



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**

REGION III  
2443 WARRENVILLE ROAD, SUITE 210  
LISLE, ILLINOIS 60532-4352

June 10, 2021

Mr. Rod Penfield  
Site Vice President  
Energy Harbor Nuclear Corp.  
Perry Nuclear Power Plant  
10 Center Road  
Perry, OH 44081

SUBJECT: PERRY NUCLEAR POWER PLANT – NRC INSPECTION OF TEMPORARY  
INSTRUCTION 2515/194, INSPECTION OF THE LICENSEE'S  
IMPLEMENTATION OF INDUSTRY INITIATIVE ASSOCIATED WITH THE  
OPEN PHASE CONDITION DESIGN VULNERABILITIES IN ELECTRIC  
POWER SYSTEMS (NRC BULLETIN 2012-01) – INSPECTION REPORT  
05000440/2021011

Dear Mr. Penfield:

On April 30, 2021, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at Perry Nuclear Power Plant and discussed the results of this inspection with you and other members of your staff. The results of this inspection are documented in the enclosed report.

No findings or violations of more than minor significance were identified during this inspection.

This letter, its enclosure, and your response (if any) will be made available for public inspection and copying at <http://www.nrc.gov/reading-rm/adams.html> and at the NRC Public Document Room in accordance with Title 10 of the *Code of Federal Regulations* 2.390, "Public Inspections, Exemptions, Requests for Withholding."

Sincerely,

**/RA/**

Richard A. Skokowski, Chief  
Engineering Branch 3  
Division of Reactor Safety

Docket No. 05000440  
License No. NPF-58

Enclosure:  
As stated

cc w/ encl: Distribution via LISTSERV®

Letter to Rod Penfield from Richard A. Skokowski dated June 10, 2021.

SUBJECT: PERRY NUCLEAR POWER PLANT – NRC INSPECTION OF TEMPORARY INSTRUCTION 2515/194, INSPECTION OF THE LICENSEE'S IMPLEMENTATION OF INDUSTRY INITIATIVE ASSOCIATED WITH THE OPEN PHASE CONDITION DESIGN VULNERABILITIES IN ELECTRIC POWER SYSTEMS (NRC BULLETIN 2012-01) – INSPECTION REPORT 05000440/2021011

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**U.S. NUCLEAR REGULATORY COMMISSION**  
**Inspection Report**

Docket Number: 05000440

License Number: NPF-58

Report Number: 05000440/2021011

Enterprise Identifier: I-2021-011-0038

Licensee: Energy Harbor Nuclear Corp.

Facility: Perry Nuclear Power Plant

Location: Perry, Ohio

Inspection Dates: April 26, 2021 to April 30, 2021

Inspectors: A. Dahbur, Senior Reactor Inspector

Approved By: Richard A. Skokowski, Chief  
Engineering Branch 3  
Division of Reactor Safety

Enclosure

## **SUMMARY**

The U.S. Nuclear Regulatory Commission (NRC) continued monitoring the licensee's performance by conducting a NRC Inspection of Temporary Instruction 2515/194, Inspection of the Licensee's Implementation of Industry Initiative Associated with the Open Phase Condition Design Vulnerabilities in Electric Power Systems (NRC Bulletin 2012-01) – Inspection at Perry Nuclear Power Plant, in accordance with the Reactor Oversight Process. The Reactor Oversight Process is the NRC's program for overseeing the safe operation of commercial nuclear power reactors. Refer to <https://www.nrc.gov/reactors/operating/oversight.html> for more information.

### **List of Findings and Violations**

No findings or violations of more than minor significance were identified.

### **Additional Tracking Items**

None.

## INSPECTION SCOPES

Inspections were conducted using the appropriate portions of the inspection procedures (IPs) in effect at the beginning of the inspection unless otherwise noted. Currently approved IPs with their attached revision histories are located on the public website at <http://www.nrc.gov/reading-rm/doc-collections/insp-manual/inspection-procedure/index.html>. Samples were declared complete when the IP requirements most appropriate to the inspection activity were met consistent with Inspection Manual Chapter (IMC) 2515, "Light-Water Reactor Inspection Program - Operations Phase." The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel to assess licensee performance and compliance with Commission rules and regulations, license conditions, site procedures, and standards.

