

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

July 6, 1994

NRC INFORMATION NOTICE 94-49: FAILURE OF TORQUE SWITCH ROLL PINS

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the potential inservice failure of the torque switch roll pin in Limitorque Corporation (Limitorque) actuators. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar failures. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

Pilgrim Nuclear Power Station, Unit 1.

On March 9, 1994, after a surveillance test of a motor-operated valve (MOV) in the high-pressure coolant injection (HPCI) system, the MOV could not be opened after being closed. The failed valve is a normally open test and maintenance valve on the pump discharge line. When closed, the valve maintains the pressure isolation boundary during inservice stroke time testing of the normally closed HPCI system injection valve; it receives an open signal upon initiation of the HPCI automatic start logic. The MOV breaker tripped open on overload and prevented the MOV from being opened remotely as designed. The valve is operated by a Limitorque SMB-0 actuator (Licensee Event Report (LER) 50-293/94-002).

Evaluation of this failure revealed that the direct cause of the inability of the MOV to open was the failure of the MOV torque switch drive pinion gear roll pin. With the roll pin broken, the torque switch did not deenergize the motor upon completing the close stroke and the MOV electrical breaker tripped open. The licensee, Boston Edison Company, declared the HPCI system inoperable and determined that an increase in the impact load on the roll pin apparently resulted from high pullout thrust and increased forces due to hardened grease in the torque switch spring pack. The licensee learned about a hammering of the torque switch on valve unseating observed at another nuclear power plant (described below for Washington Nuclear Project, Unit 2) and considered that this dynamic effect might also have contributed to the roll pin failure at the Pilgrim plant. The licensee concluded that the roll

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pin design, a small diameter pin (2.4 mm [3/32 in.]) made of relatively brittle high carbon steel (American Iron and Steel Institute (AISI) 1070), was the root cause of the failure.

The licensee opened the failed MOV to its safety position, returned the HPCI system to an operable status, and established corrective action to replace the failed torque switch model with one that has a larger diameter roll pin of improved material. The licensee evaluated the potential for this problem to affect those MOVs that must close during an accident scenario and subsequently reopen. The licensee determined that such MOVs are operable with the existing roll pin design. As MOVs are disassembled for diagnostic testing, the licensee plans to install spring packs with internal relief devices to prevent grease hardening in the spring pack.

Hope Creek Nuclear Station, Unit 1.

On August 14, 1993, during inservice testing of valves, a HPCI pump discharge valve failed to fully open during an open stroke test. The valve, a 14-inch, horizontally mounted, flexible wedge gate valve, provides coolant from the HPCI system to the core spray system during actuation of the emergency core cooling system. The motor overload contacts for this same valve tripped during the subsequent close stroke. The valve is operated by a Limitorque SB-3 actuator (LER 50-354/93-005).

Evaluation of this failure revealed that the torque switch roll pin was broken, probably because of shearing forces. The failure of the roll pin allowed premature torque switch actuation on the open stroke and failure of torque switch actuation on the close stroke. The licensee, Public Service Electric and Gas Company, replaced the torque switch and is administratively controlling the number of valve strokes for this valve as part of an ongoing root-cause evaluation. The licensee plans to complete the root-cause evaluation and perform further diagnostic testing during the next planned outage in the spring of 1994.

Four previous torque switch roll pin failures have occurred at the Hope Creek Station. Three of these failures (March 1988, November 1989, and September 1991) involved the same HPCI pump discharge valve actuator that was involved in the failure that occurred in August 1993. The fourth failure, in November 1990, involved an SMB-1 actuator installed vertically in the HPCI steam supply line. Each of the valves is stroke-tested quarterly in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Inservice Testing."

Washington Nuclear Project, Unit 2.

In August 1993, the licensee, Washington Public Power Supply System, notified Limitorque about a problem with torque switch roll pins in MOV actuators with model numbers SB/SMB 0 through 5. The valves were apparently sticking in their seats when closed and causing increased stress on the torque switch roll pin during valve unseating (see Pilgrim LER 50-293/94-002).

Palo Verde Nuclear Station, Units 1, 2, 3.

On May 26, 1992, the licensee, Arizona Public Service Company, requested technical assistance in a letter to Limatorque to address failures of torque switch roll pins. The licensee had experienced at least 14 failures of pins (roll and groove pins) in torque switches on 10 different MOV actuators. Two failures occurred in actuators with model number SMB-00, two for SB-0, eight for SMB-1, and two for SB-3. (NRC Inspection Reports 50-528/94-11, 50-529/94-11, 50-530/94-11).

Using strain gages, the licensee found the dynamic torque during operation to be excessive during rapid acceleration (snapback) of the spring pack immediately following unseating of the valve. The licensee found that for actuators with model SB that have a lost motion drive sleeve (hammerblow feature), the compensator spring increased the snapback acceleration.

