

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

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NRC INFORMATION NOTICE 2006-03: MOTOR STARTER FAILURES DUE TO  
MECHANICAL-INTERLOCK BINDING

**ADDRESSEES**

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.

**PURPOSE**

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to inform addressees about the recent motor starter failures due to the mechanical interlock binding between the "open" and "close" contactors at Cooper Nuclear Station (CNS). 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.

**DESCRIPTION OF CIRCUMSTANCES**

On September 23, 2005, during a forced outage at CNS, an operator attempted to close a residual heat removal (RHR) Train C suppression pool isolation motor-operated valve (MOV) to align the RHR system for shutdown cooling. The valve failed to close. The licensee inspected the 480 V MOV starter and found that the starter close contactor coil remained energized, overheated, and failed. The problem was attributed to a slightly deformed mechanical interlock which prevented the energized contactor from engaging properly. Later the same day, as operators attempted to open the RHR Train B shutdown cooling isolation valve to place RHR into shutdown cooling, the valve did not immediately open when the control switch was taken to the open position. The valve opened on the second attempt. The licensee inspected the motor starter and found a similar problem where the mechanical interlock was slightly deformed and was causing the open and close contactors of the reversing starter to bind intermittently.

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## DISCUSSION

The mechanical interlock with a reversing starter prevents a phase-to-phase fault by preventing simultaneous actuation of the open and close contactors. This device is a redundant protection for the electrical interlock in a reversing starter. The licensee's root cause investigation found that an inappropriate mounting alignment of the mechanical interlock caused a slight deformation (bowing) of the nylon mechanical interlock for the open and close contactors of the MOV. The deformation caused the interlock to bind and prevented the energized motor starter contactor from engaging properly. The interlock had been positioned too close to the open and close contactors. The mounting hole was offset 1/8 of an inch or more from the center line. According to the manufacturer's (Cutler Hammer's) instructions for mechanical interlocks, the mounting offset from the centerline should have been 1/16 of an inch. This problem was attributed to a fabrication error by the vendor. The slight misalignment of the mechanical interlock in combination with the creep of the nylon material of the interlock under stress over time slightly deformed the interlock, causing the interlock to bind against the open and close contactors.

CNS's root cause investigation identified seven such events (including this event) at CNS since 1988. These events included abnormally long MOV opening or closing times, failed contactor coils, and blown power fuses to the starter control circuit. The licensee's analysis did not indicate any obvious precursor problems, leading to the conclusion that the failures occurred unexpectedly.

The root cause investigation by the CNS also found that similar interlock problems had occurred at several other nuclear plants. NRC Inspection Reports 50-346/99-11 (Accession No. ML993370095) and 50-361/99-15 (Accession No. ML993330092) document similar mechanical interlock problems at Davis-Besse Nuclear Station and San Onofre 2 Nuclear Station, respectively, in 1999.

To correct the problem at CNS, the licensee changed the mounting arrangement. Instead of a drilled hole in the interlock support bracket, the licensee created a slot that allows lateral adjustment to align the interlock and replaced the damaged components. The licensee also scheduled preventive maintenance to inspect similar mechanical interlocks in the active MOV starters.

Subtle fabrication or installation errors in mechanical interlocks in motor starters can lead to unexpected failures over time. A thorough evaluation and trending of the MOV stroke time during the surveillance can help prevent unanticipated failures.

## CONTACT

This information notice requires no specific action or written response. Please direct any questions about this matter to one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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