

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

July 24, 1998

INFORMATION NOTICE 96-48, SUPPLEMENT 1: MOTOR-OPERATED VALVE
PERFORMANCE ISSUES

Addressees

All holders of operating licenses for nuclear power reactors except those who have permanently ceased operation and have certified that fuel has been permanently removed from the reactor vessel.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to recent guidance from Limatorque Corporation for predicting torque output from its motor actuators used to open and close motor-operated valves (MOVs). This supplement to NRC Information Notice (IN) 96-48 (August 21, 1996), "Motor-Operated Valve Performance Issues," revises the information on motor actuator output presented earlier. The information in IN 96-48 on the Electric Power Research Institute (EPRI) MOV Performance Prediction Program and on the failure of MOV keys is not affected by this supplement's updated information on motor actuator output. 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

As discussed in IN 96-48, Limatorque Corporation established a standard practice for determining the appropriate size of motor actuators as described in its "SEL" documents in the 1970s. According to those documents, Limatorque predicts the torque output of MOV actuators through the use of the following equation:

$$\text{Actuator torque} = (\text{MT})(\text{Eff})(\text{AF})(\text{OAR})(\text{DVF})$$

- where MT = motor torque
- Eff = actuator gear efficiency
- AF = application factor
- OAR = overall actuator gear ratio
- DVF = degraded voltage factor

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Limatorque provided additional information on the sizing of motor actuators in its Technical Update 92-02 (dated October 9, 1992).

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In the SEL documents and Technical Update 92-02, Limatorque specified the following to be assumed in the equation for sizing ac-powered motor actuators:

- MT = nominal motor starting torque,
- Eff = "pullout" gear efficiency from a table provided by Limatorque for the specific actuator size and gear ratio,
- AF = 0.9 or lower, depending on the particular application,
- OAR = overall actuator gear ratio based on the particular actuator, and
- DVF = square of the ratio of actual to rated motor voltage.

The NRC staff reviewed the criteria for sizing motor actuators established by Limatorque during an inspection in 1993. The NRC staff found Limatorque's assumptions for the individual parameters in the sizing criteria to be based primarily on engineering judgment without independent justification. However, the NRC staff retained confidence in the prediction of output torque based on the success of the Limatorque criteria in sizing motor actuators over the previous years. For more information on the inspection findings, see NRC Inspection Report 99900100/93-01, dated June 28, 1993 (Accession Nos. 9308180192, 9308180201, and 9308180277).

In the early 1990s, dynamic tests of MOVs by nuclear power plant licensees in response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," revealed that valve vendors had significantly underpredicted the operating requirements for many safety-related valves under their design-basis conditions. This finding led licensees to request that Limatorque relax certain criteria used in the sizing equation for ac-powered motor actuators which would result in predicting higher actuator output torque. For example, Limatorque allowed particular licensees to assume 110 percent of the rated motor starting torque and a "run" efficiency (up to 20 to 30 percent greater than the "pullout" efficiency) for specific MOVs and their application. Further, Limatorque Technical Update 93-03 (dated September 1993) allowed licensees to assume an application factor of 1.0 (rather than 0.9) where the motor voltage was less than 90 percent of the motor's rated voltage. As a result of such relaxations of Limatorque's motor actuator sizing criteria, many licensees revised their MOV calculations to incorporate the relaxed criteria for all ac-powered motor actuators.

Description of Circumstances

In 1994, concerns were raised about the adequacy of Limatorque's relaxed criteria in reliably predicting the torque output of ac-powered motor actuators. In a paper presented by Texas Utilities Electric Company at an NRC/ASME Symposium on Valve and Pump Testing in July 1994, it generally appeared that the actuator sizing method would only be adequate if the original sizing criteria were used with "pullout" efficiency and a 0.9 application factor assumed. (See NUREG/CP-0137 (July 1994), "Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing.") At another NRC/ASME symposium in July 1996, Commonwealth Edison Company reported that its review of available test data indicated that use of "pullout" efficiency combined with a 0.9 application factor was needed to establish a conservative lower bound for actual actuator gear efficiencies. (See NUREG/CP-0152 (July 1996), "Proceedings of the Fourth NRC/ASME Symposium on Valve and Pump Testing.") Also at the July 1996

symposium, the Idaho National Engineering and Environmental Laboratory (INEEL) reported that preliminary results of tests sponsored by the NRC Office of Nuclear Regulatory Research similarly suggested the need to combine "pullout" efficiency with a 0.9 application factor to reliably predict the actuator gear efficiency. In IN 96-48, the NRC staff alerted licensees to these results of NRC-sponsored and industry tests of motor actuator output.

In July 1997, the NRC issued NUREG/CR-6478, "Motor Operated Valve (MOV) Actuator Motor and Gearbox Testing," which described in detail the results of the NRC-sponsored tests of motor actuator performance. The testing program revealed that motor output was typically greater than nominal starting torque. However, the program indicated that actuator efficiency was normally less than "run" efficiency (and in some cases even less than "pullout" efficiency), and that motor output under degraded voltage conditions was less than predicted by the square of the ratio of actual to rated motor voltage.

