Omaha Public Power District
444 South 16th Street Mall
Omaha, NE 68102-2247

LIC-12-0051
May 24, 2012

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

References:
1. Docket Number 50-285
2. Letter from OPPD (D. J. Bannister) to NRC Document Control Desk (DCD) dated October 27, 2011 (LIC-11-0106)
3. Letter from NRC (A. Vegel) to OPPD (D. J. Bannister) dated March 12, 2012 (NRC-12-0022)(EA-12-023)
4. Letter from OPPD (D. J. Bannister) to NRC Document Control Desk (DCD) dated March 22, 2012 (LIC-12-0030)
5. Letter from NRC (E. E. Collins) to OPPD (D. J. Bannister) dated April 10, 2012 (EA-12-023)
6. Letter from OPPD (D. J. Bannister) to NRC Document Control Desk (DCD) dated May 9, 2012 (LIC-12-0068)

SUBJECT: NRC Inspection Report 05000285/2012010, Reply to a Notice of Violation (NOV); EA-12-023

In Reference 5, the Nuclear Regulatory Commission (NRC) transmitted a Red Finding and a Notice of Violation (NOV) to the Omaha Public Power District (OPPD). This Red finding involved the failure to ensure that the General Electric AKD-5 480 Vac electrical switchgear design requirements were properly implemented and maintained through proper maintenance, modification, and design activities along with the failure to implement and maintain in effect all provisions of the fire protection program.

OPPD performed an initial root cause analysis to determine the causes of the switchgear fire and develop associated corrective actions. However, to ensure a complete understanding of the causes of the fire an independent third party analysis was performed. The original due date for the response to EA-12-023 was May 10, 2012. In order to complete the third party analysis and report the results in the response to EA-12-023, a 14 day extension was requested and granted by Mr. Jeff Clark of the Region IV NRC staff. The basis for the extension is provided in Reference 6.

Pursuant to 10 CFR 2.201, OPPD admits the violations occurred and a response to the NOV is provided in the enclosure to this letter.

OPPD recognizes the potential safety importance of fires; therefore, the prevention of fires is of the utmost importance to OPPD. Actions have been completed to bring OPPD into compliance with the specific deficiencies in station procedures, equipment and training as

identified in Reference 5. Additional actions are planned to address deficiencies in station human performance, safety culture and problem identification and resolution.

This letter contains regulatory commitments that are summarized on the last page of the enclosure. If you should have any questions, please contact me.

D. J. Bannister
Site Vice President and CNO

Enclosure

DJB/rmc

c: E. E. Collins, Jr., NRC Regional Administrator, Region IV
L. E. Wilkins, NRC Project Manager
J. C. Kirkland, NRC Senior Resident Inspector

REPLY TO A NOTICE OF VIOLATION

Omaha Public Power District
Fort Calhoun Station

Docket No. 50-285
License No. DPR-40
EA-12-023

During an NRC Inspection conducted from September 12, 2011 to February 29, 2012, violations of NRC requirements were identified. In accordance with the NRC Enforcement Policy, the violations are listed below:

A. 10 CFR Part 50, Appendix B, Criterion III, "Design Control," requires, in part that: (1) design changes, including field changes, be subject to design control measures commensurate with those applied to the original design; (2) measures be established to assure that applicable regulatory requirements and the design basis for safety-related structures, systems and components are correctly translated into specifications, drawings, procedures, and instructions; and (3) these measures assure that appropriate quality standards are specified and included in design documents and that deviations from such standards are controlled.

Contrary to the above requirement, from November 2009 to June 7, 2011, the licensee failed to ensure that design changes were subject to design control measures commensurate with those applied to the original design; failed to assure that applicable regulatory requirements and the design basis for safety-related structures, systems, and components were correctly translated into drawings, procedures, and instructions; and failed to ensure that these measures assured that appropriate quality standards were specified and included in the design documents. Specifically, design reviews, work planning and instructions for a modification to install new 480 Vac load center breakers failed to ensure that the cradle adapter assemblies had low resistance connections with the switchgear bus bars by establishing a proper fit and requiring low resistance connections to assure that design basis requirements were maintained.

