Energy Harbor Nuclear Corp.
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440-280-7300

June 1, 2022
L-22-099

10 CFR 50.90
10 CFR 50.12

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT:
Perry Nuclear Power Plant, Unit No. 1
Docket No. 50-440, License No. NPF-58
Supplement to License Amendment Request to Revise the Methodology Used for Flood Hazard Analysis (EPID L-2021-LLA-0067)

By letter dated April 7, 2021 [Agencywide Documents Access and Management System (ADAMS) Accession No. ML21106A027], Energy Harbor Nuclear Corp. submitted to the Nuclear Regulatory Commission (NRC) a license amendment request for the Perry Nuclear Power Plant, Unit No. 1 (PNPP) to revise the Updated Safety Analysis Report (USAR) to change the methodology used for analysis of flooding hazards and drainage within the local intense precipitation (LIP) domain and reflect the results from the new analysis. Based on the new analysis, a new flood hazard protection scheme was also proposed for PNPP. In addition, Energy Harbor Nuclear Corp. requested exemptions in accordance with 10 CFR 50.12 to credit non-safety related protection features including: (1) permanent (passive) and temporary (deployable) flood barriers, and (2) the use of the plant storm drain system in mitigation of flood levels during a LIP event.

By letter dated July 9, 2021 (ADAMS Accession No. ML21165A001), the NRC staff described the terms and conditions of using a regulatory audit to support review of these requests and provided a regulatory audit plan. By letter dated August 17, 2021 (ADAMS Accession No. ML21237A075), Energy Harbor Nuclear Corp. agreed to the terms and conditions set forth in the letter and provided executable electronic versions of input and output files as requested by the NRC staff.

During the regulatory audit, multiple clarification calls were held between NRC staff reviewers and Energy Harbor Nuclear Corp. personnel. Clarification calls held on February 23, 2022 and March 31, 2022 included discussion of the new flood hazard scheme and proposed addition of requirements into the PNPP Operational

Requirements Manual (ORM) in lieu of adding a new limiting condition of operation (LCO) to the Technical Specifications (TS). As a result of these discussions, Energy Harbor Nuclear Corp. is proposing to add new TS 3.7.11, Flood Protection. A mark-up of the new TS 3.7.11 is provided in Attachment 1. A mark-up of the table of contents is also provided because this proposed change is adding a new TS. A mark-up of the proposed TS Bases for this new TS is provided in Attachment 2 for information only.

The basic description of the new flood protection scheme contained in the April 7, 2021 request remains valid. The location of the requirement driving the action is moved from the PNPP ORM into TS 3.7.11. A meteorological forecast warning still initiates entry into plant off-normal instructions, which provide guidance for operator actions. If flood barriers are not deployed in the timeframe allotted, a plant shutdown is initiated. USAR Section 2.4.14, Technical Specification and Emergency Operation Requirements, and other sections, as applicable, would be modified to reference the new TS 3.7.11 instead of the ORM.

The previously provided no significant hazards consideration included a statement that there are no technical specification changes associated with the request. Because that is no longer the case, Attachment 3 provides an updated no significant hazards consideration. This version supersedes the one previously provided. The conclusion remains the same.

The February 23, 2022 and March 31, 2022 clarification calls also included discussion related to the evaluation of the concrete walls used as flood barriers at PNPP. In response to this discussion, Energy Harbor Nuclear Corp. has prepared an addendum to calculation 50:77.000, Evaluation of Flood Barriers, to evaluate the existing concrete barrier wall for flexural forces. Addendum A-02 demonstrates that the existing concrete flood barrier wall can resist flexural loading caused by the design basis flood-born missile, hydrostatic, and hydrodynamic loads determined in the base calculation without concrete failure. A copy of the addendum is enclosed.

This supplemental information does not impact the requested exemptions submitted by the April 7, 2021 letter.

There are no regulatory commitments contained in this submittal. If there are any questions, or if additional information is required, please contact Mr. Phil H. Lashley, Manager – Fleet Licensing, at 330-696-7208.

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 1, 2022.

Sincerely,

Christopher M. Elliott

Attachments:
1. Technical Specification Page Markups
2. TS Bases Page Markups (for information only)
3. No Significant Hazards Consideration

Enclosure:
Calculation 50:77.000, Evaluation of Flood Barriers, Addendum A-02

cc: NRC Region III Administrator
NRC Resident Inspector
NRR Project Manager
Executive Director, Ohio Emergency Management Agency,
State of Ohio (NRC Liaison)
Utility Radiological Safety Board

Attachment 1
L-22-099

Technical Specification Page Markups

(4 pages follow)

(continued)

3.7 PLANT SYSTEMS

3.7.11 Flood Protection

LCO 3.7.11 Flood protection shall be provided for safety-related systems, structures, and components via deployment of flood barriers at a meteorological Trigger Event warning.

