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

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

COMMONWEALTH EDISON COMPANY

BRAIDWOOD STATION, UNITS 1 AND 2

BYRON STATION, UNITS 1 AND 2

DOCKET NOS. STN 50-456, STN 50-457, STN 50-454 AND STN 50-455

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

ENCLOSURE

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 GL: (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 13, 1996, Commonwealth Edson Company (ComEd, the licensee) submitted its 180-day response to GL 95-07 for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2 (Braidwood and Byron). The NRC staff reviewed the licensee's submittals and requested additional information in a letter of April 2, 1996. In a letter of May 24, 1996, the licensee provided the additional information. In a letter of June 5, 1996, the NRC issued a second request for additional information and in a letter of July 5, 1996, the licensee provided the additional information. In letters of December 12 and 30, 1996, the licensee further supplemented its response to the second request for additional information. In a letter of May 14, 1997, the NRC issued a third request for additional information and in letters of May 29, 1998, and July 29, 1999, the licensee provided the additional information.

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 ComEd letters of February 13, May 24, July 5, and December 12 and 30, 1996, May 29, 1998, and July 29, 1999, described the scope of valves evaluated in response to GL 95-07. The licensee did not include the residual heat removal (RHR) pump suction valves from the reactor coolant system (RCS) hot legs, 1(2) RH8701A/B and 1(2) RH8702A/B, in the scope of GL 95-07 because these valves are used during plant conditions below Hot Standby. This is acceptable because the safe shutdown design basis for Braidwood and Byron is Hot Standby. Normally open, safety-related power-operated gate

valves which are closed for testing 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 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 Undertaken by Licensee

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:

3.2.1 Valve Modifications

The licensee stated that the RHR crosstie isolation valves, 1(2) RH8716A, were modified to eliminate the potential for pressure locking.

The licensee stated that it planned to modify the RHR pump discharge valves to the charging pump suction, 1(2) CV8804A, to eliminate the potential for pressure locking. As a short-term corrective action, the licensee is relying on a combination of bonnet leakage and actuator capability calculations to demonstrate that the valves are capable of opening during pressure-locking conditions. The staff finds that the short-term corrective action is acceptable until the modifications to eliminate the potential for pressure locking are complete. These valves are scheduled to be modified during the fall 2000 refueling outage (RFO) for Byron, Unit 1; the spring 2001 RFO for Byron, Unit 2; the fall 2001 RFO for Braidwood, Unit 1; and the fall 2000 RFO for Braidwood, Unit 2.

The licensee stated that RHR pump suction valves from the refueling water storage tank (RWST), 1(2) SI8812A/B, are susceptible to pressure locking. As short-term corrective action, procedures were revised to align one train of RHR to the RWST while in Mode 4. As long-term corrective action, the licensee plans to modify the valves to eliminate the potential for pressure locking. The NRC staff finds that the short and long-term corrective actions provide acceptable methods for eliminating the potential for valves 1(2) SI8812A/B to pressure lock.

The NRC staff finds that physical modification to valves susceptible to pressure locking is an appropriate long-term corrective action to ensure operability of the valves and is, thus, acceptable. The staff also views crediting natural depressurization of the bonnets as an acceptable short-term corrective action to ensure that the valves are not susceptible to pressure locking when required to open.

3.2.2 Analysis of Valve Performance

The licensee stated that the RHR to RCS hot leg injection valves, 1(2) SI8840, are susceptible to pressure locking. As a corrective action, the licensee is performing an analysis to demonstrate that these valves are not required to open to mitigate a design basis accident and plans to revise its Updated Final Safety Analysis Report (UFSAR) to indicate that the valves are not required to open to mitigate an accident. The staff finds the licensee's pressure-locking analysis acceptable because there are two additional redundant RCS hot leg injection flow paths (1(2) SI8802A/B) from the safety injection system that were evaluated for pressure locking and are capable of operating during pressure-locking conditions.

The licensee stated that the charging pump RCS cold leg injection valves, 1(2) SI8801A/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 the valves. Pressure-locking conditions no longer exist once the pressure in the bonnet is equal to the pressure in the upstream piping. The staff accepts operation of actuators for approximately 1 second at locked-rotor conditions because testing performed by Idaho National Engineering and Environmental Laboratory (NUREG/CR-6478) demonstrates that the capability of the actuator does not degrade.

3.3.3 Use of ComEd Thrust-Prediction Methodology

The licensee stated that it used the ComEd thrust-prediction methodology to demonstrate that the pressurizer power operated relief block valves, 1(2)RY-8000A/B, are capable of opening during pressure-locking conditions.

The licensee stated that it plans to modify the actuators for the safety injection pump RCS hot leg injection valves, 1(2) SI8802A/B, to increase actuator capability and use the ComEd thrust-prediction methodology to demonstrate that the valves are capable of opening during pressure-locking conditions. The licensee also plans to use the ComEd thrust-prediction methodology to demonstrate that the RHR pump discharge valves to the charging pump suction, 1(2) CV8804B, are capable of opening during pressure-locking conditions. As a short-term corrective action, the licensee is relying on a combination of bonnet leakage and actuator capability calculations to demonstrate that the valves are capable of opening during pressure-locking conditions. The staff finds that the short-term corrective action is acceptable until the modifications to eliminate the potential for pressure locking are complete. Valves 1(2) SI8802A/B are scheduled to be modified during the fall 2000 RFO for Byron, Unit 1; the spring 2001 RFO for Byron, Unit 2; the fall 2001 RFO for Braidwood, Unit 1; and the fall 2000 RFO for Braidwood, Unit 2. The licensee indicated in its submittal of July 29, 1999, that the calculation for 1(2) CV8804B would be completed by September 1, 1999. The completion of the calculation by that date was confirmed by the licensee by telephone.

The licensee stated that a relief valve was installed on the bonnet on each RHR pump containment sump suction valve, 1(2) SI8811A/B, to limit the pressure in the bonnet of each valve during thermal induced pressure-locking conditions. The licensee used its ComEd thrust-prediction methodology to demonstrate that the valves are capable of opening during

pressure-locking conditions when pressure in the bonnet is below the relief valve setpoint. On April 9, 1997, the 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. ComEd indicated that its methodology is undergoing review and 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. 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.

3.3.4 Procedural Requirements

The licensee stated that the containment spray pump discharge isolation valves 1(2) CS007A/B, are susceptible to pressure locking. As a corrective action, procedures were revised to cycle the valves following evolutions that could potentially create a pressure locking-condition.

The licensee stated that the component cooling water (CCW) valves from the RHR heat exchangers, 1(2) CC9412, are susceptible to pressure locking when the RHR pumps operate on 1recirculation flow for longer than 2.4 hours with CCW to the RHR heat exchangers isolated. The licensee stated that operating procedures contain precautions to not operate the RHR pumps on recirculation flow for longer than 2.4 hours unless CCW is aligned to the RHR heat exchangers; therefore, no additional corrective action is required.

The staff finds that the licensee's procedural requirements to cycle valves 1(2) CS007A/B and limit the time that CCW to the RHR heat exchangers is isolated provide assurance that pressure-locking conditions are adequately identified and eliminated and are, thus, acceptable.

3.3.5 Operating Temperature Thresholds

The licensee stated that all flexible and solid wedge gate 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 RHR pump recirculation valves, 1(2) RH 610/611, exceed these temperature thresholds. The licensee stated that the closing thrust for these valves was reduced and specific operational history demonstrates that the valves are not susceptible to thermal binding since lowering the closing thrust.

The screening criteria 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 the Braidwood Station, Units 1 and 2, and Byron 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, 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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