B. 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action, " requires in part, that measures be established to assure that conditions adverse to quality such as failures, defective material and equipment, and non conformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition.

Contrary to the above requirement, from May 22, 2008, to June 7, 2011, the licensee failed to assure that the cause of the significant condition advise to quality was determined and corrective action was taken to preclude repetition. Specifically, the licensee failed to ensure that their preventative maintenance program for the safety-related 480 Vac electrical power distribution system was

adequate to ensure proper cleaning of conductors, proper torqueing of bolted conductor or bus bar connections, and adequate inspection guidance for abnormal connection temperatures. In 2008, the licensee identified that preventative maintenance procedure EM-PM-EX-1200, "Inspection and Maintenance of Model AKD-5 Low Voltage Switchgear," was less than adequate as a result of a root cause analysis for the failure of bus-tie breaker BT-1B3A to close on demand and loss of bus 1B3A The licensee categorized this failure as a significant condition adverse to quality. The analysis concluded that breaker BT-1B3A had high resistance connections which occurred as a result of both procedure deficiencies and inadequate implementation resulting in the failure to remove dirt and hardened grease from electrical connections. The licensee implemented corrective actions to address these procedural deficiencies; however the corrective actions were inadequate to prevent high resistance connections in load center 1B4A due to the presence of hardened grease and oxidation. The procedure did not contain adequate guidance for torqueing bolted connections or measuring abnormal connection temperatures due to loose electrical connections in the bus compartment of the switchgear.

C. License Condition 3.0, "Fire Protection Program," requires, in part, that the licensee implement and maintain in effect all provisions of the approved Fire Protection Program as described in the Updated Safety Analysis Report and as approved in NRC safety evaluation reports. Section 9.11.1 of the Updated Safety Analysis Report describes the fire protection system design basis and states, in part, that the design basis of the fire protection systems includes commitments to 10 CFR Part 50, Appendix R, Section III.G. "Fire protection of safe shutdown capability," Section III.G.1.a., requires, in part, that fire protection features be provided for structures, systems, and components important to safe shutdown, and that these features be capable of limiting fire damage so that one train of systems necessary to achieve and maintain hot shutdown conditions is free of fire damage.

Contrary to the above requirement, from November 2009, to June 7, 2011, the licensee failed to implement and maintain in effect all provisions of the approved Fire Protection Program. Specifically, the licensee failed to ensure that design reviews for electrical protection and train separation of the 480 Vac electrical power distribution system were adequate to ensure that a fire in load center 1B4A would not adversely affect operation of redundant safe shutdown equipment in load center 1B3A, such that one train of systems necessary to achieve and maintain hot shutdown conditions were free of fire damage. Combustion products from the fire in load center 1B4A migrated across normally open bus-tie breaker BT-1B4A into the non-segregated bus duct, shorting all three electrical phases. The non-segregated bus ducting electrically connected load center 1B4A with the Island Bus 1B3A-4A and, through normally closed bus-tie breaker BT-1B3A, to the redundant safe shutdown train.

These violations are associated with a Red Significance Determination Process finding,

OPPD Response – NOV A

1. Reason for the Violation

Due to aging issues and the lack of spare parts, a total of twelve original 480 Vac General Electric (GE) AK-50 circuit breakers were replaced during the 2009 FCS refueling outage. The GE AK-50 circuit breakers were replaced because they were approximately 40 years old. The twelve circuit breakers were replaced on nine 480 Vac safety-related switchgear buses. The GE original equipment was replaced with Square D circuit breakers supplied through Nuclear Logistics Incorporated (NLI).

The original GE AK-50 circuit breakers racked into the circuit breaker cubicles making direct insertion onto the bus stabs. The switchgear was manufactured with welded aluminum bus work transitioning to welded aluminum to copper bus stabs. The original copper bus stabs were supplied with a silver contact area of approximately one inch that the original GE AK-50 circuit breaker finger clusters made electrical contact. For most environments the silver plating provides a higher conductive material to maintain a high quality electrical connection for long periods of time.

