UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE ROAD, SUITE 210
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January 13, 2020

Mr. Bryan C. Hanson
Senior VP, Exelon Generation Co., LLC
President and CNO, Exelon Nuclear
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3 – 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 REPORT 05000237/2019011 AND 05000249/2019011

Dear Mr. Hanson:

On December 6, 2019, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at Dresden Nuclear Power Station, Units 2 and 3 and discussed the results of this inspection with Mr. Roger Bauman 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/

Robert C. Daley, Chief
Engineering Branch 3
Division of Reactor Safety

Docket Nos. 05000237 and 05000249
License Nos. DPR-19 and DPR-25

Enclosure:
As stated

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Letter to Bryan C. Hanson from Robert C. Daley dated January 13, 2020.

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U.S. NUCLEAR REGULATORY COMMISSION
Inspection Report

Docket Numbers:	05000237 and 05000249
License Numbers:	DPR-19 and DPR-25
Report Numbers:	05000237/2019011 and 05000249/2019011
Enterprise Identifier:	I-2019-011-0050
Licensee:	Exelon Generation Company, LLC
Facility:	Dresden Nuclear Power Station, Units 2 and 3
Location:	Morris, IL
Inspection Dates:	December 02, 2019 to December 06, 2019
Inspector:	I. Hafeez, Reactor Inspector
Approved By:	Robert C. Daley, 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 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 at Dresden Nuclear Power Station, Units 2 and 3, 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 inspector 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.

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) 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 open phase conditions.

Dresden Nuclear Power Station selected Schweitzer Engineering Laboratories (SEL) 451-5 microprocessor based relays for the OPC Relays which are located on the high voltage side of the following transformers (TR): on Unit 2, TR 86 (345-kV to 138-kV) which feeds Reserve Auxiliary Transformers (RATs) 22 (138-kV to 4-kV) & on Unit 3,

RAT 32 (345-kV to 4-kV). The OPC relay schemes monitor and compare the positive, negative and zero sequence current input from existing Current Transformers (CT's). The OPC relays monitors/detects 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 and initiate actions to separate that source from the onsite distribution through the existing RAT 22 or RAT 32 respective lockout relays (If an OPC is detected on TR 86, a signal is transmitted to RAT 22 OPC relay via a fiber optic communication link. The OPC relay for RAT 22 then trips the RAT 22 lockout). The relay scheme also employs a time delay to filter out short duration transients and to coordinate with other switchyard protective features. The short time delay (0.7 seconds) ensures that the system only responds to valid, persistent open phase conditions. Unit 2 completed the transition to active mode in November of 2019. The licensee has scheduled U3 transition from monitoring mode to active mode in December 2019.

INSPECTION RESULTS

Observation: Protective Actions Criteria	2515/194

(1) OPC's that are detected will be alarmed in the Main Control Room (MCR) common annunciator panel.

(2) See item 2 in table titled "Detection, Alarms, and General Criteria Exceptions" for inspector identified exceptions

(3) The licensee's design document, test results and analysis showed that the short time delay (a time delay of 0.7 seconds was selected for the OPC relays to coordinate with the fault clearing time of 345-kV switchyard primary and zone 2 relays) used in the open phase condition design/protective scheme is expected to minimize misoperation or spurious trips in the range of voltage unbalances normally expected in the transmission system. The analysis also showed that the time delay properly coordinates with switchyard fault assumptions. Based on this, the inspector had reasonable assurance that the actuation circuit design would not result in lower overall plant operation reliability.

(4) No Class-1E circuits were being replaced with non-Class 1E circuits in the design.

(5) The licensee revised Dresden Updated Final Safety Analysis Report (UFRSAR), Section 8.3.1.3.2., "Auxiliary Power Connections to the Switchyards" and added "The RAT's and TR 86 have protective relaying and includes phase and ground overcurrent, current differential, sudden pressure, and open phase detection." The change was incorporated into Updated Final Safety Analysis Report, Revision 11.

See item 5 in table titled "Detection, Alarms, and General Criteria Exceptions" for inspector identified exceptions.

Observation: Detection, Alarms, and General Criteria	2515/194

(1) Dresden Station has determined that OPCs are credible events and have implemented design changes to mitigate the effects. EC 388778 and EC 388779 have installed an open phase relay scheme to detect, alarm and protect from open phase conditions.

