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

September 28, 1994

NRC Information Notice 94-69: POTENTIAL INADEQUACIES IN THE PREDICTION OF TORQUE REQUIREMENTS FOR AND TORQUE OUTPUT OF MOTOR-OPERATED BUTTERFLY VALVES

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 potential inadequacies in the prediction of torque requirements for and torque output of motor-operated butterfly valves. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar events or problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

Several problems regarding inadequacies in the prediction of torque requirements to operate butterfly valves and available torque from their motor actuators have been reported through Generic Letter (GL) 89-10 reviews. A significant example pertains to an event that occurred at the Catawba nuclear power plant.

On February 25, 1993, the licensee for the Catawba facility determined that both loops of the service water systems had been inoperable since August 1992, because three of the four service water pump discharge valves could not open against the pump discharge pressure. In August 1992, the licensee had reduced the torque switch settings on two of the four service water system discharge valves (one in each train) to address a concern that, under minimum voltage conditions, the motor operators for these valves might stall at a torque value lower than the maximum torque setpoint. The new torque switch settings were measured on a test bench and judged to be adequate based on manufacturer sizing equations. Following this modification of the two valves, differential pressure testing was not conducted to ensure the valves would function under design-basis conditions.

The licensee determined that these valves failed to open at the established torque output because the seat material had hardened with age and bearings had degraded with raw water service. Such other variables as gearbox efficiency, application-specific flow characteristics, and packing friction also affect the torque required to operate a butterfly valve. This event indicated that the engineering analysis performed to derive the torque requirements of the two referenced valves did not adequately address age degradation of the valves.

Some significant problems at other nuclear power plants relating to torque requirements of butterfly valves and available torque from their motor actuators are discussed below:

- In March 1994, the licensee for the Perry facility found that certain butterfly valves required higher seating torque than expected. Dynamic testing showed that the bearing friction coefficient for certain butterfly valves with stainless steel bushings was higher than the value originally assumed (0.25) in the calculations. Specifically, the bearing coefficient of friction was 0.634 for a fuel pool cooling and cleanup valve with stainless steel bushings, and 0.334 for an emergency service water valve with graphite-lubricated stainless steel bushings. The licensee investigated the effect of this information on 17 motor-operated valves, the entire plant population of motor-operated butterfly valves with stainless steel bushings. No operability problems were found. However, the licensee is evaluating possible modifications to improve margins for the four butterfly valves in the fuel pool cooling and cleanup system.

- In November 1993, the licensee for the Palo Verde facility determined that the condensate storage tank isolation valve would not have opened or closed completely under design-basis conditions with the as-found torque switch settings. The safety function of the valve is to isolate the condensate storage tank should non-seismic piping rupture downstream. The licensee also found that a containment isolation valve would not have closed under design-basis conditions with the as-found torque switch settings because the measured closing torque at torque switch trip was less than the minimum torque required in accordance with the design-basis calculation.

- In March 1993, the licensee for the Comanche Peak facility reported that a valve in the containment hydrogen purge system had demonstrated a lower torque output at torque switch trip during loaded testing on a torque test stand than that delivered at torque switch trip during static insitu testing. The licensee demonstrated that no operability concern existed for this valve. However, this apparent reduction in torque output at torque switch trip under loaded conditions for a motor-operated butterfly valve could have implications for other motor-operated valves.

- In May 1992, the licensee for the Zion facility determined that 12 of the 15 butterfly valves in the service water system were inoperable because their torque switch settings did not support the original design basis maximum differential pressure of 862 kPa [125 psid]. The remaining three valves would have supported a maximum differential pressure of 862 kPa [125 psid]; however, it would not have supported the current design requirement of 971 kPa [141 psid]. This event was caused by deficiencies in the pre-service design installation testing.

- In March 1992, the licensee for the Grand Gulf facility determined that the actuators for the suppression pool makeup system dump valves were undersized (they could not meet the torque requirements). It was found that the actuators were undersized because the flow rate specified in the design specification for the valves, which was used by the valve manufacturer to size the actuators, was the minimum required flow rate to ensure a "post-loss of coolant accident" drywell vent coverage of at least two feet above the top row vents with maximum emergency core cooling systems pump-down of the suppression pool. The size of the valves should have been determined using maximum expected design-basis flow rate based on the actual configuration of the system.

