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

June 5, 1990

NRC INFORMATION NOTICE NO. 90-40: RESULTS OF NRC-SPONSORED TESTING OF MOTOR-OPERATED VALVES

Addressees:

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

Purpose:

This information notice is intended to provide addressees with specific information regarding the results of recent NRC-sponsored testing of motor-operated valves (MOVs) which was discussed at a public meeting on April 18, 1990. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid problems with safety-related MOVs. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Background:

The NRC Office of Nuclear Regulatory Research (RES) has been sponsoring an MOV testing program in support of the resolution of Generic Safety Issue 87 (GI-87), "Failure of HPCI Steam Line Without Isolation." The initial scope of GI-87 involved the evaluation of the capability of certain motor-operated flexible wedge gate containment isolation valves to mitigate the loss of reactor coolant inventory in the event of a pipe break outside of the containment building at boiling-water-reactor (BWR) plants. The particular MOVs involved in the GI-87 program were those in the turbine steam supply lines for the high pressure coolant injection (HPCI) and reactor core isolation cooling (RCIC) systems, and in the supply line to the reactor water cleanup (RWCU) system.

The MOV research is applicable to the programs established by licensees in response to Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." In that generic letter, the staff recommended that licensees and construction permit holders establish a program to provide for the testing, inspection, and maintenance of safety-related MOVs and certain other MOVs in safety-related systems. The purpose of this program is to provide assurance that the MOVs will function when subjected to design-basis differential pressure and flow conditions. As part of the generic letter program, the staff recommended that licensees and permit holders test the MOVs



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within the program in situ under design-basis conditions, where practicable. The schedule in the generic letter requested that the description of the MOV program be available within about a year of issuance of the generic letter and that the initial test program be completed in approximately five years. As a followup to the initial program, the staff recommended that the MOV switch settings and, thus, operability of the MOVs be reverified periodically.

Although the generic letter has a five-year schedule for completing the initial program, the staff indicated at the public workshops held to discuss the generic letter that the NRC regulations require that licensees act to resolve operability problems with specific MOVs when the problems are identified. As part of its review of the research results, the staff will consider the need to accelerate a portion or all of the Generic Letter 89-10 program for particular MOVs or systems.

In Generic Letter 89-10, the staff acknowledges that in situ testing of some MOVs within the generic letter program under design-basis conditions will not be practicable. At the generic letter workshops, the staff discussed several possible alternatives if such testing is not practicable, as well as potential problems and limitations associated with those alternatives. For instances in which testing of an MOV in situ under design-basis conditions is not practicable and the licensee cannot currently justify the use of an alternative to design-basis testing in situ, the staff has recommended the use of a "two-stage" approach: the licensee would set the MOV operating switches by means of the best data available and then would work to obtain applicable test data as soon as possible. The staff believes that applicable test data can be obtained within the five-year schedule. For the initial setting of the MOV switches under the two-stage approach, the test results obtained through the NRC research may constitute some of the best data available for the tested valves under a variety of fluid conditions.

Description of Circumstances:

The MOV testing program for GI-87 has been conducted in two phases by the Idaho National Engineering Laboratory (INEL). Phase I was performed in 1988 at the Wyle Laboratory facility in Huntsville, Alabama. The most significant tests in that phase consisted of opening and closing two 6-inch flexible wedge gate valves (manufactured by Anchor/Darling and Velan) under high differential pressure and high-temperature water conditions. The valves in Phase I of the research program were considered typical of those used for containment isolation in the supply line to the RWCU system. The results of the tested valves were discussed at a public meeting on February 1, 1989, and are documented in NUREG/CR-5406, "BWR Reactor Water Cleanup System Flexible Wedge Gate Isolation Valve Qualification and High Energy Flow Interruption Test."

Phase II of the MOV test program was performed in 1989 at the Kraftwerk Union facility in the Federal Republic of Germany. This phase consisted of opening and closing three 6-inch flexible wedge gate valves (Anchor/Darling, Velan, and Walworth) and three 10-inch flexible wedge gate valves (Anchor/Darling, Powell, and Velan) against normal and blowdown (design-basis) flow conditions. The Phase II 6-inch and 10-inch valves were considered typical of those used for containment isolation in the supply line to the RWCU system and the turbine

steam supply line of the HPCI systems, respectively. On December 26, 1989, the NRC staff issued Information Notice 89-88, "Recent NRC-Sponsored Testing of Motor-Operated Valves," which alerted addressees to the tests and provided some preliminary results. On April 18, 1990, the NRC staff held a public meeting to discuss the results of Phase II of the MOV testing program. The test data are available in printed form in the NRC Public Document Room (Accession No. 9005170154). Magnetic tapes of the test data are available through the INEL Office of Technology Transfer.

The overall objectives of the MOV test program included the determination of the force required to close the tested valves under various operating and design-basis fluid conditions through the measurement of stem thrust. Other program objectives were the determination of opening thrust requirements for the tested valves under different fluid conditions; evaluation of valve closure force components (such as disc friction and packing drag); measurement of the effects of temperature, pressure, and valve design on valve opening and closing loads; and evaluation of the valve thrust equation commonly used in the industry.