APPLICABILITY: At all times.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Requirements of the LCO not met.	A.1 Deploy flood barriers.	Prior to being within 36 hours of projected start of the Trigger Event
B. Required Action and associated Completion Time of Condition A not met in MODE 1, 2, or 3.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	12 hours 36 hours
C. Required Action and associated Completion Time of Condition A not met in other than MODE 1, 2, or 3.	C.1 Suspend CORE ALTERATIONS except for control rod insertion. AND C.2 Initiate action to fully insert all insertable control rods in core cells containing one or more fuel assemblies. AND	Immediately Immediately

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. (continued)	C.3 Initiate action to restore primary containment to OPERABLE status. AND C.4 Initiate action to restore isolation capability in each required primary containment penetration flow path not isolated. AND ----------NOTE---------- Entry and exit is permissible under administrative control. ---------- C.5 Initiate action to close one door in each primary containment air lock.	1 hour 1 hour 1 hour

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.11.1	Monitor 7-day meteorological forecast for Trigger Event.	24 hours

Attachment 2
L-22-099

TS Bases Page Markups (for information only)

(6 pages follow)

Information Only

TSB Table of Contents (continued)

B 3.7 PLANT SYSTEMS

B 3.7.11 Flood Protection

BASES

BACKGROUND

As originally licensed, the design of the Perry Nuclear Power Plant (PNPP) facility for flood protection conformed to the requirements of 10 CFR 50, Appendix A, GDC 2 (Ref. 1) with respect to protection against natural phenomena. The design of the facility met the acceptance criteria of Section 3.4.1 of NUREG-0800 (Ref. 2). The flood hazard protection scheme was entirely passive.

Throughout the life of the facility, various changes to the immediate plant area have occurred that have affected the runoff characteristics of overland flow of water and resulted in less effective drainage characteristics. The cumulative change in overland water discharge paths has resulted in inefficient site drainage for the local intense precipitation (LIP) flooding event and the potential for floodwater intrusion into safety-related buildings and non-safety related buildings that potentially communicate with safety-related buildings. This change, combined with a reconstituted hydrologic analysis, resulted in a change to the flood hazard protection scheme for PNPP to one that is now partially passive.

Flood barriers used at PNPP include passive (permanent or normally installed/deployed) barriers and temporary incorporated barriers as defined in Regulatory Guide 1.102 (Ref. 3). The flood barriers are not active components.

As described in the PNPP Updated Safety Analysis Report (USAR) Section 2.4.10 (Ref. 4), PNPP is passively protected from external flooding hazards from the adjacent streams (referred to as the Major Stream and the Diversion Stream) and Lake Erie for the entire range of postulated flooding events. The LIP flooding event represents the bounding external flood hazard for PNPP. The PNPP LIP domain consists of the site property bounded on the north by Lake Erie, the east by the new Diversion Stream, the west by the Major Stream, and to the south by the Major and Diversion Streams' drainage basins. The LIP domain is passively protected for flooding events up to and including the Standard Project Storm (SPS) determined by engineering calculation 50:75.000 (Ref. 5). Precipitation (rainfall) events in excess of the SPS require deployment of temporary flood protection barriers in order to preserve the function of safety-related structures, systems, and components (SSCs).

(continued)

BASES

BACKGROUND (continued)

Hydraulic analyses have determined the point at which the permanent and passive protection features (such as walls, door sills/closure plates/ramps, dike, berms, administratively closed openings, etc.) would be exceeded due to precipitation events. The precipitation event at which passive protection is exceeded is used to define the site's consequential rainfall event. These values are used to establish two meteorological (weather) forecast warning levels, Monitoring Threshold and Trigger Event. The two meteorological warning levels used for PNPP are determined by engineering calculation 50:85.000 (Ref. 6).

The Monitoring Threshold warning level is set at 2.1 inches of rainfall in a 24-hour period. This warning level serves as an initial warning of possible forthcoming significant precipitation at the site. This event corresponds to a 1-year recurrence interval precipitation event.

The Trigger Event warning level is set at a precipitation intensity of 1.9 inches in 1 hour (Ref. 5). The Trigger Event is not an actual precipitation event, rather, it is a control setpoint intended to initiate operator actions to deploy mitigation strategies for a possible forthcoming consequential rainfall event. This event corresponds to an approximately 18-year recurrence interval precipitation event. Setpoints are also provided for 6-, 12-, and 24-hour event durations of the same recurrence interval.

For PNPP, meteorological forecast monitoring ensures the site is alerted in advance of a consequential rainfall event so that flood mitigation can be implemented to maintain plant safety. Meteorological forecast monitoring is provided via an external meteorological service, as described in Reference 4. The meteorological forecasting employs an ensemble technique using diversified inputs and a 95th percentile confidence value. This meteorological forecast monitoring provides an allowance of 12 hours for deployment of flood barriers, which is sufficient time for operators to deploy the barriers prior to the need for initiation of plant shutdown.