The Square D circuit breakers were not an exact replacement for the GE equipment; therefore, a cradle assembly was utilized to ensure that the Square D equipment would match-up to the GE switchgear. The cradle assembly consists of finger clusters that engage the bus bars on the back of the GE switchgear, and has stabs on the circuit breaker side of the cradle assembly that accept the circuit breaker finger clusters. The replacement circuit breaker finger clusters that engage the bus bars were longer than the original circuit breaker finger clusters and did not engage the silver-plated area of the bus stabs. The circuit breaker finger clusters engaged the bus bar in a contact area of hardened grease which is the most likely cause of a high resistance connection at the stab to finger interface. The high resistance connection overheated the finger cluster resulting in bus grounding and phase-to-phase shorting.

An analysis determined that the root cause of the fire in the 480 Vac bus 1B4A was the FCS design process failed to identify critical parameters and interfaces such as the silver plating contact area on the switchgear cubicle bus stabs, and the critical differences in dimensions that impact the cradle alignment with the circuit breaker cubicle when specifications for the replacement for the original GE AK-50 circuit breakers were developed. The analysis also identified the following contributing causes:

- Design engineers had limited knowledge of GE AKD-5 switchgear which resulted in over-reliance on vendor knowledge and skill.
- A modification procedure lacks requirements to identify and compare critical design requirements for the use of operating experience criteria.
- The design change specifications did not consider the partial plating of the GE-AKD-5 switchgear stabs, resulting in the replacement circuit breaker cradles engaging the bus stabs at the edge of and beyond the silver-plated contact area.
- As-left resistance readings from the line to load side of the switchgear finger cluster engagement following circuit breaker replacement were not confirmed.

2. Corrective Steps Taken and the Results Achieved

- Applicable modification procedures were revised to include requirements for the identification of critical interface characteristics during the design process.
- Applicable modification procedures were revised to include requirements for expanding the operating experience search criteria to include both internal and external applicable documents.
- The AKD-5 switchgear bus bar engagement area for the replacement 480 Vac circuit breaker finger clusters were silver plated to ensure full engagement of the finger clusters.
- The 12 replacement circuit breaker cradles were adjusted to ensure that the circuit breaker finger clusters engaged the silver-plated area. The finger cluster to bus bar engagement was confirmed through acceptable as-left resistance readings of the line to load side connections of the applicable switchgear.

3. Corrective Steps That Will be Taken

- Switchgear and circuit breaker training will be included in the engineering initial and continuing training programs by September 3, 2012.
- A trending program that evaluates resistance measurements of the finger cluster to bus bar engagement line to load side connections of applicable switchgear during preventative maintenance activities will be developed by September 15, 2012.

4. Date When Full Compliance Will be Achieved

Based on the completion of required revisions to appropriate modification procedures and physical changes to the affected 480 Vac switchgear buses, OPPD is currently in compliance.

OPPD Response – NOV B

1. Reason for the Violation

The FCS 480 Vac electrical distribution system consists of nine switchgear buses that power safety-related equipment required for the operation of the plant. The switchgear is GE AKD-5 480 Vac switchgear that was installed during construction of FCS and has been in service for approximately 40 years.

The switchgear was manufactured with welded aluminum bus work transitioning to welded aluminum to copper bus stabs that are tipped with approximately one inch of silver plating. The original copper bus stabs were supplied with a silver contact area of approximately one inch that the original GE AK circuit breaker finger clusters make electrical contact. For most environments the silver plating provides a higher conductive material to maintain a high quality electrical connection for long periods of time.

