UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, ILLINOIS 60532-4352

September 2, 2021

Mr. David Rhoades
Senior VP, Exelon Generation Company, LLC
President and CNO, Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: CLINTON POWER STATION – 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) REPORT 05000461/2021013

Dear Mr. Rhoades:

On July 16, 2021, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at Clinton Power Station. On July 21, 2021, the NRC inspectors discussed the results of this inspection with Mr. T. Chalmers, Site Vice President 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,

Richard A. Skokowski Signed by Skokowski, Richard on 09/02/21

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

Docket No. 05000461
License No. NPF-62

Enclosure:
As stated

cc w/ encl: Distribution via LISTSERV®

Letter to David Rhoades from Richard A. Skokowski dated September 2, 2021.

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U.S. NUCLEAR REGULATORY COMMISSION
Inspection Report

Docket Number:	05000461
License Number:	NPF-62
Report Number:	05000461/2021013
Enterprise Identifier:	I-2021-013-0007
Licensee:	Exelon Generation Company, LLC
Facility:	Clinton Power Station
Location:	Clinton, IL
Inspection Dates:	May 24, 2021 to May 28, 2021
Inspectors:	I. Hafeez, Reactor Inspector L. Kozak, Senior Reactor Analyst
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 an 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) at Clinton Power Station, 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. Starting on March 20, 2020, in response to the National Emergency declared by the President of the United States on the public health risks of the coronavirus (COVID-19), inspectors were directed to begin telework. In addition, regional baseline inspections were evaluated to determine if all or a portion of the objectives and requirements stated in the IP could be performed remotely. If the inspections could be performed remotely, they were conducted per the applicable IP. In some cases, portions of an IP were completed remotely and on site. The inspections documented below met the objectives and requirements for completion of the IP.

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)

This inspection was conducted using Temporary Instruction 2515/194 (ADAMS Accession No. ML20230A328), dated August 18, 2020. The inspectors reviewed the licensee's implementation of Nuclear Energy Institute voluntary industry initiative in compliance with Commission guidance. The inspectors discussed the impacts of open phase conditions on the licensee's electrical system design, the ability to detect and alarm open phase conditions 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 local and in the control room, and analyzed potential impacts associated with the design implementation on the current licensing basis. The inspectors also reviewed licensee analysis and calculations, and performed distribution system and switchyard equipment walkdowns.

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. ML19163A176), dated June 6, 2019, including updating their licensing basis to reflect the need to protect against open phase conditions. For sites that are implementing the risk-informed evaluation method to demonstrate that operator manual actions will be sufficient to mitigate the impact of an OPC, in lieu of TI Section 03.01.b (automatic protective actions), TI Section 03.01.c will be performed.

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) Clinton Power Station has Installed Schweitzer Engineering Laboratories (SEL) 451-5 microprocessor based relays for the Open Phase Condition (OPC) Relays which are located on the high voltage side (345kV) of Reserve Auxiliary Transformers (RAT) and (138kV) Emergency Reserve Auxiliary Transformer (ERAT) to the appropriate 4 kV safety related buses that are maintained in a split bus configuration lineup. The relay schemes monitor and compare the positive, negative and zero sequence current input from existing Current Transformers (CT's). The OPC relays monitors/detect an open phase condition, which is defined as one or two phases, with or without a ground for the OPC or low load conditions. The relay algorithm/scheme and associated setpoint calculations were developed by the licensee to detect the loss of phase on the preferred offsite source for the engineered safety feature buses. If an open or loss of phase is detected the relays actuate contacts which, in turn, provides an alarm in the Main Control Room (MCR).

In lieu of automatic open phase protective actions, Exelon implemented an alarm only strategy that relies on proper operator actions to diagnose and respond to an open phase condition. At the end of this inspection the SEL relays were monitoring the associated power sources and would provide main control room annunciation if a loss of one- or two-phase conditions was detected or if a relay was non-functional.