Flood barrier deployment is implemented via site procedure ONI-ZZZ-1 (Ref. 7). Barrier size and locations have been determined in order to prevent floodwater intrusion into safety-related buildings and non-safety related buildings that potentially communicate with safety-related buildings.

This Technical Specification ensures temporary flood protection barriers are deployed in advance of a LIP flooding event.

(continued)

BASES (continued)

APPLICABLE SAFETY ANALYSES

The flood design basis for the PNPP site includes use of deployable flood barriers to protect site safety-related buildings and non-safety related buildings that potentially communicate with safety-related buildings in the LIP flood hazard event. The deployment of these flood protection features preserves the function of safety-related SSCs. The flood protection scheme precludes the plant from entering an unanalyzed condition, serves as the assumed initial condition for the design basis LIP flood event, and imposes an operating restriction on the plant.

The flood protection scheme also serves as the primary success path to mitigate the design basis LIP flood.

The flood protection scheme satisfies Criterion 2 and Criterion 3 of the NRC Final Policy Statement on Technical Specification Improvements (58 FR 39132).

LCO

The flood hazard analysis determined that LIP flooding is the bounding external flood hazard for PNPP. Deployment of flood barriers is required to prevent floodwater intrusion into safety-related buildings and non-safety related buildings that potentially communicate with safety-related buildings, thus protecting safety-related SSCs. The Trigger Event warning level is set such that actions can be taken to mitigate flooding from a possible forthcoming consequential rainfall event.

APPLICABILITY

Flood protection is required at all times to protect safety-related SSCs relied upon for safe operation, normal plant shutdown, to maintain cold shutdown conditions, and to maintain shutdown and refueling conditions because the Trigger Event could occur at any time.

ACTIONS

A.1

With the requirements of the LCO not met, deployment of flood barriers must occur to protect the plant from floodwater intrusion into safety-related buildings and non-safety related buildings that potentially communicate with safety-related buildings. Sufficient time is allowed so that the flood barriers are in place 36 hours prior to the projected start of the Trigger Event itself. The allowed Completion Time is reasonable.

(continued)

BASES

ACTIONS (continued)

B.1 and B.2

With the Required Action and Completion Time of A.1 not met in MODE 1, 2, or 3, the plant must be brought to MODE 3 within 12 hours and MODE 4 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

C.1, C.2, C.3, C.4, and C.5

All CORE ALTERATIONS except control rod insertion, if in progress, are immediately suspended in accordance with Required Action C.1, and action to fully insert all insertable control rods in core cells containing one or more fuel assemblies is initiated immediately in accordance with Required Action C.2. Action initiated under Required Action C.2 must continue until all insertable control rods containing one or more fuel assemblies have been fully inserted. This will preclude mechanisms that could lead to criticality. Suspension of CORE ALTERATIONS shall not preclude the completion of movement of a component to a safe condition. Control rods in core cells containing no fuel assemblies do not affect reactivity of the core and therefore do not have to be inserted.

Action must also be initiated within 1 hour to provide means for control of potential radioactive releases. This includes restoring primary containment to OPERABLE status, and primary containment isolation capability (i.e., one closed door in each primary containment air lock, and at least one primary containment isolation valve associated instrumentation are OPERABLE or other acceptable administrative controls to assure isolation capability) in each penetration flow path not isolated that is assumed to be isolated to mitigate radioactivity releases. This may be performed as an administrative check, by examining logs or other information, to determine if the components are out of service for maintenance or other reasons. It is not necessary to perform the Surveillances needed to demonstrate the OPERABILITY of the components. If, however, any required component is inoperable, then it must be restored to OPERABLE status. In this case, Surveillances may need to be performed to restore the component to OPERABLE status. In

(continued)

BASES

ACTIONS (continued)

addition, at least one door in each primary containment air lock must be closed. The closed air lock door completes the boundary for control of potential radioactive releases. With the appropriate administrative controls however, the closed door can be opened intermittently for entry and exit. The administrative controls required consist of the stationing of a dedicated individual to assure closure of the door except during the entry and exit, and assuring the door is closed after completion of the containment entry and exit. This allowance is acceptable due to the need for containment access and due to the slow progression of events that may result from inadequate shutdown margin. Inadvertent reactor criticalities would not be expected to result in the immediate release of appreciable fission products to the containment atmosphere. Actions must continue until all requirements of this Condition are satisfied.

SURVEILLANCE REQUIREMENTS

SR 3.7.11.1

A 7-day meteorological forecast is used to monitor for a Trigger Event and provides ample warning time for deployment of flood protection barriers. If barriers are not deployed in the timeframe allotted, there is sufficient warning time available for a plant shutdown to occur.

