UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

March 6, 1997

NRC INFORMATION NOTICE 97-07: PROBLEMS IDENTIFIED DURING GENERIC LETTER 89-10 CLOSEOUT INSPECTIONS

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 general conclusions derived from NRC inspections of programs developed at nuclear power plants in response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

In response to operating events, research results, and the findings in NRC Bulletin 85-03, "Motor-Operated Valve Common Mode Failures During Plant Transients due to Improper Switch Settings," the NRC staff requested in GL 89-10 that holders of nuclear power plant operating licenses and construction permits ensure the design-basis capability of their safety-related motor-operated valves (MOVs) by periodically reviewing MOV design bases, verifying MOV switch settings, testing MOVs under design-basis conditions where practicable, improving evaluations and corrective actions associated with MOV failures, and determining trends of MOV problems. The NRC staff issued seven supplements to GL 89-10 to provide further guidance to the industry on implementation of the generic letter.

On September 18, 1996, the NRC staff issued GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves." GL 96-05 contains detailed guidance on the development of long-term programs to ensure the design-basis capability of safety-related MOVs. It also includes updated information on long-term MOV performance. In the area of MOV periodic verification, the recommendations of GL 96-05 supersede those of GL 89-10.

Over a number of years, industry and NRC activities associated with GL 89-10 have increased, reflecting both the evolution of technological development and experience gained over time and the rising expectations of both the industry and the NRC staff. Activities have included generic communications, workshops, MOV Users' Group meetings, symposia on

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pumps and valves, and a massive MOV testing and analysis effort by the Electric Power Research Institute (EPRI). As a result, information on MOV performance has been widely disseminated over the past few years.

Description of Circumstances

Most nuclear power plant licensees have notified the NRC that they consider their programs to verify the design-basis capability of safety-related MOVs in response to GL 89-10 to be complete. The NRC staff has been conducting inspections of the development, implementation, and completion of these programs. In performing the inspections, the NRC staff has followed Temporary Instruction (TI) 2515/109, "Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance." The NRC staff recently updated this TI to provide guidance on GL 89-10 closeout inspections and on the scope of GL 89-10 programs. The NRC staff plans to complete its review of the GL 89-10 programs at most nuclear plants in 1997.

Through MOV testing, analyses, and operational events over the past few years, the nuclear industry and the NRC staff have identified weaknesses in the original design, manufacture, maintenance, and testing of safety-related MOVs. During inspections to review completion of GL 89-10 programs, the NRC staff has found that some licensees have not fully verified the design-basis capability of their safety-related MOVs. For example, the NRC staff has found that little testing bases existed in support of original assumptions by some licensees (and actuator and valve manufacturers) for friction coefficients and efficiencies affecting thrust and torque requirements and actuator output when sizing and setting MOVs. As a result, licensees have had unexpected difficulty in demonstrating to the staff that they have adequately completed their GL 89-10 programs.

When reviewing the development and implementation phases of the GL 89-10 programs, the NRC inspectors identified specific items and concerns that needed attention before completion of the programs. These items and concerns are discussed in the inspection reports prepared by the NRC staff. During inspections to evaluate completion of the GL 89-10 programs, the NRC staff found that some licensees had not resolved the items and concerns identified in the previous inspection reports. In addition, some licensees had not recognized that the MOV program has to be kept up to date on the basis of new information on MOV performance.

In GL 89-10, the NRC staff recommended that MOVs within the scope of the generic letter be tested under design-basis conditions where practicable. In Supplement 6 to GL 89-10, the NRC staff provided guidance for licensees on grouping MOVs that were not practicable to test dynamically. Some licensees have also chosen to group MOVs to minimize the amount of dynamic testing under their GL 89-10 programs. The MOV grouping guidelines recommend that dynamic test data be obtained on a reasonable sample of MOVs and that the resulting information be applied to the remaining MOVs in the group.

During GL 89-10 closeout inspections, the NRC staff found that some licensees provided weak justification for the design-basis capability of MOVs that have not been dynamically

tested. As stated in Supplement 6 to GL 89-10, the NRC staff considers plant-specific test data to be the best source of information when attempting to justify the design-basis capability of MOVs. The plant-specific test data would be obtained from the specific MOV being evaluated or, if testing was not practicable, from other similar MOVs under similar fluid conditions at the plant.

In developing the justification for the design-basis capability of MOVs that are not dynamically tested, it is important to consider the extent and reliability of the information being applied to the MOV under evaluation. For example, MOVs of similar manufacture and fluid conditions have been found to have a range of performance characteristics. Therefore, reliance on data from a few MOVs tested under industry programs or at other plants might be insufficient to justify the design-basis capability of similar MOVs at a specific plant. Plant-specific testing needs to be repeatable or at least validated through the performance of statistically valid testing.