## OTHER ACTIVITIES – TEMPORARY INSTRUCTIONS, INFREQUENT AND ABNORMAL

### 2515/194 - Inspection of the Licensee's Implementation of Industry Initiative Associated with the Open Phase Condition Design Vulnerabilities in Electric Power Systems (NRC Bulletin 2012-01)

The inspector reviewed the licensee's implementation of the "Nuclear Energy Institute Voluntary Industry Initiative," (ADAMS Accession No. ML15075A454) dated March 16, 2015.

The objective of Temporary Instruction 2515/194 is to verify that licensees have appropriately implemented the Nuclear Energy Institute voluntary industry initiative (ADAMS Accession No. ML15075A454), dated March 16, 2015, including updating their licensing basis to reflect the need to protect against open phase conditions (OPCs). The inspector discussed the impacts of OPCs on the licensee's electrical system design, the ability to detect and alarm OPCs on station transformers, and ongoing implementation of training and updates to operating procedures with plant staff. The inspector reviewed licensee and vendor documentation, and performed system walkdowns to verify that the installed equipment was supported by the design documentation. The inspector verified that the licensee had completed the installation and testing of equipment (with the exception of the tripping functions), installed and tested alarming circuits both locally and in the control room, and analyzed potential impacts associated with the design implementation on the current licensing basis. The inspector also reviewed licensee analysis and calculations, and performed distribution system equipment walkdowns.

The inspector performed Section 03.01 of the Temporary Instruction in order to determine whether the licensee appropriately implemented the voluntary industry initiative, dated March 16, 2015 (ADAMS Accession No. ML15075A454). This included reviewing how the licensee updated their licensing basis to reflect the need to protect against OPCs.

### Inspection of the Licensee's Implementation of Industry Initiative Associated with the Open Phase Condition Design Vulnerabilities in Electric Power Systems (NRC Bulletin 2012-01) (1 Sample)

- (1) For Perry Nuclear Power Plant (PNPP), the specific impacts of an OPC are dependent on the electrical layout of the plant. The PNPP 345 kV switchyard consisted of four transmission terminals which come in to feed the two Main Buses, Main Bus 1 (East Bus) and Main Bus 2 (West Bus), in a breaker and a half configuration. The West Bus supplies the Unit 1 Startup Transformer, 100-PY-B, while the East Bus supplies the Unit 2 Startup Transformer, 200-PY-B. The emergency buses are fed from these two transformers, through buses L10 and L20, and interbus transformers LH-1-A and LH-2-A. Buses L10 and L20 can both be

powered from either startup transformer, while interbus transformer LH-1-A is powered by L10 and LH-2-A is powered by L20. The emergency buses EH11, EH12, and EH13 are then powered by either LH-1-A or LH-2-A. Under normal configurations one emergency bus will be powered by one interbus transformer while the remaining two emergency buses will be powered by the other interbus transformer; however, the specific configuration can vary.

PNPP selected the open phase detection system designed and manufactured by Power System Sentinel Technologies, LLC, (PSSTech) as the design vendor for the OPC system. The Open Phase Protection System (OPPS) was designed to protect the offsite power sources from a loss of phase condition. An OPPS cabinet was installed at each of the startup transformers, 151150002 and 251150002. New detection equipment was added at each of the startup transformers to monitor for an OPC present on the high side (345kV) phases. For each startup transformer, an OPPS cabinet alarm/trouble output was connected in parallel to its respective local transformer control panel annunciator. The annunciator at the local transformer control panel provided transform's generic trouble annunciation in the control room.