An external meteorological service is employed to continuously monitor meteorological conditions at the site and issue automated alerts to control room personnel to support this surveillance requirement.

Monitoring the meteorological forecasting every 24 hours, provides plant personnel with the opportunity to ensure the site is in a flood-ready condition prior to the arrival of a consequential rain event.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 2.

2. NUREG-0800, “Standard Review Plan,” Section 3.4.1.

3. Regulatory Guide 1.102.

4. USAR, Section 2.4.10.

5. Calculation 50:75.000, Design Basis Standard Project Storm (SPS) Determination

6. Calculation 50:85.000, Precipitation Hazard Alert Evaluation.

7. ONI-ZZZ-1, Acts of Nature – Severe Weather.

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 (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, to reflect the results from the new analysis, and revise the flood hazard protection scheme for the site. To support the revised flood hazard protection scheme, new Technical Specification 3.7.11, Flood Protection, is added to plant technical specifications. Energy Harbor Nuclear Corp. has determined that the proposed changes require prior Nuclear Regulatory Commission approval.

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 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.

Enclosure
L-22-099

Calculation 50:77.000, Evaluation of Flood Barriers, Addendum A-02

(9 pages follow)

FirstEnergy

CALCULATION ADDENDUM

CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
50:77.000	0	A-02

☐ BV1 ☐ BV2 ☐ BV1/2 ☐ BV3 ☐ BVSWT ☐ DB ☒ PY

TITLE/SUBJECT: (*Must Match Original Calculation Title/Subject*)
Evaluation of Flood Barriers

☐ **OAR Coversheet:** ☐ Addendum uses NOP-CC-3002 forms ☐ Addendum uses Vendor's forms

Classification:	☐ Tier 1 Calculation	☒ Safety-Related/Augmented Quality	☐ Non-safety-Related
Open Assumptions:	☐ Yes ☒ No	If Yes, Enter Tracking Number	
Initiating Document(s):	ECP 19-0155		

Computer Program(s)

Program Name	Version / Revision	Category	Status	Description
Microsoft Office	Office 365	C	Approved	Word Processor

Objective or Purpose of Addendum:

The purpose of this addendum is to demonstrate that the existing concrete flood barrier wall relied upon as part of the flooding design basis reconstitution can withstand the hydrostatic, hydrodynamic, and impact loads associated with a postulated Probable Maximum Precipitation (PMP) event.

Scope of Addendum:

Analyze the existing concrete flood barrier for postulated loads anticipated during a PMP.

Describe where the Addendum will be evaluated for Regulatory Applicability.

The base calculation was evaluated by RAD/Screen 14-01234. Since methodology, acceptance criteria, and compliance with acceptance criteria are not changed, this addendum is bounded by RAD/Screen 14-01234.

Co-Prepared By (Print, Sign, and Date):

Douglas R. Facemyer 5/11/2022 Jacob Schafer 5/11/2022

Reviewed / Verified By (Print, Sign, and Date):

Gaurav Shrestha 5/11/2022

Approved By (Print, Sign, and Date):

Jeremy Schudel 5/13/22

CALCULATION NO.	CALCULATION REV.	ADDENDUM NO.
50:77.000	0	A-02

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DEPARTMENT INTERFACES ASSOCIATED TO ADDENDUM:

Department	Name of Person performing the Impact Review
Design Engineering - Structural	Douglas Facemyer; impact review waived due to the impacted department performing the calculation addendum.

SUMMARY OF ADDENDUM

SUMMARY OF RESULTS/CONCLUSIONS OF ADDENDUM:

The existing concrete flood barrier wall is shown to be capable of withstanding the postulated flood waters, including dynamic loading from impact velocity and impact from postulated flood-born debris.

LIMITATIONS OR RESTRICTIONS CREATED BY ADDENDUM:

Use of barriers as part of the Design Basis for flooding is not permitted without prior NRC approval.

IMPACT OF ADDENDUM ON OUTPUT DOCUMENTS:

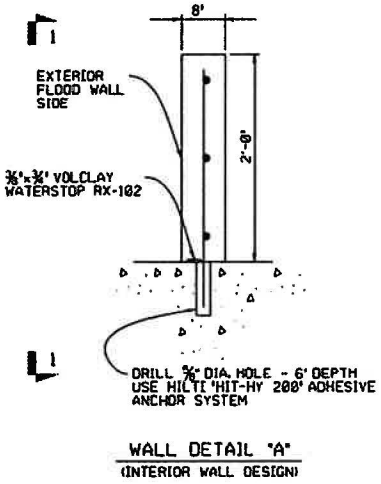
This addendum does not impact any additional output documents separate from those listed in the base calculation (USAR Change 13-293).

