UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
245 PEACHTREE CENTER AVENUE NE, SUITE 1200
ATLANTA, GEORGIA 30303-1257

July 13, 2016

William R. Gideon
Site Vice President
Brunswick Steam Electric Plant
8470 River Rd. SE (M/C BNP001)
Southport, NC 28461

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT - NRC INSPECTION REPORT NO. 05000325/2016008

Dear Mr. Gideon:

On May 31, 2016, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at your Brunswick Steam Electric Plant, Unit 1. The purpose of the inspection was to review issues related to the February 7, 2016, Alert declaration and loss of offsite power (LOOP). On June 2, 2016, the NRC inspectors discussed the results of this inspection with Ms. Annette Pope and other members of your staff. Inspectors documented the results of this inspection in the enclosed inspection report.

The enclosed inspection report discusses a finding for which the NRC has not yet reached a preliminary significance determination. As described in Section 1R12 of the enclosed report, a finding was identified for the failure to have adequate procedures to perform maintenance on the startup auxiliary transformer (SAT) non-segregated bus duct and the 1B reactor recirculation pump (RRP) variable frequency drive (VFD) cables, which resulted in water intrusion in the SAT non-segregated bus duct, and faulted 1B RRP VFD cables. These two degraded conditions eventually led to an Alert declaration, SAT differential lockout, a Unit 1 manual SCRAM, and a LOOP. This issue was not an immediate safety concern because the emergency diesel generators started and loaded as expected, and in approximately three hours, offsite power was re-established through the unit auxiliary transformer backfeed to supply the safety-related buses. Within approximately five hours from the start of the event, the emergency declaration was terminated because offsite power was restored to the emergency buses. Additionally, the appropriate procedures will be revised.

The NRC will inform you in a separate correspondence when the preliminary significance has been determined. We intend to complete and issue our final safety significance determination within 90 days from the date of this letter. The NRC's significance determination process is designed to encourage an open dialogue between your staff and the NRC; however, the dialogue should not affect the timeliness of our final determination.

If you disagree with the finding not associated with a regulatory requirement in this report, you should provide a response within 30 days of the date of this inspection report, with the basis for your disagreement, to the Regional Administrator, Region II; and the NRC resident inspector at the Brunswick Steam Electric Plant.

In accordance with Title 10 of the *Code of Federal Regulations* 2.390, "Public Inspections, Exemptions, Requests for Withholding," of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records System (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

George T. Hopper, Chief
Reactor Projects Branch 4
Division of Reactor Projects

Docket No.: 50-325
License No.: DPR-71

Enclosure:
IR 05000325/2016008
w/Attachment: Supplemental Information

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If you disagree with the finding not associated with a regulatory requirement in this report, you should provide a response within 30 days of the date of this inspection report, with the basis for your disagreement, to the Regional Administrator, Region II; and the NRC resident inspector at the Brunswick Steam Electric Plant.

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ADAMS: ☒ Yes ACCESSION NUMBER: ML16195A012 ☒ SUNSI REVIEW COMPLETE ☒ FORM 665 ATTACHED

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Letter to William R. Gideon from George T. Hopper dated July 13, 2016

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT - NRC INSPECTION REPORT NO. 05000325/2016008

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REGION II

Docket Nos.:	50-325
License Nos.:	DPR-71
Report Nos.:	05000325/2016008
Licensee:	Duke Energy Progress, Inc.
Facility:	Brunswick Steam Electric Plant, Unit 1
Location:	8470 River Road, SE Southport, NC 28461
Dates:	February 7, 2016, through May 31, 2016
Inspectors:	M. Catts, Senior Resident Inspector M. Schwieg, Resident Inspector
Approved by:	George T. Hopper, Chief Reactor Projects Branch 4 Division of Reactor Projects

Enclosure

SUMMARY

IR 05000325/2016008; February 7, 2016, through May 31, 2016; Brunswick Steam Electric Plant, Unit 1; Maintenance Effectiveness.

This report covers approximately a four-month period of inspection by resident inspectors. One finding with pending significance was identified by the inspectors. The significance of inspection findings are indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, issued April 29, 2015, "Significance Determination Process." The cross-cutting aspect was determined using IMC 0310, "Components Within the Cross-Cutting Areas," dated December 4, 2014. The NRC's program for overseeing the safe operations of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 5.

