



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

July 18, 2017

Mr. Tom Simril  
Site Vice President  
Duke Energy Corporation  
Catawba Nuclear Station  
4800 Concord Road  
York, SC 29745-9635

**SUBJECT: CATAWBA NUCLEAR STATION – NRC INSPECTION REPORT  
05000414/2017011**

Dear Mr. Simril:

On July 12, 2017, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at your Catawba Nuclear Station Unit 2 and discussed the results of this inspection with you and other members of your staff. The results of this inspection are documented in the enclosed report.

Section 1R15 of the enclosed report discusses a finding with two associated apparent violations for which the NRC has not yet reached a preliminary significance determination. This finding involved a failure to adequately develop and adjust preventive maintenance activities in accordance with procedure AD-EG-ALL-1202, "Preventive Maintenance and Surveillance Testing Administration," thus allowing a condition adverse to quality to remain uncorrected.

We intend to issue our final safety significance determination and enforcement decision, in writing, within 90 days from the date of this letter. The NRC's significance determination process (SDP) is designed to encourage an open dialogue between your staff and the NRC; however, neither the dialogue nor the written information you provide should affect the timeliness of our final determination. We ask that you promptly provide any relevant information that you would like us to consider in making our determination. We are currently evaluating the significance of this finding and will notify you in a separate correspondence once we have completed our preliminary significance review. You will be given an opportunity to provide additional information prior to our final significance determination unless our review concludes that the finding has very low safety significance (i.e. Green).

T. Simril

2

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 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding."

Sincerely,

***/RA/***

Frank Ehrhardt, Chief  
Reactor Projects Branch 1  
Division of Reactor Projects

Docket No.: 50-414  
License No.: NPF-52

Enclosure:  
IR 05000414/2017011  
w/Attachment: Supplemental Information

cc Distribution via ListServ

T. Simril

3

SUBJECT: CATAWBA NUCLEAR STATION – NRC INSPECTION REPORT  
05000414/2017011 July 18, 2017

**DISTRIBUTION:**

M. Kowal, RII  
K. Sloan, RII  
OE Mail  
RIDSNNRRDIRS  
PUBLIC  
RidsNrrPMCatawba Resource

**ADAMS Accession No. ML17199B961**

|        |           |           |           |           |           |  |  |
|--------|-----------|-----------|-----------|-----------|-----------|--|--|
| OFFICE | RII:DRP   | RII:DRP   | RII:DRP   | RII:DRP   | RII:DRP   |  |  |
| NAME   | JAustin   | CScott    | JWorosilo | MToth     | FEhrhardt |  |  |
| DATE   | 7/13/2017 | 7/17/2017 | 7/13/2017 | 7/18/2017 | 7/18/2017 |  |  |

**OFFICIAL RECORD COPY**

**U.S. NUCLEAR REGULATORY COMMISSION**

**REGION II**

Docket No.: 50-414

License No.: NPF-52

Report No.: 05000414/2017011

Licensee: Duke Energy Carolinas, LLC

Facility: Catawba Nuclear Station, Units 2

Location: York, SC 29745

Dates: April 11, 2017 through July 12, 2017

Inspectors: J. Austin, Senior Resident Inspector  
C. Scott, Resident Inspector

Approved by: Frank Ehrhardt, Chief  
Reactor Projects Branch 1  
Division of Reactor Projects

Enclosure

## SUMMARY

IR 05000414/2017011, April 11, 2017 through July 12, 2017; Catawba Nuclear Station, Unit 2; Operability Determinations and Functionality Assessments.

The report covered a three-month period of inspection by the resident inspectors. There was one NRC-identified finding with two associated apparent violations (AV) documented in this report. The significance of inspection findings are indicated by their color (i.e., greater than Green, or Green, White, Yellow, Red) and determined using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process," (SDP) dated April 29, 2015. The cross-cutting aspects are determined using IMC 0310, "Aspects within the Cross-Cutting Areas" dated December 4, 2014. All violations of NRC requirements are dispositioned in accordance with the NRC's Enforcement Policy dated November 1, 2016. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 6.