LIST NEW DOCUMENTS TO BE ADDED TO THE DOCUMENT INDEX (DIN).

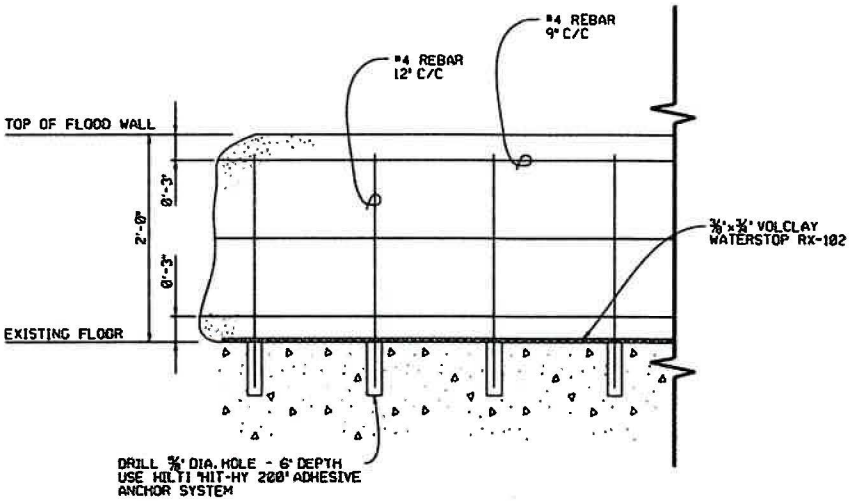
DIN No.	Document Number/Title	Revision, Edition, Date	Reference	Input	Output
			☐	☐	☐

Method of Analysis

As described in the base calculation, the existing concrete barrier wall has various configurations depending on location. In some instances, the wall is installed on the exterior of existing buildings where it is doweled into the exterior walls below grade. In other instances, the wall is installed directly on existing concrete. In all instances, the walls have these general characteristics: use of #4, A615, Grade 60 rebar, doweled into concrete at 12" on-center typical (using Hilti HIT-HY 200 as the adhesive system), 24" height, 8" thickness and #4 A615, Grade 60 rebar at 9" on-center installed horizontally along the length of the wall.



WALL DETAIL "A"
(INTERIOR WALL DESIGN)



SECTION 1-1
(NOTE: SECTION 1-1 IS TYPICAL OF ALL WALL TYPES UNLESS OTHERWISE NOTED ON AN INDIVIDUAL DETAIL)

The base calculation evaluated the overturning moment caused on the wall by hydrostatic, hydrodynamic, and design basis flood-born missile loading. Furthermore, the base calculation observed that the concrete wall is very robust in comparison to the aluminum panels which were evaluated for the same loading. Since the aluminum panels were found acceptable, it was determined that the concrete walls were as well. However, the actual concrete wall itself, was not evaluated against PMP loading. This addendum performs that task.

In order to demonstrate the adequacy of the concrete wall, the design basis flood loading moment determined in the base calculation, Attachment 1, is applied to the concrete wall.

Assumptions

None.

Acceptance Criteria

The loading on the concrete barriers shall be less than or equal to the allowable stress established by ACI 318-71 [DIN No. 26].

Computations

Required Reinforcement Area of Steel

Calculation 50:77.000, Rev. 0, Attachment 1, determines the following loading conditions:

Mu = 7.201 kip-in = 600.1 ft-lbs

Mu = 601 ft-lbs

In order to evaluate the capacity of the concrete wall, it shall be treated as a singly reinforced, simply supported beam. As indicated in the base calculation, the overturning moment from the design basis event loading is resisted by the Hilti adhesive system. In treating the concrete wall as a standalone beam, no credit is taken for this overturning resistance and the actual wall can be evaluated independently. In order for the linear concrete beam to resist Mu, a minimum Area of Steel, As, must be present within the tension block of the beam. The minimum area of steel, for a one-way concrete beam with tension reinforcement, can be determined using equations found in ACI-318 [DIN No. 26].

$As = ((Mu) / (\Phi * fy * (d - \lambda/2))$ where:

Φ = strength reduction factor, 0.9 for bending in reinforced concrete , with or without axial tension and for axial tension.

fy = specified yield strength of non-prestressed reinforcement, 60,000 psi for A615, Grade 60

d = distance from extreme compression fiber to centroid of tension reinforcement. Given the dimensions of the beam, this value is 4 inches.

λ = distance from centroid of compressed area to extreme compression fiber.

Per ACI-318, when determining the minimum required steel area based on a known required strength, it is a good estimate to start with a value of $\lambda = 0.1*d = 0.1 \times 4$ in = 0.4 in for the distance from the centroid of compressed area to extreme compression fiber.

