



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO LICENSEE RESPONSE TO GENERIC LETTER 95-07, "PRESSURE LOCKING  
AND THERMAL BINDING OF SAFETY-RELATED POWER-OPERATED GATE VALVES"

NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2

DOCKET NOS. 50-282 AND 50-306

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

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 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 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 12, 1996, Northern States Power Company (NSP, or licensee) submitted its 180-day response to GL 95-07 for Prairie Island Nuclear Generating Plant. The NRC staff reviewed the licensee's submittal and requested additional information in a letter dated July 8, 1996. In a letter of August 6, 1996, the licensee provided the additional information. In a letter of July 1, 1999, the licensee supplemented its 180-day response to GL 95-07.

### 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 Northern States Power Company letters of February 12 and August 6, 1996, and July 1, 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 Prairie Island Nuclear Generating Plant 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 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 it used a thrust-prediction methodology developed by Commonwealth Edison Company (ComEd) to demonstrate that the pressurizer power operated relief valve block valves, (1)MV-32195, (1)MV-32196, (2)MV-32197, and (2)MV-32198, are capable of opening during pressure-locking conditions.

The licensee stated that the containment sump to residual heat removal (RHR) pump suction valves (sump side), (1)MV-32075, (1)MV-32076, (2)MV-32178, and (2)MV-32179, were susceptible to pressure locking. Procedures were revised to cycle the valves prior to leaving cold shutdown to ensure that the water is drained from the bonnet of each valve. The licensee stated that the ComEd pressure-locking thrust prediction methodology was used to demonstrate that the valves are capable of opening during pressure-locking conditions. The licensee's evaluation concluded that there is a mixture of air and water in the bonnet of each valve when pressure-locking conditions exist and that the presence of air minimizes the increase of pressure in the bonnets. The NRC staff finds that the licensee's evaluation of the effects of entrapped air in the bonnet of each valve is consistent with the findings contained in NUREG/CR-6611, "Results of Pressure Locking and Thermal Binding Tests of Gate Valves," and is therefore acceptable.

On April 9, 1997, the NRC staff held a public meeting to discuss the technical adequacy of the ComEd pressure-locking thrust prediction methodology and its generic use by licensees in their submittals responding to GL 95-07. The minutes of the public meeting were issued on April 25, 1997. At the public meeting, ComEd recommended that, when using its methodology, minimum margins should be applied between calculated pressure-locking thrust and actuator capability. These margins along with diagnostic equipment accuracy and methodology limitations are defined in a letter from ComEd to the NRC dated May 29, 1998 (Accession Number 9806040184). The NRC considers the use of the ComEd pressure locking methodology acceptable provided these margins, diagnostic equipment accuracy requirements and methodology limitations are incorporated into the pressure-locking calculations. ComEd indicated that its methodology may be revised. 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. Under this condition, the staff finds that the ComEd methodology

provides a technically sound basis for assuring that valves susceptible to pressure locking are capable of performing their intended safety-related function.

- b. The licensee stated that the RHR system to vessel injection valves, (1)MV-32064, (1)MV-32065, (2)MV-32167, and (2)MV-32168, were susceptible to pressure locking and that, as corrective action, procedures were revised to require that these valves be maintained in the open position. The staff finds that changing the normal position of valves susceptible to pressure locking from normally shut to normally open is an appropriate corrective action to ensure operability of the valves and is thus acceptable.
- c. The licensee stated that a bonnet vent with manual valve was installed on the RHR system to safety injection pump suction valves, (1)MV-32206, (1)MV-32207, (2)MV-32208, and (2)MV-32209, and the containment sump to RHR pump suction valves (pump side), (1)MV-32077, (1)MV-32078, (2)MV-32167, and (2)MV-32168. Procedures were revised to cycle the bonnet vent valve prior to opening (1)MV-32206, (1)MV-32207, (2)MV-32208, or (2)MV-32209 during pressure-locking conditions. The staff finds that the licensee's modification that installed a bonnet vent in conjunction with a procedural change to cycle the bonnet vent valve following conditions that result in pressure locking provides assurance that pressure-locking conditions are eliminated, and is an acceptable corrective action.
- d. The licensee stated that the containment spray pump discharge isolation valves, (1)MV-32103, (1)MV-32105, (2)MV-32114, and (2)MV-32116, were 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 licensee stated that in the future it may implement a plant design change to ensure these valves are not susceptible to pressure locking.

The NRC staff finds that the licensee's corrective action provides assurance that pressure locking conditions are adequately identified and eliminated, and is thus acceptable.

- e. The licensee stated that all flexible and solid wedge gate valves in 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 the Prairie Island Nuclear Generating Station 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.

Principal Contributor: S. Tingen, NRR

Date: August 24, 1999