### Cornerstone: Mitigating Systems

- To Be Determined (TBD): The inspectors identified an AV of Technical Specification 5.4.1.a, "Procedures," for the licensee's failure to adequately develop and adjust the preventive maintenance strategy for the emergency diesel generator (EDG) excitation system in accordance with AD-EG-ALL-1202, "Preventive Maintenance and Surveillance Testing Administration." The inspectors also identified an associated AV of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 Appendix B, Criterion XVI, "Corrective Actions," for the failure to correct a condition adverse to quality associated with elevated operating temperatures of EDG excitation system diodes. This resulted in the failure of an EDG excitation system diode and overcurrent trip of the 2A emergency diesel output breaker during a surveillance test performed on April 11, 2017. The licensee entered this condition into their corrective action program as Condition Report 2116069. The 2A EDG was returned to service on April 14, 2017 following replacement of the excitation system diodes.

The failure to adequately develop and adjust preventive maintenance activities in accordance with AD-EG-ALL-1202, thus allowing a condition adverse to quality to remain uncorrected, was a performance deficiency. This performance deficiency was more than minor because it affected the mitigating systems cornerstone attribute of equipment performance and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems and components that respond to initiating events to preclude undesirable consequences (i.e. core damage). Specifically, failure to adjust the preventive maintenance activities for the EDG excitation system by incorporating operating experience, corrective maintenance history, and structures, systems, and components (SSC) performance history led to the failure of diode CR4 in the EDG excitation system and caused the 2A EDG output breaker to trip open on April 11, 2017. Using NRC Inspection Manual Chapter 0609, Attachment 4, "Initial Characterization of Findings," dated June 19, 2012, the inspectors determined that the issue affected the mitigating systems cornerstone. In accordance with NRC Inspection Manual Chapter 0609, Appendix A, "The Significance Determination Process (SDP) for Findings at Power," dated June 19, 2012, the inspectors determined that the issue required a detailed risk evaluation because the finding represents an actual loss of function of a single train for greater than its technical specification allowed outage time.

This finding has a cross-cutting aspect of operating experience in the area of problem identification and resolution, because the organization did not systematically and effectively evaluate relevant internal and external operating experience in a timely manner. Specifically, Condition Report 1566561 documented industry operating experience regarding EDG excitation system diodes failing at an increased rate and that operating experience was not effectively implemented and institutionalized through changes to station processes, procedures, and equipment. This issue is indicative of current performance because the station did not take effective corrective actions to address the degradation of the EDG excitation system. [P.5] (Section 1R15)

## REPORT DETAILS

### 1. REACTOR SAFETY

Cornerstones: Initiating Events, Mitigating Systems, and Barrier Integrity

#### 1R15 Operability Determinations and Functionality Assessments (71111.15)

##### a. Inspection Scope

###### Operability and Functionality Review

The inspectors selected the operability determination listed below for review based on the risk-significance of the associated components and systems. The inspectors reviewed the technical adequacy of the determinations to ensure that technical specification operability was properly justified and the components or systems remained capable of performing their design functions. To verify whether components or systems were operable, the inspectors compared the operability and design criteria in the appropriate sections of the technical specification and updated final safety analysis report to the licensee's evaluations. Where compensatory measures were required to maintain operability, the inspectors determined whether the measures in place would function as intended and were properly controlled. Additionally, the inspectors reviewed a sample of corrective action documents to verify the licensee was identifying and correcting any deficiencies associated with operability evaluations. Documents reviewed are listed in the attachment.