$As = ((601 \text{ ft-lbs} * 12 \text{ in/ft}) / 0.9*60{,}000 \text{ psi}*(4 - 0.4/2 \text{ in})) = 7212 \text{ in-lbs} / 205200 \text{ lb/in} = 0.0351 \text{ in}^2$

In order to check the estimated λ value, the thickness of the compression zone can be determined by considering the geometry of the beam and the area of concrete which makes up the compression zone, Ac:

$Ac = (fy*As) / (0.85*f'c) = (60{,}000 \text{ psi}*0.0351 \text{ in}^2) / (0.85*3000 \text{ psi}) = 0.826 \text{ in}^2$

The thickness of the compression zone is determined by dividing Ac by the width of the beam (12 in):

$t = Ac / 12 \text{ in} = 0.826 \text{ in}^2 / 12 \text{ in} = 0.069 \text{ in}$

The initial estimate of λ is therefore found to be conservative. If the centroid of the compression block area described above were to be found, the calculated λ would be less than the value used above (0.1*d) which would increase the denominator in the As equation.

The actual As credited from 1 piece of #4 rebar = $1 \times \pi(0.25 \text{ in})^2 = 0.196 \text{ in}^2$.

The actual As >> required As. Therefore, no additional refinement is performed of the λ value utilized in this calculation. The thickness of the compression zone also verifies that the existing reinforcement is within the tension block.

Concrete Wall Thickness

Reinforced concrete members subject to bending shall be designed to have adequate stiffness to limit deflections or any deformations which may adversely affect the strength or serviceability of the structure at surface loads [Chapter 9, DIN No. 26]. From Table 9.5(a) – Minimum Thickness of Beams or Ribbed One-Way Slabs Unless Deflections are Computed, we find that members described as beams or ribbed one-way slabs, which are cantilever (most stringent requirements), are required to have a minimum thickness of l /8. In this case, the length of the concrete wall, is the height of the wall or 24 inches. Therefore, the minimum required thickness is 3 inches. Since the concrete wall is 8 inches thick, it exceeds the requirement. Note: this requirement is for non-prestressed reinforced concrete members made with normal weight concrete and Grade 60 reinforcement.

ACI 318 also prescribes requirements for concrete protection for reinforcement. From Table 7.14.1.1, Cast-in-place concrete (non-prestressed), we see that for #5 bar or smaller, exposed to earth or weather, the minimum cover is 1-1/2 inches. For cast-in-place and permanently exposed to earth, the minimum cover is 3 inches.

Therefore, with respect to protecting the reinforcement and considering deflection, both requirements are met by the current concrete wall design.

Shear Strength

In order to determine the shear stress applied to the concrete wall, it can again be viewed as a singly reinforced, simply supported beam. The moment applied to the wall (determined in Attachment 1 of the base calculation) can be applied to this beam and a shear stress can be determined using Beam Diagram #7 from the AISC Steel Construction Manual [DIN No. 2]. In order to do this, a 1 foot section of the concrete wall is examined. The vertical anchor system has been shown to resist the design bases forces. Therefore, it is reasonable to identify these anchors as "supports" for the beam which is examined in this section. Per Beam Diagram #7:

Using l = 1 ft

Mu = (P*l) / 4 = 601 ft-lbs; P = 2404 lbs.

R = V_u = P/2; V = 1202 lbs

Per ACI-318, the nominal shear stress, v_u, shall be computed by $v_u = V_u / (\Phi * b_w * d)$ where:

b_w = web width, or diameter of circular sections, in. In this case, this is simply the thickness of the beam, or 8 inches.

Using values determined above for the remaining parameters, nominal shear stress is calculated:

v_u = (1202 lbs) / (0.85 * 8 inches * 4 inches) = 44.19 = 45 psi

Per Section 11.4, the Nominal permissible shear stress for non-prestressed members shall not exceed 2*SQRT(fc). The concrete wall is made of 3,000 psi concrete. Therefore, the nominal permissible shear stress shall not exceed 109.5 psi. Since the nominal shear stress, 45 psi, is less than the permissible, 109 psi, shear reinforcement is not required, and no further investigation is required. Note: the forces applied to the concrete barrier represent a necessity to evaluate one-way shear only.

Spalling/Perforation Considerations

The concrete wall was not specifically evaluated for perforation or spalling due to impact loads in the base calculation. Impact loads were evaluated as equivalent static loads following the guidance of FEMA P-259, January 2012 (DIN No. 17). The acceptability of the concrete wall with respect to deformation due to impact loads (that is, perforation, spalling, etc.) was determined qualitatively based on the nature of the flood-born hazard. Conservatively assuming the velocity of the hazard to be that of the water velocity at the barrier (no reduction taken as discussed in Section 4.1.2.9 of FEMA P-259), the flood-born missile velocity is limited to only 2 feet per second. Additionally, the vertical rebar has been shown to be capable of resisting design loads. The horizontal reinforcement acts as distribution reinforcement and would distribute localized loading (such as the tornado missile) so that concentrated stresses are reduced and more evenly distributed through the concrete wall. By inspection and acknowledging the rigid, composite nature of the concrete wall, the assumed missile velocity is judged to be insufficient to cause material damage to the concrete wall.