(2) The inspector determined that with an open phase condition present and no accident condition signal, the OPC protection relay system would not adversely affect the function of important-to-safety systems, structures and components when the trip function is active.

As per the design description, the OPC relays will trip the Reserve Auxiliary Transformer (RAT) lockout relays after a 0.7 second time delay. The RAT lockout relays would isolate the RAT by opening both primary and secondary side breakers. After the RAT isolates, an automatic fast transfer connects the safety-related buses fed by the RAT to the Unit Auxiliary Transformer (UAT). The licensee's analysis verified that the OPC relays can detect and isolate an OPC prior to any motor damage. The algorithm time delay limits the motor's exposure to negative sequence current which helps prevent excessive motor heating.

See item 2 in table titled "Protective Actions Criteria Exceptions" for inspector identified exceptions.

(3) See item 3 in table titled "Protective Actions Criteria Exceptions" for inspector identified exceptions.

(4) No surveillance requirements for the SEL 451-5 were added to the plant Technical Specifications.

See item 4 in table titled "Protective Actions Criteria Exceptions" for inspector identified exceptions.

Observation: Detection, Alarms, and General Criteria Exceptions	2515/194

(2) Based on review of the licensee's calculation for the relay setting limits used in the Open Phase Condition algorithms, the inspector determined that the OPC relay detection circuits are sensitive enough to identify an OPC. Specifically, an OPC is detected as long as the primary positive sequence current in the TR 86/RAT22 &32 is greater than the MINLOAD (low load) (alarm setting Load approximately 3.07/0.70/ 2.66MVA based on relay sensitivity). The RATs are normally loaded above the MINLOAD threshold.

(5) While the change was incorporated into UFSAR as a trip to the RAT lockout relays, the revision did not reference any design analysis, discuss design features, discuss theory of operation for the OPC system, or list major components associated with the open phase condition equipment in detail. However, the licensee concluded that the level of detail provided in the UFSAR for the open phase condition protection was consistent with the level of detail provided for other non-safety conditions that provide an input to the associated transformer lockout relay trips.

Observation: Protective Actions Criteria Exceptions	2515/194

(2) During low loading of the RAT or open phase detection (OPD) relay trouble alarms, manual actions may be required to address the existence of an OPC condition. The inspector discussed the potential need for manual actions with the licensee and the licensee agreed that the current procedures did not specifically address implementation of protective actions if manual actions were required. The lack of guidance for system response when manual actions are needed, and weaknesses identified in alarm response procedures was captured in AR 04301869, "NRC OPC Inspection Improvement Identified."

(3) The following information was aggregated from engineering analyses, training materials and conversations with licensee staff as a detailed description of the system operation and performance was not located within the UFSAR.

The following description presumes that the RAT transformer is loaded above the low load alarm point. For the case where an OPC occurs and an accident condition (LOCA) signal are present simultaneously, the accident signal causes the diesel generators to start. Additionally, the accident signal will start the ESF loads. The fist start attempt will place the ESF loads onto the transformer with the missing phase. The ESF load start attempt is initiated because the open phase detection (OPD) to RAT lockout actuation takes 0.8 seconds to execute. The RAT lockout relays would isolate the RAT by opening both primary and secondary side breakers. After the RAT isolates, with an accident signal present, the analysis showed the safety-related undervoltage relaying scheme would separate the engineered safety feature busses from the RAT. Subsequently, the Emergency Diesel Generator (EDG) associated with each Engineered Safety Feature (ESF) bus would automatically connect to the ESF bus and allow the ESF loads to be powered from the EDG.

(4) At the time of this inspection, the licensee had established a functional test schedule which includes testing the relay metering function and verifying relay settings against calculated values. The licensee had not established a periodic setpoint calibration testing schedule to verify relay performance is within tolerances assumed within supporting analyses. These activities were captured in Condition Record AR04301993 to identify Procedure Enhancements related to testing relay setpoints.

EXIT MEETINGS AND DEBRIEFS

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

- On December 6, 2019, the inspector presented the 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 results to Mr. Roger Bauman and other members of the licensee staff.

