Progress Energy

January 5, 2004

SERIAL: BSEP 03-0158 10 CFR 50.73

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Brunswick Steam Electric Plant, Unit No. 2
Docket No. 50-324/License No. DPR-62
Licensee Event Report 2-03-004

Gentlemen:

In accordance with the Code of Federal Regulations, Title 10, Part 50.73, Progress Energy Carolinas, Inc. submits the enclosed Licensee Event Report. This report fulfills the requirement for a written report within sixty (60) days of a reportable occurrence.

Please refer any questions regarding this submittal to Mr. Edward T. O'Neil, Manager – Support Services, at (910) 457-3512.

Sincerely,

David H. Hinds
Plant General Manager
Brunswick Steam Electric Plant

CRE/cre

Enclosure: Licensee Event Report

IE22

**Progress Energy Carolinas, Inc.**
Brunswick Nuclear Plant
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Southport, NC 28461

cc (with enclosure):

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NRC FORM 366 (7-2001) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 7-31-2004

Estimated burden per response to comply with this mandatory information collection request: 50 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to the information collection.

# LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

| 1. FACILITY NAME | 2. DOCKET NUMBER | 3. PAGE |
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| Brunswick Steam Electric Plant (BSEP), Unit 2 | 05000324 | 1 OF 6 |

**4. TITLE**
Loss of Generator Excitation Results in Reactor Protection System and Other Specified System Actuations

| 5. EVENT DATE | | | 6. LER NUMBER | | | 7. REPORT DATE | | | 8. OTHER FACILITIES INVOLVED | |
|---|---|---|---|---|---|---|---|---|---|---|
| MO | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REV NO | MO | DAY | YEAR | FACILITY NAME | DOCKET NUMBER |
| | | | | | | | | | BSEP, Unit 1 | 05000325 |
| 11 | 04 | 2003 | 2003 | -- 004 -- | 00 | 01 | 05 | 2004 | FACILITY NAME | DOCKET NUMBER 05000 |

| 9. OPERATING MODE | 1 |
|---|---|
| 10. POWER LEVEL | 96 |

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20.2201(b) | | 20.2203(a)(3)(ii) | | 50.73(a)(2)(ii)(B) | | 50.73(a)(2)(ix)(A) |
| | 20.2201(d) | | 20.2203(a)(4) | | 50.73(a)(2)(iii) | | 50.73(a)(2)(x) |
| | 20.2203(a)(1) | | 50.36(c)(1)(i)(A) | X | 50.73(a)(2)(iv)(A) | | 73.71(a)(4) |
| | 20.2203(a)(2)(i) | | 50.36(c)(1)(ii)(A) | | 50.73(a)(2)(v)(A) | | 73.71(a)(5) |
| | 20.2203(a)(2)(ii) | | 50.36(c)(2) | | 50.73(a)(2)(v)(B) | | OTHER Specify in Abstract below or in NRC Form 366A |
| | 20.2203(a)(2)(iii) | | 50.46(a)(3)(ii) | | 50.73(a)(2)(v)(C) | | |
| | 20.2203(a)(2)(iv) | | 50.73(a)(2)(i)(A) | | 50.73(a)(2)(v)(D) | | |
| | 20.2203(a)(2)(v) | | 50.73(a)(2)(i)(B) | | 50.73(a)(2)(vii) | | |
| | 20.2203(a)(2)(vi) | | 50.73(a)(2)(i)(C) | | 50.73(a)(2)(viii)(A) | | |
| | 20.2203(a)(3)(i) | | 50.73(a)(2)(ii)(A) | | 50.73(a)(2)(viii)(B) | | |

**12. LICENSEE CONTACT FOR THIS LER**

| NAME | TELEPHONE NUMBER (Include Area Code) |
|---|---|
| Charles R. Elberfeld, Lead Engineering Technical Support Specialist | (910) 457-2136 |

**13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT**

| CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX | CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX |
|---|---|---|---|---|---|---|---|---|---|
| B | TL | EXC | General Electric | Y | | | | | |

| 14. SUPPLEMENTAL REPORT EXPECTED | | | 15. EXPECTED SUBMISSION DATE | MO | DAY | YEAR |
|---|---|---|---|---|---|---|
| | YES (If yes, complete EXPECTED SUBMISSION DATE). | X NO | | | | |