Cornerstone: Initiating Events

- TBD. A self-revealing finding with two examples was identified for the licensee's failure to have adequate procedures to perform maintenance on the startup auxiliary transformer (SAT) non-segregated bus duct and the 1B Reactor Recirculation Pump (RRP) variable frequency drive (VFD) cables. The first example, from May 1997 to the present, procedure 0PM-NSB001, Inspection and Cleaning Non-Segregated Buses, did not contain sufficient information to ensure that deficiencies that could lead to water intrusion in the SAT non-segregated bus duct were identified and corrected. The second example, from October 2003 to June 20, 2016, procedure 0SPP-CBL011, Splicing of Wires and Cables Without Tape, failed to specify use of a depth-limiting cutting tool for removing semi-conductor insulation on the 1B RRP VFD cables. The licensee entered this issue into the corrective action program (CAP) as nuclear condition report (NCR) 1998726.

  The inspectors determined that the failure of the licensee to have adequate procedures to perform maintenance on the SAT non-segregated bus duct and the 1B RRP VFD cables was a performance deficiency. The finding was more than minor because it was associated with the equipment performance attribute of the Initiating Events Cornerstone and adversely affected the cornerstone objective to limit the likelihood of events that upset plant stability and challenge critical safety functions during shutdown as well as power operations. Specifically, the failure to perform adequate maintenance on the SAT non-segregated bus duct and the 1B RRP VFD cables resulted in a SAT differential lockout, a Unit 1 manual reactor SCRAM, and a loss of offsite power (LOOP). Using IMC 0609, Appendix A, issued June 19, 2012, the Significance Determination Process for Findings At-Power, the inspectors determined the finding screened to a more detailed risk evaluation because the finding caused a reactor trip and the loss of mitigation equipment relied upon to transition the plant from the onset of the trip to a stable shutdown condition. The finding could not be screened to Green and is pending an initial significance characterization and is not yet finalized. The finding does not currently present an immediate safety concern because the licensee repaired the A phase fault on the non-segregated bus, resealed the bus duct bank, spliced in new cables to the 1B RRP VFD breaker and replaced the 1B RRP VFD breaker. The finding has a cross-cutting aspect in the area of human performance associated with the avoid complacency attribute because individuals failed to recognize and plan for the possibility of mistakes, latent issues, and inherent risk, even while expecting successful outcomes, and individuals failed to implement appropriate error reduction tools. Specifically, the licensee failed to plan for the inherent risk associated with water intrusion into the SAT non-segregated bus duct and failed to implement error reduction tools when inspecting and repairing the duct. [H.12] (Section 1R12)

REPORT DETAILS

1. REACTOR SAFETY

Cornerstones: Initiating Events, Mitigating Systems, and Barrier Integrity

1R12 Maintenance Effectiveness (71111.12 – 2 samples)

a. Inspection Scope

The inspectors assessed the licensee's treatment of the issues listed below to verify the licensee appropriately addressed equipment problems within the scope of the maintenance rule (10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"). The inspectors reviewed procedures and records to evaluate the licensee's identification, assessment, and characterization of the problems as well as their corrective actions for returning the equipment to a satisfactory condition. Documents reviewed are listed in the Attachment.

- Work orders (WOs) 20055940 20056366, 1B RRP VFD cubicle repairs after electrical fault
- WO 20055939, SAT non-segregated bus repairs after electrical fault

b. Findings

Introduction. A self-revealing finding with two examples was identified for the licensee's failure to have adequate procedures to perform maintenance on the SAT non-segregated bus duct and the 1B RRP VFD cables. The first example, from May 1997 to the present, procedure 0PM-NSB001, Inspection and Cleaning Non-Segregated Buses, did not contain sufficient information to ensure that deficiencies that could lead to water intrusion in the SAT non-segregated bus duct were identified and corrected. The second example, from October 2003 to June 20, 2016, procedure 0SPP-CBL011, Splicing of Wires and Cables Without Tape, failed to specify use of a depth-limiting cutting tool for removing semi-conductor insulation on the 1B RRP VFD cables.