INSPECTION RESULTS

Observation: Temporary Instruction 2515/194-03.01 Voluntary Industry Initiative	2515/194

Based on discussions with Clinton staff, review of design and testing documentation, and walkdowns of installed equipment, the inspectors had reasonable assurance that Clinton is appropriately implementing, with a noted exceptions discussed below, the voluntary industry initiative at Clinton Power Station. The inspectors verified the following criteria:

(1) [03.01(a)(1)] Open phase conditions are detected and will be alarmed in the Main Control Room (MCR) common annunciator panel.

(2) [03.01(a)(2)] Detection circuits are sensitive enough to identify an OPC for credited loading conditions (i.e., high and low loading). See next section for inspector identified exceptions.

(3) [03.01(a)(3)] The open phase condition design and protective schemes minimize misoperation or spurious action in the range of voltage unbalance normally expected in the transmission system that could cause separation from an operable off-site power source. Additionally, Exelon has demonstrated that the actuation circuit design does not result in lower overall plant operation reliability.

(4) [03.01(a)(4)] No Class-1E circuits were replaced with non-Class-1E circuits in this design.

(5) [03.01(a)(5)] The Updated Final Safety Analysis Report was updated to discuss the design features and analyses related to the effects of any OPC design vulnerability.

(6) [03.01(a)(6)] Identify if Open Phase Isolation System (OPIS) detection and alarm components are maintained in accordance with station procedures or maintenance program, and that periodic tests, calibrations, setpoint verifications, or inspections (as applicable) have been established. See next section for inspector identified

exceptions.

Use of Risk-Informed Evaluation Method

(1) [03.01(c)(1)] Review licensee's evaluation of NEI 19-02 and Attachment 1 of VII, Revision 3 stated above. Verify that the plant configuration matches the changes made to the PRA model used to evaluate an OPC, and that the logic of the PRA model changes is sound. Consult with regional Senior Reactor Analyst (SRA) if inspectors have any questions or concerns regarding the PRA model. See next section for inspector identified exceptions.

(2) [03.01(c)(2)] Review the procedure(s) and operator actions required to respond to an OPC alarm and potential equipment trip, with an operator walkthrough and simulator demonstration if possible (during the walkthrough, verify that the procedure which validates that the OPC alarm is legitimate would identify the proper indication to validate the OPCs at all possible locations). See next section for inspector identified exceptions.

(3) [03.01(c)(3)] Observations associated with procedures and operator actions required to respond to an OPC alarm and potential equipment trip match the Human Reliability Analysis (HRA).

(4) [03.01(c)(4)] Sensitivity analyses used in the Clinton PRA analysis for using Operator Manual Actions (OMAs) in leu of OPC automatic protective relay actuation, did not exceed the thresholds defined in the NEI 19-02 guidance document for delta Core Damage Frequency (CDF) or delta Large Early Release Frequency (LERF).

(5) [03.01(c)(5)] Assumptions, procedures, and operator actions specified in the Clinton NEI 19-02 analysis 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.
(c) Operating procedures for steps taken to recover equipment assumed tripped, locked out, or damaged due to an OPC.
(d) Where recovery was assumed in the PRA analysis for tripped electric equipment, restoration of the equipment was based on analyses that demonstrate that automatic isolation trips did not result in equipment damage.

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

[03.01(a)(2)] – Detection circuits are sensitive enough to identify an OPC for credited loading conditions (i.e., high and low loading).

Exception – Based on review of the licensee's calculation for the relay setting limits used in the Open Phase Condition algorithms in some scenarios where automatic detection may not be possible due to very low or no load conditions, or when transformers are in a standby mode. Specifically, an OPC is detected as long as the primary positive sequence current in the RAT and ERAT is greater than the MINLOAD (low load) based on relay sensitivity. The RATs are normally loaded above the MINLOAD threshold and automatic detection will occur as soon as loads are transferred to the standby source. Additionally, where automatic

detection is not reliable, Exelon has established monitoring requirements on a per shift basis, to look for evidence of an open phase condition. During low loading of the RATs or open phase detection (OPD) relay trouble alarms, manual actions may be required to address the existence of an OPC condition.

[03.01(a)(6)] – Identify if Open Phase Isolation System (OPIS) detection and alarm components are maintained in accordance with station procedures or maintenance program, and that periodic tests, calibrations, setpoint verifications, or inspections (as applicable) have been established.

