

December 11, 2000

Mr. Gregg R. Overbeck
Senior Vice President, Nuclear
Arizona Public Service Company
P. O. Box 52034
Phoenix, AZ 85072-2034

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 -
GENERIC LETTER 95-07, "PRESSURE LOCKING AND THERMAL BINDING
OF SAFETY-RELATED POWER-OPERATED GATE VALVES," AND
SUMMARY OF MEETING HELD ON SEPTEMBER 27, 2000 (TAC NOS.
M93497, M93498 AND M93499)

Dear Mr. Overbeck:

On August 17, 1995, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 95-07 to request that licensees take 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.

In the letters of October 10, 1995, and February 21, 1996, Arizona Public Service Company (APS) submitted its 60-day and 180-day responses to GL 95-07, respectively, for Palo Verde Nuclear Generating Station, Units 1, 2, and 3 (Palo Verde). In a letter dated June 28, 1996, APS supplemented its 180-day response to GL 95-07. In its letters of August 6, 1996, October 8, 1999, and March 31 and October 5, 2000, APS provided responses to requests for additional information (RAIs) regarding GL 95-07. The RAIs were in (1) the staff's letters of June 27, 1996, June 11, 1999, and August 3, 2000, and (2) the public meeting conducted on September 27, 2000, to discuss the pressure-locking model developed by APS in response to GL 95-07. The summary of the September 27, 2000, meeting is Enclosure 1.

The NRC staff has reviewed the APS submittals and finds that APS has adequately addressed the actions requested in GL 95-07, as discussed in the enclosed safety evaluation (Enclosure 2). Therefore, this letter closes out the staff's actions for GL 95-07 and TAC Nos. M93497, M93498, and M93499 for Palo Verde.

The only commitments made by APS in this review were to (1) modify valves that were considered susceptible to pressure locking and (2) develop administrative controls for valves that were considered susceptible to thermal binding. By the letter of October 5, 2000, APS stated that the valves that were identified as susceptible to pressure locking in the letters of February 21 and June 28, 1996, have been modified. In the letter of June 28, 1996, APS stated that the additional administrative controls that were identified as being needed for the valves susceptible to thermal binding have been developed. Therefore, the commitments by APS for GL 96-06 have been completed.

G. R. Overbeck

- 2 -

If you have any questions concerning this letter, please contact me at 301-415-1307, or by e-mail at jnd@nrc.gov.

Sincerely,

/RA/

Jack N. Donohew, Senior Project Manager, Section 2
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-528, STN 50-529,
and STN 50-530

Enclosures: 1. Summary of the September 27, 2000, Meeting
 2. Safety Evaluation

cc w/encls: See next page

G. R. Overbeck

- 2 -

If you have any questions concerning this letter, please contact me at 301-415-1307, or by e-mail at jnd@nrc.gov.

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* No major changes to EMEB Memo dated 10/17/00

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August 18, 1999

December 11, 2000

LICENSEE: Arizona Public Service Company

FACILITY: Palo Verde Nuclear Generating Station, Units 1, 2, and 3

SUBJECT: SUMMARY OF MEETING HELD ON SEPTEMBER 27, 2000, TO DISCUSS
GENERIC LETTER 95-07, "PRESSURE LOCKING AND THERMAL BINDING
OF SAFETY-RELATED POWER-OPERATED VALVES"

On September 27, 2000, the NRC and the Palo Verde licensee, Arizona Public Service Company (the licensee), met in Rockville, Maryland to discuss the progress made by the licensee for final resolution of Generic Letter 95-07. The meeting notice was issued September 18, 2000.

In the meeting, the licensee discussed (1) the history and methodology for resolution of this generic letter at Palo Verde, (2) the modifications made or planned to mitigate pressure locking and thermal binding at Palo Verde, (3) a comparison of the licensee's model for predicting pressure locking and thermal binding of safety-related power-operated valves with other industry models; and (4) the proposed responses to the NRC staff's questions related to this generic letter.

The final responses from the licensee are in the licensee's letter of October 5, 2000, on the generic letter.

The list of attendees for the meeting is in Table 1. A copy the slides presented by the licensee is in ADAMS Accession No. ML003774464.