The tests for each MOV included cold leakage, cold and hot cycling, opening and closing under normal flow, closure under design-basis, and partial opening and closing under high differential pressure and flow conditions. Although the tested valves were intended to be typical of those used for containment isolation in the HPCI and RWCU systems of BWR plants, the results of the tests should be considered in terms of their applicability to all MOVs in nuclear power plants. A detailed analysis of the test data should be available in July 1990. Nevertheless, the NRC staff has begun to develop conclusions from the test data as a result of its review of the data and the discussions at the April 18, 1990, public meeting. Several preliminary conclusions are discussed below:

1. Regardless of fluid conditions (i.e., steam, slightly subcooled water, or cold water), the tested valves required more thrust for opening and closing under various differential pressure and flow conditions than would have been predicted from standard industry calculations and typical friction factors. Thus, a potential exists for the underestimation of thrust requirements for valves in applications, and under fluid conditions, other than those of the valves involved in the NRC research. For the conduct of the tests, the motor operators for the valves were sized, and the torque switches were set, in an effort to ensure that each valve would fully stroke without regard to the thrust requirements predicted by the commonly used valve thrust equation. (Despite this effort, one valve failed to close completely during a blowdown test.) To provide an indication of the accuracy of the valve thrust equation, the thrust predicted by that equation for valve friction factors of both 0.3 and 0.5 was calculated during each test. Table 1 provides a summary of the blowdown tests and the minimum required thrust to close the tested valves. The table also indicates whether the valve thrust equation would have bounded the thrust requirement if valve friction factors of 0.3 or 0.5 had been used.

2. Some of the tested valves sustained considerable internal damage during the blowdown tests. The occurrence of internal damage can cause the thrust required to operate a valve to exceed the thrust requirements predicted by the valve thrust equation. Such valves were referred to as "unpredictable" in the test program and included the 6-inch Anchor/Darling valve and the 10-inch Anchor/Darling, Powell, and Velan valves. In some instances, this increase in required thrust can be considerable and might exceed the capability of the motor or operator. Thrust requirements to close unpredictable valves under design-basis loads cannot be accurately determined without testing the valves (either individually or as prototypes) under those conditions.

3. The research program revealed that the testing of a valve under static or low flow conditions cannot always be used to accurately predict the behavior of the valve under design-basis conditions by extrapolation. For example, the valves that were damaged during blowdown tests operated normally under less severe flow tests. Thus, low-flow tests might not identify a valve that requires significantly more thrust than predicted by the valve thrust equation (i.e., a valve that is unpredictable).

4. During opening of the valves, the maximum required thrust did not always occur at unseating. Rather, in certain instances, it occurred much later during the valve stroke. At nuclear plants, the staff has found that torque switches for MOVs are sometimes bypassed only during the initial portion of the opening stroke on the assumption that the thrust required to unseat the valve would be the maximum thrust for the full stroke. Thus, the research results raise a concern that the torque switches in some MOVs at nuclear plants might not be bypassed for a sufficient period of time during the opening stroke.

5. For certain tests, the valve was closed from a partially open position. This partial stroking of the valve failed to predict the thrust requirements and to identify nonpredictable performance that were found during closure of the valve from a full open position. For example, during certain blowdown tests, valve damage began to occur before the valve was half closed. The accumulated damage over the full stroke influences the thrust required to close the valve.

6. The research program revealed that measurements of torque, thrust, and motor operating data were needed to completely characterize MOV performance. For example, the measurement of torque or thrust alone cannot identify problems in the conversion of torque to thrust (i.e., abnormally large stem factors). Such problems can cause the thrust measured at normal or static conditions to be misleading as compared to the thrust that actually would be available under design-basis conditions. The measurement of motor operating characteristics allows the adequacy of the motor to be determined.

7. The research program revealed that reliable information can be obtained from diagnostic analysis of MOVs only when operating data are collected by trained personnel using accurate and calibrated equipment. The MOV data must then be evaluated by individuals experienced in the performance of MOV diagnostic analysis.

The staff is continuing its review of the results of the MOV research. From this review, the staff may prepare additional information notices that discuss the staff's conclusions regarding the research. If an immediate safety problem is identified, the staff will initiate regulatory action to ensure the MOVs will perform their safety functions.