Description. On February 7, 2016, a coastal storm with strong winds and heavy rains was passing through the plant area. At 1314 hours Eastern Standard Time (EST), on Unit 1, two arc flashes occurred, one in the SAT non-segregated bus and the other in the circuit breaker cubicle that powers the 1B RRP VFD. The first arc flash occurred when water entered the SAT non-segregated bus housing through a degraded seal and an area that had been previous repaired. The water created the conditions conducive to an arc flash on the A phase of the SAT non-segregated bus. The fault created a voltage imbalance which led to the second arc flash which occurred in the breaker cubicle on the B phase of the 1B RRP VFD cabling where cable insulation was found to be degraded. These two grounds resulted in a SAT differential lockout and trip, a loss of both RRPs, a Unit 1 manual reactor SCRAM, and a LOOP. Emergency Diesel Generators (EDGs) 1, 2, 3, and 4 automatically started and EDGs 1 and 2 loaded emergency buses 1 and 2. At 1326 hours, the licensee reported a breaker failure of the 1B RRP bus breaker AA9 for the 1B RRP VFD, and an Alert was declared under emergency action level (EAL) HA 2.1 due to a fire or explosion resulting in visible damage to any H-1 area [turbine building] containing safety-related systems or components. The inspectors responded to the control room and provided an independent assessment of the events to the NRC regional office.

At approximately 1628 hours, the licensee re-established offsite power through the unit auxiliary transformer backfeed to supply the safety-related buses. At 1730 hours, the licensee downgraded to a Notice of Unusual Event because the plant no longer met the criteria for an Alert, but met the criteria for an EAL SU 1.1 due to a loss of all offsite alternating current power to Emergency 4 kV buses E1 (E3) and E2 (E4) for greater than or equal to 15 minutes. Unit 2 was not directly affected by the event, however, due to the shared electrical distribution system, Unit 2 was in a Technical Specification Action Statement 3.8.1 due to the Inoperable Unit 1 SAT. At 1814, the emergency declaration was terminated because offsite power was restored to the emergency buses.

The licensee performed a root cause evaluation and identified two root causes. The first root cause was procedure 0PM-NSB001, Inspection and Cleaning Non-segregated Buses, did not contain sufficient rigor to ensure that deficiencies that can lead to water intrusion were identified and corrected. Specifically, the procedure did not clearly identify the location of areas that are most susceptible to water intrusion, and did not provide acceptance criteria for degradation or corrective actions for resolving degradation. The licensee stated that water intrusion into the non-segregated bus was evident from standing water in the bottom of the enclosure, corrosion on the sides of the bus enclosure, and the appearance of condensation and evaporation on the bus insulating tape. The licensee determined that water intrusion through the seal between the non-segregated bus enclosure to the SAT bushing box led to impedance degradation of the Glastic fire barrier that resulted in the non-segregated bus phase to ground fault. The licensee determined the caulking had been installed for many years and was degraded such that it could not have passed a satisfactory inspection in 2014 during the previous outage. In the root cause evaluation, the licensee stated, “The [non-segregated] bus enclosure was known to be susceptible to water intrusion due to inadequate design and the issue had been entered into the Plant Health process for resolution, but, more than four years after identification, the resolution had still not been clearly slotted for implementation. Review identified, but did not schedule, more robust interim actions to mitigate the risk of failure.” The licensee repaired the A phase fault on the non-segregated bus by installing new insulators, cleaning up the A phase, re-taping, and reusing the bus bar until spring 2018 outage B122R1. The licensee also sealed the non-segregated bus duct bank to prevent any further water intrusion. Finally, the corrective action to preclude repetition (CAPR), due to be complete in August 2016, is to revise the procedures and model WOs to ensure that preventative maintenance will identify and resolve potential sources of water intrusion.

The second root cause was the failure of procedure 0SPP-CBL011, Splicing of Wires and Cables Without Tape, to specify use of a depth-limited cutting tool for removing semi-conductor insulation which resulted in damage to the cable insulation for the 1B RRP VFD B phase. Forensic analysis of the B phase cable identified that the stress control tube that connects the cable to the termination lug was improperly assembled. A ring cut into the dielectric insulation material was observed at the failure point of the cable where insulation had been cut to allow installation of the stress control tube in 2010. The licensee spliced in new cables to the 1B RRP VFD breaker and replaced the breaker. The CAPR to address this issue was to incorporate the following in procedure 0SPP-CBL011: 1) Semi-conductor insulation cutback of medium voltage cable shall be performed with a depth-limited cutting tool, and 2) Cable preparation instructions for medium voltage cables shall include inspection after performing semi-conductor insulation cutback to verify and resolve damage to insulation or conductor. The inspectors reviewed the root cause evaluation and corrective actions and agreed with the licensee determinations.