To ensure the reliability of the switchgear, periodic preventative maintenance (PM) actions (e.g., cleaning, bolt torqueing, connection resistance checks, etc.) must be performed. From 1997 to the present, the PM procedure for the inspection and maintenance of model AKD-5 480 Vac switchgear contained instructions to clean and inspect the bus side of the switchgear; however, the FCS PM strategy has not included the bus side inspections of the switchgear. The switchgear design is such that access to the bus compartment of the switchgear is extremely difficult and FCS PM procedures did not contain sufficient instructions to remove the switchgear bus compartment inspection covers. The electrical maintenance department incorrectly interpreted the lack of instructions to mean that bus compartment maintenance was not required and maintenance was performed only in accessible areas of the switchgear. The requirement to periodically inspect the bus compartment has been opposed due to these switchgear access restrictions.

The reason for the violation is a procedural gap between the vendor and industry recommended cleaning, inspection, and testing recommendations. OPPD instituted Reliability Centered Maintenance (RCM) in 1991. RCM performed a rigorous evaluation of the vendor recommended maintenance at the task level. RCM used Failure Modes Effect Analysis to look at how the equipment could fail. RCM then used the vendor manual to create a PM program designed to prevent the failure modes identified. In 2006, OPPD began to use the Equipment Reliability Optimization Program (EROP) to institute changes to the PM program to improve the reliability of critical equipment, including circuit breakers. The EROP established critical equipment and determined maintenance frequencies by using industry best practices. This review was conducted at a high level and did not review specific tasks required to accomplish the high level PM objectives. Subsequent reviews and the EROP failed to identify task level vendor recommendations.

Previous corrective actions for bus tie circuit breaker BT-1B3A failing to close in 2008 did not consider procedure changes to require switchgear panel removal, nor were design changes made to allow easier access to the bus side of the switchgear.

An analysis of the FCS PI&R culture issues concluded that flawed mental models, misguided beliefs and misplaced values have driven, influenced, and permitted the misalignment of the individual, leader, and organizational behaviors (norms) needed for effective and timely detection, evaluation, and correction of performance deficiencies. The FCS organizational values regarding PI&R preclude a self-improving culture and learning environment.

The analysis also concluded that:

- The FCS organization has not consistently displayed the leadership and oversight skills necessary to reinforce expectations and to hold personnel accountable for successful completion of PI&R activities.
- Organizational leadership has designated personnel to perform and approve cause analyses without ensuring those individuals have sufficient skills and knowledge to perform cause analyses and to plan solutions using a systematic method.
- Significant events and equipment failures have recurred indicating weaknesses in cause analysis and timely and effective problem resolution.
- Previous corrective action plan steps were not developed using a systematic change management process to assure the right mental model was being implemented from the start and to assure the follow-through monitoring and coaching was incorporated to anchor the desired PI&R behaviors in the field.
- Station effectiveness reviews are not conducted in a manner and to a depth that assures that corrective actions for precluding problem repetition have been institutionalized.

2. Corrective Steps Taken and the Results Achieved

- GE 480 Vac AKD-5 switchgear was modified to add access panels that allow for the safe inspection and cleaning of the AKD-5 switchgear buses.
- The GE 480 Vac AKD-5 switchgear bus PM procedure was revised to include instructions for the cleaning of conductors, proper torqueing of bolted conductor or bus bar connections, and inspection guidance for abnormal connection temperatures.
- PM tasks that included the cleaning of conductors and proper torqueing of bolted conductor and bus bar connections were completed for the GE AKD-5 480 Vac switchgear buses.
- The FCS corrective action process was revised and implemented. This program provides enhanced expectations for the FCS PI&R culture.

- Prior to implementation of the revised corrective action process, FCS site wide training was provided for Condition Report Owners, Corrective Action Review Group members, Root Cause Analysts, Corrective Action Review Board members, Daily Screening Team members, etc. This training provided the "right picture" expectations for effectively applying the mental models, beliefs, values and behaviors needed for the effective and timely detection, evaluation, and correction of performance deficiencies.
- Training was provided to FCS leaders to provide the "right picture" expectations for effectively applying the mental models, beliefs, values and behaviors needed for the effective and timely detection, evaluation, and correction of performance deficiencies.
- Additional corrective actions and effectiveness reviews on PI&R culture improvements are being tracked through the FCS corrective action program.