Impact Load Reduction for Concrete Wall

In the analysis above, it is shown that only 1 vertical rebar member is sufficient to resist bending forces applied to the concrete barrier wall. It is also shown that the geometry of the wall is such that it is able to resist shear loading without the need of shear reinforcement. The design of the wall is such that multiple horizontal rebar is installed. That rebar acts to distribute loading applied to the concrete barrier wall. Each vertical reinforcement member is responsible for a tributary width of 6" on either side of the reinforcement. When the spacing of the vertical members and quantity of horizontal reinforcement is considered, it is evident, and reasonable, to assume that a minimum of 3 vertical members are going to contribute to resisting the postulated loading.

Results / Conclusions

The concrete barrier is shown to be adequate. The concrete barrier is shown to meet appropriate design codes for the expected loads.

FirstEnergy

DESIGN VERIFICATION RECORD

NOP-CC-2001-01 Rev. 00

SECTION I: TO BE COMPLETED BY DESIGN ORIGINATOR

DOCUMENT(S)/ACTIVITY TO BE VERIFIED:

Calculation 50:77.000, Revision 0, Addendum A-02

☒ SAFETY RELATED ☐ AUGMENTED QUALITY ☐ NONSAFETY RELATED

SUPPORTING/REFERENCE DOCUMENTS

ACI-318 1971	AISC, 7th Edition

DESIGN ORIGINATOR: *(Print and Sign Name)*
Douglas R. Facemyer

DATE 5/11/2022

SECTION II: TO BE COMPLETED BY VERIFIER

VERIFICATION METHOD *(Check one)*

☒ DESIGN REVIEW *(Complete Design Review Checklist or Calculation Review Checklist)* ☐ ALTERNATE CALCULATION ☐ QUALIFICATION TESTING

JUSTIFICATION FOR SUPERVISOR PERFORMING VERIFICATION:

N/A

APPROVAL: *(Print and Sign Name)*

DATE

EXTENT OF VERIFICATION:
This calculation addendum has been verified for completeness and accuracy in accordance with NOP-CC-2001. A complete math check has been performed. A Calculation Review Checklist has been performed.

COMMENTS, ERRORS OR DEFICIENCIES IDENTIFIED? ☐ YES ☒ NO

RESOLUTION: *(For Alternate Calculation or Qualification Testing only)*
N/A

RESOLVED BY: *(Print and Sign Name)*

N/A

DATE

VERIFIER: *(Print and Sign Name)*
Gaurav Shrestha

DATE 5/11/2022

APPROVED BY: *(Print and Sign Name)*
Jeremy Schudel

DATE 5/13/22

CALCULATION REVIEW CHECKLIST

NOP-CC-2001-04 Rev. 06

CALCULATION NO. 50:77.000
REV. 0
ADDENDUM NO. A-02
UNIT 1

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
GENERAL					
1 Does the stated objective/purpose clearly describe why the calculation is being performed?		X			
2. Are design input / output documents and references listed and clearly identified in the document index, including edition and addenda, where applicable?		X			
3. Were verbal inputs from third parties properly documented?	X				
4. Are design input parameters, such as physical and geometric characteristic and regulatory or code and standard requirements, accurately taken from the design input documents and correctly incorporated, including tolerances and units?		X			
5. Are the design inputs relevant, current, consistent with design/licensing bases and directly applicable to the purpose of the calculation, including appropriate tolerances and ranges/modes of operation?		X			
6. Are all design inputs retrievable? If not, have they been added as attachments?		X			
7. Are preliminary or conceptual inputs clearly identified for later confirmation as open assumptions?	X				
8. Where applicable, were construction and operating considerations included as input information?		X			
9. Were design input / output documents properly updated to reference this calculation?		X			
ASSUMPTIONS					
10. Have the assumptions necessary to perform the analysis been clearly identified and adequately described?		X			
11. Are all assumptions for the calculation reasonable and consistent with design/licensing bases?		X			
12. Have all open assumptions needing later confirmation been clearly identified on the Calculation cover sheet, including when the open assumption needs to be closed?	X				
13. Has an SAP Activity Initiation Form been created for open assumptions?	X				
14. Have engineering judgments been clearly identified?		X			
15. Are engineering judgments reasonable and adequately documented?		X			
16. Is suitable justification provided for all assumptions/engineering judgements (except those based upon recognized engineering practice, physical constants or elementary scientific principles)?		X			
METHOD OF ANALYSIS					
17. Is the method used appropriate considering the purpose and type of calculation?		X			
18. Is the method in accordance with applicable codes, standards, and design/licensing bases?		X			
IDENTIFICATION OF COMPUTER CODES (Ref: NOP-SS-1001)					
19. Have the versions of the computer codes employed in the design analysis been certified for this application?	X				
20. Are codes properly identified along with source (vendor, organization, etc.)?	X				
21. Is the code applicable for the analysis being performed?	X				
22. Is the computer program(s) being used listed on the Energy Harbor Usable Software List for the site?	X				