- Unit 2, 2A Emergency Diesel Generator Tripped, Condition Report 2116069

##### b. Findings

Introduction: The inspectors identified an AV of Technical Specification 5.4.1.a, "Procedures," for the licensee's failure to adequately develop and adjust the preventive maintenance strategy for the EDG excitation system in accordance with AD-EG-ALL-1202, "Preventive Maintenance and Surveillance Testing Administration." The inspectors also identified an associated AV of 10 CFR Part 50 Appendix B, Criterion XVI, "Corrective Actions," for the failure to correct a condition adverse to quality associated with elevated operating temperatures of EDG excitation system diodes. This resulted in the failure of an EDG excitation system diode and overcurrent trip of the 2A emergency diesel output breaker during a surveillance test performed on April 11, 2017.

Description: On April 11, 2017, during monthly surveillance testing of the 2A EDG, in accordance with PT/2/A/4350/002A, "Diesel Generator 2A Operability Test," the EDG output breaker unexpectedly tripped open on an overcurrent relay actuation. The breaker opened approximately three minutes after reaching full load (5750 kW). The diesel was subsequently secured and declared inoperable. During troubleshooting, the licensee discovered that diode CR4 in the EDG excitation circuit shorted, causing the diesel output breaker to trip open on overcurrent. The 2A EDG was returned to service

on April 14, 2017 following replacement of the excitation system diodes. Condition Report 2116069 was initiated to investigate the diode failure.

Because the Catawba EDG excitation system is an overcompensated design, it will supply more power than normally required. The voltage regulator uses shunt silicon control rectifiers (SCR) to bypass the excess excitation current away from the generator field to control generator output voltage. These SCRs direct the excess current through diodes CR2, CR4 and CR6. Diodes CR2, CR4 and CR6 also carry the generator field current. As such, these diodes are in a conducting state for longer intervals than other diodes in the bridge and, based on industry operating experience, internal temperatures can be approximately 60 degrees Fahrenheit greater than diodes CR1, CR3 and CR5.

During review of this issue, inspectors found several condition reports, generic communications, and vendor recommendations associated with failed or degraded components in the EDG excitation systems.

- In 1986, SER Supplement #5 Transamerican Delaval Inc. (TDI) owner's group documented deficiencies with cabinet ventilation and diode (rectifier) temperature.
- In 1986, the licensee had a diode failure of CR2 on the 1A EDG. Corrective actions were to replace CR2 (Work Request 21042OPS-1).
- In 1987, TDI recommended inspection of heat sensitive labels before and after each EDG run to determine whether diode overheating was occurring. They also recommended modifications that included improving the mounting of diode heat sinks and the installation of cooling fans in the cabinet. The licensee completed installation of the fans for all the EDG cabinets in 1987.
- In 1988, diode CR6 failed (shorted) on the 1A EDG (Work Request 27213OPS).
- In 1989, diode CR4 failed (shorted) on the 1A EDG (Work Request 51246OPS). Corrective actions included replacing all diodes/SCRs for the 1A EDG.
- In 1990, the licensee replaced all diodes for all four EDG's and completed the final mounting changes to the diode heat sinks. The licensee discontinued inspection of the heat labels, before and after each diesel run, because mounting changes to the diode heat sinks was believed to be a permanent solution to address diode overheating.
- NRC Information Notice 2005-15 discussed the loss of an EDG that was identified following a transient at Palo Verde Nuclear Generating Station Units 1, 2, and 3. A failed diode in phase B of the Unit 2 train A EDG voltage regulator exciter circuit resulted in a reduced excitation current and failure of the diesel. On July 13, 2005, this issue was placed in the licensee's corrective action program as Condition Report 1438907 but it was closed without action.