- In March 1991, while performing diagnostic tests on a butterfly valve of the primary containment purge and exhaust system, the licensee for the Limerick facility discovered that the "as-found" torque switch setting for the valve motor actuator was too low. This would have resulted in the motor actuator tripping on high torque before the valve could adequately close and seat if this valve was required to close during a design-basis differential pressure condition. In addition, the testing indicated that the actual motor actuator torque output for this valve was lower than the design torque output requirement. As a result, the valve would not have been capable of performing its primary containment isolation design function. When the licensee reviewed the original startup test records for all motor-operated butterfly valves in the same system, it found eight other valves that did not meet the design torque specifications for adequate valve seating in the event of a design basis differential pressure condition, or for which no test data were available to support the adequacy of butterfly valve testing.

Discussion

These examples of recent problems illustrate that many variables affecting the application of butterfly valves, including flow, pressure, seat material degradation, gearbox efficiency, turbulence in the system, as well as packing and bearing frictions, can have an impact on the required torque to operate a butterfly valve and on the torque output of their motor actuators. A primary basis for the NRC issuance of Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," with its request to test safety-related motor-operated valves under design-basis conditions where

practicable, is the uncertainties surrounding the prediction of torque/thrust requirements by valve vendors.

Related Generic Communications

- NRC Information Notice 93-88, "Status of Motor-Operated Valve Performance Prediction Program by the Electric Power Research Institute," November 30, 1993
- NRC Information Notice 90-21, "Potential Failure of Motor-Operated Butterfly Valves To Operate Because Valve Seat Friction Was Underestimated," March 22, 1990
- NRC Information Notice 84-04, "Failure of Elastomer Seated Butterfly Valves Used Only During Cold Shutdowns," January 18, 1984

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 for
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

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

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(319) 851-5111

Attachment:
List of Recently Issued NRC Information Notices

Attachment filed in Jacket

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
94-68	Safety-Related Equipment Failures Caused by Faulted Indicating Lamps	09/27/94	All holders of OLs or CPs for nuclear power reactors.
94-67	Problem with Henry Pratt Motor-Operated Butterfly Valves	09/26/94	All holders of OLs or CPs for nuclear power reactors.
94-66	Overspeed of Turbine-Driven Pumps Caused by Governor Valve Stem Binding	09/19/94	All holders of OLs or CPs for nuclear power reactors.
94-65	Potential Errors in Manual Brachytherapy Dose Calculations Generated Using a Computerized Treatment Planning System	09/12/94	All U.S. Nuclear Regulatory Commission medical licensees.
94-64	Reactivity Insertion Transient and Accident Limits for High Burnup Fuel	08/31/94	All holders of OLs or CPs for nuclear power reactors and all fuel fabrication licensees.
94-63	Boric Acid Corrosion of Charging Pump Casing Caused by Cladding Cracks	08/30/94	All holders of OLs or CPs for pressurized water reactors.
94-62	Operational Experience on Steam Generator Tube Leaks and Tube Ruptures	08/30/94	All holders of OLs or CPs for pressurized water reactors.
94-61	Corrosion of William Powell Gate Valve Disc Holders	08/25/94	All holders of OLs or CPs for nuclear power reactors.
94-60	Potential Overpressurization of Main Steam System	08/22/94	All holders of OLs or CPs for pressurized-water reactors.

OL = Operating License
CP = Construction Permit

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original signed by C.I. Grimes
for Brian K. Grimes, Director
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OFFICE	*EMEB:DE	*EMEB:DE	*EMEB:DE	*EMEB:DE	*DE:NRR
NAME	MKhanna	TScarbrough	GJohnson	RWessman	BSheron
DATE	08/01/94	08/01/94	08/02/94	08/05/94	08/26/94

OFFICE	*TECH ED	*OGCB:DORS	*OGCB:DORS	DORS:NRR
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DATE	08/31/94	09/01/94	09/07/94	09/21/94

DOCUMENT NAME: 94-69.IN

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Note: Comments from the cognizant resident inspectors and NRR project managers were solicited. One comment from the Catawba PM was received and has been incorporated.