March 20, 2001

MEMORANDUM TO: Kenneth E. Brockman, Director
Division of Reactor Projects, Region IV

FROM: Suzanne C. Black, Deputy Director ***/RA by John A. Zwolinski Acting for/***
Division of Licensing Project Management, NRR

SUBJECT: REQUEST FOR TECHNICAL ASSISTANCE - EVALUATION OF DC SYSTEM GROUNDS AT COOPER NUCLEAR STATION
TIA 00-20 (TAC NO. MB0877)

By memorandum dated December 20, 2000, Region IV requested Office of Nuclear Reactor Regulation (NRR) technical assistance to determine if the licensee has “reasonable assurance that the 125-volt dc circuits in the drywell would have remained operable during a high energy line break, or would the 10-amp circuit fuses have likely opened resulting in a common cause failure of both trains" of 125-volt circuits.

Background - As a result of root cause findings relating to a reported deficiency with the environmental qualification (EQ) program at the Cooper Nuclear Station (CNS), the licensee as part of its commitment to long term corrective actions, performed a review of its existing EQ program design bases against its document files supporting EQ of equipment. The licensee’s review identified, in part, a nonconforming condition in which a specific type of EQ equipment (PCI Pressure Switches) may be installed at CNS without conduit seals. The tested configuration used rigid conduit routed through the test chamber wall. This effectively sealed off the switch internals and wire leads from the loss-of-coolant accident (LOCA) test environment. Therefore, the existing CNS installed configuration that utilizes rigid conduit attached to the switch and then run to an unsealed junction box within the drywell does not adequately represent the tested configuration. The installed configuration could potentially allow steam/moisture intrusion to the switch internals for which it may not be qualified. Thus, the licensee determined that the EQ design basis for PCI pressure switches were in an installed configuration that was not supported by a test/analysis included in its document files.

The NRC inspectors found that the switches, as well as indication and controls for the safety relief valves (SRVs), were powered through a 10-amp-fused circuit from the safety related 125-volt dc system. A concern was expressed that multiple flow paths for electric current to ground may result in the dc system when these nonconforming EQ switches (as well as other nonconforming EQ equipment) are exposed to a harsh environment during a LOCA. These multiple flow paths could cause a current greater than 10-amps in the SRV 10-amp-fuse protected circuits causing loss of the SRVs.

The licensee, based on operability assessment (OE 4-11673 revision 01), concluded that a maximum of 9.13-amps could flow through the SRV 10-amp-fuse protected circuit. The NRC inspectors reviewed the licensee’s operability assessment, and determined that the licensee had not applied uncertainty tolerance to the resistive values used in its current analysis. The inspectors concluded that, if appropriate uncertainty margin was applied, the fuses could open and result in the loss of SRV capability.

Region IV, by a memorandum to the Division of Licensing Project Management dated December 20, 2000, requested NRR assistance in determining whether the NRR staff agrees with the licensee's operability assessment or with Region IV's conclusion that the current through the SRV 10-amp-fuse protected circuit could be greater than 10-amps.

NRR evaluated the licensee's operability evaluation and determined that it was unable to find a reasonable assurance that the 125-volt dc SRV circuit would have remained operable during a high energy line break or a LOCA. The NRR staff concluded that when current paths to the ground are postulated on both positive and negative sides of the dc power supply, the current paths create a short circuit condition. This short circuit condition can have an adverse impact on the operability of the dc power supply and its distribution system. The potential loss of the dc power supply as a result of a LOCA will have a significant impact on the plant risk. A safety evaluation prepared by the NRR's Division of Engineering supporting the above conclusions is attached.

Docket No. 50-298

Attachment: As stated

cc w/att: B. Platchek, RI
L. Plisco, RII
G. Grant, RIII

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION (NRR)

RELATED TO TIA 00-20 (TAC NO. MB0877)

NEBRASKA PUBLIC POWER DISTRICT

COOPER NUCLEAR STATION

DOCKET NO. 50-298

A Region IV memorandum to the Division of Licensing Project Management dated December 20, 2000, (Reference 3) requested NRR assistance in determining the following:

- Does the licensee have reasonable assurance that the 125-volt dc circuits in the drywell would have remained operable during a high energy line break, or would the 10-amp circuit fuses have likely opened resulting in a common cause failure of both trains?

