UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

August 23, 2013

NRC INFORMATION NOTICE 2013-14: POTENTIAL DESIGN DEFICIENCY IN MOTOR-OPERATED VALVE CONTROL CIRCUITRY

## ADDRESSEES

All holders of and applicants for 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," except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

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

## PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to a potential control circuit design deficiency in motor-operated valves (MOVs) that could result in incorrect valve position indication with the valve in an improper position during a loss-of-coolant accident (LOCA). 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.

## DESCRIPTION OF CIRCUMSTANCES

In an event report dated September 21, 2012, Exelon Generation Company notified the NRC that several MOVs at Limerick Generating Station, Units 1 and 2 could remain partially open following the initiation of an automatic isolation signal in response to a design-basis LOCA. Specifically, when power is interrupted to the actuator of certain MOVs during the shedding of loads associated with the plant's as-designed LOCA response, the MOVs may not automatically resume operation once power was restored. Additionally, the valve position indicating lights would incorrectly indicate that the valves were fully closed when the actual valve position could be as much as 15 percent open. Multiple primary containment isolation valves (PCIVs) in different systems at Limerick, Units 1 and 2, were susceptible to this condition.

## BACKGROUND

With IN 1985-20, "Motor-Operated Valve Failures due to Hammering Effect," the NRC staff summarized a design deficiency in which certain MOVs repeatedly cycled at the end of their operating travel. The IN described a phenomenon—known as "hammering"—during which

relaxation of the gearing within the actuator of a closed MOV could lead to repeated attempts to further close the valve as long as the MOV continued to receive a valve-close demand signal. Such a continuing signal might occur during a sealed-in accident signal (e.g., containment isolation signal) or if a plant operator held the control switch in the closed position. MOV hammering can lead to burn-out of the MOV motor or damage to the valve and actuator. MOV hammering can also force the valve disc into the seat such that re-opening of the valve is difficult.

Supplement 1 to IN 1985-20 describes certain types of MOVs that are susceptible to hammering. In particular, MOVs with low gear ratios that are commonly used in applications requiring high-speed valve actuation are susceptible to hammering. After these MOVs are closed and their torque switch contacts open, internal forces exerted through the torque switch pinion and Belleville washer assembly within the MOV actuator can cause the torque switch to reclose and resupply power to the MOV motor because the actuator gearing does not provide sufficient resistance to motion. Consequently, MOVs that use these gear sets are characterized as "nonlocking." Conversely, MOVs with high gear ratios can resist the internal forces on the actuator gearing; therefore, they do not allow the torque switch to re-close and re-supply power to the motor. MOVs with high gear ratios are not susceptible to hammering and are characterized as "locking."

IN 93-98, "Motor Brakes on Valve Actuator Motors," the NRC staff summarized an MOV issue related to motor brakes installed in MOVs to minimize the inertial loads during valve closure after control switch trip. Motor brakes can be used to help avoid hammering in MOVs with nonlocking gear mechanisms. However, improper sizing and operation of motor brakes might not prevent hammering, and can result in problems with the performance of the MOV as discussed in IN 93-98.

**DISCUSSION**

Certain system designs may require high-speed valve actuation and, thus, necessitate the application of MOVs with actuator gearing that is nonlocking. In these cases, licensees or vendors may have designed features within the MOV circuitry to avoid the hammering issue.

One approach to avoid MOV hammering, such as implemented at Limerick, relies on a limit switch contact to serve as an "isolation permissive" function. When the isolation permissive limit switch contact is closed, a sealed-in signal to close the valve (e.g., containment isolation) would be allowed to energize the valve close circuit. Once the valve reaches a certain position in its travel, the isolation permissive limit switch contact opens. During the continued MOV operation, the MOV circuitry is designed to allow current to flow around the open limit switch contact. After the torque switch opens, power is interrupted to the MOV motor and the valve travel stops. If the torque switch re-closes inadvertently (such as by relaxation of the actuator gearing), the MOV circuitry does not allow the current to flow around the open limit switch contact, and power is not restored to the MOV motor. The MOV circuitry can be designed to allow power to be restored to the MOV motor when valve operation is needed, such as by use of the MOV hand switch in the control room.

In a recent 10 CFR 50.72 "Immediate Notification Requirements for Operating Nuclear Power Reactors," event notification (EN No. 48334), Exelon reported that several MOVs at Limerick, Units 1 and 2, that used an isolation permissive limit switch could potentially remain partially open during the plant's designed response to a LOCA. The followup 10 CFR 50.73 "License Event Report System," licensee event report (LER No. 05000352-2012007, Agencywide

Documents Access and Management System (ADAMS) Accession No. ML12293A100) provides further details on the MOV vulnerability that was discovered during a licensee-led evaluation of electrical system voltage that would be expected to occur during a LOCA. The evaluation identified that the MOVs with an isolation permissive limit switch setting were set to a value of 5 percent to 15 percent of open travel. This represents a "dead zone" in the valve close circuitry. The licensee determined that if power is interrupted to the affected valve actuators after the isolation permissive limit switch contact opened, but before the valve reached its closed position, the affected PCIVs could potentially remain as much as 15 percent open. This condition could occur if, during the plant's designed response to a LOCA, the load shed sequence occurred when a valve was within the dead zone. In this case, once power was sequenced back to the MOV, it would not resume motion because the isolation permissive limit switch contact would be open, thus, preventing the actuation signal from reaching the MOV motor. Furthermore, the valve indicating lights would indicate fully closed because the close position indicating light contacts share the same limit switch rotor as the isolation permissive limit switch contacts, and the valve would indicate closed when entering the set dead zone. The conditions just described could leave a valve open by as much as 15 percent, although the valve position indication would indicate closed.

Upon discovery of this condition, the licensee declared the PCIVs inoperable and implemented design changes to remove this vulnerability in MOVs at Limerick, Units 1 and 2. The licensee's corrective actions are described in the referenced LER 05000352-2012007. This LER provides further details on this issue and the licensee's response. The licensee is considering long-term corrective action to modify the MOV gearing for the affected MOVs to install locking gear sets to prevent potential torque switch hammering and to allow removal of the limit switch permissive circuitry. This would allow the MOVs to restart during a LOCA power restoration sequence to fully close the valves and to provide accurate valve position indication. This design change would also obviate the need for the affected limit switch contacts for these valves, thereby eliminating the "dead zone" and the root cause of the issue.

This issue and LER were reviewed by NRC inspectors and dispositioned as a licensee-identified, non-cited violation, of very low safety significance. This LER was closed in the Limerick Generating Station NRC Integrated Inspection Report 05000352/2012005 and 05000353/2012005, dated February 5, 2013; see page 35, section 4OA3.2 and page 40, section 4OA7 of the inspection report for more details (ADAMS Accession No. ML13036A364). In this licensee's particular situation, the issue was determined to be of very low safety significance. However, similar problems at other licensees might have greater safety significance.

The NRC expects that recipients will review the information, links, and references provided in this IN for applicability and consider actions, as appropriate for their facilities to avoid similar problems. However, no specific action or written response to the NRC is required for this IN.

**CONTACT**

This information notice does not require any specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate NRC project manager.

***/RA/***

Laura A. Dudes, Director
Division of Construction Inspection
and Operational Programs
Office of New Reactors

***/RA/***

Lawrence E. Kokajko, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contact: Michael Farnan, NRR
301-415-1486
E-mail: Michael.Farnan@nrc.gov

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