Analysis. The inspectors determined that the failure of the licensee to have adequate procedures to perform maintenance on the SAT non-segregated bus duct and the 1B RRP VFD cables was a performance deficiency. The finding was more than minor because it was associated with the equipment performance attribute of the Initiating Events Cornerstone and adversely affected the cornerstone objective to limit the likelihood of events that upset plant stability and challenge critical safety functions during shutdown as well as power operations. Specifically, the failure to perform adequate maintenance on the SAT non-segregated bus duct and the 1B RRP VFD cables resulted in a SAT differential lockout, a Unit 1 manual reactor SCRAM, and a LOOP. Using IMC 0609, Appendix A, issued June 19, 2012, the SDP for Findings At-Power, the inspectors determined the finding screened to a more detailed risk evaluation because the finding caused a reactor trip and the loss of mitigation equipment relied upon to transition the plant from the onset of the trip to a stable shutdown condition. The finding could not be screened to Green and is pending an initial significance characterization and is not yet finalized. The finding does not currently present an immediate safety concern because the licensee repaired the A phase fault on the non-segregated bus, resealed the bus duct bank, spliced in new cables to the 1B RRP VFD breaker and replaced the 1B RRP VFD breaker. The finding has a cross-cutting aspect in the area of human performance associated with the avoid complacency attribute because individuals failed to recognize and plan for the possibility of mistakes, latent issues, and inherent risk, even while expecting successful outcomes, and individuals failed to implement appropriate error reduction tools. Specifically, the licensee failed to plan for the inherent risk associated with water intrusion into the SAT non-segregated bus duct and failed to implement error reduction tools when inspecting and repairing the duct. [H.12]

Enforcement. The inspectors did not identify a violation of regulatory requirements associated with this finding since the SAT and the 1B RRP VFD are not safety-related components. The licensee entered this issue into the CAP as NCR 1998726. Because this finding does not involve a violation of regulatory requirements and the significance has not been determined, it is identified as FIN 05000325/2016008-01, Inadequate Procedures to Perform Maintenance on the SAT non-segregated bus and the 1B RRP VFD cables.

4OA3 Follow-up of Events (71153 – 2 samples)

.1 (Closed) Unresolved Item (URI) 05000325/2016001-03, Alert Declared Due to Electrical Fault Resulting in a Fire/Explosion

a. Inspection Scope

The inspectors completed a review of URI 05000325/2016001-03, Alert Declared Due to Electrical Fault Resulting in a Fire/Explosion. On February 7, 2016, the licensee declared an Alert, in accordance with EAL HA 2.1 due to an explosion/fire in the Unit 1 balance of plant (BOP) 4 kV switchgear bus area. A manual reactor SCRAM was initiated due to loss of both recirculation system VFDs as a result of an electrical fault. The SAT experienced a lockout fault, interrupting offsite power to emergency buses 1 and 2. EDGs 1, 2, 3, and 4 automatically started and EDGs 1 and 2 synchronized to emergency buses 1 and 2 per design. The licensee restored offsite power to the emergency buses and exited the event declaration. The licensee wrote NCR 1998726 to address this event. The licensee's immediate corrective actions were to repair the cables on the SAT non-segregated bus and the 1B RRP VFD. The inspectors reviewed the cause evaluation. Documents reviewed are listed in the Attachment.

b. Findings

The enforcement aspects of this issue are documented in Section 1R12 of this report. No additional findings were identified during the review of this URI. This URI is closed.

.2 (Closed) Licensee Event Report 05000325, 2016-001-00, Electrical Bus Fault Results in Lockout of Startup Auxiliary Transformer and Loss of Offsite Power

a. Inspection Scope

On February 7, 2016, at 1312 EST, Unit 1 was in Mode 1 at 88 percent of rated power. An electrical fault occurred on a BOP 4 kV bus, resulting in a lockout of the SAT and a loss of both RRPs. A manual reactor SCRAM was initiated due to loss of both recirculation system VFDs as a result of an electrical fault. The EDGs supplied emergency electrical busses until offsite power was restored at 1628 EST. The loss of power and reactor water level changes resulted in automatic closures of various primary containment isolation valves. The electrical fault resulted in an electrical explosion; therefore, an Alert was declared at 1326 EST. The immediate cause of this event was a fault in a non-segregated electrical bus connected to the SAT and a fault on the 1B RRP VFD circuit breaker which resulted in a SAT lockout. The licensee identified the root causes as insufficient detail in applicable maintenance instructions for inspecting the non-segregated bus housing and inadequate instructions for terminating electrical cables in the 1B RRP VFD circuit breaker cubicle. Corrective actions included repairing equipment damaged by the electrical fault and revising the procedures and work instructions. The licensee entered this issue into the CAP as NCR 1998726. The inspectors reviewed the cause evaluation and the Licensee Event Report (LER). Documents reviewed are listed in the Attachment.

