6.0 REGULATORY REQUIREMENTS

6.1 Inspection and Enforcement Bulletin 85-03

November 15, 1985

To: **All Holders of Nuclear Power Reactor Operating Licenses (OLs) or Construction Permits (CPs) for Action**

Subject: **IE BULLETIN NO. 85 03: MOTOR-OPERATED VALVE COMMON MODE FAILURES DURING PLANT TRANSIENTS DUE TO IMPROPER SWITCH SETTINGS**

Purpose

The purpose of this bulletin is to request licensees to develop and implement a program to ensure that switch settings on certain safety-related motor-operated valves are selected, set and maintained correctly to accommodate the maximum differential pressures expected on these valves during both normal and abnormal events within the design basis.

Description of Circumstances

There have been two recent events, and a number of earlier events, during which motor-operated valves failed on demand, in a common mode, due to improper switch settings.

Event 1, Davis-Besse Plant - On June 9, 1985, the Davis-Besse Plant experienced a complete loss of main and auxiliary feedwater. This event was described previously in IE Information Notice No. 85-50, “Complete Loss of Main and Auxiliary Feedwater at a PWR Designed by Babcock & Wilcox,” and in NUREG-1154, “Loss of Main and Auxiliary Feedwater Event at the Davis-Besse Plant on June 9, 1985.” Normally open, Limitorque motor-operated auxiliary feedwater (AFW) gate valves failed to reopen on either an automatic or manual signal from the main control room after they were inadvertently closed during the event. While other failures also occurred in the AFW system, the failure of these two valves was itself enough to prevent AFW from reaching either steam generator. During the recovery from this event, the valves were opened with the handwheels.

The results of licensee troubleshooting activities after the event led to the conclusion that the setting for the torque switch bypass limit (torque bypass) switch in each valve's control circuit had not been set to remain closed long enough to provide the necessary bypass function on valve opening with differential pressure conditions across the valve. During the event, the valves experienced a high differential pressure after closing. The torque bypass switch on both valves was improperly set, causing the torque switches to become operable prematurely. This condition stopped valve travel before the valve discs were fully off their seats.

The torque bypass switches were set to drop out after the valves opened to 5% full-stroke. The 5% full-stroke setting was based on a number of handwheel turns. In a 10 CFR 21 report, submitted subsequent to the

event, Toledo Edison Company identified two reasons why the torque bypass switch settings were not adequate: (1) the 5% full-stroke settings were not adequate for unseating the AFW system discharge valves with large differential pressures across the valves and (2) the procedure for setting this switch was defective in that the 5% full-stroke was not specified to be in addition to the handwheel turns required to take up the motor-operator coast and backlash. The torque bypass switch setting errors were revealed only when high differential pressure conditions across the valves caused higher loadings. The valve failures were reproduced during tests performed by the licensee with differential pressures applied across the valves.

During the tests, the valves operated properly when low differential pressures were applied across them, but failed to open when high differential pressures were applied. The valves were instrumented during these tests to obtain signature traces of critical parameters.

Event 2, Sequoyah Plant Unit 2 - An event involving partial loss of main feedwater occurred on May 2, 1985, at Sequoyah Nuclear Plant Unit 2 while in Mode 2 and returning to power after a reactor trip. Feedwater was being supplied through the main feedwater (MFW) system isolation valve bypass lines. Operators attempted to open the MFW system isolation valves to supply water to the steam generators; however, two of the four MFW isolation valves would not open. The startup was discontinued and the unit was returned to hot shutdown.

During examination to determine the reason for the valve failures, the licensee discovered that both valve stems had sheared from their discs. The discs were found in the closed positioning within the valve seats. The stems had suffered fracture failures through approximately three-quarters of the diameter of the shafts, in addition to stress failures of the remaining quarter. The Limitorque motor-operators on the valves use limit switches to control valve motion in the open direction. These MFW system isolation valves are large (18 inch diameter), fast acting (154 inches per minute travel speed) valves. Because of the high speed of these valves and the large mass of the discs, the selection of the limit switch setpoint needs to account for the large momentum of the disc and its continued motion after the limit switch deenergizes the valve motor-operator. The set point was not correctly established and the disc impacted the backseat during opening. The failure mechanism of these valves was identified by the licensee to be impact loading of the stem on the opening stroke as a result of the disc impacting the backseat, combined with a stress failure of the remaining portion of the stem on the opening stroke. Main feedwater valves are not included in the actions requested by this bulletin. The NRC is, however, continuing to evaluate the Sequoyah event.

