



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RESPONSE TO GENERIC LETTER 95-07, "PRESSURE LOCKING
AND THERMAL BINDING OF SAFETY-RELATED POWER-OPERATED GATE VALVES"
MILLSTONE NUCLEAR POWER STATION, UNIT NO. 2
DOCKET NUMBER 50-336

1.0 INTRODUCTION

Pressure locking and thermal binding represent potential common-cause failure mechanisms that can render redundant safety systems incapable of performing their safety functions. The identification of susceptible valves and the determination of when the phenomena might occur requires a thorough knowledge of components, systems, and plant operations. Pressure locking occurs in flexible-wedge and double-disk gate valves when fluid becomes pressurized inside the valve bonnet and the actuator is not capable of overcoming the additional thrust requirements resulting from the differential pressure created across both valve disks by the pressurized fluid in the valve bonnet. Thermal binding is generally associated with a wedge gate valve that is closed while the system is hot and then is allowed to cool before an attempt is made to open the valve.

Pressure locking or thermal binding occurs as a result of the valve design characteristics (wedge and valve body configuration, flexibility, and material thermal coefficients) when the valve is subjected to specific pressures and temperatures during various modes of plant operation. Operating experience indicates that these situations were not always considered in many plants as part of the design basis for valves.

2.0 REGULATORY REQUIREMENTS

10 CFR Part 50 (Appendix A, General Design Criteria 1 and 4) and plant licensing safety analyses require or commit (or both) that licensees design and test safety-related components and systems to provide adequate assurance that those systems can perform their safety functions. Other individual criteria in Appendix A to 10 CFR Part 50 apply to specific systems. In accordance with those regulations and licensing commitments, and under the additional provisions of 10 CFR Part 50 (Appendix B, Criterion XVI), licensees are expected to act to ensure that safety-related power-operated gate valves susceptible to pressure locking or thermal binding are capable of performing their required safety functions.

On August 17, 1995, the NRC issued Generic Letter (GL) 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," to request that licensees take certain actions to ensure those safety-related power-operated gate valves that are susceptible to pressure locking or thermal binding are capable of performing their safety functions within the current licensing bases of the facility. GL 95-07 requested that each licensee, within 180 days of the date of issuance of the generic letter (1) evaluate the operational configurations of safety-

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related power-operated gate valves in its plant to identify valves that are susceptible to pressure locking or thermal binding, and (2) perform further analyses and take needed corrective actions (or justify longer schedules) to ensure that the susceptible valves, identified in (1) above, are capable of performing their intended safety functions under all modes of plant operation, including test configurations. In addition, GL 95-07 requested that licensees, within 180 days of the date of issuance of the generic letter, provide to the NRC a summary description of (1) the susceptibility evaluation used to determine that valves are or are not susceptible to pressure locking or thermal binding, (2) the results of the susceptibility evaluation, including a listing of the susceptible valves identified, and (3) the corrective actions, or other dispositioning, for the valves identified as susceptible to pressure locking or thermal binding. The NRC issued GL 95-07 as a "compliance backfit" pursuant to 10 CFR 50.109(a)(4)(i) because modification may be necessary to bring facilities into compliance with the rules of the Commission referenced above.

In a letter of February 13, 1996, Northeast Nuclear Energy Company (NNECO) submitted its 180-day response to GL 95-07 for Millstone Nuclear Power Station, Unit No. 2. The NRC staff reviewed the licensee's submittal and requested additional information in a letter dated June 19, 1996. In a letter of August 7, 1996, the licensee provided the additional information. During the period of August 4 through 8, 1997, the NRC staff performed an inspection to review specific aspects of information summarized in the licensee's responses to GL 95-07. This inspection is documented in NRC Inspection Report 50-336/97-203. The licensee responded to the inspection report findings in a letter dated July 17, 1998.

3.0 STAFF EVALUATION

3.1 Scope of Licensee's Review

GL 95-07 requested that licensees evaluate the operational configurations of safety-related power-operated gate valves in their plants to identify valves that are susceptible to pressure locking or thermal binding. The NNECO letters of February 13, and August 7, 1996, and July 17, 1998, described the scope of valves evaluated in response to GL 95-07. The NRC staff has reviewed the scope of the licensee's susceptibility evaluation performed in response to GL 95-07 and found it complete and acceptable. The criteria for determining the scope of power-operated valves for GL 95-07 are consistent with the staff's acceptance of the scope of motor-operated valves associated with GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance."