3. Corrective Steps That Will be Taken

- A trending program that evaluates testing resistance measurements of the finger cluster to bus bar engagement line to load side connections of applicable switchgear during preventative maintenance activities will be developed by September 15, 2012.

4. Date When Full Compliance Will be Achieved

Based on the revision to the 480 Vac PM procedures and the completion of the affected 480 Vac bus PM activities, OPPD is currently in compliance.

OPPD Response – NOV C

1. **Reason for the Violation**

On June 7, 2011, while in mode 5 (refueling shutdown condition), a fire in 480 Vac load center 1B4A resulted in a loss of power to loads supplied from the 1B4A load center, as well as a trip of the main supply circuit breaker to load center 1B3A which is associated with the redundant train of safety-related 480 Vac power to FCS. This was a violation of the requirements of 10 CFR 50, Appendix R, Section III.G.1.a, "Fire Protection of Safe Shutdown Capability," which requires, in part, that one train of systems necessary to achieve and maintain hot shutdown conditions be free of fire damage.

During normal plant operation, 480 Vac load center main and appropriate bus tie circuit breakers are expected to remain closed to provide 480 Vac power to their associated buses. In the event of a fault on the associated bus, a load center main or bus tie circuit breaker should open to isolate the fault without opening the next circuit breaker upstream, i.e., the circuit breakers should coordinate to isolate the fault by preserving power to loads not directly impacted by the fault.

The original main and bus tie GE AK-50 circuit breakers were equipped with oil dashpot overcurrent trip devices. Due to reliability concerns, the oil dashpots were replaced with GE RMS 9 solid state overcurrent trip devices in 1993. Due to spurious operation of these trip devices, they were replaced with Westinghouse Amptector trip devices in 1996. Reliability improved with the Amptector trip devices; however, due to aging concerns, the circuit breakers were replaced with Square D Masterpact NW circuit breakers equipped with Micrologic overcurrent trip units in the 2009 modification.

Extensive analysis and vendor testing of the 1B3A main and bus tie circuit breakers that were in-service at the time of the June 7, 2011, 1B4A fire was performed. The circuit breakers were tested in a configuration to replicate field conditions at the time of the fire as closely as possible. Approximately 12,500 amps were applied into both circuit breakers to simulate a fault. If the circuit breakers are properly coordinated, the bus tie circuit breaker should open in approximately 0.3 seconds and the main circuit breaker should remain closed. Contrary to expectations, the main circuit breaker tripped in 0.05 seconds and the bus tie circuit breaker did not open which indicated that the circuit breakers would not coordinate when subjected to fault current.

The Square D Masterpact NW circuit breaker Micrologic overcurrent trip units contain an optional Zone Selective Interlock (ZSI) that when used, allow adjacent circuit breakers to communicate with each other to minimize opening time during a fault. The ZSI feature is not part of the FCS design and was not available in the original GE circuit breakers. The consequence of not disabling the ZSI feature of

the main circuit breaker is that the circuit breaker will open when it senses the fault current with no intentional time delay (i.e., the main circuit breaker will trip instantaneously before the bus tie circuit breaker).

An inspection of the 1B3A main circuit breaker wire jumpers revealed that the reason the 1B3A main circuit breaker opened was that wire jumpers were not properly configured to disable the ZSI, thus allowing the main circuit breaker to open during the 1B4A fire instead of the 1B3A bus tie circuit breaker.

Vendor documents state that the Masterpact NW breakers are supplied with the ZSI feature disabled. However, the cause analysis concluded that the 1B3A circuit breaker/cradle assembly was received at FCS without the ZSI feature properly disabled. Vendor factory acceptance testing, FCS receipt inspection, and post modification testing of the new circuit breakers failed to identify the wired jumper error on circuit breaker/cradle assembly 1B3A, because the test module used to perform the acceptance testing bypassed the ZSI zone feature.

