



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**  
REGION I  
2100 RENAISSANCE BOULEVARD, SUITE 100  
KING OF PRUSSIA, PENNSYLVANIA 19406-2713

April 8, 2020

Mr. Eric Carr  
President and Chief Nuclear Officer  
PSEG Nuclear, LLC  
P. O. Box 236  
Hancock's Bridge, NJ 08038

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2 – REISSUED  
TEMPORARY INSTRUCTION 2515/194 REPORT 05000272/2020010 AND  
05000311/2020010

Dear Mr. Carr:

The U.S. Nuclear Regulatory Commission (NRC) identified two technical corrections in NRC Temporary Instruction 2515/194 Inspection Report 05000272/2020010 and 05000311/2020010, dated March 20, 2020, (ADAMS Accession No. ML20077L169). The switchyard inter-tie breaker between the Salem and Hope Creek switchyards described in the description of the plant electrical distribution system is a normally closed breaker versus a normally open breaker as described in the original issue of this report. In addition, the 500 kV Open Phase Protection system installed in the Salem switchyard has no active trip feature installed, and operates in alarm and detection mode only. The description of this feature was also corrected in the electrical distribution system of the report. As a result of these two corrections, this report is being re-issued in its entirety. Neither of these corrections has any effect on the assessment outcomes described in the original report, or this reissued report.

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,

X /RA/

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Signed by: Glenn T. Dentel  
Glenn T. Dentel, Chief  
Engineering Branch 2  
Division of Reactor Safety

E. Carr

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Docket Nos. 05000272 and 05000311  
License Nos. DPR-70 and DPR-75

Enclosure:  
As stated

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SUBJECT: SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2 – REISSUED  
 TEMPORARY INSTRUCTION 2515/194 REPORT 05000272/2020010 AND  
 05000311/2020010 DATED APRIL 8, 2020

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

Docket Numbers: 05000272 and 05000311

License Numbers: DPR-70 and DPR-75

Report Numbers: 05000272/2020010 and 05000311/2020010

Enterprise Identifier: I-2020-010-0011

Licensee: PSEG Nuclear, LLC

Facility: Salem Nuclear Generating Station, Units 1 and 2

Location: Hancock's Bridge, NJ 08038

Inspection Dates: March 2, 2020 to March 5, 2020

Inspectors: C. Hobbs, Reactor Inspector  
J. Patel, Senior Resident Inspector

Approved By: Glenn T. Dentel, Chief  
Engineering Branch 2  
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 at Salem Nuclear Generating Station, Units 1 and 2, 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 inspectors reviewed the licensee's implementation of the "Nuclear Energy Institute Voluntary Industry Initiative," (ADAMS Accession No. ML15075A454) dated March 16, 2015. This included reviewing how the licensee updated their licensing basis to reflect the need to protect against open phase conditions.

### 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) Salem Unit 1 and Unit 2 electrical power distribution system is divided into three voltage levels: 500 kV, 13 kV, and 4kV. The offsite electrical power system consists of the 500 kV and 13 kV voltage levels which are contained inside the Salem switchyard, while the onsite electrical power distribution system begins at the 4 kV voltage level, outside of the Salem switchyard. Electrical power enters the Salem switchyard at the 500 kV system which consists of a 500 kV ring bus with two separate offsite power transmission lines supplying power to different sections of the 500 kV ring bus. In addition, there is a third connection which is an inter-tie to the Hope Creek 500 kV switchyard that is normally closed. The 500 kV ring bus supplies power to four Station Power Transformers (SPTs) which step the voltage down to 13 kV. Normal configuration is SPT 1 and 2 supply 13 kV power to the North 13 kV Bus, while SPT 3 and 4 supply 13 kV power to the South 13 kV Bus. The North 13 kV Bus supplies power to SPTs 11, 12, 21, and 22 which step the voltage down to 4 kV. SPTs 11, 12, 21, and 22 supply alternate power to eight non-vital 4 kV buses called group buses. Salem Unit 1 group non-vital buses are supplied by SPTs 11 and 12, while Salem Unit 2 group non-vital buses are supplied by SPTs 21 and 22. The group buses are normally powered by Auxiliary Power Transformers (APTs) 1 and 2 which are powered from Salem Unit 1 main generator and Salem Unit 2 main generator when their respective reactors are at power. During a reactor trip, power to the non-vital 4 kV group buses will be automatically transferred to SPTs 11 and 12 for Salem Unit 1, and SPTs 21, and 22 for Salem Unit 2.

