UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
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December 13, 2017

NRC INFORMATION NOTICE 2017-05, Revision 1: POTENTIAL BINDING OF SCHNEIDER ELECTRIC/SQUARE-D MASTERPACT NT AND NW 480-VAC CIRCUIT BREAKER ANTI-PUMP FEATURE

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities."

All holders of and applicants for a power reactor early site permit, combined license, standard design approval, or manufacturing license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." All applicants for a standard design certification, including such applicants after initial issuance of a design certification rule.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this revised information notice (IN) to inform addressees about recent issues related to the operation of Schneider Electric/Square-D Masterpact 480-volt alternating current (VAC) NT and NW circuit breakers. The design of the breaker results in a susceptibility to internal binding in certain circumstances that can prevent the breaker from closing on demand. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. Suggestions contained in this IN are not NRC requirements. Therefore, no specific action or written response is required.

This revision supersedes IN 2017-05 in its entirety.

DESCRIPTION OF CIRCUMSTANCES

On March 9, 2015, during Division I emergency core cooling system and loss-of-coolant accident testing at River Bend Station, control building chiller 1C shed from the electrical bus as expected, but then failed to restart and sequence onto the emergency diesel generator. Because of unrelated issues that prevented the other three chillers from starting, this resulted in a loss of control room cooling. Control room ventilation duct air temperatures rose from 18 degrees Celsius (64.5 degrees Fahrenheit) to 23.9 degrees Celsius (75 degrees Fahrenheit) before compensatory measures were implemented. The technical specification limit is 104 degrees Fahrenheit. The failure of chiller 1C to restart was the result of mechanical internal binding of a 480-volt alternating current (Vac) Masterpact NT circuit breaker. The licensee later determined that this same condition had been responsible for nine breaker failures at the site from 2007–2015 and may have been a factor in six additional breaker failures.

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All of these breakers were installed at River Bend Station with a "standing close" signal, where the closing coil of the breaker remained energized while the breaker was in its normal, closed position. This circuit configuration set up a situation where any "open" signal, if received while the breaker was also receiving a "close" signal, would activate the mechanical anti-pump interlock—a feature designed to prevent the circuit breaker from cycling between closing and opening. Testing performed by the breaker vendor and dedicating entity, AZZ/Nuclear Logistics, Inc. (AZZ/NLI), found that the anti-pump mechanism was susceptible to mechanical internal binding of the closing coil plunger, which would prevent the breaker from closing until manual action was taken to operate the breaker locally. The licensee identified susceptible breakers and reconfigured the circuitry so the breakers would no longer be subject to a standing close signal.

Subsequently, the licensee reviewed notifications from AZZ/NLI of additional circuit alignments that could lead to activation of the anti-pump interlock and potentially introduce the same failure mechanism. Specifically, AZZ/NLI determined that all Masterpact NT and NW style remote electrically operated circuit breakers are susceptible to the mechanical internal binding of the anti-pump mechanism and the closing coil plunger if the breaker receives a start signal longer than 200 milliseconds during the approximately 4 seconds it takes for the spring charging motor to recharge the closing springs. The licensee identified additional impacted breakers in multiple systems that had not been included in the original extent of condition checks because they were not subject to a standing close signal. They included breakers for the emergency ventilation fans in the Division 1 and 2 emergency diesel generator rooms, and breakers supplying the Division 1 and 2 containment unit coolers and the Division 1 and 2 auxiliary building general area unit coolers. Subsequent notification from AZZ/NLI alerted the licensee to further potential problems with breakers that had already been modified to address the issue with the standing close signal. The affected breakers could be manually operated to start or stop their associated equipment, if necessary for operation. The licensee identified compensatory measures for each impacted breaker to restore system operability until further modifications could be made. This included placing Division 1 systems in continuous run when possible to avoid susceptibility to the failure mechanism and implementing a standing order with dedicated operators to press the "push to open" button on the breaker after any remote opening during power operations or hot-shutdown conditions. This manual action would clear the binding condition if it occurred and allow the breaker to close if a subsequent close signal was received.

The NRC chartered a special inspection to review the events surrounding the loss of control room cooling. The results of the inspection are available in NRC Special Inspection Report 05000458/2015010, dated February 16, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16047A268). Additional information is available from the River Bend Licensee Event Reports 05000458/2016-005, dated April 25, 2016 (ADAMS Accession No. ML16126A229), and 05000458/2016-006, dated July 12, 2016 (ADAMS Accession No. ML16208A056), and from the 10 CFR Part 21, "Reporting of Defects and Noncompliance," report 2016-20-03 submitted by AZZ/NLI on September 22, 2016 (ADAMS Accession No. ML16278A471).

