floods. Each component of the protection must be passive and in place, as it is to be used for flood protection, during normal plant operation. It is permissible not to provide hardened protection for some of these features if sufficient warning time is shown to be available to shut the plant down and implement adequate emergency procedures.

It is recognized in this regulatory guide that during the life of a nuclear power plant, unanticipated changes to the site environs, which may adversely affect the flood-producing characteristics, are possible. Regulatory Position C.3 states, in part:

> Significantly adverse changes in the runoff or other flood-producing characteristics of the site environs, as they affect the design basis flood, should be identified and used as the basis to develop or modify emergency operating procedures, if necessary, to mitigate the effects of the increased flood.

Regulatory Guide 1.102, Revision 1, September 1976 – Flood Protection for Nuclear Power Plants

This regulatory guide describes types of flood protection acceptable to the NRC staff for the safety-related SSCs identified in Regulatory Guide 1.29. In addition, this guide describes acceptable methods of protecting nuclear power plants from the effects of Probable Maximum Precipitation (PMP) falling directly on the site.

The definition of PMP is contained in Regulatory Guide 1.59 (from Appendix A, now ANSI N170-1976). Probable maximum precipitation is the estimated depth for a given duration, drainage area, and time of year for which there is virtually no risk of exceedance. The probable maximum precipitation for a given duration and drainage area approaches and approximates the maximum that is physically possible within the limits of contemporary hydrometeorological knowledge and techniques.

For the purposes of Regulatory Guide 1.102, the Design Basis Flooding Level (DBFL) is defined as the maximum water elevation attained by the controlling flood, including coincident wind-generated wave effects.

Methods of flood protection for nuclear power plants fall into one of the following three types:

1. Dry Site

   The plant is built above the DBFL, and therefore safety-related structures, systems, and components are not affected by flooding.

2. Exterior Barrier

   Safety-related structures, systems, and components are protected from inundation and static and dynamic forces thereof by engineered features external to the immediate plant area. Such features may, when properly designed and maintained, produce the equivalent of a dry site, although care must be taken to ensure that safety-related structures, equipment, and components are not adversely affected by the differential hydraulic head.

3. Incorporated Barrier

   Safety-related structures, system, and components are protected from inundation and static and dynamic effects by engineered features in the structure/environment interface.

Working definitions of the types of flood protection acceptable to the NRC staff are provided in Regulatory Guide 1.102.

Regulatory Guide 1.231, Revision 0, January 2017 – Acceptance of Commercial-Grade Design and Analysis Computer Programs Used in Safety-Related Applications for Nuclear Power Plants

In this regulatory guide, the NRC staff approves for use, with clarification, EPRI Technical Report 1025243, "Plant Engineering: Guideline for the Acceptance of Commercial-Grade Design and Analysis Computer Programs Used in Nuclear Safety-Related Applications," Revision 1. The NRC staff considers the methods in EPRI Technical Report 1025243, Revision 1, to be acceptable for complying with the requirements of 10 CFR 21 and Appendix B to 10 CFR 50 for the dedication of design and analysis computer programs as basic components for use in safety-related applications, subject to the following conditions:

- Revision 1 of EPRI Technical Report 1025243 states that its scope and basic intent is to provide acceptance guidance for non-process (that is, not installed in plant SSCs) computer programs used in the design and analysis of plant SSCs. As such, the NRC staff does not accept the use of Revision 1 of EPRI Technical Report 1025243 dedication methodology for process (installed or embedded) computer programs or software tools associated with process computer programs.

- Revision 1 of EPRI Technical Report 1025243 states that portions of the guidance can be used for any commercially procured computer program. Additionally, the EPRI document provides guidance for a range of safety classifications and for computer programs used for purposes other than design and analysis. The NRC staff's approval of the EPRI document is limited to design and analysis applications. Although the NRC's limited acceptance is not meant to preclude a user from using the guidance for other applications, this RG expresses no position on the capability or acceptability of the EPRI guidance in such applications.

- Because of their importance to safety, the guidelines (indicated by the verb "should") contained in Revision 1 of EPRI Technical Report 1025243 must be treated the same as the requirements (indicated by the verb "shall") of the guidance, with the following exceptions:

    - Acknowledgements and Appendices

    - Section 2

    - Activities associated with computer programs used for applications classified as augmented quality or non-safety-related

In view of the above, the site characteristics and analyses previously described in the proposed changes to the PNPP USAR are acceptable for use in reconstituting the design basis of the original probable maximum flood (PMF) event (small stream flood) and LIP domain analyses and protecting safety-related SSCs from flood hazards.

4.2 No Significant Hazards Consideration

Pursuant to 10 CFR 50.90, Energy Harbor Nuclear Corp. is submitting a request for an amendment to Facility Operating License No. NPF-58 for Perry Nuclear Power Plant, Unit No. 1 (PNPP). The proposed amendment revises the PNPP Updated Safety Analysis Report to include a change in methodology used for analysis of flooding hazards and drainage within the local intense precipitation domain at the site, to reflect the results from the new analysis, and revise the flood hazard protection scheme for the site. Energy Harbor Nuclear Corp. has determined that the proposed changes require prior Nuclear Regulatory Commission approval. There are no technical specification changes associated with this request.

Energy Harbor Nuclear Corp. has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, “Issuance of amendment,” as discussed below:

1. Does the proposed amendment involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No.

   The proposed changes reflect the updated hydrologic analysis using new methodology for the LIP computational domain, including incorporation of updated flood hazard analysis results and new figures into the PNPP Updated Safety Analysis Report (USAR), and revision of the site flood hazard protection scheme using a warning time for deployment of temporary flood barriers. The proposed changes result in additional margin between the revised flood elevations and limiting safety-related systems, structures, and components. Implementation of these changes does not (1) prevent the safety function of any safety-related system, structure, or component during an external flood; (2) alter, degrade, or prevent action described or assumed in any accident described in the USAR from being performed, because the safety-related systems, structures, or components remain adequately protected from the effects of external floods; (3) alter any assumptions previously made in evaluating radiological consequences; or (4) affect the integrity of any fission product barrier.

   Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No.

   The proposed change does not introduce any new accident causal mechanisms, nor do they impact any plant systems that are potential accident initiators. The use of the new methodology for the LIP computational domain cannot create a new or different accident. Although the revised flood protection scheme includes

a new earthen berm, the LIP model conservatively incorporates a berm failure consideration to ensure that the plant is protected against possible degradation.

Therefore, the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed amendment involve a significant reduction in a margin of safety?

   Response: No.

   The proposed change does not alter the permanent plant design, including instrument set points, that is the basis of the assumptions contained in the safety analyses. The results of the flood mitigation strategies, developed in response to the reconstituted hydrologic analysis, increase the margin to the flooding elevation required to protect safety-related systems, structures, or components during external flooding events from approximately one inch at doors of interest to approximately 4.5 inches at the door with the maximum flow depth. Therefore, the proposed change does not prevent any safety-related structures, systems, or components from performing their required functions during an external flood.

   Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based on the above, Energy Harbor Nuclear Corp. concludes that the proposed amendment does not involve a significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of “no significant hazards consideration” is justified.

4.3 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission’s regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5.0 ENVIRONMENTAL EVALUATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact

statement or environmental assessment need be prepared in connection with the proposed amendment.

6.0 ATTACHMENTS