**16. ABSTRACT** (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)


On November 4, 2003, at approximately 1732 hours, Unit 2 received a generator/turbine trip due to loss of generator excitation, which resulted in a Reactor Protection System (RPS) actuation. All control rods fully inserted into the core. Plant response to the transient also resulted in High Pressure Coolant Injection and Reactor Core Isolation Cooling System actuations on low reactor pressure vessel (RPV) coolant level with injection into the RPV. Additionally, Primary Containment Isolation System (PCIS) actuation signals for Valve Groups 1, 2, 3, 6, and 8 were received and the valves closed as required. All four Emergency Diesel Generators automatically started but did not load because electrical power was not lost to the emergency buses.

The initiator of the plant transient event and system actuations was the failure of the generator exciter inner collector ring and brush holders, which resulted in loss of excitation to the generator. The root cause of the failure is a fabrication deficiency due to poor workmanship at the time of original installation of the collector ring onto the exciter shaft. Weaknesses in brush maintenance, preventive maintenance, monitoring, and trending were also identified as the root cause of the event.

The damaged components were replaced. Enhanced exciter brush monitoring has been implemented on both Units 1 and 2. This event is being reported in accordance with 10 CFR 50.73(a)(2)(iv)(A). The safety significance of this occurrence is considered minimal.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

INTRODUCTION

On November 4, 2003, at approximately 1732 hours, Unit 2 received a generator/turbine trip due to loss of generator excitation [TL], which resulted in a Reactor Protection System (RPS) [JC] actuation. All control rods fully inserted into the core. Plant response to the transient also resulted in High Pressure Coolant Injection (HPCI) [BJ] and Reactor Core Isolation Cooling (RCIC) [BN] System actuations on low reactor pressure vessel (RPV) coolant level, with injection into the RPV. Additionally, Primary Containment Isolation System (PCIS) [JM] actuation signals for Valve Groups 1, 2, 3, 6, and 8 were received and the valves closed as required. As a result of the associated electrical transient, a PCIS Valve Group 6 isolation was also received on Unit 1. All four Emergency Diesel Generators (EDGs) [EK] automatically started but did not load because electrical power was not lost to the emergency buses. At the time of the event, Unit 2 was in Mode 1, (i.e., Run) at approximately 96 percent of rated thermal power (RTP) and Unit 1 was in Mode 1 at 93 percent of RTP, with all Emergency Core Cooling Systems operable for both units. At approximately 1857 hours, with Unit 2 in Mode 3 (i.e., Hot Shutdown), another RPS actuation was received due to low RPV coolant level while cycling Safety Relief Valves (SRVs) [RV]. At 2120 hours, notification was made to the NRC (i.e., Event Number 40297) in accordance with 10 CFR 50.72(b)(2)(iv)(A), (b)(2)(iv)(B), and (b)(3)(iv)(A). This event is being reported in accordance with 10 CFR 50.73(a)(2)(iv)(A) as manual and automatic actuation of specified systems.

EVENT DESCRIPTION

On November 4, 2003, at approximately 1732 hours, the Unit 2 generator exciter [EXC] inboard collector ring (i.e., Alterrex Serial # CH8371544, General Electric Company, Reference TAB 32'S GEK 18539C Figure 7, Mechanical Outline Drawing GEK 34D105050) and brush holders failed resulting in a loss of generator excitation. The loss of generator excitation resulted in a decrease in generator voltage and AC bus voltages on Unit 2 for about three to four seconds, with a dip to approximately 40 percent of nominal voltage values. After the generator tripped, the Unit 2 bus loads were automatically transferred from the Unit Auxiliary Transformer to the Site Auxiliary Transformer (SAT). Additionally, all four EDGs automatically started, as a result of the generator trip, but did not load because electrical power was not lost to the emergency buses. Upon transfer to the SAT, the bus voltages returned to nominal values. Details of this event will be discussed in two sections: (1) Unit 2 Scram and Associated Transients, and (2) Plant Responses to the Voltage Transient.

