



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"  
NORTH ANNA POWER STATION, UNITS 1 AND 2  
DOCKET NOS. 50-338 AND 50-339

## 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 North Anna 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. 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 No. 50-338, 339/97-01. On August 6, 1999, the licensee provided a response to a second request for additional information regarding GL 95-07 forwarded by the NRC staff on May 20, 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, 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 North Anna 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 except in the instances when the system/train is declared inoperable in accordance with technical specifications. 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 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)860A/B	Low Head Safety Injection (LHSI) Containment Sump Isolation
1(2)-SI-MOV-1(2)890A/B	LHSI Pump Discharge to 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	Pressurizer Power Operated Relief Valve (PORV) Block
1(2)-RC-MOV-1(2)536	Pressurizer PORV Block
1-RS-MOV-100B	Casing Cooling Pump Discharge Isolation
2-RS-MOV-200A/B	Casing Cooling Pump Discharge Isolation
1(2)-SI-MOV-1(2)836	High Head Safety Injection (HHSI) Pump Discharge to Alternate Cold Legs
1(2)-SI-MOV-1(2)867C/D	Boron Injection Tank Outlet
1(2)-SI-MOV-1(2)869A/B	HHSI Pump Discharge to Hot Legs

Pressure locking tests sponsored by the NRC were conducted by Idaho National Engineering and Environmental Laboratory (INEEL) 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 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. The boron injection tank inlet valves, 1(2)-SI-MOV-1(2)867A/B, are susceptible to pressure locking for approximately 1 second following a loss of offsite power

concurrent with emergency core cooling system automatic initiation. It takes approximately 1 second for a charging pump to develop full discharge pressure and equalize pressure across the upstream disk of each valve. The staff accepts operation of actuators for approximately 1 second at locked-rotor conditions because testing performed by INEEL (NUREG/CR-6478) demonstrates that the capability of the actuator does not degrade.

- d. The licensee stated that the quench spray pump discharge valves 1(2)-QS-MOV-1(2)01A/B, are susceptible to pressure locking. As corrective action, procedures were revised to cycle the valves following evolutions that could potentially create a pressure-locking condition.

The staff finds that the licensee's procedural requirements to cycle valves 1(2)-QS-MOV-1(2)01A/B provide assurance that pressure-locking conditions are adequately identified and eliminated, and, are thus, 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. Operating conditions for the PORV block valves, 1(2)-RC-MOV-1(2)535 and 1(2)-RC-MOV-1(2)536, exceed these temperature thresholds. The licensee stated that specific operational history demonstrates that the valves are not susceptible to thermal binding. The actuator for valve 2-RC-MOV-2536 is equipped with a spring compensator which further reduces the potential for the valve to thermally bind.

The screening criteria and operational history results used by the licensee 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 North Anna 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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