Background

As a result of root cause findings relating to a reported deficiency with the environmental qualification (EQ) program at the Cooper Nuclear Station (CNS) (Reference 1), the licensee as part of their commitment to long term corrective actions performed a review of their existing EQ program design bases against their document files supporting EQ of equipment. This review identified, in part, a nonconforming condition in which a specific type of EQ equipment (PCI Pressure Switches) may be installed at CNS without conduit seals. The tested configuration used rigid conduit routed through the test chamber wall. This effectively sealed off the switch internals and wire leads from the loss-of-coolant-accident (LOCA) test environment. Therefore, the existing CNS installed configuration that utilizes rigid conduit attached to the switch and then run to an unsealed junction box within the drywell does not adequately represent the tested configuration. The installed configuration could potentially allow steam/moisture intrusion to the switch internals for which it may not be qualified. Thus, the licensee determined that the EQ design basis for PCI pressure switches were in an installed configuration that was not supported by a test/analysis included in their document files.

An Nuclear Regulatory Commission (NRC) special inspection (Reference 2) found these switches, as well as indication and controls for the safety relief valves (SRVs), powered through a 10-amp-fused circuit from the safety related 125-volt dc system. A concern was expressed that multiple flow paths for electric current to ground may result in the dc system when these nonconforming EQ switches (as well as other nonconforming EQ equipment) are exposed to a harsh environment during a LOCA. These multiple flow paths could cause a current greater than 10-amps in the SRV 10-amp-fused circuits causing loss of the SRVs.

ATTACHMENT

The licensee's operability assessment (OE 4-11673 revision 01) concluded that a maximum of 9.13-amps could flow through the SRV 10-amp-fused circuit. This 9.13-amps was derived from the summation of the following currents:

- 2-amps assumed as the normal circuit current,
- 1.13-amps based on the ground detection system load resistance and zero resistance at the PCI pressure switch due to its being in an EQ nonconforming condition, and
- 6-amps based on a 20.96 Ohm circuit breaker (trip coil) load resistance and zero resistance to ground at valve limit switches and at one (or all) PCI pressure switches due to the EQ nonconforming condition.

The licensee also provided a supplemental assessment, "White paper for SRV past operability," relating to the above described concern. This supplemental assessment concluded that a maximum of 8.248-amps could flow through the SRV 10-amp-fused circuit. The 8.248-amps was derived from the summation of the following currents:

- 1.401-amps based on dc system load and voltage study (NEDC 87-131C, Revision 8) for maximum normal circuit amperage,
- 1.13-amps based on the ground detection system load resistance and zero resistance to ground assumed on the positive side of one (or all) PCI pressure switches (MS-PS-300A-H) due to the EQ nonconforming condition,
- 0.464-amps [the sum of eight indicating lights with each having a load rating of 0.046-amps per NEDC 87-131C and eight relays each having a load rating of 0.012-amps per NEDC 87-131C] based on zero resistance to ground assumed at each of the eight SRV accumulator pressure alarm switches (MS-PS-256A-H) and at one (or all) PCI pressure switches due to the EQ nonconforming condition,
- 3.36-amps [breaker trip coil drawing 3.36-amps at 70 volts] based on zero resistance to ground assumed at either RR-MO43A/B or RR-MO53A/B limit switches and at one (or all) PCI pressure switches due to the EQ nonconforming condition.
    - 6-amps [breaker trip coil design rating is 6-amps per NEDC 87-131C] was not considered because it will energize the breaker in 50 milliseconds removing the ground fault at RR-MO43A/B or RR-MO53A/B limit switches.
- 0.032-amps [relay having a load rating of 0.032-amps per NEDC 87-131C] based on zero resistance to ground assumed at RR-MO53 limit switch and at one (or all) PCI pressure switches due to the EQ nonconforming condition.
- 0.556-amps [the sum of four MSIV solenoid valves having a load rating of 0.139-amps] based on zero resistance to ground assumed on the positive side of each of the four MSIV solenoid coils and at one (or all) PCI pressure switches due to the EQ nonconforming condition.
    - Greater than 10-amps based on zero resistance to ground assumed on the negative leads of the MSIV solenoid coil and at one (or all) PCI pressure switches due to the EQ nonconforming condition. [This fault was not included because of its being removed by the 5-amp MSIV circuit opening to remove the fault.]