In IN 96-48, the NRC staff stated that it was discussing with Limitorque the discrepancy between guidance relaxing the original motor actuator sizing criteria and the recent motor actuator test results. The NRC staff also stated that Limitorque was developing updated information for the industry on the sizing of its motor actuators. At an MOV Users Group meeting of nuclear power plant licensees in December 1997, Limitorque informed the licensees that it was considering retracting its previous relaxation of the sizing criteria and that it would issue a documented notification. In April 1998, the NRC staff conducted an inspection at Limitorque of the manufacturer's response to the information on the adequacy of its relaxation of the ac-powered motor actuator sizing criteria. For information on the specific inspection findings, see NRC Inspection Report 99900100/98-01, dated July 13, 1998.

Discussion

On May 15, 1998, Limitorque prepared Technical Update 98-01 to provide updated guidance for determining the output torque capability of an ac-powered Limitorque motor actuator. In that update, Limitorque specifies that, in the sizing equation, licensees should use nominal motor starting torque, "pullout" efficiency, overall actuator gear ratio based on the particular actuator and an application factor (typically 0.9), and should apply an exponent of 2 to the ratio of actual to rated motor voltage. Where voltage exceeds 90 percent of the motor's rated voltage, Limitorque allows customers to disregard the degraded voltage factor because of standard motor design characteristics. Limitorque also allows customers to use more optimistic assumptions than are specified in Technical Update 98-01 whenever actual test data or certain engineering data are available. In light of available test data, Limitorque alerts customers to specific motor actuators that require special attention in determining output torque capability. Limitorque guidelines for considering the effects of elevated temperature on ac-powered motor starting torque continue to be provided in Limitorque Technical Update 93-03.

With respect to dc-powered motor actuators, the sizing equation developed by Limitorque in the SEL documents is similar to the one used for ac-powered motor actuators. The assumptions in the sizing equation for dc-powered motor actuators include nominal motor starting torque, application factor, "pullout" efficiency, overall actuator gear ratio based on the particular actuator and a degraded voltage factor where an exponent of 1 is applied to the ratio of actual to rated motor voltage. The NRC Office of Nuclear Regulatory Research is presently

sponsoring a program at the INEEL to study the performance of dc-powered motor actuators and to provide a basis for re-evaluating initial test results for a dc-powered motor actuator described in NUREG/CR-6478. Limitorque will review the information on the output of dc-powered motor actuators to determine whether the sizing guidance needs to be updated.

In summary, in light of recent tests and studies of motor-actuator output, Limitorque has retracted its relaxation of the sizing criteria for ac-powered motor actuators through issuance of Limitorque Technical Update 98-01. Limitorque has conducted workshops with nuclear power plant licensees to discuss its updated guidance on sizing ac-powered motor actuators. Limitorque is continuing to evaluate its sizing guidance for dc-powered motor actuators. The NRC staff will be evaluating licensee consideration of the updated Limitorque guidance as part of its review of MOV programs developed in response to GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves."

Related Generic Communications

NRC Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," June 28, 1989.

NRC Generic Letter 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," September 18, 1996.

NRC Information Notice 96-48, "Motor-Operated Valve Performance Issues," August 21, 1996.

NRC Information Notice 97-07, "Problems Identified During Generic Letter 89-10 Closeout Inspections," March 6, 1997.

This information notice requires no specific action or written response. However, recipients are reminded that they are required by 10 CFR 50.65 to take industry-wide operating experience (including information presented in NRC Information Notices) into consideration, where practical, when setting goals and performing periodic evaluations. 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.

orig /s/'d by
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Technical contacts: Thomas G. Scarbrough, NRR
 301-415-2794
 Email: tgs@nrc.gov

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**LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES**

Information Notice No.	Subject	Date of Issuance	Issued to
98-26	Settlement Monitoring and Inspection of Plant Structures Affected By Degradation of Porous Concrete Subfoundations	7/24/98	All holders of OLs for nuclear power reactors; all holders of or applicants for licenses to operate Independent Spent Fuel Storage Installations; and designers and fabricators of Independent Spent Fuel Storage Installations
98-25	Loss of Inventory from Safety- Related, Closed-Loop Cooling Water Systems	7/8/98	All holders of OLs for nuclear power reactors; except those licensees who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.
98-24	Stem Binding in Turbine Governor Valves in Reactor Core Isolation Cooling (RCIC) and Auxiliary Feedwater (AFW) Systems	6/26/98	All holders of operating licenses for nuclear power reactors except those who have permanently ceased operation and have certified that fuel has been permanently removed from the reactor vessel
98-23	Crosby Relief Valve Setpoint Drift Problems Caused by Corrosion of the Guide Ring	6/23/98	All holders of operating licenses for pressurized water reactors (PWRs), except those licensees permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel

OL = Operating License
CP = Construction Permit

sponsoring a program at the INEEL to study the performance of dc-powered motor actuators and to provide a basis for re-evaluating initial test results for a dc-powered motor actuator described in NUREG/CR-6478. Limitorque will review the information on the output of dc-powered motor actuators to determine whether the sizing guidance needs to be updated.

In summary, in light of recent tests and studies of motor-actuator output, Limitorque has retracted its relaxation of the sizing criteria for ac-powered motor actuators through issuance of Limitorque Technical Update 98-01. Limitorque has conducted workshops with nuclear power plant licensees to discuss its updated guidance on sizing ac-powered motor actuators. Limitorque is continuing to evaluate its sizing guidance for dc-powered motor actuators. The NRC staff will be evaluating licensee consideration of the updated Limitorque guidance as part of its review of MOV programs developed in response to GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves."

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