On November 27, 2019 Perry communicated to the NRC via docketed letter L-19-214 that PNPP intends to use a probabilistic risk assessment risk-informed evaluation to implement the OPPS via alarms and operator response vice having the system automatically trip the offsite sources. This is in accordance with NEI 19-02, Rev 0, "Guidance for Assessing Open Phase Condition Implementation Using Risk Insights". It was determined that the existing annunciator design utilizing the generic startup transformer trouble alarms did not allow for an expeditious operator response due to the need to dispatch a non-licensed operator outside to the associated startup transformer and the OPPS unit to determine the specific cause of the alarm. It was determined that without a more direct method of alerting control room operators of an OPC, the risk analysis would not meet the threshold specified in NEI 19-02. The licensee performed a modification and added a direct OPC alarm in Unit 1 Control Room from both startup transformers.

During the site visit, the inspectors observed that the PSSTechs panels were in the "Normal" mode of operation monitoring and would alarm the control room if a loss of one- or two-phase conditions is detected.

## INSPECTION RESULTS

Observation: Temporary Instruction 2515/194-03.01 Voluntary Industry Initiative	2515/194
Based on discussions with Perry staff, review of design and testing documentation, and walkdowns of installed equipment, the inspectors had reasonable assurance that Perry is appropriately implementing, with noted exceptions discussed below, the voluntary industry initiative at PNPP. The inspectors verified the following criteria:	
<u>Detection, Alarms and General Criteria</u>	
<ol style="list-style-type: none"> <li>1. [03.01(a)(1)] OPCs are detected and alarmed in the control room.</li> <li>2. [03.01(a)(2)] Detection circuits are sensitive enough to identify an OPC for credited loaded conditions (i.e. high and low loading).</li> <li>3. [03.01(a)(4)] No Class 1E circuits were being replaced with non-Class 1E circuits in this design.</li> </ol>	

4. [03.01(a)(5)] The Final Safety Analysis Report was updated to discuss the design features and analyses related to the effects of any OPC design vulnerability.
5. [03.01(a)(6)] The OPC detection and alarm components are maintained in accordance with Perry's procedures or maintenance program, and periodic tests, calibrations setpoint verifications or inspections (as applicable) have been established.

Use of Risk-Informed Evaluation Method

1. [03.01(c)(1)] The plant configuration matched the changes made to the probabilistic risk assessment model to address an OPC, and the logic of the probabilistic risk assessment model changes is sound. Two exceptions were noted by the inspectors and documented in separate observations.
2. [03.01(c)(2)] The procedures which validate that the OPC alarm would identify the proper indication to validate the OPCs at all possible locations.
3. [03.01(c)(3)] Observations associated with procedure(s) and operator actions required to respond to an OPC alarm and potential equipment trip match the Human Reliability Analysis.
4. [03.01(c)(4)] Assumptions listed in the NEI 19-02 Appendix A evaluation and the sensitivity analyses listed in Section 5 of the evaluation were verified.
5. [03.01(c)(5)] Assumptions, procedures, operator actions and Perry's analyses specified above are consistent with the plant-specific design and licensing basis, including:
  - a. Initiating events considered in the analysis;
  - b. Boundary conditions specified in Attachment 1 of the NEI Voluntary Industry Initiative, Revision 3; and
  - c. Operating procedures for steps taken to recover equipment assumed tripped/locked out or damaged due to the OPCs (or use of alternate equipment).

Observation: Use of Risk-Informed Evaluation Method Exceptions	2515/194
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Use of Risk-Informed Evaluation Method

[03.01(c)(1)] The plant configuration matched the changes made to the probabilistic risk assessment model to address an OPC, and the logic of the probabilistic risk assessment model changes is sound.

Exception 1:

Perry's NEI 19-02 evaluation assumed an OPC initiating event frequency and probability to be 5.43E-03/yr based on accepted industry data per guidance in NEI 19-02, Section 4.2. However, Perry, in their analysis, modified this frequency and divided by two and was applied equally to the two startup transformers. An OPC on the Unit 1 Startup Transformer 1S11S0002 is modeled with the initiating event IE-OPC-U1, while an OPC on the Unit 2 Startup Transformer 1S11S0002 is modeled with the initiating event IE-OPC-U2. Both initiating events were assumed to have a frequency of 2.715E-03/yr.