Unit 2 Scram and Associated Transients

On November 4, 2003, at approximately 1732 hours, and approximately three seconds into the voltage transient, the Unit 2 generator/turbine tripped, resulting in an RPS actuation. The voltage decrease also resulted in PCIS Valve Group 1 (i.e., Main Steam Isolation valves (MSIVs), Main Steam Line Drain valves, and Reactor Recirculation Sample valves), Group 3 (i.e., Reactor Water Cleanup isolation valves), and Group 6 (i.e., Containment Atmosphere Control/Dilution, Containment Atmosphere Monitoring, and Post

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

EVENT DESCRIPTION (continued)

Unit 2 Scram and Associated Transients (continued)

Accident Sampling System isolation valves) isolations. Event Notification 40297 stated that a Group 10 (i.e., Non-Interruptible Air to Drywell Isolation Valves) isolation occurred; however, review of the event and plant documentation could not validate the isolation. Four of 11 SRVs opened for a short duration on mechanical setpoints in response to the pressure transient. Maximum RPV steam dome pressure measured during the event was 1108 psig.

RPV coolant level decreased to below the Low Level 1 setpoint, which resulted in a Group 2 (i.e., Drywell Equipment and Floor Drain, Traversing In-core Probe, Residual Heat Removal (RHR) Discharge to Radwaste, and RHR Process Sample isolation valves) isolation and a Group 8 (i.e., RHR Shutdown Cooling Suction and RHR Inboard Injection isolation valves) isolation signal; however, the Group 8 valves were already closed as required by plant conditions prior to the event. RPV coolant level continued to decrease to the Low Level 2 setpoint, at which time the HPCI and RCIC Systems actuated and injected into the RPV to restore level.

After RPV coolant level was restored the HPCI System was secured. RPV coolant level and pressure were controlled using the Control Rod Drive [AA] System flow, the RCIC System, and by manually cycling SRVs. The RHR loops were placed in the suppression pool cooling mode of operation as needed to remove decay heat. Activities were in progress to open the MSIVs to use the main condenser for the reactor cooldown. At approximately 1857 hours, a second RPS actuation was received when RPV coolant level decreased below the Low Level 1 setpoint due to level shrink after an SRV was closed during manual cycling. RPS logic was reset at approximately 1922 hours. At approximately 1934 hours, the MSIVs were opened to re-establish the main condenser as a heat sink. At approximately 2300 hours, the 2B Reactor Feed Pump was started to provide makeup to the RPV and the RCIC System was secured.

On November 5, 2003, at approximately 0452 hours, RHR loop A was placed in the shutdown cooling mode of operation. At approximately 0554 hours, Unit 2 entered Mode 4 (i.e., Cold Shutdown).

Plant Responses to Voltage Transient

On November 4, 2003, at approximately 1732 hours, the loss of Unit 2 generator excitation resulted in a voltage transient on Unit 2 AC buses. The transient was characterized as a voltage decrease for about three or four seconds, with a dip to approximately 40 percent of nominal voltage values, at which time the voltages returned to normal values. The voltage transient caused the main stack radiation monitor, which is common to both Units 1 and 2, to initiate a logic signal resulting in isolation of the Reactor Building Ventilation [VA] Systems, automatic starting of the Standby Gas Treatment (SGT) Systems [BH], and PCIS Group 6 isolations for both units. The affected equipment responded successfully except for the Unit 2 SGT System Train A. Operations personnel reset a high temperature trip signal that was locked in during the voltage transient and were able to successfully start Train A manually.

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EVENT DESCRIPTION (continued)

Plant Responses to Voltage Transient (continued)

On November 4, 2003, at approximately 1812 hours, the Unit 1 Reactor Building Ventilation System was restarted and at approximately 1825 hours, it was restarted for Unit 2. At approximately 1824 hours, the Unit 1 SGT System was secured and at approximately 2055 hours, the Unit 2 SGT System was placed in standby. The PCIS Group 6 isolations were reset for both units as conditions allowed. By 2034 hours, all four EDGs were placed in standby.

The voltage transient also affected other equipment on both units which required operator action to restore the equipment. The occurrences were evaluated considering the plant design and it was determined that these effects were to be expected based on the nature of the voltage transient and automatic load stripping of the emergency buses. The adequacy of the plant under-voltage protection logic was evaluated in light of the voltage transient associated with this event and it was determined that the present design is adequate.