NRC Field Evaluation - As a part of the resolution of Generic Issue II.E.6 “In-Situ Testing of Valves,” the NRC contracted with the Oak Ridge National Laboratory in 1984 to perform a limited study to determine the effectiveness of signature tracing techniques in determining the operational readiness of safety-related motor-operated valves. It was hoped also that this study could provide some insight as to current conditions of valve switch settings at nuclear power plants. Signature traces of motor current, torque and limit switch actuations and axial motion of the worm gear (an indication of operator torque) were obtained from 36 motor-operated valves at 4 nuclear plant sites. Although the formal technical report [NUREG/CR-4380 “Evaluation of the Motor-Operated Valve Analysis and Test System (MOVATS) to Detect Degradation, Incorrect Adjustments, and Other Abnormalities in Motor-Operated Valves”] has not been issued, the current draft of the report indicates that (1) this inspection method can be used to improve current ASME methods and (2) there were abnormalities with nearly every valve tested.

Table 1 contains a summary of the study's findings with respect to switch setting abnormalities. Of particular interest with respect to the events described above is the finding that 75% of the valves had improperly set torque bypass switches (56% of the valves had the close-to-open torque bypass switch set so that it was opening before the valve fully unseated) and 8% of the valves were unintentionally backseating. The abnormalities in Table 1 have not been fully evaluated at this time, and they should not be interpreted to mean that any abnormality resulted in an inoperable valve.

Background

The NRC has previously identified common mode failures, on demand, of valves. IE Circular No. 77-01, "Malfunction of Limitorque Valve Operators," reported that on October 28, 1976, two motor-operated (Limitorque) valves located between the refueling water storage tank and the charging pump suction at the Trojan Nuclear Plant failed to open in response to a spurious safety injection (SI) signal. The malfunction in both valves resulted from the torque switch in the opening circuit becoming activated before the valves were fully off their seats. The valves also were equipped with a torque bypass switch. Each of the valves that malfunctioned was found to have its torque bypass switch adjusted such that it allowed the torque switch to be operable in the circuit before the valve was moved from its seat. The licensee's investigation revealed that in each case the valve had been manually closed hard on its seat following a maintenance operation.

Examination by the licensee revealed similar improper adjustments of the torque bypass switches on several other motor-operated valves in safety-related systems.

IE Information Notice No. 81-31, "Failure of Safety Injection Valves To Operate Against Differential Pressure," reported on September 3, 1981, that both trains of the San Onofre Unit 1 safety injection system were found to be inoperable when challenged to operate against differential pressure.

Improperly set switches were the principal cause of these failures. There were no adverse consequences in this particular event because there was no accident that required safety injection. The reactor pressure remained above the safety injection pump's shutoff head; therefore, no actual injection of later would have occurred if the valves had opened. However, had reactor pressure decreased and actual injection been required, injection flow would not have been automatically available as designed. These valves had been regularly tested at each refueling outage, but the tests were not required to be performed with differential pressure across these valves.

Florida Power Corporation reported an event at Crystal River Unit 3 in LER 77-9. During plant cooldown with the unit in hot shutdown, decay heat removal valves in the decay heat removal pump suction would not open with remote actuation. These failures were caused by pressure acting on the gate valve discs. The valves were opened manually with the handwheels. The torque switches were reset.

In addition to common mode valve failures on demand, there have been numerous common mode failures discovered during testing or as a result of investigating a single failure. NUREG/CR-2270, "Common Cause Fault Rates for Valves," February 1983, contains reports of 99 common cause valve fault events from 1976 through 1980.

The NRC has previously identified other problems with motor-operated valve switches in Bulletin No. 72-3, "Limitorque Valve Operator Failures"; IE Information Notice No. 79-03, "Limitorque Valve Geared Limit Switch Lubricant; Circular No. 81-13, "Torque Switch Electrical Bypass Circuit for Safeguard Service Valve Motors"; Information Notice No. 82-10, "Following Up Symptomatic Repairs To Assure Resolution of the Problem"; and Information Notice No.84-10, "Motor-operated Valve Torque Switches Set Below the Manufacturer's Recommended Value."

The failure and potential failure of Westinghouse Electro-Mechanical Division motor-operated gate valves to close are discussed in IE Bulletin No. 81-02 and IE Bulletin No. 81-02, Supplement 1, "Failure of Gate Type Valves To Close Against Differential Pressure."

Copies of the above referenced NRC bulletins, circulars and information notices can be obtained from your local public document room.