The South 13 kV Bus supplies power to SPTs 13, 14, 23, and 24. Each Salem unit has three vital 4kV buses that supply power to Engineered Safeguard Features (ESFs) 480 V loads. SPTs 13 and 14 supply power to Salem Unit 1, 4 kV vital buses,

while SPTs 23 and 24 supply power to Salem Unit 2, 4 kV vital buses. Normal configuration is to have one SPT carry the load for two 4 kV vital buses, while the other SPT carries the load for one 4 kV vital bus. In the event both SPTs are lost or degraded to a vital 4 kV bus, each 4 kV vital bus has its own respective standby diesel generator that will start and synchronize onto its respective 4 kV vital bus, automatically within 13 seconds. Only two vital 4 kV buses are required to shutdown an individual Salem unit. The third 4 kV vital bus on each Salem unit is for redundancy.

The Open Phase Protection (OPP) system utilized at Salem consists of a hybrid design with protection at both the 500 kV level and additional protection at the 13 kV level. At the 500 kV level, the OPP system utilizes the Power Systems Sentinel Technologies, LLC (PSSTech) design. This design consists of a neutral current injection method, in which a small neutral current is injected to the primary (high) side neutral bushing. Changes in the neutral impedance are then monitored to determine if an open phase condition exists. This method of protection is designed to work in both high and low transformer loading conditions. At Salem Nuclear Generating Station, each PSSTech system control cabinet contains single channel protection, with one Schweitzer Engineering Laboratories (SEL) protection relay. One PSSTech system control cabinet is installed at each of the four 500 kV transformers (SPTs 1, 2, 3, and 4) in the Salem switchyard. At the time of the inspection, the PSSTech system functions in alarm only mode, and has no automatic trip function.

At the 13 kV level, OPP is provided by SEL-751 multifunction negative sequence relays (59Q) that monitor vital 4 kV bus infeed through potential transformers. Eight relays total, four for each Salem Unit are installed. Each SPT feeding power to 4 kV vital buses, has two 59Q relays installed that utilize a two out of two coincidence logic to prevent spurious trips of the system. Relay settings have been adjusted to account for normal system grid imbalance. In the event an OPC is detected at the 13 kV level, the affected 4 kV bus will fast transfer to the alternate in-feed. This would be STPs 13 or 14 for Salem Unit 1, and SPTs 23 or 24 for Salem Unit 2. This would be accomplished by activation of the SPT lockout relay. At the time of the inspection, the SEL-751 relays were operating in alarm mode only, with the active trip feature disabled by opening knife switches located next to the relays.

## INSPECTION RESULTS

Detection, Alarms, General, and Protective Actions Criteria	2515/194
<p>Based on discussion with PSEG staff, review of design and testing documentation, and walkdowns of installed equipment, the inspectors had reasonable assurance that PSEG is appropriately implementing, with noted exceptions discussed below, the Voluntary Industry Initiative at Salem Nuclear Generating Station. The inspectors determined that:</p> <p>03.01(a)(1) Open Phase Conditions are detected and alarmed in the main control room for both Salem units.</p> <p>03.01(a)(2) Open Phase Condition detection circuits are sensitive enough to identify an OPC for all credited transformer loading conditions (high and low loading). In addition, enhanced monitoring criteria have been proceduralized for taking an OPP PSST panel out of service, as well as for non-functional SEL-751 relays.</p>	

03.01(a)(3) Open Phase Condition design schemes minimize misoperation and spurious operation in the range of voltage unbalance normally expected in the transmission system. Misoperation and spurious operation have been accounted for in calculation, implemented through protective relay settings, and utilization of coincidence logic at the 4 kV level for protection against OPC at the 13 kV level.

03.01(a)(4) No Class-1E circuits were replaced with non-Class-1E circuits during the implementation of the OPC modification.

03.01(a)(5) The Salem Unit 1 and Unit 2 UFSAR was updated to discuss the design features and protection schemes for the OPP system under UFSAR change notice 17-015.

03.01(b)(1) Salem Unit 1 and Unit 2 have determined that an OPC is a credible failure and have installed an Open Phase Protection system for both units.

