

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

October 15, 1998

**NRC INFORMATION NOTICE 98-38: METAL-CLAD CIRCUIT BREAKER MAINTENANCE
ISSUES IDENTIFIED BY NRC INSPECTIONS**

Addressees

All holders of operating licenses for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to inspection findings concerning inadequate preventive and corrective maintenance programs and corrective actions. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

In 1997, failures of safety-related circuit breakers at nuclear power facilities prompted reactive inspections by the NRC. The staff is concerned about these failures because a common failure mode of safety-related circuit breakers could significantly hamper a plant's ability to deal with a transient. This information notice will offer some insights gained from the findings of the reactive inspections.

In response to these recent events, the NRC is now conducting a series of inspections at some nuclear power plants, original equipment manufacturer (OEM) facilities, and third-party overhaul contractor shops to determine the present state of medium-voltage and low-voltage metal clad circuit breaker maintenance and overhaul programs. At the conclusion of these inspections, the staff will evaluate the results, along with the progress made by the Electric Power Research Institute's Nuclear Maintenance Applications Center (EPRI/NMAC) circuit breaker users groups and the Nuclear Energy Institute (NEI) task force, to determine whether further regulatory actions are needed.

The staff recognizes that the industry is working to improve the reliability of medium and low-voltage circuit breakers, as evidenced by the activities of the EPRI/NMAC circuit breaker users groups and the NEI Circuit Breaker Task Force. Those groups are working to issue preventive maintenance and overhaul guidance for breakers made by General Electric, Westinghouse, and Asea Brown Boveri (ABB).

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Description of Circumstances

In 1997, three nuclear power plants were either forced to shut down or to extend an outage, and one plant considered shutting down because a potential common failure mode called into question the operability of safety-related circuit breakers. The NRC sent inspection teams to the four sites to review and evaluate licensee maintenance practices and corrective actions. All of the breakers in the discussions that follow were manufactured by Westinghouse or General Electric, but ABB product lines have also experienced similar problems over the last few years. Issues involving circuit breaker maintenance and overhaul are germane to all manufacturers.

CLINTON POWER STATION

On August 5, 1997, Clinton Power Station was preparing to return to power after an outage when the A-train residual heat removal (RHR) pump supply breaker did not open on demand when operators attempted to swap RHR pumps in the shutdown cooling mode. Only two weeks before this event, on July 22, 1997, the reserve auxiliary transformer (RAT) feeder breaker to the 4-kV bus for Division 1 failed to open when operators attempted to swap the bus feed to the emergency reserve auxiliary transformer. The failed breakers in both instances were Westinghouse Type DHP 4-kV metal clad circuit breakers. Because (1) there appeared to be a common failure mode, (2) the licensee corrective action for the first breaker failure did not prevent the second failure, and (3) there was a poor maintenance history, the NRC dispatched an augmented inspection team (AIT) to the site and issued a demand for information (DFI) letter concerning the licensee's corrective action program and its effectiveness in ensuring the operability and reliability of safety-related systems, and informing the licensee that a response was required before the NRC would authorize a plant restart. The plant remains shut down at this time.

The AIT concluded that both of the circuit breaker failures were caused by inadequate and inappropriate preventive maintenance activities, and deficiencies in Clinton's corrective action program. The preventive maintenance program did not include lubrication of all vendor-recommended areas, most notably in the main and arcing contacts. The licensee also used unapproved cleaning agents, which inadvertently removed vendor-applied lubricant, and then did not relubricate the affected areas. The licensee also did not effectively evaluate the July 22 breaker failure. These combined deficiencies resulted in the introduction of a common failure mode for all of the safety-related 4-kV Westinghouse breakers at the plant. The licensee's investigation of the August 5 breaker failure was significantly more rigorous than the investigation into the July 22 failure had been. However, NRC prompting was necessary at times to ensure a thorough licensee investigation. For example, initially the licensee investigation focused on the lack of lubrication, and did not consider that the opening springs could have contributed to the failure. Subsequent review determined that although the lack of lubrication was the main contributor to the RHR breaker failure, a bent and shortened kick-out spring also played a significant role. Refer to NRC Inspection Report 50-461/97018 (Accession #9712040128) for further details.

INDIAN POINT 2 NUCLEAR POWER PLANT

On October 14, 1997, Consolidated Edison Company of New York voluntarily shutdown its Indian Point 2 Nuclear Power Plant (IP2) because of concerns about the operability and reliability of its safety-related 480-V Westinghouse Type DB-50 circuit breakers. The action was taken after experiencing recurring problems with these breakers to either close on demand or to remain closed.

An NRC inspection identified several weaknesses associated with the licensee's corrective maintenance, preventive maintenance, and other corrective actions concerning circuit breakers. In June 1997, the licensee hired a contractor to perform a root-cause analysis. The contractor's report did not discuss all the possible failure modes and erroneously concluded that the DB-50 breaker failures were caused by malfunctioning solid-state trip devices (Amptectors) and operating mechanism binding caused by accumulated dust and dirt contaminating the mechanism's lubricant. The inadequate root-cause analysis led to the occurrence of more failures, which eventually prompted the October shutdown. Before the plant shutdown, the licensee did not vigorously pursue a root cause after experiencing a breaker failure. Typically, a failed breaker would be removed from service and the preventive maintenance procedure would be performed to restore it to an operable status without identifying the cause of the problem.