Exception – Clinton has not developed any maintenance PMs for the OPC relays. At the time of this inspection, the licensee had not established a functional test schedule, which includes testing the relay metering function (sensing circuit is continuous) and verifying relay settings against calculated values. The licensee had not established a periodic setpoint calibrations testing schedule to verify relay performance is within tolerances assumed within supporting analyses.

[03.01(c)(1)] – Review licensee's evaluation of NEI 19-02 and Attachment 1 of VII, Revision 3 stated above. Verify that the plant configuration matches the changes made to the PRA model used to evaluate an OPC, and that the logic of the PRA model changes is sound. Consult with regional Senior Reactor Analyst (SRA) if inspectors have any questions or concerns regarding the PRA model.

Exception – The plant configuration did not match the Probabilistic Risk Assessment (PRA) model. The PRA model used an alarm associated with the static var compensator (SVC) and not the OPIS to detect an OPC and prompt operator action. However, the SVC and its associated alarm were being removed from service. The SVC alarm was more distinct than the OPIS alarm, which was a common computer point with multiple inputs. In addition, the SVC alarm was large, red in color, and had an associated "hard card" that was well trained on. The differences between the SVC alarm and the OPIS computer alarm as the cue for operator action would lead to some differences in the PRA model and associated human reliability analysis. However, the NRC concluded the difference was not likely to impact the overall outcome of the evaluation. The licensee intended to update the risk evaluation to match the plant configuration for OPC detection in the future.

[03.01(c)(2)] – Review the procedure(s) and operator actions required to respond to an OPC alarm and potential equipment trip, with an operator walkthrough and simulator demonstration if possible (during the walkthrough, verify that the procedure which validates that the OPC alarm is legitimate would identify the proper indication to validate the OPCs at all possible locations).

Exception – The procedures which validate that an OPC alarm would identify the proper voltage indication to validate the OPC at all ESF buses. The inspectors discussed this potential outcome with the licensee and the licensee agreed that the current design analysis did not specifically address ESF bus voltage with and without SVC on. Additionally, the licensee initiated IR 04425627, "Action Tracking for 2021 NRC Open Phase Inspection," to address weaknesses identified in alarm response procedures. The inspector noted that various alarm response procedures did not provide Operations personnel instructions for the cases where the OPC condition might exist in conjunction with low loading of the RATs or open phase detection (OPD) relay trouble alarms.

EXIT MEETINGS AND DEBRIEFS

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

- On July 21, 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) results to Mr. T. Chalmers, Site Vice President and other members of the licensee staff.

DOCUMENTS REVIEWED

Inspection Procedure	Type	Designation	Description or Title	Revision or Date
2515/194	Calculations	CL-MISC-029	PRA Application Notebook Clinton Power Station Open Phase Condition Evaluation	0
	Drawings	E02-1AP01	Single Line Diagram Part 1 Clinton Power Station Unit 1 Clinton, Illinois	AE
		E02-1AP03	Electric Loading Diagram Clinton Power Station Unit 1 Clinton, Illinois	AD
		E02-1AP12	Relaying & Metering Diagram Reserve Auxiliary Transf. B Clinton Power Station Unit 1 Clinton, Illinois	T
		E02-1AP99	Reserve Aux Transformer B Auxiliary Protective Relay Clinton Power Station Unit 1 Clinton, Illinois	B
	Engineering Changes	EC-394754/394755	ERAT and RATB Open Phase Detection LOCA Analysis	0
	Miscellaneous	11335-293,349	Clinton Power Station Loss of Phase Detection Relay Monitoring Final Report for October 2017 - September 2018	05/24/2021
	Procedures	CPS3501.01H001	Loss of RAT SVC Actions Hard Card	0c
		CPS3503.01C006	ERAT Open Phase Checklist	03/24/2016
		CPS3505.01C007	RAT B Open Phase Checklist	04/13/2017
		CPS5009.03	Alarm Panel 5009 Annunciators - ROW 3	04/09/2020
		CPS5010.04	Alarm Panel 5010 Annunciators - ROW 4	12/10/2017
		CPS5011.08	Alarm Panel 5011 Annunciators - ROW 8	04/09/2020