The licensee observed another effect of impact loading of the torque switch. During unseating of the valve, the torque switch contact bar flipped onto its side, interrupting electrical continuity and motor operation as though the torque switch had actuated. The licensee replaced the contact bar compression springs with stiffer springs and attributed the root cause to the recoil force that impacts the contact bar when the valve is unseating.

Discussion

On March 23, 1994, Limatorque submitted a report to the NRC in response to the recent failures of torque switch roll pins, in accordance with Part 21 of Title 10 of the Code of Federal Regulations (Part 21 report). This report discusses potential failures of the torque switch roll pin in Limatorque MOV actuators with model numbers SMB/SB/SBD-0 through -4, -4T, -5, -5T, and -5XT. Limatorque stated that (1) it did not have the required expertise relative to valve and system design to perform a root cause analysis of these potential failures, (2) an affected isolation valve that must move from its open position to its closed position may not reopen reliably, (3) an affected injection valve would open and close, provided that no abnormal conditions were present during the previous valve closure, such as thermal overload trip or excessive motor current, (4) the licensee corrective action is to acquire and analyze site data relative to this issue, (5) Limatorque modified the roll pin design by replacing the 2.4 mm [3/32-in.] diameter pins with 3.2 mm [1/8-in.] diameter shear-proof pins and (6) Limatorque will replace the 303 stainless steel shaft material for new torque switches with 416 stainless steel material.

On December 11, 1990, Limatorque submitted a Part 21 report of the potential failure of the torque switch roll pin in SMB-00 actuators. This report limited the scope of concern to MOV actuators with model numbers SMB-, SB-, and SBD-00 that have heavy spring packs that are declutched under maximum rated load.

The recent torque switch roll pin failures occurred during motor-driven operation of the MOVs. In contrast, the Limatorque Part 21 report dated

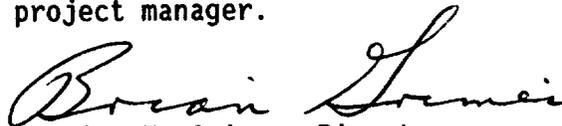
December 11, 1990, discusses failures during declutching of the actuator under loaded conditions to allow manual operation.

Related Generic Communications.

Potential overthrusting of motor-operated valves is discussed in NRC Information Notice 92-83, "Thrust Limits for Limitorque Actuators and Potential Overstressing of Motor-Operated Valves," issued March 27, 1992.

Information Notice 92-83 discusses several industry qualification testing programs that are being used by licensees to increase motor-operated valve thrust allowable limits. These higher thrust limits may cause various actuator subcomponents, including torque switch roll pins, to be subjected to higher stress levels and thus to incur higher failure rates.

This information notice requires no specific action or written response. 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.



Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contacts: James S. Stewart, RI
(215) 337-5240

Thomas G. Scarbrough, NRR
(301) 504-2794

Christopher Myers, RIV
(510) 975-0260

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94-13, Supp. 1	Unanticipated and Unintended Movement of Fuel Assemblies and other Components due to Improper Operation of Refueling Equipment	06/28/94	All holders of OLs or CPs for nuclear power reactors.
94-47	Accuracy of Information Provided to NRC during the Licensing Process	06/21/94	All U.S. Nuclear Regulatory Commission Material Licensees.
94-46	NonConservative Reactor Coolant System Leakage Calculation	06/20/94	All holders of OLs or CPs for nuclear power reactors.
94-45	Potential Common-Mode Failure Mechanism for Large Vertical Pumps	06/17/94	All holders of OLs or CPs for nuclear power reactors.
94-44	Main Steam Isolation Valve Failure to Close on Demand because of Inadequate Maintenance and Testing	06/16/94	All holders of OLs or CPs for nuclear power reactors.
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OL = Operating License
 CP = Construction Permit

December 11, 1990, discusses failures during declutching of the actuator under loaded conditions to allow manual operation.

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Information Notice 92-83 discusses several industry qualification testing programs that are being used by licensees to increase motor-operated valve thrust allowable limits. These higher thrust limits may cause various actuator subcomponents, including torque switch roll pins, to be subjected to higher stress levels and thus to incur higher failure rates.

Original signed by

Brian K. Grimes

Brian K. Grimes, Director
 Division of Operating Reactor Support
 Office of Nuclear Reactor Regulation

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steam supply line. Each of the valves is stroke-tested quarterly in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Inservice Testing." No torque switch roll pins in SB-3 and SMB-1 actuators installed at Hope Creek have failed.

On December 11, 1990, Limitorque notified the NRC of the potential failure of the torque switch roll pin in SMB-00 actuators in accordance with the Code of Federal Regulations, Title 10, Part 21 (10 CFR Part 21). The recent failures at Hope Creek indicate that this potential may be more widespread than originally believed.

Potential overthrusting of motor-operated valves is discussed in NRC Information Notice 92-83, "Thrust Limits for Limitorque Actuators and Potential Overstressing of Motor-Operated Valves," issued March 27, 1992.

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concerned by email

with comments

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