If MOV-specific data and plant-specific data for similar MOVs are not available, other sources of information appropriate for the plant's MOVs must be found. In the search for this information, the range of performance under similar fluid conditions needs to be considered. For example, EPRI made significant efforts to predict bounding thrust requirements through its program of separate effects tests, flow loop testing, and analytical methodology. In a safety evaluation (SE) dated March 15, 1996 (Accession number 9608070280), the NRC staff approved the EPRI MOV Performance Prediction Methodology (PPM) when used in accordance with certain conditions and limitations. Selective application of the EPRI test data or methodology might not be reliable without full consideration of the NRC staff SE on the EPRI PPM. Further, the NRC staff has determined that it is difficult to select the specific point of flow isolation of tested valves and to apply flow isolation data from one valve to another.

Key parameters to be addressed in verifying the design-basis capability of MOVs are valve friction coefficients (i.e., valve factor), stem friction coefficients, and load sensitive behavior (i.e., rate-of-loading effects). During GL 89-10 closeout inspections, the NRC staff found that some licensees were using qualitative arguments to justify assumptions for these quantitative parameters. As discussed previously, MOVs that have not been dynamically tested need to have adequate justification for their design-basis capability. The most reliable source of information on valve friction coefficients, stem friction coefficients, and load sensitive behavior is the specific licensee's plant. Licensees can best demonstrate the validity of their assumptions for these parameters by ensuring that sufficient test data are available for their specific plants and by analyzing the data for the plant- and valve-specific parameters.

Pressure locking and thermal binding of gate valves were particular MOV performance problems identified in GL 89-10. To some extent, the NRC staff has addressed licensee responses to this issue in GL 89-10 inspections. The NRC staff issued GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," to provide specific recommendations to licensees and to request their responses in regard to pressure locking and thermal binding of gate valves. GL 95-07 also requested that licensees submit

their responses to this issue separate from their submittals on their GL 89-10 programs. Nevertheless, the NRC staff may request information from licensees during GL 89-10 inspections regarding the operability of specific MOVs found to be susceptible to pressure locking or thermal binding.

On February 28, 1992, the NRC staff issued NRC Information Notice (IN) 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire." In that IN, the NRC staff alerted licensees to conditions (sometimes referred to as "hot shorts") found at several plants that could result in the loss of capability to maintain the reactor in a safe shutdown condition in the unlikely event that a control room fire forced reactor operators to evacuate the control room. During NRC inspections of MOV programs and other licensee activities, the NRC staff has identified weaknesses in the responses of some licensees to potential short-circuiting of MOV control circuitry in the event of a plant fire.

Attachment 1 to this information notice contains examples of licensee problems in supporting specific aspects of their bases for stating GL 89-10 actions have been completed. Attachment 2 contains a list of recently issued NRC information notices.

Related Generic Communications

BL 85-03	"Motor-Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings," dated November 15, 1985
GL 89-10	"Safety-Related Motor-Operated Valve Testing and Surveillance," dated June 28, 1989
GL 89-10 Sup. 1	"Safety-Related Motor-Operated Valve Testing and Surveillance," dated June 13, 1990
GL 89-10 Sup. 2	"Safety-Related Motor-Operated Valve Testing and Surveillance," dated August 3, 1990
GL 89-10 Sup. 3	"Safety-Related Motor-Operated Valve Testing and Surveillance," dated October 25, 1990
GL 89-10 Sup. 4	"Safety-Related Motor-Operated Valve Testing and Surveillance," dated February 12, 1992
GL 89-10 Sup. 5	"Safety-Related Motor-Operated Valve Testing and Surveillance," dated June 28, 1993
GL 89-10 Sup. 6	"Safety-Related Motor-Operated Valve Testing and Surveillance," dated March 8, 1994
GL 89-10 Sup. 7	"Safety-Related Motor-Operated Valve Testing and Surveillance," dated January 24, 1996

GL 95-07 "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," dated August 17, 1995

GL 96-05 "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," dated September 18, 1996

IN 92-17 "NRC Inspections of Programs Being Developed at Nuclear Power Plants in Response to Generic Letter 89-10," dated February 26, 1992

IN 92-18 "Potential for Loss of Remote Shutdown Capability during a Control Room Fire," dated February 28, 1992

IN 96-48 "Motor-Operated Valve Performance Issues," dated August 21, 1996

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.

