UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

December 8, 2008

NRC INFORMATION NOTICE 2008-20: FAILURES OF MOTOR OPERATED VALVE ACTUATOR MOTORS WITH MAGNESIUM ALLOY ROTORS

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, as well as licensees and certificate holders of nuclear fuel cycle facilities.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of recent failures and corrective actions for motor-operated valve (MOV) actuator motors due to corrosion of the magnesium alloy rotors. The NRC expects recipients to review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

The NRC continues to inform the industry of the potential for MOV actuator motor magnesium alloy rotors to corrode and subsequently fail under certain conditions. The NRC issued two previous INs to alert the industry of this problem. Technical information in the previous INs is not repeated in this IN.

The following are instances in 2007 where MOVs with actuator motors manufactured with magnesium alloy rotors did not operate on demand due to motor failure:

River Bend, Unit 1

On May 25, 2007, at River Bend, Unit 1, the reactor inlet heater ‘A’ outboard motor operated isolation valve failed to operate due to magnesium alloy rotor corrosion that was attributed to a steam leak from an adjacent main steam shutoff valve. This main steam shutoff valve, which also was an MOV with a magnesium alloy rotor, failed to operate approximately four months later on September 29, 2007. Licensee corrective actions for these MOV failures included identifying the MOV actuator motors susceptible to this failure mechanism and performing borescope inspections of the susceptible actuator motors. Eight MOV motors at River Bend were replaced because the motor inspections failed the inspection criteria.

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Quad Cities, Unit 1

On September 4, 2007, at Quad Cities, Unit 1, the high-pressure coolant injection (HPCI) primary containment isolation valve failed to operate. The motor for this valve was installed in 1994. The packing on this valve catastrophically failed in 2002 resulting in high-pressure steam in the immediate area of the motor for several hours. The motor experienced two planned stall events while placing that valve on its backseat in an attempt to mitigate the packing leak. Motor control center testing had been completed in May 2006 with no issues identified. Quarterly inservice tests did not identify any degradation. Licensee corrective actions included improving the procedures, training, and equipment used to perform borescope inspections of susceptible actuator motors.

Dresden, Unit 3

On September 12, 2007, at Dresden Unit 3, the HPCI primary containment isolation valve failed to operate. The motor, installed in 2002, is located in the upper drywell where temperatures are approximately 180 ºFahrenheit (F) [82 ºCelsius (C)]. The licensee performed a borescope inspection of the valve in 2006 with no issues identified. Licensee corrective actions included improving the procedures, training, and equipment used to perform borescope inspections of susceptible actuator motors. The licensee replaced four MOV motors at Dresden, Unit 2, in November 2007 because the borescope inspection of the motors failed the inspection criteria.

BACKGROUND

Many safety- and non-safety-related MOVs utilize Limitorque actuators with Reliance motors or a similarly styled design by a different manufacturer (e.g., Electric Apparatus). Based on torque requirements, aluminum and magnesium alloy rotors are utilized in MOV actuators. Valve actuators with a motor maximum torque of 40 foot-pounds [54 newton-meters] are typically aluminum, and magnesium alloy rotors are used for applications requiring greater than 60 foot-pounds [81 newton-meters] torque. Flowserve Technical Update 06-01, dated December 26, 2006, states that Limitorque actuator frame sizes 180 and larger are typically constructed with magnesium alloy rotors. However, one licensee identified that its facility contained Limitorque actuator frame sizes 56 and larger that were manufactured with magnesium alloy rotors. Flowserve Technical Update 06-01 also states that it is Limitorque's intention (where possible) to replace the remaining magnesium alloy rotor designs with an aluminum alloy rotor design in order to eliminate the failure mechanism.

The magnesium alloy rotor bars, end rings, and cooling fins are an integral structure cast through the iron lamination stack. The rotor assembly is painted to prevent corrosion. The magnesium alloy (nominal 90 percent magnesium – 10 percent aluminum) has a linear thermal expansion coefficient that is double the coefficient for iron. High inrush current heats the motor internals causing the temperature of the rotor assembly to increase. An MOV motor stall event is an example of a condition that creates a high current inrush to the motor. Although the rotor assembly is painted to limit corrosion, the paint bridging the intersection of the rotor end ring and iron lamination would be stressed by differential thermal expansion between the rotor and iron laminations. Magnesium is an active metal and is anodic to iron. Any gaps, scratches, or cracks in the coating will expose any unprotected areas to atmospheric conditions. Bare magnesium surfaces are subject to general and galvanic corrosion in the presence of water (such as through high humidity, steam or condensation). Corrosion can cause a magnesium alloy rotor assembly to degrade, which can lead to sudden motor failure.

The following NRC and industry generic communications address MOV actuator motor failures due to the corrosion of the magnesium alloy rotor:

- General Electric (GE) Service Information Letter (SIL) 425, dated July 17, 1985: This SIL recommended that licensees determine the plant-specific applications of magnesium alloy rotors subject to harsh environment, and evaluate the adequacy of long-term cooling assuming failure of magnesium alloy rotor MOVs a few days after the design basis event (DBE). Some systems may allow for the operator to position the valve to its safety position immediately following the DBE instead of waiting for automatic actuation, while other systems may require realignment to a standby mode after initial core cooling. In addition to operator training, it may be prudent to disconnect some of the valve actuation logic following safety position actuation to prevent valve realignment without operator actions.

- NRC IN 86-02, "Failure of Valve Operator Motor during Environmental Qualification Testing," dated January 6, 1986: This IN described the results of the GE environmental qualification laboratory tests on three motors in response to issues at the River Bend and Nine Mile Point nuclear power stations. GE tested-to-failure three new motors in varying environmental conditions, with the most limiting failure being a new motor which failed after 43 days in a high temperature environment under a maximum temperature of 223 ºF [106 ºC]. The NRC suggested that licensees review the qualification of these motors in their DBE applications.

- NRC IN 2006-26, "Failure of Magnesium Rotors in Motor-Operated Valve Actuators," dated November 20, 2006: This IN discussed three MOV actuator failures attributed to the corrosion of the magnesium alloy motor rotors that occurred in 2005 and 2006. The IN reaffirms the necessity of adequate inspection and preventive maintenance on MOV actuator motors manufactured with magnesium alloy rotors to ensure safe operation of nuclear power facilities.

DISCUSSION

Licensees rely on MOVs being operable to satisfy many technical specification requirements. In addition, MOVs are used in systems credited in accident analyses. Because licensees often use MOVs of the same type and manufacturers in redundant trains of several safety systems, MOV actuator failures due to magnesium alloy rotor corrosion raises the possibility of a common mode failure. Many MOVs are within the scope of Title 10 of the *Code of Federal Regulations,* Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

The industry has issued several licensee event reports and a number of operational experience reports describing failure of safety-related MOVs to operate due to corrosion of the magnesium alloy rotor. This is the third IN that the NRC has issued to alert the industry of this problem.

Despite industry awareness of the problem and subsequent corrective measures, failures of MOV actuators attributed to the corrosion of the magnesium alloy rotors continue to occur.

GENERIC IMPLICATIONS

NRC has initiated discussions with stakeholders to address the generic implications of MOV actuator motors susceptible to the corrosion of the magnesium alloy rotor. Specifically, these discussions involve the extent and effectiveness efforts by all licensees to identify and inspect susceptible safety-related MOV actuator motors, and take corrective actions. An important part of these discussions is licensee evaluations of GE SIL 425.

CONTACT

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

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Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections.

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