This methodology was previously identified during inspection at other plants, based on previous discussions between the NRC inspectors and the NRC subject matter expert staff at Headquarter and what was documented in the inspection reports for these plants, the inspectors concluded that this methodology used at Perry was not consistent with the guidance and methods described in NEI 19-02. This may affect the assessment of the

change in risk as measured by delta core damage frequency (CDF) and delta large early release frequency (LERF) and other related results.

Inspector review and assessment of Perry's NEI 19-02 analysis PRA-PY1-19-019, Revision 1, Section 6 results and sensitivity studies indicated that using initiating frequency of  $5.43\text{E-}03/\text{yr}$ , delta CDF would change from  $1.02\text{E-}6/\text{yr}$  to  $2.06\text{E-}06/\text{yr}$  and delta LERF results would change from  $1.65\text{E-}7/\text{yr}$  to  $3.41\text{E-}7/\text{yr}$ , and that the CDF ceiling criteria would still be met ( $<1\text{E-}5/\text{yr}$ ) even if the current results were doubled. This issue was documented in CR 2021-03627.

Exception 2:

During the inspection and based on inspectors' question, an error was identified that the PRA modeling during specific plant alignments did not correctly reflect the impact of OPPS contacts that prevented the fast bus transfer during an OPC. Specifically, for normal alignment of safety buses shared between L10 and L20, with an open phase on either startup transformer, the condition will not result in an automatic or manual plant trip without random failures. The operator is directed by procedure to isolate either L10 or L20 and restore the plant to a safe condition. However, the PRA model had incorrectly allowed a fast bus transfer to logically occur following operator isolation of either L10 or L20 thus inappropriately restoring power. This issue was documented in CR 2021-03404.

## **EXIT MEETINGS AND DEBRIEFS**

The inspectors verified no proprietary information was retained or documented in this report.

- On April 30, 2021, the inspectors presented the NRC Inspection of Temporary Instruction 2515/194, Inspection of the Licensee's Implementation of Industry Initiative Associated with the Open Phase Condition Design Vulnerabilities in Electric Power Systems (NRC Bulletin 2012-01) – Inspection results to Rod L. Penfield, Site Vice President, Nuclear and other members of the licensee staff.



## DOCUMENTS REVIEWED

Inspection Procedure	Type	Designation	Description or Title	Revision or Date
2515/194	Corrective Action Documents	CR-2021-00345	PM Revision for Open Phase Panel Maintenance Processed Incorrectly	01/20/2021
	Corrective Action Documents Resulting from Inspection	CR 2021-03404	Error in PRA Assessment PRA-PY1-019-R01 Regarding Open Phase System PRA Modeling	04/28/2021
		CR-2021-03627	NRC Questions' Assumption in PRA Assessment PRA-PY1-019-R01 Regarding Open Phase Initiating Event Frequency	05/04/2021
	Drawings	206-0010-00000	Main One Line Diagram 13.8KV and 4.16KV	FF
		208-0206-00006	13.8KV Bus L10 Startup Alternate Supply Breaker L1004	T
		208-0220-00042	Startup Transformer 100-PY-B	0
	Engineering Changes	19-0203-001	Dedicated Open Phase Control Room Annunciators	0
		ECP 15-0057	Design and Installation of Open Phase Protection Systems for Unit 1 and 2 Startup Transformers	4
		ECP 15-0057-001	Design and Installation of Open Phase Protection System for Unit 1 and 2 Startup Transformers	4
	Engineering Evaluations	PRA-PY1-19-019	Risk Evaluation for Manual Response to an Open Phase Condition	1
	Procedures	AR1-S11-S002-0001	Startup Transformer 100-PY-B (Unit 1)	13
		ARI-H13-P870-0001	Aux and Startup Power	20
		SOI-S11	Power Transformers	26
	Self-Assessments	CA-SA-PY-2021-0001	Perry 2021 Pre-NRC Open Phase Inspection	02/04/2021