Additionally, the FCS design change process does not provide guidance to evaluate design features of new components in regard to the possibility that they may adversely affect required performance characteristics if not properly installed.

The following items contributed to the inadvertent tripping of 1B3A main circuit breaker:

- Detailed standards for performing and documenting wire/continuity checks for new wiring do not exist.
- A questioning attitude by FCS personnel was not employed concerning the details of the operation of the replacement Masterpact NW circuit breakers.
- The Masterpact NW circuit breaker vendor manual does not clearly state the consequences of not disabling the ZSI.

2. Corrective Steps Taken and the Results Achieved

- The 1B3A circuit breaker ZSI was disabled and the circuit breaker returned to service.
- The remaining 11 Masterpact NW main and bus tie circuit breaker wired jumpers were inspected and the ZSI on these circuit breakers were found to be correctly disabled. Since the ZSI on the remaining 11 Masterpact NW circuit breakers were properly disabled, the potential for the opening of other redundant safety-related circuit breakers did not exist at the time of the 1B4A fire.
- Circuit breaker maintenance procedures were revised to verify that the appropriate ZSI remain disabled.

3. Corrective Steps That Will be Taken

- Appropriate design control procedures will be revised to require FCS personnel to contrast features of new equipment with the original equipment including a consideration of potential adverse impact of new features on required performance characteristics; require modifications to test in the as-built condition whenever possible; and document critical parameters within the design change process. This will be completed by June 15, 2012.
- Modifications of equipment supplied by Nuclear Logistics, Incorporated, will be reviewed to determine if they contain wiring errors that testing would not have identified. This will be completed by June 29, 2012.
- Appropriate procedures will be revised to provide instructions for verifying new wiring installations by July 11, 2012.
- Lessons learned from this event will be incorporated into the design engineering risk and rigor procedure by August 15, 2012.
- A case study that identifies the specifics of this event and reinforces the use of the human performance toolbox will be developed and provided to appropriate FCS personnel by September 15, 2012.
- A review of modifications that were created/implemented within a selected nine-month window will be performed to determine if failure modes introduced by features that were not part of original equipment could have been introduced will be completed by April 15, 2013.
- A review of modifications that were created/implemented within a selected18-month window will be performed to determine if failure modes introduced by features that were not part of the original equipment could have been introduced will be completed by January 15, 2014.

4. Date When Full Compliance Will be Achieved

Based on the identification and correction of the wiring error in circuit breaker 1B3A, OPPD is currently in compliance.

Regulatory Commitments

Commitment	Due Date	CR Number
Switchgear and circuit breaker training will be included in the engineering initial and continuing training programs.	September 3, 2012	2011-5414
A trending program that evaluates testing resistance measurements of the line to load side connections of applicable switchgear during preventative maintenance activities will be developed.	September 15, 2012	2011-5414
Appropriate design control procedures will be revised to require FCS personnel to contrast features of new equipment with the original equipment including a consideration of potential adverse impact of new features on required performance characteristics; require modifications to test in the as-built condition whenever possible, and document critical parameters within the design change process.	June 15, 2012	2011-6621
Modifications of equipment supplied by Nuclear Logistics, Incorporated, will be reviewed to determine if they contain wiring errors that testing would not have identified.	June 29, 2012	2011-6621
Appropriate procedures will be revised to provide instructions for verifying new wiring installations.	July 11, 2012	2011-6621
Lessons learned from this event will be incorporated into the design engineering risk and rigor procedure.	August 15, 2012	2011-6621
A case study that identifies the specifics of this event and reinforces the use of the human performance toolbox will be developed and provided to appropriate FCS personnel.	September 15, 2012	2011-6621
A review of modifications that were created/implemented within a selected nine month window will be performed to determine if failure modes introduced by features that were not part of original equipment could have been introduced will be completed.	April 15, 2013	2011-6621
A review of modifications that were created/implemented within a selected 18-month window will be performed to determine if failure modes introduced by features that were not part of original equipment could have been introduced will be completed.	January 15, 2014	2011-6621