/RA/

Jack N. Donohew, Senior Project Manager, Section 2
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-528, STN 50-529,
and STN 50-530

Attachment: List of Meeting Attendees

ENCLOSURE 1

MEETING ATTENDEES

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2 AND 3

GENERIC LETTER 95-07, "PRESSURE LOCKING AND THERMAL BINDING

OF SAFETY-RELATED POWER-OPERATED VALVES"

SEPTEMBER 27, 2000

ARIZONA PUBLIC SERVICE COMPANY

Scott Bauer
James Proctor
Steve Coppock
Michael Powell
Steve Lopez
Mike Renfro

NRC

Mel Fields
Steve Dembek
Stephen Tingen
Gene Imbro
Thomas Scarbrough
Girija Shukla
David Terao

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"
ARIZONA PUBLIC SERVICE COMPANY, ET AL.
PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3
DOCKET NOS. STN 50-528, STN 50-529, AND STN 50-530

1.0 INTRODUCTION

On August 17, 1995, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," to request that licensees take 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.

In the letters of October 10, 1995, and February 21, 1996, Arizona Public Service Company (the licensee) submitted its 60-day and 180-day responses to GL 95-07, respectively, for Palo Verde Nuclear Generating Station, Units 1, 2 and 3 (Palo Verde). In a letter dated June 28, 1996, the licensee supplemented its 180-day response to GL 95-07. On August 6, 1996, October 8, 1999, and March 31 and October 5, 2000, the licensee provided responses to requests for additional information regarding GL 95-07 forwarded by the NRC staff on June 27, 1996, June 11, 1999, and August 3, 2000. A public meeting was conducted on September 27, 2000, to discuss the pressure-locking model developed by the licensee in response to GL 95-07. The meeting summary is being issued with this safety evaluation as Enclosure 1 to the cover letter.

2.0 BACKGROUND

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.

ENCLOSURE 2

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.

3.0 REGULATORY REQUIREMENTS

The regulations, 10 CFR Part 50 (Appendix A, and 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 GL 95-07 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 modifications of equipment may be necessary to bring facilities into compliance with the regulations of the Commission referenced above.

In response to the generic letter, the licensee submitted letters of October 10, 1995; February 21, June 28, and August 6, 1996; October 8, 1999; and March 31 and October 5, 2000. Some of these letters were in response to requests for additional information regarding GL 95-07 in NRC staff letters of June 27, 1996, June 11, 1999, and August 3, 2000. In addition, there was a public meeting conducted on September 27, 2000, to discuss the pressure-locking model developed by the licensee in 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 licensee's letters of February 21, June 28 and August 6, 1996, October 8, 1999, and March 31 and October 5, 2000, 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 concludes that it is complete and acceptable.

Normally open, safety-related power-operated gate valves that are closed for test or surveillance but which must return to the open position were evaluated within the scope of GL 95-07 except in the instance when the system/train is declared inoperable in accordance with the unit technical specifications while a valve susceptible to pressure locking or thermal binding is closed for testing.

The staff finds the licensee's 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," dated June 28, 1989.

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 developed a pressure-locking model to demonstrate that the following valves are capable of opening during pressure-locking conditions:

1/2/3-AF-34	Auxiliary Feedwater (AFW) Pump Discharge
1/2/3-AF-35	AFW Pump Discharge
1/2/3-AF-36	AFW Pump Discharge
1/2/3-AF-37	AFW Pump Discharge
1/2/3-CH-536	Gravity Feed Line to Charging Pumps Isolation Valve
1/2/3-SG-134	AFW Pump Turbine Steam Supply
1/2/3-SG-138	AFW Pump Turbine Steam Supply
1/2/3-SI-651	Low Pressure Safety Injection (LPSI) Shutdown Cooling Suction
1/2/3-SI-652	LPSI Shutdown Cooling Suction
1/2/3-SI-653	LPSI Shutdown Cooling Suction
1/2/3-SI-654	LPSI Shutdown Cooling Suction
1/2/3-SI-655	AFW Pump Turbine Steam Supply
1/2/3-SI-656	LPSI Shutdown Cooling Suction
1/2/3-SI-671	Containment Spray Header Isolation
1/2/3-SI-672	Containment Spray Header Isolation
1/2/3-SI-685	LPSI Containment Spray to Shutdown Cooling Heat Exchanger
1/2/3-SI-686	Shutdown Cooling Heat Exchanger Outlet
1/2/3-SI-688	Containment Spray Shutdown Cooling Heat Exchanger Bypass
1/2/3-SI-693	Containment Spray Shutdown Cooling Heat Exchanger Bypass