03.01(b)(2) With an OPC occurrence and no accident condition signal present, an OPC will not adversely affect the function of important-to-safety SSCs. The OPP system at Salem Units 1 and 2 is designed to actuate an existing transformer lockout relay at the 13 kV level if the active trip feature of the system is enabled. The trip function, if enabled, would provide an additional input to the associated transformer lockout relays, however, the credited plant response is unaffected and will be the same regardless of the conditions that generated the lockout of the transformer.

No findings were identified.

Protective Actions Exceptions	2515/194
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03.01(b)(3) With an OPC occurrence and an accident condition signal present, the inspectors could not verify that automatic detection and actuation will transfer loads as required to mitigate postulated accidents to an alternate source and ensure safety functions are preserved. At the time of the inspection, the OPP system at Salem Units 1 and 2 was operating in alarm mode only with the active trip features of the system disabled. Alarm response procedures are in place to have operators manually transfer the 4 kV bus to the alternate in-feed if it is determined that an OPC exists. The OPP system was still in the 24 month monitoring period described in the Nuclear Energy Institute (NEI) Voluntary Industry Initiative (VII). The monitoring period is scheduled to end in December 2020, at which time the station will decide to enable active trip features of the system or adopt the risk informed operator manual action methodology described in NEI technical report 19-02. This exception was documented in NOTF 20846122.

03.01(b)(4) Periodic tests, calibrations, and setpoint verifications had not been established for the OPP system at the time of the inspection. This exception was identified in the station self-assessment conducted prior to the start of the inspection and documented in NOTFs 20845339 and 20846123.

## EXIT MEETINGS AND DEBRIEFS

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

- On March 5, 2020, the inspectors presented the Temporary Instruction 2515/194 results to Mr. David Sharbaugh, Plant Manager and other members of the licensee staff.



**DOCUMENTS REVIEWED**

Inspection Procedure	Type	Designation	Description or Title	Revision or Date	
2515/194	Calculations	ES-15.020	Salem Open Phase Protection Analysis	0	
		ES-15.022(Q)	Salem 1E Motor Operability Analysis for Unbalanced Loads	0	
	Corrective Action Documents	NOTFs 20825396, 20828253, 20828254, 2028256			
		NOTFs 20845339, 20846122, 20846123			
	Drawings	203000 S 8789-67	Salem Unit 1 & Unit 2 One Line Diagram - Generators & Main Transformers	67	
		203000-SIMP-3	Salem Unit 1 & Unit 2 One Line Diagram - Salem 500 kV - 4 kV Electrical Distribution	3	
		203002 A 8789-37	Salem Unit 1 One Line Diagram - 4160V Vital Buses	37	
		208625 S 1000-39	Salem Unit 1 & Unit 2 One Line Diagram - 500 kV Switchyard	39	
	Engineering Changes	SCN 17-015	Salem Units 1 & 2 UFSAR change notice for Open Phase Condition protection system	11/16/17	
	Engineering Evaluations	DCP 80119154	50.59 Review Salem Unit 1 Open Phase Protection	0	
		DCP 80119205	50.59 Review Salem Unit 2 Open Phase Protection	0	
	Procedures	S1.OP-DL.ZZ-0002(Q)	Salem Unit 1 Control Room Log Modes 5, 6, and Defueled	52	
		S1.OP-DL.ZZ-0003(Q)	Salem Unit 1 Control Room Log Modes 1 - 4	92	
		S1.OP-ST.500-0001(Q)	Salem Unit 1 - Electrical Power Systems AC Sources Alignment	16	
		S1.OP.AR.ZZ-0010(Q)	Salem Unit 1 - Alarm K-45 - Open Phase	47	
		S2.OP-AR.ZZ-	Salem Unit 2 - Alarm K-45 - Open Phase	36	

Inspection Procedure	Type	Designation	Description or Title	Revision or Date
		0010(Q)		
		S2.OP-DL.ZZ-0002(Q)	Salem Unit 2 Control Room Log - Modes 5, 6, and Defueled	50
		S2.OP-DL.ZZ-0003(Q)	Salem Unit 2 Control Room Log Modes 1 - 4	116
		S2.OP-ST.500-0001(Q)	Salem Unit 2 - Electrical Power Systems AC Sources Alignment	14
		SC.OP-DL.ZZ-007(Z)	Electrical Equipment Log	17