- 1.305-amps assuming a 100 ohm resistance to ground (based on an EQ similarity analysis) at the drywell personnel airlock indicating lights and at one (or all) PCI pressure switches due to the EQ no-conforming condition.

The NRC inspectors determined that the licensee's assessment had not applied appropriate uncertainties (resistive tolerance) for establishing worst case electric current flow through the SRV 10-amp-fused circuit. When the worst case resistive load tolerances are applied, they concluded that the current through the SRV 10-amp-fused circuit could be greater than 10-amps. They felt that the nonconforming EQ conditions coincident with a LOCA would likely cause the circuit fuses to open resulting in a loss of the SRV opening function.

In a Task Interface Agreement (TIA) (Reference 3), Region IV requested assistance in determining the following:

- Does the licensee have reasonable assurance that the 125-volt dc circuits in the drywell would have remained operable during a high energy line break, or would the 10-amp circuit fuses have likely opened resulting in a common cause failure of both trains?

<u>Evaluation:</u>

<u>Does the licensee have reasonable assurance that the 125-volt dc circuits in the drywell would have remained operable during a high energy line break</u>?

Based on a review of the licensee's operability assessment described above, we agree with Region IV's conclusion that the current through the SRV 10-amp-fused circuit could be greater than 10-amps. When a failure (such as, a zero ohm resistance to ground) is postulated to occur at the same time for each of the EQ nonconforming conditions, we believe that the current through the SRV 10-amp-fused circuits could be greater than 10-amps. From the licensee's assessment, we were unable to find a basis for concluding reasonable assurance that the 125-volt dc circuits in the drywell (i.e., the SRV circuits) would have remained operable during a high energy line break or LOCA.

For current through the SRV 10-amp-fused circuit to be greater than the normal circuit current of about 1.4-amps, an electric current conduction path to ground must be present at the pressure switch due to the EQ nonconforming condition. In addition, there must be one or more electric current conduction paths to ground occurring at the same time due to other EQ nonconforming conditions.

Typical fuses have a design capability such that they can support 110 percent of their rating indefinitely and 135 percent of their rating for one hour. The 10-amp SRV fuses (installed at the Cooper plant) are designed to support continuous amperage of 11-amps (and 13.5-amps for a period of one hour). The safety related licensing basis requirement for these 10-amp SRV fuses is to remain closed. Continued compliance with this requirement (over the design life of the Cooper plant) is assured primarily by the fuse manufacturer's qualification testing assuring that the design rating remains relatively constant over the expected life of the fuse and by periodic maintenance assuring that the fuse terminal connection resistance remains low.
Based on (a) design margin (about 8-amps) between the maximum normal SRV circuit current

(2-amps maximum) and the fuse design rating (10-amps), (b) manufacturer's qualification testing, and (c) periodic maintenance, there is reasonable assurance that the SRV fuses will remain closed when needed during a design-basis accident. However, when the circuit current through the 10-amp SRV fuse is increased, potentially, to either 9.13-amps or 8.248-amps as indicated in the licensee's operability assessments, most of the design margin is lost. With the loss of design margin, reasonable assurance, that the SRV fuses will remain closed when needed during a design-basis accident, is lost.

In regard to the EQ nonconforming conditions identified in the electrical circuit associated with the four inboard Main Steam Isolation Valves (MSIVs), we are similarly unable to establish reasonable assurance that the 5-amp MSIV fuse will open before the 10-amp SRV fuse, thus, isolating the MSIV EQ non-conforming condition and its current contribution to the SRV 10-amp-fused circuit. The SRV 10-amp-fused circuits are initially assumed to have greater than 5-amps of current flowing due to normal and the postulated EQ nonconforming conditions. If we postulate an additional zero resistance to ground at the MSIVs, this will create a direct short across the battery. Current would flow through the postulated new ground, the 5-amp MSIV fuse, the battery, the 10-amp SRV fuse, and the initially postulated ground at the pressure switch. With an amperage of greater than 5-amps initially flowing through the 10-amp-fused SRV circuit, there would not be reasonable assurance (with the additional short circuit current amperage) such that the MSIV 5-amp-fuse would open and the 10-amp SRV fuse would remain closed. The possibility exists for the 10-amp SRV fuse to open and for the 5-amp MSIV fuse to either open or remain closed.

