



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"
SURRY POWER STATION, UNITS 1 AND 2
DOCKET NOS. 50-280 AND 50-281

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 require 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

Title 10 of the *Code of Federal Regulations* (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 that 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-related power-operated gate valves in its plant to identify

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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 configuration. In addition, GL 95-07 requested that licensees, within 180 days of the date of issuance of the GL, 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 7, 1996, Virginia Electric and Power Company submitted its 180-day response to GL 95-07 for Surry Power Station, Units 1 and 2. The NRC staff reviewed the licensee's 180-day response and requested additional information in a letter dated June 6, 1996. In a letter of July 3, 1996, the licensee provided the additional information. On August 6 and November 29, 1999, the licensee provided responses to a second request for additional information regarding GL 95-07 forwarded by the NRC staff on May 25, 1999.

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 Virginia Electric and Power Company letters of February 7 and July 3, 1996, and August 6 and November 29, 1999, 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 licensing basis for Surry Power Station, Units 1 and 2, is Hot Shutdown; therefore, valves that are operated during conditions below Hot Shutdown are not in the scope of GL 95-07. Normally open, safety-related power-operated gate valves which are closed for test or surveillance but must return to the open position were evaluated within the scope of GL 95-07. The staff finds 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 configuration. 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:

1(2)-SI-MOV-1(2)867C/D	High Head Safety Injection (HHSI) Pump Discharge to Reactor Coolant System (RCS) Cold Legs
1(2)-SI-MOV-1(2)890A/B	Low Head Safety Injection (LHSI) Pump Discharge to RCS Hot Legs

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. A modified industry gate valve thrust equation was used to calculate the thrust required to open the following flexible wedge gate valves during pressure locking conditions:

1(2)-RC-MOV-1(2)535/536	Pressurizer Power Operated Relief Valve Block
1-SI-MOV-1842	HHSI Pump Discharge to Alternate RCS Cold Legs
1-SI-MOV-1869B	HHSI Pump Discharge to RCS Hot Legs
2-SI-MOV-2869A/B	HHSI Pump Discharge to RCS Hot Legs

The results of the calculation demonstrated that the margin between calculated pressure locking thrust and actuator capability is equal to or exceeds 20 percent. Pressure locking tests sponsored by the NRC were conducted by Idaho National Engineering and Environmental Laboratory on a flexible wedge 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 calculation conservatively estimated the thrust required to open a pressure-locked flexible wedge gate valve. The staff finds that the modified industry gate valve thrust equation provides reasonable assurance that flexible wedge gate valves susceptible to pressure locking are capable of performing their intended safety-related function. The staff considers that calculations that are used to demonstrate that valves can overcome pressure locking are required to meet the requirements of 10 CFR Part 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants, and therefore, controls are required to be in place to ensure that any industry pressure-locking thrust prediction methodology requirements and revisions are properly implemented. Until more definitive industry criteria are developed, the staff concludes that the licensee's action to address pressure locking of these flexible wedge gate valves is acceptable.

- c. A modified industry gate valve thrust equation was used to calculate the thrust required to open the following double disk gate valves during pressure locking conditions:

1-SI-MOV-1869A	HHSI Pump Discharge to RCS Hot Legs
2-SI-MOV-2842	HHSI Pump Discharge to Alternate RCS Cold Legs

The results of the calculation demonstrated that the margin between calculated pressure locking thrust and actuator capability is equal to or exceeds 40 percent. 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 calculation conservatively estimated the thrust required to open a pressure-locked double disk gate valve. The staff finds that the modified industry gate valve thrust equation provides reasonable assurance that flexible wedge gate 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 is equal to or exceeds 40 percent. The staff considers that calculations that are used to demonstrate that valves can overcome pressure locking are required to meet the requirements of 10 CFR Part 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants, and therefore, controls are required to be in place to ensure that any industry pressure-locking thrust prediction methodology requirements and revisions are properly implemented. Until more definitive industry criteria are developed, the staff concludes that the licensee's action to address pressure locking of these double disk gate valves is acceptable.

- d. The licensee stated that procedures require that the LHSI pump containment sump suction piping be filled with water to insulate the LHSI pump containment sump isolation valves, 1(2)-SI-MOV-1(2)860A/B, from the hot, post-accident sump fluid. The staff finds that the licensee's procedural change to maintain the piping between the containment sump and valves 1(2)-SI-MOV-1(2)860A/B full of water provide assurance that thermal-induced pressure-locking conditions are eliminated, and is acceptable corrective action.

The licensee stated that valves 1(2)-SI-MOV-1(2)860A/B are not susceptible to hydraulic-induced pressure locking following a containment pressurization event. The licensee's analysis concluded that containment pressure is not sufficient to reposition the valve disk of each valve; therefore, the valves are not susceptible to hydraulic-induced pressure locking. The NRC staff concludes that the licensee's analysis to address pressure locking of these valves is acceptable.

- e. The licensee stated that valves within the scope of GL 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 Surry Power Station, Units 1 and 2, that are susceptible to pressure locking or

thermal binding. In addition, the NRC staff finds that the licensee has taken 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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