b. Findings

The enforcement aspects of this issue are documented in Section 1R12 of this report. No additional findings were identified during the review of this LER. This LER is closed.

4OA6 Meetings, Including Exit

On June 2, 2016, the resident inspectors presented the inspection results to Ms. Annette Pope, Director of Nuclear Organizational Effectiveness, and other members of the licensee's staff. The inspectors verified that no proprietary information was retained by the inspectors or documented in this report.

ATTACHMENT: SUPPLEMENTAL INFORMATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

W. Gideon	Vice President
K. Moser	Plant Manager
K. Allen	Director, Design Engineering
A. Brittain	Director, Nuclear Plant Security
P. Brown	Manager, Nuclear Performance Improvement
J. Ferguson	Manager, Nuclear Oversight
L. Grzeck	Manager, Nuclear Regulatory Affairs
J. Hicks	Manager, Nuclear Training
B. Houston	Manager, Maintenance
F. Jefferson	Director, Nuclear Engineering
J. Johnson	Manager, Nuclear Chemistry
J. Kalamaja	Manager, Nuclear Operations
E. Neil	Manager, Nuclear Rad Protection
J. Nolin	General Manager, Nuclear Engineering
A. Padleckas	Assistant Ops Manager, Training
A. Pope	Director, Nuclear Organization Effectiveness
T. Sherrill	Senior Nuclear Engineering Technologist
R. Wiemann	Director, Electrical/Rx Systems

NRC Personnel

G. Hopper	Chief, Reactor Projects Branch 4

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened		
05000325/2016008-01	FIN	Inadequate Procedures to Perform Maintenance on the SAT non-segregated bus and the 1B RRP VFD cables (Section 1R12)
Closed		
05000325/2016001-03	URI	Alert Declared Due to Electrical Fault Resulting in a Fire/Explosion (Section 4OA3.1)
05000325/2016-001-00	LER	Electrical Bus Fault Results in Lockout of Startup Auxiliary Transformer and Loss of Offsite Power (Section 4OA3.2)

LIST OF DOCUMENTS REVIEWED

Common Documents Reviewed
Updated Final Safety Analysis Report
Individual Plant Examination
Individual Plant Examination of External Events
Technical Specifications and Bases
Technical Requirements Manual
Control Room Narrative Logs
Plan of the Day

Section 1R12: Maintenance Effectiveness
Procedures
0PM-NSB001, Inspection and Cleaning Non-Segregated Buses, Rev. 11
0SPP-CBL011, Splicing of Wires and Cables Without Tape, Rev. 13

Condition Reports
1998726

Work Orders
20055940 20056366 20055939 2076508

Section 4OA3: Follow-up of Events and Notice of Enforcement Discretion
Procedures:
0PM-NSB001, Inspection and Cleaning Non-Segregated Buses, Rev. 11
0SPP-CBL011, Splicing of Wires and Cables Without Tape, Rev. 13
0EOP-01-SBO-08, Supplemental Diesel Alignment, Rev. 1
AD-PI-ALL-0100, Corrective Action Program, Rev. 5
1OP-50, Plant Electrical System Operating Procedure, Rev. 122
0AOP-36.1, Loss of Any 4160V Buses or 480V E-Buses, Rev. 69

Condition Reports:
1998726 2013417

Work Orders:
20055940 20056366 20055939 2076508

Drawings:
BN-50.0.01, Electrical Distribution, Rev. 5

Miscellaneous:
LER 05000325, 2016-001-00, Electrical Bus Fault Results in Lockout of Startup Auxiliary Transformer and Loss of Offsite Power, April 6, 2016
SD-39.1, System Description Supplemental Diesel Generator, Rev. 0
0OI-01.07, Notifications for Alert, February 7, 2016