The licensee's examination of EQ nonconforming conditions, found no bare wires with the cable laying directly on metal enclosures. The licensee, from this, concluded that the conduction path to ground would be due to surface moisture conduction and that the surface moisture conduction would not result in a bolted fault condition (i.e., a zero ohm resistance to ground condition). We agree that the initial conduction path would most likely be from surface moisture conduction caused by the accident environment. However, we disagree that surface moisture conduction would not result in a bolted fault. If there is a conduction path, we believe that initially there would be heat generated by the resistance created by the surface moisture conduction path to ground. The heat generated by the conduction path could potentially cause (a) the evaporation of surface moisture thus clearing the conduction path, (b) an intermittent conduction path due to evaporation and additional moisture, (c) the cable connection to burn open, (d) a fire leading to failure of adjacent cables, or (e) a fire leading to a continuous low resistance or bolted fault to ground. The surface moisture conduction path could result in a bolted fault condition.

Based on the above, we are unable to find reasonable assurance that the 125-volt dc SRV circuits would have remained operable.

<u>Would the 10-amp circuit fuses have likely opened resulting in a common cause failure of both trains?</u>

Based on the above described evaluation, there will be some increased probability for the 10-amp SRV circuit fuses to open resulting in a common cause failure of both (SRV dc power supply) trains. However, this scenario is unlikely. Ground faults postulated (that are needed for the current through the SRV circuit to exceed an amperage of 10-amps) are not (by design) automatically transferred to the alternate 125-volt dc power supply. For there to be a common cause failure of both (SRV dc power supply) trains, there would need to be other ground faults postulated (and they would need to occur at the same time) on the alternate 125-volt dc power supply. The occurrence of a sufficient number of these ground faults at the same time at different locations is considered unlikely. The more likely scenario (when zero resistance to ground is postulated for each EQ nonconforming condition) would be for the SRV circuit to burn resulting in a common cause failure of one or more SRV circuits. Also, a more likely scenario would be loss of the dc power supply to safety system loads (including the SRV loads) when multiple grounds are postulated. These scenarios were not addressed as part of the licensee's operability evaluation.

The licensee's assessment primarily focused on the operability of SRV circuits when postulating worst case failure (i.e., zero resistance to ground) due to EQ nonconforming conditions. The assessment assumed a current path to ground on the positive side of the dc power supply (only at the SRV pressure switches) in combination with multiple current paths to ground on the negative side of the dc power supply due to other EQ nonconforming components. Potential current ground paths on the positive side (at locations other than at the PSI pressure switches) were ignored. These current paths were ignored because they divert current away from the SRV circuit thus reducing current flowing through the 10-amp fused SRV circuit and reducing the probability that the SRV circuit fuses will open during a LOCA. For the evaluation of SRV circuits, ignoring these current paths may be conservative; however, when current paths to ground are postulated on both the positive and negative sides of the dc power supply, they create a short circuit condition. This short circuit condition can have an adverse impact on the operability of the dc power supply and its distribution system. The potential loss of the dc power supply as a result of a LOCA will have a significant impact on plant risk. This short circuit condition and potential loss of the dc power supply were not addressed as part of the licensee's operability assessment.

Principal Contributor: J. Knox

Date: March 20, 2001

References:

1. Nebraska Public Power District, Cooper Nuclear Station, Licensee Event Report, Non-conservative Drywell Temperature Profile Places Plant in a Condition Outside of Design Basis, August 28, 2000, Adams Accession Number ML003747398

2. Letter dated December 18, 2000, from NRC to Nebraska Public Power District, Cooper Nuclear Station Special Inspection, NRC Inspection Report No. 50-298/00-07, Preliminary Yellow Finding, EA-00-248, Adams Accession Number ML003778318

3. Memorandum to NRR from Region IV dated December 20, 2000, Task Interface Agreement (TIA) - Request for Evaluation of DC System Grounds at CNS (00TIA20), Adams Accession Number ML003779611