1/2/3-SI-694	LPSI Containment Spray to Shutdown Cooling Heat Exchanger
1/2/3-SI-696	Shutdown Cooling Heat Exchanger Outlet
1/2/3-SI-604	High Pressure Safety Injection Long Term Loop Recirculation
1/2/3-SI-609	High Pressure Safety Injection Long Term Loop Recirculation

The bonnets of valves 1/2/3-AF-34, 35, 36, and 37, and 1/2/3-SI-651 and 652 are equipped with a pressure relief valve and the bonnets of valves 1/2/3-SI-653, 654, 655 and 656 are equipped with a spring check valve to limit the pressure inside each valve's bonnet. The licensee's pressure-locking model was used to demonstrate that these valves are capable of operating during pressure-locking conditions when the pressure in the bonnet is at the relief/spring check valve setpoint.

In its letter dated October 5, 2000, the licensee stated that valves 1/2/3-SI-672 may operate at locked rotor conditions for 1.44 seconds following a safety injection/containment spray actuation signal. It takes 1.44 seconds for voltage to each actuator to recover following a safety injection/containment spray actuation signal. The NRC 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, "Motor-Operated Valve (MOV) Actuator Motor and Gearbox Testing") demonstrates that the capability of the actuator does not degrade in this short time period.

On September 27, 2000, a public meeting was conducted to discuss the technical adequacy of the Palo Verde pressure-locking model. At the public meeting, the licensee recommended that, when using its pressure-locking model, a minimum margin of 10% should be applied between calculated pressure-locking thrust and actuator capability except in instances where maximum bonnet pressure is 200 psig or less in rigid valves (900# class Anchor Darling and 1500# class Borg-Warner flexible wedge gate valves). In its letter dated October 5, 2000, the licensee described the test results that were used to validate its pressure-locking model. Comparison of test data obtained from valves that were tested during pressure-locking conditions with the calculated results of the licensee's pressure-locking model indicates that the pressure-locking model accurately predicted the amount of thrust required to open the pressure locked test valves. The licensee's pressure-locking model overpredicted the amount of thrust required to open a rigid pressure locked test valve when bonnet pressure was less than 200 psig; therefore, the 10% margin is not necessary. The NRC staff considers that calculations that are used to demonstrate that valves can overcome pressure locking are required to meet the provisions of 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," and therefore, controls are required to be in place to ensure that revisions are properly implemented. With this understanding, the staff finds that the licensee's pressure-locking model provides a technically sound basis for ensuring that valves susceptible to pressure locking are capable of performing their intended safety-related function.

- b. 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 licensee stated that shutdown cooling suction valves, 1/2/3-SI-651, 652, 653 and 654, were susceptible to thermal binding and

that procedures were revised to close these valves prior to exceeding 300 °F. Testing identified that, when these valves are exposed to a temperature decrease of 215 °F, an additional 40% thrust is required to open the valves to overcome the force attributed to thermal binding. The licensee stated that each of these valves has been set up to provide the additional thrust required to open during thermal-binding conditions. The staff finds that these actions provide assurance that thermal-binding conditions are eliminated and are thus acceptable.

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 Palo Verde 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 in GL 95-07.

The only commitments made by the licensee in this review were to (1) modify valves that were considered susceptible to pressure locking and (2) develop administrative controls for valves that were considered susceptible to thermal binding. By the letter of October 5, 2000, the licensee stated that the valves that were identified as susceptible to pressure locking in the letters of February 21 and June 28, 1996, have been modified. In the letter of June 28, 1996, the licensee stated that the additional administrative controls that were identified as being needed for the valves susceptible to thermal binding have been developed. Therefore, the licensee's commitments for GL 96-06 have been completed.

Principal Contributor: S. Tingen

Date: December 11, 2000