DOCUMENTS REVIEWED

Inspection Procedure	Type	Designation	Description or Title	Revision or Date
2515/194	Calculations	DRE12-0031	Unit 3 Loss of Phase Detection Relay Settings	02
		DRE12-0032	Unit 2 Loss of Phase Detection Relay Settings	02
		DRE12-0059	Dresden Unit 3 Offsite Power System Open Phase EMTP Evaluation	A
		DRE12-0060	Dresden Unit 2 Offsite Power System Open Phase EMTP Evaluation	A
		DRE14-0004	Dresden Unit 3 Open Phase Detection LOCA Analysis	001
		DRE14-0005	Dresden Unit 2 Open Phase Detection LOCA Analysis	001
		DRE16-0009	Dresden Unit 2 & 3 Backfeed Open Phase EMPT Evaluation	000
	Corrective Action Documents Resulting from Inspection	AR 04301869	NRC OPC Inspection Improvement Identified	12/05/2019
		AR 04301885	NRC OPC Inspection: Enhance 12E-2958 Contact Descriptions	12/05/2019
		AR 04301993	NRC OPC Inspection: Enhance Testing Procedures	12/06/2019
		AR 04302035	NRC OPC Inspection: Calculation Clarification	12/06/2019
	Drawings	12E-2301	Single Line Diagram Main Power Transformer Generator UAT 21, RAT 22	AS
		12E-2302A	Station Key Diagram 4160V and 480V Switchgears 480V MCCS	Y
		12E-2333	Relay & Metering Diagram Reserve Auxiliary Transformer 22 & 4160V Switchgear 23 & 24	T
		12E-2339	Schematic Diagram Reserve Auxiliary Transformer 22 Tripping Relays	Y
		12E-2342	Schematic Diagram 4160V Bus 23 Main and Reserve Feed G.C.B.'S	AF
		12E-2368	Schematic Diagram Circulating Water Pumps & Discharge Valves	N
		12E-2391	Schematic Diagram Service Water Pumps & Strainers	Q
		12E-2430	Schematic Diagram Core Spray System 1	BU
		12E-2575BQ	Schematic Diagram Control Room Annunciator Panel 902-8 Part 5 of 6	M
		12E-2583	Window Engraving Main Control Room Annunciator Panels 902-7, 902-8, 923-2 &923-5	CC

Inspection Procedure	Type	Designation	Description or Title	Revision or Date
		12E-2958	Schematic Diagram Reserve Auxiliary Transformer 32 Tripping Relays	W
		12E-3301	Single Line Diagram	AQ
		12E-3333	Relaying & Metering Diagram Reserve Auxiliary Transformers 32 and 4160V Switchgears 33 & 34	N
		12E-6652B	Schematic Diagram Tripping Connection For 100MVA 345/238KV Transformer 86(2-8600-86)	2
		12E-710	Schematic Diagram 138KV Differential Tripping	T
		12E-9B	One Line Relay & Instrument Diagram For 138KV Bus Sheet 3	B
	Engineering Changes	EC 388778	RAT TR32 Open Phase Detection Protective Circuit Installation	06
		EC 388779;	RAT TR22/TR86 Open Phase Protective Relay Circuit Installation;	08
	Procedures	DAN 902(3)-8 E-2	RES AUX TR 22 Trip Alarm	15
		DAN 902-8 G-10	RES AUX TR22/TR86 Low Load/Trouble Alarm	01
		DAN 903-8 E-4	RES AUX TR32 Open Phase Alarm	6
		DAN 923-2 C-5	Actuation of applicable Breaker Auxiliary 52 Contacts	10
		DOA 6500-12	Low Switchyard Voltage	29
		DOP 6400-10	Removing/Restoring Transformer 22(32) For Outage Maintenance	17
		MA-DR-773-232	Dresden Reserve Auxliary Transformer 22 and Transformer 86 Relay Routine	16
		MA-DR-773-233	Dresden Reserve Auxliary Transformer 32 Control Circuit Checks	16
	Work Orders	01897976	D2 RFL Com Cal Reserve Aux TR22 Relays/Meters	07/12/2017
		04578673	D3 RFL Com Test RAT32 Relays/Meters	03/13/2018