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 NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Thomas G. Scarbrough, NRR
(301) 492-0916

Richard J. Kiessel, NRR
(301) 492-1154

Attachments:
1. Table 1 - GI-87 Research Results for Blowdown Tests
2. List of Recently Issued NRC Information Notices

TABLE 1
GI-87 RESEARCH RESULTS FOR BLOWDOWN TESTS

| Manufacturer | D/P (psi) | T (°F) | Fluid | Required Thrust (lbs) | NOTES |
|---|---|---|---|---|---|
| SIX-INCH VALVES | | | | | |
| Anchor/Darling (Phase 1) | 990 | 524 | Hot water | 20,000 | (1)(2) |
| Anchor/Darling (Phase 2) | 900 | 520 | Hot water | >23,000 | (1)(2)(3) |
| Velan (Phase 1) | 990 | 524 | Hot water | 15,000 | (4) |
| Velan (Phase 2) | 950 | 520 | Hot water | 14,000 | (2) |
| | 1040 | 550 | Steam | 14,000 | (4) |
| | 750 | <100 | Cold water | 13,000 | (2) |
| | 600 | 540 | Hot water | 9,000 | (2) |
| | 1000 | 470 | Hot water | 14,000 | (2) |
| | 1300 | 520 | Hot water | 16,000 | (4) |
| Walworth | 920 | 520 | Hot water | 9,000 | (4)(5)(6) |
| | 1100 | 550 | Hot water | 12,000 | (4)(5)(6) |
| | 1300 | 570 | Hot water | 15,000 | (4)(5)(6) |
| TEN-INCH VALVES | | | | | |
| Anchor/Darling | 750 | 510 | Steam | 29,000 | (1)(2) |
| Powell | 800 | 525 | Steam | 28,000 | (1)(4) |
| | 1040 | 550 | Steam | 29,000 | (1)(4) |
| Velan | 990 | 550 | Steam | 33,000 | (1)(2) |
| | 1400 | 590 | Steam | 40,000 | (1)(2) |
| | 1100 | 560 | Steam | 36,000 | (1)(2) |

NOTES:

1. Valve damage during stroke could result in higher thrust requirements than predicted by the valve thrust equation. (These valves are referred to as "unpredictable").

2. The valve thrust equation with valve friction factors of either 0.3 or 0.5 did not bound the required thrust in the blowdown test.

3. The torque switch tripped before full valve closure.

4. The valve thrust equation with a valve friction factor of 0.3 did not bound the required thrust in the blowdown test, but the equation did bound the required thrust if a valve friction factor of 0.5 was used.

5. This valve had a removable guide which deformed during the blowdown test.

6. In determining whether the MOV can accommodate the required thrust to close the valve, the weak link among the motor, operator, and valve must be identified. For the Walworth valve, this is especially important because stems with relatively small diameters are typically used in these valves.

# LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

| Information Notice No. | Subject | Date of Issuance | Issued to |
|---|---|---|---|
| 90-39 | Recent Problems With Service Water Systems | 6/1/90 | All holders of OLs or CPs for nuclear power reactors. |
| 90-38 | Requirements for Processing Financial Assurance Submittals for Decommissioning | 5/29/90 | All fuel facility and materials licensees. |
| 90-37 | Sheared Pinion Gear-to-Shaft Keys in Limitorque Motor Actuators | 5/24/90 | All holders of OLs or CPs for nuclear power reactors. |
| 90-36 | Apparent Falsification of State of Connecticut Weight Certificates | 5/24/90 | All holders of OLs or CPs for nuclear power reactors, and 10 CFR 70 licensees. |
| 90-35 | Transportation of Type A Quantities of Non-Fissile Radioactive Materials | 5/24/90 | All U.S. NRC licensees. |
| 90-34 | Response to False Siren Activations | 5/10/90 | All holders of OLs or CPs for nuclear power reactors. |
| 90-33 | Sources of Unexpected Occupational Radiation Exposures at Spent Fuel Pools | 5/9/90 | All holders of OLs or CPs for nuclear power reactors. |
| 90-32 | Surface Crack and Subsurface Indications in the Weld of A Reactor Vessel Head | 5/3/90 | All holders of OLs or CPs for nuclear power reactors. |
| 90-31 | Update on Waste Form and High Integrity Container Topical Report Review Status, Identification of Problems with Cement Solidification, and Reporting of Waste Mishaps | 5/4/90 | All holders of OLs or CPs for nuclear power reactors, fuel cycle licenses, and certain by-product materials licenses. |

OL = Operating License
CP = Construction Permit

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1. Table 1 - GI-87 Research Results for Blowdown Tests
2. List of Recently Issued NRC Information Notices

Document Name: IN 90-40
*SEE PREVIOUS CONCURRENCES

| | | | | |
|---|---|---|---|---|
| | | | D/DOEA:NRR | *C/OGCB:DOEA:NRR |
| | | | CERossi | CHBerlinger |
| | | | 05/30/90 | 05/25/90 |
| *EMEB:DET:NRR | *C/EMEB:DET:NRR | *D/DET:NRR | *OGCB:DOEA:NRR | *RPB:ADM |
| TGScarbrough | LBMarsh | JERichardson | RJKiessel | TechEd |
| 05/25/90 | 05/25/90 | 05/25/90 | 05/25/90 | 05/25/90 |

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|---|---|---|---|---|---|---|---|
| NAME | :TGScarbrough | :LBMarsh | :JERichardson | :RJKiessel | :DGrbic | :CHBerlinger | :
| DATE | :5/25/90 | :5/25/90 | :5/25/90 | :5/25/90 | :5/25/90 | :5/25/90 | :

| OFC | :D:DOEA:NRR | : | : | : | : | : | :
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