- In 2005, diode CR4 failed (shorted) on the 1A EDG (Condition Report 1435421). The root cause evaluation stated that operation of diodes at higher than optimal temperatures contributed to the failure and that diodes CR2, CR4, and CR6 were subjected to undesired thermal stress. Based on this evaluation, the licensee implemented design changes to improve the heat sink and allow cooler operation of the diodes. They also began performing current checks of the SCRs and cabinet thermography every 18 months to ensure that the diodes were operating below rated temperature. The current checks ensure that the current flow between the SCRs does not differ by more than 10 percent between the three legs. All diodes on all four EDGs were replaced in 2006.
- On April 29, 2012, industry operating experience related to “Loss of Emergency Diesel Generator Excitation,” was placed into the licensee’s corrective action program as Condition Report 1566561, but closed it was without action. Condition Report 1566561 describes the failure of a diesel surveillance test due to a short on diode CR4. The diesel used the same design voltage regulator as used at Catawba. The report stated that the service life of diodes is reduced by the increased operating temperature even though the diodes are operating below their rated temperature. The industry operating experience concluded that the average life span of emergency diesel generator excitation system diodes is approximately 12 years and recommended that licensees review EDG diodes subjected to elevated temperatures during operation and adjust the scope or frequency of their preventive maintenance programs accordingly.

The inspectors noted that the elevated operating temperatures of the EDG diodes, first identified by the owner’s group in 1986, was a condition adverse to quality. Additionally, inspectors determined that the operating experience in Condition Report 1566561 was not adequately evaluated and incorporated into the preventive maintenance program, in that the licensee’s EDG diodes were susceptible to the same heat related failure mechanisms described in the operating experience. Licensee procedure AD-EG-ALL-1202 states in part that industry operating experience, corrective maintenance history and SSC performance “shall be considered when developing the overall maintenance strategy for equipment within the scope of the preventive maintenance program.” It further states in part that the “preventive maintenance program should be continuously under review for change based on new and better information from sources internal and external to nuclear generation” and that “operating experience is an essential element for continuously improving equipment reliability.” The licensee failed to use the operating experience and revise the preventive maintenance strategy to prevent this issue from impacting 2A EDG reliability and availability. Because the licensee failed to follow licensee procedure AD-EG-ALL-1202, a condition adverse to quality was not corrected. The failure to address the elevated diode temperatures ultimately resulted in failure of the 2A EDG.

Analysis: The failure to adequately develop and adjust preventive maintenance activities in accordance with AD-EG-ALL-1202, thus allowing a condition adverse to quality to remain uncorrected, was a performance deficiency. This performance deficiency was more than minor because it affected the mitigating systems cornerstone attribute of

equipment performance and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems and components that respond to initiating events to preclude undesirable consequences (i.e., core damage). Specifically, failure to adjust the preventive maintenance activities for the EDG excitation system by incorporating operating experience, corrective maintenance history and SSC performance history led to the failure of diode CR4 in the EDG excitation system and caused the 2A EDG output breaker to trip open on April 11, 2017. Using NRC Inspection Manual Chapter 0609, Attachment 4, "Initial Characterization of Findings," dated June 19, 2012, the inspectors determined that the issue affected the mitigating systems cornerstone. In accordance with NRC Inspection Manual Chapter 0609, Appendix A, "The Significance Determination Process (SDP) for Findings at Power," dated June 19, 2012, the inspectors determined that the issue required a detailed risk evaluation because the finding represents an actual loss of function of a single train for greater than its technical specification allowed outage time.

This finding has a cross-cutting aspect of operating experience in the area of problem identification and resolution, because the organization did not systematically and effectively evaluate relevant internal and external operating experience in a timely manner. Specifically, Condition Report 1566561, documented industry operating experience regarding EDG excitation system diodes failing at an increased rate, and that operating experience was not effectively implemented and institutionalized through changes to station processes, procedures, and equipment. This issue is indicative of current performance because the station did not take effective corrective actions to address the degradation of the EDG excitation system. [P.5].

Enforcement: Technical Specification 5.4.1.a, "Procedures," requires, in part, that procedures shall be established, implemented, and maintained covering the applicable procedures recommended in Appendix A of Regulatory Guide 1.33, Revision 2. Section 9.b of Appendix A to Regulatory Guide 1.33, Revision 2, requires, in part, that "preventive maintenance schedules be developed to specify inspection or replacement of parts that have a specific lifetime." The licensee established Procedure AD-EG-ALL-1202 to provide direction for implementing the preventive maintenance program. Section 5.3 of Procedure AD-EG-ALL-1202, requires that maintenance strategies for equipment within the scope of the preventive maintenance program be developed by considering operating experience, corrective maintenance history and SSC performance.