CALCULATION REVIEW CHECKLIST

NOP-CC-2001-04 Rev. 06

CALCULATION NO. 50:77.000
REV. 0
ADDENDUM NO. A-02
UNIT 1

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
23. Does the computer model, that has been created, adequately reflect actual (or to be modified) plant conditions (e.g., dimensional accuracy, type of model/code options used, time steps, etc.)?	X				
24. Did the computer output generate any ERROR or WARNING Messages that could invalidate the results?	X				
25. Is the computer output reasonable when compared to inputs and what was expected?	X				
COMPUTATIONS 26. Are the equations used consistent with recognized engineering practice and design/licensing bases?		X			
27. Is there a reasonable justification provided for the uses of any equations not in common use?	X				
28. Were the mathematical operations performed properly and the results accurate?		X			
29. Have adjustment factors, uncertainties, empirical correlations, etc., used in the analysis been correctly applied?		X			
30. Is the result presented with proper units and tolerance?		X			
31. Has proper consideration been given to results that may be overly sensitive to very small changes in input?		X			
CONCLUSIONS 32. Is the magnitude of the result reasonable and expected when compared to inputs?		X			
33. Is there a reasonable justification provided for deviations from the acceptance criteria?	X				
34. Are stated conclusions justifiable based on the calculation results?		X			
35. Are all pages sequentially numbered and marked with a valid calculation and revision number?		X			
36. Is all information legible and reproducible?		X			
37. Is the calculation presentation complete and understandable without any need to refer back to the Originator for clarification or explanations?		X			
38. Is calculation format presented in a logical and orderly manner, in conformance with the standard calculation content of NOP-CC-3002 (Attachment A)?		X			
39. Have all changes in the documentation been initialed (or signed) and dated by the author of the change and all required reviewers?		X			
DESIGN/LICENSING 40. Have all calculation results stayed within existing design/licensing basis parameters?		X			
41. If the response to Question 40 is NO, has Licensing been notified as appropriate? (i.e. UFSAR or Tech Spec Change Request has been initiated).	X				
42. Is the direction of trends reasonable?		X			
43. Has the calculation Preparer used all applicable design information/requirements provided?		X			
44. Did the calculation Preparer determine if the calculation was referenced in design basis documents and/or databases?		X			
45. Did the Preparer determine if the calculation was used as a reference in the UFSAR?		X			
46. If the calculation is used as a reference in the UFSAR, is a change to the UFSAR required or an update to the UFSAR Validation Database, if applicable, required?	X				
47. If the answer to Question 46 is YES, have the appropriate documents been initiated?	X				

CALCULATION REVIEW CHECKLIST

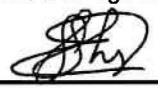
NOP-CC-2001-04 Rev. 06

CALCULATION NO. 50:77.000
REV. 0
ADDENDUM NO. A-02
UNIT 1

QUESTION	NA	Yes	No	COMMENTS	RESOLUTION
48. Has the applicability of 10CFR50.59 to this calculation been considered and documented?		X			
ACCEPTABLE					
49. Does the calculation meet its purpose/objective?		X			
50. Is the calculation acceptable for use?		X			
51. What checking method was used to review the calculation? Check all that apply.					
• spot check for math					
• complete check for math		X			
• comparison with tests					
• check by alternate method					
• comparison with previous calculation					
52. If the calculation was prepared by a vendor, does it comply with the technical and quality requirements described in the Procurement Documents? Reference the Purchase Order number or other procurement document number in the Comments Section of this question.	X				
53. Have Professional Engineer (PE) certification requirements been addressed and documented where required by ASME Code (if applicable).	X				

Review Summary:

A complete check of calculation has been performed including a complete check of math, correct sourcing of design inputs, and correct application of design codes / standards. This calculation is acceptable for use.

Review / Design Verification *(Required for calculations prepared using EHN process)*		**Owner's Acceptance Review** *(Required for calculations prepared by a vendor)*	
Technical Review *(Print and Sign Name)*	Date	**OAR Reviewer** *(Print and Sign Name)*	Date
N/A		N/A	
Design Verification *(Print and Sign Name)*	Date		
Gaurav Shrestha 	5/11/2022		