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Attachments:
1. Examples of Problems Identified During GL 89-10 Closeout Inspections
2. List of Recently Issued NRC Information Notices

Attachment filed in Jacket

EXAMPLES OF PROBLEMS IDENTIFIED DURING GL 89-10 CLOSEOUT INSPECTIONS

Thrust and Torque Requirements for Non-Dynamically Tested Motor-Operated Valves (MOVs)

Some licensees had made general assumptions regarding the reduction in valve factor that were based on increasing valve size, differential pressure, or fluid temperature without sufficient test data to justify these assumptions quantitatively. In addition, some licensees have had difficulty in justifying the capability of certain MOVs that have been sized and set on the basis of unsupported assumptions for thrust or torque requirements. Licensees typically predict the thrust required to operate gate and globe valves from the sum of (1) the product of a valve factor, differential pressure across the valve, and the area of the valve disk; (2) the product of the system pressure and the stem cross-sectional area; and (3) the drag of the valve packing material on the valve stem. Some licensees assumed a generic valve factor of 0.5 (or less) in predicting the thrust required to operate non-dynamically tested gate valves on the basis of their assumption that the selected valve factor was conservative. However, industry and plant-specific gate valve testing has revealed thrust requirements can exceed that predicted by a 0.5 valve factor. Similarly, industry and plant-specific globe valve testing has revealed that a valve factor of 1.1 to predict the thrust requirements might not be adequate for all globe valves. With respect to butterfly valves, industry and plant-specific testing has revealed that vendor calculations might not adequately predict the torque required to operate some butterfly valves. On the basis of industry testing and analyses, the Electric Power Research Institute (EPRI) is revising its application guide for predicting MOV thrust and torque requirements.

Use of Industry Valve Information

Some licensees have found that testing of certain MOVs under dynamic conditions is impracticable and that sufficient test information on similar MOVs at their plants is not available. Consequently, these licensees have obtained MOV performance information from other licensee or industry test programs and the MOV Performance Prediction Methodology (PPM) developed by EPRI. In comparing test data from other sources, it is important to understand the similarity of the valves; test conditions of differential pressure, temperature, and flow; diagnostic equipment and uncertainty; evaluation of the data and any anomalies (such as high static seating loads); and calculation of valve factor (including flow area assumptions). In addition, sufficient data need to be obtained to account for the variability in thrust requirements for similar valves under applicable conditions. EPRI tested a sample of valves of varying manufacture, type and size to validate a bounding methodology for predicting thrust requirements for a wide variety of valves. The NRC staff identified concerns regarding certain specific MOV tests by EPRI during its review of the methodology. These concerns were resolved with respect to the bounding nature of the EPRI methodology in developing the NRC staff safety evaluation.

Some licensees were not addressing the results of the EPRI methodology that predicted potential valve damage and unpredictable thrust requirements for specific valves, and some

licensees did not address the limitations on the applicability of the EPRI methodology (such as limitations due to the specific valve manufacturer).

Justification for Stem Friction Coefficient and Load Sensitive Behavior Assumptions

The efficiency of the conversion of actuator output torque to stem thrust is a function of the stem friction coefficient and the dimensions of the valve stem and its thread. Load sensitive behavior relates to the change in this efficiency when different thrust levels are exerted through the stem. Typically, as the thrust level increases, the stem friction coefficient increases and the thrust delivered at the torque switch trip decreases (referred to as a "rate-of-loading" effect). Some licensees initially assumed a stem friction coefficient of 0.15 (or less) or rate-of-loading effect of 15 percent (or less) and planned to justify these assumptions as part of their dynamic testing under GL 89-10. However, in some cases, insufficient data or higher-than-expected values obtained during the MOV testing caused the staff to question the licensee's initial assumptions when the data were evaluated in a statistically valid manner. For example, one licensee may have to revise the initial assumption for rate-of-loading effects up to 25 percent. Stem friction coefficient and rate-of-loading effects may vary between MOVs because of factors such as stem lubricant, lubrication frequency, environmental conditions, and manufacturing tolerances of the stem and stem nut. Therefore, it is difficult to apply information on stem friction coefficient and rate-of-loading effects from sources other than the licensee's testing program. EPRI developed bounding values for load sensitive behavior associated with gate valves as part of its MOV PPM. The NRC staff discusses conditions and limitations of the EPRI methodology in a safety evaluation dated March 15, 1996. Also, some licensees have improperly considered load sensitive behavior (or rate-of-loading effects) to be a random uncertainty, rather than a bias error or a bias/random combination error.

Grouping of MOVs

In GL 89-10, the NRC staff recommended that licensees test their safety-related MOVs under design-basis conditions where practicable. In Supplement 6 to GL 89-10, the NRC staff reiterated that recommendation but provided information on grouping MOVs in situations where a licensee either is not able to test some MOVs under design-basis conditions or chooses not to dynamically test some MOVs. For example, the NRC staff considered it important to (1) assess, when grouping MOVs, such similarities as valve manufacturer, model and size, valve flow, temperature, pressure, installation configuration, valve materials and condition, seat/guide stresses, and performance during testing; (2) test a representative sample of MOVs in each group (nominally 30 percent and no less than 2 MOVs); (3) test each MOV in a group with diagnostics under static conditions; and (4) evaluate any adverse information from individual MOV testing and determine its applicability to the entire group. Some licensees have used approaches for grouping and testing MOVs other than those described in Supplement 6 to GL 89-10. The NRC staff has found that some licensees have not adequately justified testing only one MOV in a group, or a very small sample of MOVs in the group. Also, some licensees have selected a valve factor based on a sample of tests that does not accommodate reasonable variation in the valve factor for other MOVs in the