10 CFR 50, Appendix B, Criterion XVI, "Corrective Actions," requires, in part, that conditions adverse to quality be promptly identified and corrected.

Contrary to the above, as of April 11, 2017, the licensee failed to ensure that adequate preventive maintenance activities were developed and adjusted for the EDG excitation system by incorporating operating experience. Specifically, the licensee did not effectively incorporate operating experience documented in Condition Report 1566561 into the preventive maintenance activities for EDG excitation system diodes. As a result, a condition adverse to quality associated with the elevated diode temperatures was uncorrected. This caused the 2A EDG output breaker to trip open during monthly

surveillance testing. The licensee entered this condition into its corrective action program as Condition Report 2116069. The 2A EDG was returned to service on April 14, 2017 following replacement of the excitation system diodes. This violation is being treated as an apparent violation pending a final significance determination. (AV 05000414/2017011-01, "Failure to Adequately Establish and Adjust Preventive Maintenance for Emergency Diesel Generator Excitation System Diodes")

#### 4OA6 Meetings, Including Exit

On July 12, 2017, the resident inspectors presented the inspection results to Mr. Tom Simril 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

C. Bigham, Director Nuclear Organizational Effectiveness  
B. Carroll, PRA  
J. Donahue, VP Nuclear Engineering  
C. Fletcher, Regulatory Affairs Manager  
A. Gooch, RES Engineering Director  
R. Kayler, Engineering Manager Corporate  
T. Simril, Site Vice-President

### **LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED**

#### Opened

|                     |    |   |
|---------------------|----|---|
| 05000414/2017011-01 | AV | Failure to Adequately Establish and Adjust Preventive Maintenance for Emergency Diesel Generator Excitation System Diodes. (Section 1R15) |
|---------------------|----|---|

## LIST OF DOCUMENTS REVIEWED

### **Section 1R15: Operability Evaluations**

Condition Report (CR) 1566561 IER L3-1-41, Loss of Emergency Diesel Generator  
CR1898033, Plant Evaluation AFI ER 2.2  
CR1496714, CR Documents a Performance Deficiency  
CR1441999, NSRB Observations and Action Items  
CR1449765, EDG Voltage Regulator System Replacement  
CR1406288, Potential Transformer Failure  
CR2045274, SCR Currents Need To Be Adjusted Within 10% on 2A DG  
CR20038865, 2EQC VR A SCR Currents Need to be Adjusted  
CR20032186, 2EQC VR A Current Readings Check  
CR1496597, Failure of SCR-3 for EDG – 1A  
CR2065253, SCR-3 EDG 2B not Responding to Adjustments  
CR1897975, 1B EDG Exhibited Erratic Control at Full Load during 24 hr. Run  
CR1506160, EDG Controls Will Not Return to Their Pre-Position Settings  
CR1435421, Unplanned Entry into TS 3.8.1 Due to EDG 1A Breaker Tripping  
CR2116553, Critical Spare Part Released  
CR2116581, 2A EDG Bearing #4 Temperature was Outside Normal Range  
CR2116554, EDG 2A Power Driven Potentiometer 10 CFR 50.59 Screen  
CR2116525, 2A EDG Power Driven Potentiometer as Found  
CR2116598, 2A EDG Power Driven Potentiometer 10 CFR 50.59 Screen  
CR2121320, IDO 2A EDG SCR Current Deviation  
CR2052597, Set-Up PDP Travel Limits  
CR1449765, EDG Voltage Regulators/Excitation Systems are Obsolete  
CR1491690, 2A EDG Exhibited Erratic Control  
Engineering Change EC408319, 2A EDG Power Driven Potentiometer  
Pre-Position Circuit  
Work Order (WO) 20032186, 2A EDG Thermography and Current Checks  
CR1898076, 2B EDG Determined to Not Be Able to Auto Start During Work Under WO2061411  
CR2106220, EDG 1B Power Driven Potentiometer PM Results  
CR2044615, EDG 2A Failed to Start When “Slow Start” was Attempted  
CR 2045086, Slight Power Factor Perturbations on 2A EDG  
CR2064867, 2B EDG Post Modification Test Procedure  
CR1496597, EDG 2B SCR Current Out of Tolerance  
EC114710, Allow Future Replacement of EDG Power Driven Potentiometer  
Work Request (WR) 1381MES, Replace Diodes CR1 through CR6 and SCR 1,2, and 3  
WR1383MES, Replace Diodes CR1 through CR6 and SCR 1,2, and 3  
WR7968IAE, Inspect/Repair Why Diode Labels, Discolored on Diodes CR4 and CR6 in 2  
DGCPA  
WR21042OPS-1, Inspect/Repair Cause for Loss of Field on 1AEDG  
SER Docket Nos. 560-413 and 50-414 February 1986 Supplement No. 5  
NRC Information Notice 2007-36, Emergency Diesel Generator Voltage Regulator Problems  
CR01502447, 2A DG Power Factor Intermittently Decreased to .9 Lagging  
CR02135755, Three Diodes that were tested out of the Warehouse Failed  
AD-PI-ALL-0100, Corrective Action Program, Rev.7  
AD-EG-ALL-1202, Preventive Maintenance and Surveillance Testing Administration, Rev.4  
CNM 1301.00-0354.001, Preventive Maintenance Plan for Diesel Generators, Rev D9