EVENT CAUSE

Loss of Generator Excitation

The initiator of the plant transient event and system actuations was the failure of the generator exciter inner collector ring and brush holders, which resulted in loss of excitation to the generator. The root cause of the failure is a fabrication deficiency due to poor workmanship at the time of original installation of the collector ring onto the exciter shaft in the early 1970s. The collector ring is designed to have a tight interference fit on the exciter shaft to minimize vibration. The poor workmanship was the fit-up of the collector ring assembly utilizing a peening methodology on the anti-rotation key in lieu of the proper shrink fit of the collector ring on the exciter rotor shaft. Post-failure inspection and laboratory evaluation support this conclusion.

Weaknesses in brush maintenance, preventive maintenance, monitoring, and trending were also identified as the root cause of the event. Comparison of site activities with original equipment manufacturer and industry recommendations indicate that the event may have been avoided if brush and brush rigging vibration monitoring and trending, as well as collector ring strobe light inspection activities, had been implemented per recommendations. On October 21, 2003, during the weekly exciter brush inspection, the three inboard brush currents were noted to be unequal, indicating a degraded condition with the collector ring/brushes. An action plan was developed and being implemented to address the degraded condition, but the activities were not effective in preventing the equipment failure and subsequent event.

Additional contributing causal factors include insufficient detail/incomplete training for maintenance and engineering personnel, as well as inadequate attention to emerging problems and ineffective use of operating experience. General Electric Company notified equipment users of an improved brush holder and rigging design in the early 1990 timeframe. Operating experience from other utilities indicated success with mitigation of brush vibration issues using the improved design. The improved design was not implemented at BSEP.

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EVENT CAUSE (continued)

Low Level 1 RPS Actuation due to RPV Coolant Level Shrink

The cause of the Low Level 1 RPS actuation is attributed to the level shrink caused by manual SRV cycling until the MSIVs could be re-opened. Although this method is allowed by plant procedures, pressure control using manual SRV cycling is not as stable as using the HPCI System, in the pressure control mode of operation, and the RCIC System.

Unit 2 SGT System Train A Failure to Automatically Start on Demand

Each SGT System train is designed to be able to automatically start after a complete loss of electrical power, and incorporates a specific relay logic scheme to allow that capability. On November 4, 2003, the electrical transient resulted in a short-term voltage drop to approximately 40 percent of the nominal voltage value. The voltage value during the transient decreased to a value where some relays in the start logic may or may not have dropped out. For the Unit 2 SGT System Train A only, the relays responded such that the logic had to be reset before the train could start.

CORRECTIVE ACTIONS

- The damaged components (i.e., the collector ring, the anti-rotation key, the brushes, and brush rigging) were replaced. The collector ring was properly installed on the rotor shaft.
- Preventive maintenance, exciter brush vibration monitoring, and trending program improvements are being developed and will be implemented by February 20, 2004. Program improvements for other brush applications on site are also being considered.
- Enhanced exciter brush monitoring has been implemented on both Units 1 and 2. Unit 1 exciter collector rings are scheduled to be replaced during the next refuel outage, which is scheduled to begin in February 2004.
- Design improvements to the exciter brush holders and inspection windows are being reviewed and developed.
- Training is being developed for appropriate engineering, operations, and maintenance personnel on brush maintenance topics.
- As part of the approved licensed operator training program, this event and the lessons learned associated with RPV coolant level control will be reviewed with the operating crews.
- A modification has been installed in the logic for both SGT System trains for both units to enhance logic response under degraded voltage conditions such as those experienced during this event.

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## SAFETY ASSESSMENT

The safety significance of this occurrence is considered minimal. Plant systems responded as designed to the transient and so the consequences of the transient on the fuel and vessel overpressure were minimal. The analyses in Chapter 15 of the Updated Final Safety Analysis Report fully bounded this event.

## PREVIOUS SIMILAR EVENTS

A review of events occurring within the past three years has not identified any previous similar occurrences.

## COMMITMENTS

Those actions committed to by Progress Energy Carolinas, Inc. (PEC) in this document are identified below. Any other actions discussed in this submittal represent intended or planned actions by PEC. They are described for the NRC's information and are not regulatory commitments. Please notify the Manager – Support Services at BSEP of any questions regarding this document or any associated regulatory commitments.

- Preventive maintenance, exciter brush vibration monitoring, and trending program improvements are being developed and will be implemented by February 20, 2004.