Following the plant shutdown, the IP2 licensee conducted an extensive testing program to determine the root cause of the breaker failures. High-speed video, static and dynamic closing coil current measurements, component displacements, and force measurements were made, which identified several contributors to breaker failures. Refer to NRC Inspection Report 50-247/97-13 (Accession #9802250110) for further details. The licensee has developed useful diagnostic tools that could help in revealing or predicting breaker performance problems.

COOPER NUCLEAR STATION

On October 5, 1997, failure of a non-safety-related General Electric 4-kV (Magne-Blast) circuit breaker prompted the Cooper licensee to review its breaker maintenance and overhaul program. The review identified 6 of 24 safety-related 4-kV breakers that had not been overhauled during the 23 years of plant operation. The affected breakers included two emergency diesel output breakers, two residual heat removal pump breakers, a service water pump breaker, and a 4-kV/480-V transformer supply breaker. The licensee initially considered shutting the plant down if the six safety-related breakers were judged to be inoperable. Subsequent discussions with GE about the condition of these breakers determined that the breakers were in a degraded but operable condition. The licensee implemented an accelerated program to overhaul the six breakers.

The NRC sent an inspection team to the site on October 20, 1997, to review the causes and circumstances associated with this issue. The team found that the licensee experienced several problems with the GE Magne-Blast breakers in the late 1980's and implemented a program to overhaul its safety-related 4-kV breakers, but for reasons unknown, the program was terminated in 1994 with 6 of the breakers not being overhauled. The licensee's operating experience review program did not include review of the vendor's service advice letters (SALs),

which are issued to alert customers to changes in maintenance recommendations or physical design changes made in subcomponent piece parts to address a specific identified problem. In addition, licensee review of NRC information notices was narrowly focused and sometimes did not consider the information provided in a specific notice as applicable to Cooper because of minor differences between the model numbers discussed in the notice and the components used at Cooper. Several inconsistencies were identified between licensee maintenance procedures and vendor recommendations. The licensee did not have adequate justification for many of the identified inconsistencies. Refer to NRC Inspection Report 50-298/97018 (Accession #9712220092) for further details.

INDIAN POINT 3 NUCLEAR POWER PLANT

On December 18, 1997, at Indian Point 3 Nuclear Power Plant (IP3), an RHR pump breaker (Westinghouse Type DS-416) failed to open to disconnect the pump motor from its 480-V emergency electrical bus at the end of a surveillance run. The electrical bus was declared inoperable, which forced a plant shutdown. The NRC sent a special inspection team to the site because of the potential generic implications. On December 22, 1997, during testing of additional breakers, another safety-related breaker was found to be potentially degraded.

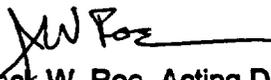
Investigation of the failed RHR pump breaker found that factory-applied lubrication (poxylube) had been removed from several locations on the operating mechanism during overhaul by a third-party contractor during refurbishment activities in 1994. Neither the licensee nor the contractor knew about the use of poxylube because the information was considered proprietary by the OEM and, as a result did not appear in any of the vendor's literature. The vendor's manual specifies some preventive maintenance actions to be taken by the customer but recommends that the breaker be returned to Westinghouse for disassembly and overhaul of the operating mechanism.

The lack of lubrication was a primary contributor to the breaker failure but the licensee and Westinghouse discovered another anomaly during the investigation. With the pole shaft reset spring removed, some breakers could be made to lock up in the closed position. Normal operation of the breaker calls for the reset spring to be installed, but the spring was removed to facilitate testing of the failed breaker. The investigation found that a combination of wear, inadequate lubrication, and clearances in the linkage subcomponents (clevises, pins, and support points) could allow the pole shaft to overtravel and cause the breaker to lock up in the closed position when the reset spring was removed. It was discovered that some breakers overhauled by the OEM would also lock up in the closed position without the reset spring attached. While this information is new to both the OEM and the licensee, it is not considered to be a defect in the breaker since the reset spring is attached during normal operation. See NRC Inspection Report 50/285 97-81 (Accession #9804080233) for details.

Related Generic Communications

Numerous information notices have been issued concerning lubrication of circuit breakers. It appears that ineffective preventive maintenance, including a lack of lubrication or inadvertent removal of factory-applied lubricant, continues to be a major factor in circuit breaker failures.

This information notice requires no specific action or written response. However, recipients are reminded that they are required to consider industry-wide operating experience (including NRC information notices) where practical, when setting goals and performing periodic evaluations under Section 50.65, "Requirement for monitoring the effectiveness of maintenance at nuclear power plants," to Part 50 of Title 10 of the Code of Federal Regulations. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.


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Attachment: List of Recently Issued NRC Information Notices

**LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES**

Information Notice No.	Subject	Date of Issuance	Issued to
98-37	Eligibility of Operator License Applicants	10/01/98	All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.
98-36	Inadequate or Poorly Controlled Non-Safety-Related Maintenance Activities Unnecessarily Challenged Safety Systems	9/18/98	All holders of operating licenses for nuclear power reactors
98-35	Threat Assessments and Consideration of Heightened Physical Protection Measures	9/4/98	All U.S. NRC fuel cycle facilities power and non-power reactor licencees (Safeguard issues, not for public disclosure.)
98-34	NRC Configuration Control Errors	8/28/98	All holders of Operating licenses for nuclear power reactors, except for those who have ceased operations and have certified that fuel has been permanently removed from the reactor vessel
98-33	NRC Regulations Prohibit Agreements that restrict or Discourage an Employee from Participating in Protected Activities	8/28/98	All holders of a U.S. Nuclear Regulatory Commission (NRC) license.

OL = Operating License
CP = Construction Permit

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 COMMENTS HAVE BEEN INCORPORATED.

D. Skeen 10/8/98