Catawba Nuclear Site Directive 3.0.04, Preventive Maintenance and Periodic Test Program, Rev. 13

WO01724280, 2EQC VR A: D/G Voltage Regulator Thermography and Current Checks

WO2063474-01, 1EQC VR A: Replace Failed SCRS and Diode

WO2149089-01, 1EQC VR B: SCR Current Deviation Greater than 10%

WO20159298-13, 2EQC VR A: Diode and SCR Current Readings

PT/2/A/4350/002 A, Diesel Generator 2A Operability Test, Rev. 113

CR1435421, Emergency Diesel Generator 1A Loss of Excitation Trip

CR1996912, Diesel Generator 1ETB tripped during a 24hr D/G run

CR1438907, NRC Information Notice 2005-15: Three Unit Trip and Loss of Offsite

CR1573984, OEDB 01-027168(OE12011) 3 B Emergency Diesel Generator Failed

CR1449082, NRC Information Notice 2007-36, Emergency Diesel Generator

CR1498459, MNT NSRB Subcommittee of 4/3/2013 recognized the need to ensure that DG procedure upgrades are occurring

CR1898003, Evaluate the station response to the extent of condition of 2A D/G

CR1897592, Documentation of EDG Electrical and Controls evaluation report

CR1497642, The 2A D/G Output Breaker tripped on reverse power while paralleling to offsite

CR1497655, Operations was paralleling 2A DG back to the ETA from the control room

CR1497685, 2A D/G reverse power tripped while being shutdown

CR1502447, 2A D/G Power factor intermittently decreased to .9 lagging factor

CR1499057, 2EQC VR SCR Currents were balanced per WO

CR2114139, 2EQC VRA: Adjust SCR currents with running 2A running

CR1527571, 1B D/G SCR percentage deviation was 12 percent

CR1513460, SCR current deviation greater than 10 percent

CR1496670, 1A D/G failed the operability PT due to failure of SCR

CR1438872, D/G Voltage Regulator SCR current measurements

CR1483094, During the 1B EDG voltage regulator PM, current measurements

CR1489938, While taking SCR readings on WO 198651002 SCR#1 was found greater than 10 percent

CR1499137, 2A DG Frequency not consistent with speed during mechanical governor checkout