BACKGROUND

The NRC IN 1988-75, "Disabling of Diesel Generator Output Circuit Breakers by Anti-Pump Circuitry," dated September 16, 1988 (ADAMS Accession No. ML031150110), and its Supplement 1, dated April 17, 1989 (ADAMS Accession No. ML082970437), discuss the circumstances in which simultaneous open and close signals for safety-related equipment actuated anti-pump circuitry on the breakers that disabled the affected equipment until the

anti-pump circuit was manually reset. In these historical cases, the design of the breaker circuitry was such that the anti-pump circuit was sealed in under certain circumstances, preventing breakers from closing. The current issue involves a situation where the anti-pump mechanism is not intended to remain sealed in, but becomes mechanically bound, with the same end result.

DISCUSSION

Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, Criterion III, "Design Control," requires, in part, to subject design changes to control measures commensurate with those applied to the original design. The Masterpact breakers used at River Bend Station and at several other sites are a modification from the original General Electric AKR electrically-operated breakers. The original breakers used an electrical anti-pump interlock feature. The change from the electrical anti-pump interlock to a mechanical anti-pump interlock feature introduces mechanical binding as a potential failure mode.

Additional breaker testing by Schneider Electric identified the following five scenarios in which the circuit breaker could be more susceptible to the mechanical binding condition that would prevent the breaker from being able to reclose on command:

(1) The closing circuit is continually energized during charge and/or open operations.

(2) An anti-pump condition is present.

(3) The breaker receives a command to open electrically before or at the same time as the close command is initiated.

(4) The operator initiates a local or remote electrical closing action that may hold the close signal for longer than 200 milliseconds, which would extend into the closing spring charging cycle.[1]

(5) The logic scheme has a component controlling the close circuit that would apply the voltage to the close coil for longer than 200 milliseconds, extending into the closing spring charging cycle.[1]

In Technical Bulletin TB-12-007, Revision 3, which is attached to the referenced 10 CFR Part 21 report (ADAMS Accession No. ML16278A471), AZZ/NLI provided a proposed modification to the breaker and an updated circuit diagram, shown in Figure 1 of this document. This modification replaces the normal XF (closing) coil in the breaker with an XFCOM coil. The XFCOM coil acts as a oneshot and releases the close coil plunger immediately after the close signal is applied to the breaker and will not reactivate the close coil plunger unless power is first removed from the operating order signal of the XFCOM and then re-applied. With the closing coil plunger retracted, this modification is designed to eliminate the potential for mechanical binding from the anti-pump feature.

[1] The closing springs are electrically recharged automatically each time the breaker closes.

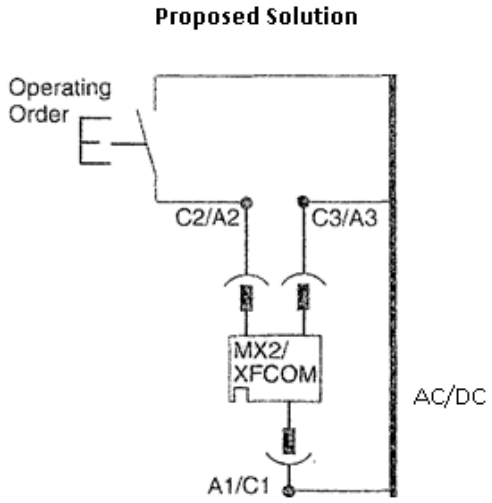

Figure 1: The XF coil in the original logic is replaced by an XFCOM coil, which releases the close coil plunger as soon as the close signal is received, eliminating the potential for binding.

The time periods involved, on the order of a few seconds, make it unlikely that a breaker not wired with a standing close signal will receive a close and an open signal in quick enough succession to expose the breaker to this vulnerability. However, this situation could occur during a design-basis scenario involving a loss of offsite power concurrent with a loss-of-coolant accident. These breakers may be installed for years with no noted issues, but still be vulnerable to a self-revealing failure. Verification that this failure mechanism will not impact the safety function of these breakers can help to ensure that systems are able to respond as intended during a design basis event.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact(s) listed below or the appropriate Office of Nuclear Reactor Regulation or Office of New Reactors project manager.

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Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under NRC Library.

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