group (for example, the bounds on the valve factor for a group of valves was not always appropriate for the scatter observed in the data). Although some licensees have grouped MOVs in ways that could not be justified, some other licensees have established such a large number of groups (as many as 50) that it is difficult to have sufficient test data for each group. Some licensees have adequately justified including MOVs with small variations in size into the same group in order to minimize the number of groups and allow sufficient data to be obtained for each group.

Degraded Voltage Calculations

The NRC staff discussed in Supplements 1 and 6 to GL 89-10 determination of the voltage assumed at MOVs for design-basis conditions. Various methods are used by licensees to determine the reduction in voltage from the grid to the MOV being evaluated. During GL 89-10 closeout inspections, the NRC staff found that some licensees had not fully justified their assumptions for the grid voltage assumed in their MOV calculations. For example, some licensees assumed full grid voltage as the starting point for calculations, rather than the degraded grid relay setpoint.

Justification for Weak Link Analyses

In Information Notice 96-48, "Motor-Operated Valve Performance Issues," the NRC staff discussed recent failures of MOV keys. Some licensees have also identified cracks in motor shafts for some MOVs. Further, missing bolts or incorrect bolting material has been found in some MOVs. These problems could be related to inadequate justification of the weak link components in MOV analyses. For example, replacement of a motor pinion key with a key of stronger material could cause the weak link to shift to another internal part, such as the motor shaft.

Analytical Evaluation of Potential Pressure Locking of Gate Valves

In Supplement 6 to GL 89-10, the NRC staff provided one acceptable approach for addressing potential pressure locking and thermal binding of MOVs. In GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," the NRC staff gave more detailed information and recommendations to address potential pressure locking and thermal binding of gate valves.

During recent GL 89-10 inspections, the NRC staff identified weaknesses in some approaches used by licensees to evaluate the effects of pressure locking of MOVs. Some licensees are relying on analytical approaches (without test-based justification) to provide confidence that the motor actuator can overcome the thrust resulting from pressure locking of its valve. The NRC staff found that some licensees assumed overly optimistic actuator efficiencies in predicting the thrust delivered by the motor actuator under pressure locking conditions. In addition, the staff found that some licensees have insufficient justification for assumptions of significant leakage from the valve bonnet over a short period, and of a very low increase in bonnet pressure with rising temperature.

Evaluation of Test Data

Some licensees have not thoroughly evaluated test data to ensure that the results are reliable. For example, an abnormally low thrust requirement or a back-calculated valve factor might indicate that the design-basis differential pressure and flow were not achieved during the test. Further, anomalies in the data traces could reveal valve or actuator damage. Some licensees have not justified extrapolation of test data based on percentage of design-basis differential pressure and absolute value of differential pressure as discussed in the EPRI MOV program.

Tracking and Trending of MOV Problems

Tracking and trending are important aspects of a licensee's periodic verification program. The NRC staff provided comments on MOV tracking and trending methods in initial reports of GL 89-10 inspections. It also identified weaknesses in the development of MOV tracking and trending methods at some nuclear plants. During GL 89-10 closeout inspections, the NRC staff found that some licensees have not fulfilled their plans to develop MOV tracking and trending methods and that some licensees have highly informal methods without specific guidelines or schedules.

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
97-06	Weaknesses in Plant-Specific Emergency Operating Procedures for Refilling the Secondary Side of Dry Once-Through Steam Generators	03/04/97	All holders of OLs or CPs for nuclear power reactors with with once-through steam generators
91-85, Rev. 1	Potential Failures of Thermostatic Control Valves or Diesel Generator Jacket Cooling Water	02/27/97	All holders of OLs or CPs for nuclear power reactors
97-05	Offsite Notification Capabilities	02/27/97	All holders of OLs or CPs for nuclear power reactors and test and research reactors
97-04	Implementation of a New Constraint on Radioactive Air Effluents	02/24/97	All materials, fuel cycle, and non-power reactor licensees
97-03	Defacing of Labels to Comply with 10 CFR 20.1904(b)	02/20/97	All material licensees involved with disposal of medical waste

OL = Operating License
CP = Construction Permit

GL 95-07 "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," dated August 17, 1995

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Attachments: Tech Editor has reviewed and concurred on 11/27/96
1. Examples of Problems Identified During GL 89-10 Closeout Inspections
2. List of Recently Issued NRC Information Notices

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