3.2 Corrective Actions

GL 95-07 requested that licensees, within 180 days, perform further analyses as appropriate, and take appropriate corrective actions (or justify longer schedules), to ensure that the susceptible valves identified are capable of performing their intended safety function under all modes of plant operation, including test configurations. The licensee's submittals discussed proposed corrective actions to address potential pressure locking and thermal binding problems. The staff's evaluation of the licensee's actions is discussed in the following paragraphs:

- a. The licensee stated that the following valves were modified to eliminate the potential for pressure locking:

2-RC-403/405 Pressurizer Power-Operated Relief Valve (PORV) Block Valves
2-SI-651/652 Shutdown Cooling Suction Header Valves

The staff finds that physical modification to valves susceptible to pressure locking is an appropriate corrective action to ensure operability of the valves and is thus acceptable.

- b. During a telephone conversation on November 5, 1998, the licensee clarified to the staff its basis for assuring that the containment sump header outlet isolation valves, 2-CS-16.1A/B, are capable of opening during a pressure locking event. The valves are scheduled to be modified during the current outage. The modification involves the installation of rupture disks that limit the pressure inside each valve's bonnet to 85 psig. A modified industry gate valve thrust equation was used to calculate the thrust required to open these double disk gate valves during pressure locking conditions with a maximum pressure of 85 psig inside the bonnets. The results of the calculation demonstrated that the margin between calculated pressure locking thrust and actuator capability exceeds 40 percent. As-found valve and stem factors were used to calculate the thrust required to open the valves during pressure locking conditions. The licensee stated that these valves are in an Alternate Test Plan Program which requires that the valve and stem factors be periodically verified. The information provided by the licensee is subject to confirmation during future NRC inspections.

Pressure locking tests sponsored by the NRC were conducted by Idaho National Engineering and Environmental Laboratory on a double disk gate valve. The results of this testing are documented in NUREG/CR-6611, "Results of Pressure Locking and Thermal Binding Tests of Gate Valves." Test data demonstrated that the modified industry gate valve thrust equation trended with the pressure locking test results but generally underestimated the thrust required to open a pressure-locked valve. The staff finds that the modified industry gate valve thrust equation provides reasonable assurance that valves susceptible to pressure locking are capable of performing their intended safety-related function provided that the margin between calculated pressure locking thrust and actuator capability exceeds 40 percent. Until more definitive industry criteria are developed, the staff concludes that the licensee's action to address pressure locking of gate valves 2-CS-16.1A/B is acceptable.

- c. The licensee stated that procedures were modified to cycle the following valves following evolutions that could potentially create a thermal binding condition:

2-MS-201/202 Turbine Driven Auxiliary Feedwater Pump Steam Admission
2-RC-403/405 Pressurizer PORV Block Valves
2-SI-651/652 Shutdown Cooling Suction Header

The staff finds that the licensee's procedural changes to require cycling the valves as corrective actions provide assurance that thermal binding conditions are eliminated, and are thus acceptable.

- d. The licensee stated that all flexible and solid wedge gate valves in the scope of GI. 95-07 were evaluated for thermal binding. When evaluating whether valves were susceptible to thermal binding, the licensee assumed that thermal binding would not occur below specific temperature thresholds. The screening criteria used by the licensee appear to provide a reasonable approach to identify those

valves that might be susceptible to thermal binding. Until more definitive industry criteria are developed, the staff concludes that the licensee's actions to address thermal binding of gate valves are acceptable.

4.0 CONCLUSION

On the basis of this evaluation, the NRC staff finds that the licensee has performed appropriate evaluations of the operational configurations of safety-related power-operated gate valves to identify valves at Millstone Nuclear Power Station, Unit No. 2, that are susceptible to pressure locking or thermal binding. In addition, the NRC staff finds that the licensee has taken, or is scheduled to take, appropriate corrective actions to ensure that these valves are capable of performing their intended safety functions. Therefore, the staff concludes that the licensee has adequately addressed the requested actions discussed in GL 95-07.

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Date: November 24, 1998