

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
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INFORMATION NOTICE 2006-29: POTENTIAL COMMON CAUSE FAILURE OF
MOTOR-OPERATED VALVES AS A RESULT OF
STEM NUT WEAR

ADDRESSEES

All holders of operating licenses for nuclear power reactors except those who have permanently ceased operation and have certified that fuel has been permanently removed from the vessel.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees of potential common cause failure of motor-operated valves (MOVs) at nuclear power plants as a result of stem nut wear. The agency expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, the suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

On March 27, 2006, during the spring refueling outage for the Susquehanna Nuclear Power Plant, Unit 1, the suppression pool suction valve for the "D" residual heat removal (RHR) pump failed to close during system functional testing. On April 6, 2006, the suppression pool suction valve for the "C" RHR pump failed to stroke during system alignment. The licensee identified the cause of these MOV failures to be excessive wear of the internal threads of the stem nut that converts the rotational motion of the motor actuator to the lateral motion of the stem to open and close the valve.

In the MOV Preventive Maintenance (PM) program at Susquehanna, the licensee had relied on the observation of stem nut thread shavings below the actuator to identify stem nut wear and the need for stem nut inspection. The licensee had not directly inspected the stem nuts for the two failed MOVs for 20 years because no stem nut thread shavings had been found below the actuator. The licensee did not have a periodic overhaul program for safety-related MOVs, nor procedures to review stem nut thread clearance when conducting diagnostic testing of safety-related MOVs.

In response to these MOV failures, the licensee evaluated diagnostic traces of rising stem MOVs at Susquehanna, Units 1 and 2 that were within the scope of Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." The licensee studied the time span required for the rotating stem nut to take-up the clearance between the valve stem

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threads and the stem nut threads to assist in identifying potential stem nut wear. The licensee evaluated previous diagnostic traces to determine changes in thread clearance to estimate the stem nut wear rate and to determine whether sufficient thread would remain through the next operating cycle. Based on this information, the licensee inspected 31 safety-related MOVs at Susquehanna and replaced the stem nuts in 18 MOVs with wear exceeding 50% of the original thread thickness. The licensee plans to conduct additional MOV stem nut inspections in the future.

The RHR suppression pool suction valves at Susquehanna, Unit 1 are normally open and do not automatically change position to perform their safety function of allowing emergency core cooling water to be taken from the suppression pool. These valves also serve a containment isolation function in that they would be remotely closed if there was a break in the RHR system. The RHR suppression pool suction valves are interlocked with the RHR shutdown cooling suction valves to prevent these valves from being open at the same time and inadvertently draining the reactor vessel. Therefore, the failure of the RHR suppression pool suction valves might have impacted the emergency core cooling function of the RHR system, or affected the primary containment isolation function, depending on valve position at the time of failure. At the time of the event, primary containment integrity was not required. With the plant shut down for refueling, the safety significance of having two inoperable RHR suppression pool suction valves was considered low. Although the RHR pumps associated with the failed valves were not being relied upon to fulfill emergency injection requirements, valve failures associated with systems being relied upon for shutdown cooling or emergency core cooling (either shutdown or at power) might have either prevented or unexpectedly altered system function, thus, complicating operator actions and necessitating further response.

The licensee submitted Licensee Event Report (LER) 50-387/2006-003-00 on July 26, 2006, in response to the MOV stem nut failures at Susquehanna (see Agencywide Documents Access and Management System Accession No. ML062190207). In the LER, the licensee listed the following as root causes for the event: (1) valve stem visual inspections for evidence of stem nut thread wear were an ineffective means for monitoring long-term stem nut thread wear; (2) routine PM activities for periodically inspecting stem nuts did not exist; and (3) procedural guidance for inspection and acceptance of stem nut thread wear was inadequate. The licensee reported that immediate corrective actions had been completed to evaluate safety-related MOVs at Susquehanna using previous diagnostic indications of stem nut thread wear and inspection of selected stem nuts to assess stem nut condition. Additional long-term corrective actions planned at Susquehanna include:

- (1) performing additional MOV inspections and replacing stem nuts, when needed;
- (2) revising the current 2-year PM activity bases, and to clarify the intent and limitations of stem inspections in response to the ineffectiveness of visual inspections to detect long-term stem nut wear;
- (3) developing a new PM activity that periodically inspects selected MOV stem nuts;
- (4) establishing a methodology and acceptance criteria for measurement of stem nut wear;

- (5) incorporating detailed instructions for performing stem nut inspections into existing procedures;
- (6) preparing procedural direction for monitoring and trending stem nut wear using MOV diagnostic data; and
- (7) modifying stem lubrication PM activities to include valve stroking.

DISCUSSION

In an MOV, the stem nut converts the rotational motion of the drive sleeve in the motor actuator to the lateral motion of the stem to open and close the valve. Stem nut failure can prevent the operation of the MOV from either the motor actuator or manual handwheel. Stem nut failure can also cause valve position for the MOV to be incorrectly displayed in the control room. The failure of a stem nut for an individual MOV can interfere with the operation of other plant equipment when its valve position signal is supplied to interlock logic systems. Further, if the stem nut threads are destroyed, a valve could potentially drift open or closed should the valve packing be unable to hold the valve stem in position.

The stem nut of an MOV is typically made of bronze material. Over a period of time and use, the stem nut will undergo wear when rotating to move the steel valve stem to open or close the valve. Stem nut wear can be influenced by several factors, including the following: (1) stem nut material; (2) normal operating loads and maximum loads; (3) stem nut rotations during a valve stroke; (4) number and frequency of valve strokes; (5) stem nut manufacture and threaded length; (6) stem and stem nut fit; (7) valve stem thread condition; and (8) stem lubricant, lubrication method and frequency, and environmental conditions for the lubricant.

The unexpected failures and significant degradation of stem nuts in MOVs at Susquehanna emphasizes the importance of PM activities in identifying MOV stem nut wear in a timely manner. For example, the absence of significant changes in diagnostic performance for monitored MOV parameters (such as stem factor, thrust, or torque), or stem nut thread shavings below the actuator, might not be sufficient to confirm that the stem nut remains in good condition. Additional PM activities, such as periodic overhaul of safety-related MOVs or evaluation of MOV diagnostic test data for stem nut thread clearance, might be needed to identify stem nut wear. Further, it is important for the PM program to ensure that new lubricant is applied to the stem nut area, such as by stroking the valve, when lubricating safety-related MOV valve stems.

Excessive stem nut wear represents a potential common cause failure mode that could impact multiple MOVs at nuclear power plants. It is typically a long-term issue that is addressed as part of PM programs at nuclear power plants. Industry guidance includes stem nut inspection as part of MOV technical repair guidelines. Vendors of MOV diagnostic equipment include stem nut thread take-up clearance as a specific parameter for monitoring stem nut wear. Appropriate PM activities, such as those to be implemented at Susquehanna, can assist in identifying significant stem nut wear prior to MOV failure.

CONTACTS

This information notice requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below.

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