Actions for All Holders of Operating Licenses or Construction Permits

For motor-operated valves in the high pressure coolant injection/core spray and emergency feedwater systems (RCIC for BWRs) that are required to be tested for operational readiness in accordance with 10 CFR 50.55a(g), develop and implement a program to ensure that valve operator switches are selected, set and maintained properly. This should include the following components:

Review and document the design basis for the operation of each valve. This documentation should include the maximum differential pressure expected during both opening and closing the valve for both normal and abnormal events to the extent that these valve operations and events are included in the existing, approved design basis, (i.e., the design basis documented in pertinent licensee submittals such as FSAR analyses and fully-approved operating and emergency procedures, etc). When determining the maximum differential pressure, those single equipment failures and inadvertent equipment operations (such as inadvertent valve closures or openings) that are within the plant design basis should be

Using the results from item a above, establish the correct switch settings. This shall include a program to review and revise, as necessary, the methods for selecting and setting all switches (i.e., torque, torque bypass, position limit, overload) for each valve operation (opening and closing).

If the licensee determines that a valve is inoperable, the licensee shall also make an appropriate justification for continued operation in accordance with the applicable technical specification.

Individual valve settings shall be changed, as appropriate, to those established in item b, above. Whether the valve setting is changed or not, the valve will be demonstrated to be operable by testing the valve at the maximum differential pressure determined in item a above with the exception that testing motor-operated valves under conditions simulating a break in the line containing the valve is not required. Otherwise, justification should be provided for any cases where testing with the maximum differential pressure cannot practicably be performed. This

justification should include the alternative to maximum differential pressure testing which will be used to verify the correct settings.

Note: This bulletin is not intended to establish a requirement for valve testing for the condition simulating a break in the line containing the valve. However, to the extent that such valve operation is relied upon in the design basis, a break in the line containing the valve should be considered in the analyses prescribed in items a and b above. The resulting switch settings for pipe break conditions should be verified, to the extent practical, by the same methods that would be used to verify other settings (if any) that are not tested at the maximum differential pressure.

Each valve shall be stroke tested, to the extent practical, to verify, that the settings defined in item b above have been properly implemented even if testing with differential pressure can not be performed.

Prepare or revise procedures to ensure that correct switch settings are determined and maintained throughout the life of the plant.[1] Ensure that applicable industry recommendations are considered in the preparation of these procedures.

Within 180 days of the date of this bulletin, submit a written report to the NRC that: (1) reports the results of item a and (2) contains the program to accomplish items b through d above including a schedule for completion of these items.

1. For plants with an OL, the schedule shall ensure that these items are completed as soon as practical and within two years from the date of this bulletin.

2. For plants with a CP, this schedule shall ensure that these items are completed before the scheduled date for OL issuance or within two years from the date of this bulletin, whichever is later.

Provide a written report on completion of the above program. This report should provide (1) a verification of completion of the requested program, (2) a summary of the findings as to valve operability prior to any adjustments as a result of this bulletin, and (3) a summary of data in accordance with Table 2, Suggested Data Summary Format. The NRC staff intends to use this data to assist in the resolution of Generic Issue II.E.6.1. This report shall be submitted to the NRC within 60 days of completion of the program. Table 2 should be expanded, if appropriate, to include a summary of all data required to evaluate the response to this bulletin.

The written reports shall be submitted to the appropriate Regional Administrator under oath or affirmation under provisions of Section 182a, Atomic Energy Act of 1954, as amended. Also, the original

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[1]. This item s intended to be completely consistent with action item 3.2, “Post-Maintenance Testing (All Other Safety-Related Components),” of Generic Letter 83-28, “Required Actions Based on Generic Implications of Salem ATWS Events.” These procedures should include provisions to monitor valve performance to ensure the switch settings are correct. This is particularly important if the torque or torque bypass switch setting has been significantly raised above that required.

copy of the cover letters and a copy of the reports shall be transmitted to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, DC 20555 for reproduction and distribution.

This request for information was approved by the Office of Management and Budget under a blanket clearance number 3150-0011. Comments on burden and duplication may be directed to the Office of Management and Budget, Reports Management, Room 3208, New Executive Office Building, Washington, DC 20503.

Although no specific request or requirement is intended, the time required to complete each action item above would be helpful to the NRC in evaluating the cost of this bulletin.

If you have any questions regarding this matter, please contact the Regional Administrator of the appropriate NRC regional office or the technical contact listed below.

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Office of Inspection and Enforcement

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Attachments:

1. Table 1
2. Table 2
3. List of Recently Issued IE Bulletins

ATTACHMENT 1

Table 1. Summary of Significant MOV Abnormalities

Bypass switch improperly set	75[a]
Incorrect thrust	50
Unbalanced torque switch	33
Valve backseating	8
High motor current	3
Torque switch abnormalities	2
Miscellaneous abnormalities	33

a. Percent of valves experiencing abnormality. The total does not equal 100 percent as most valves had more than one abnormality.