Boston Edison

Pilgrim Nuclear Power Station
Rocky Hill Road
Plymouth, Massachusetts 02360

E. T. Boulette, PhD
Senior Vice President — Nuclear

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U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
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Response to Request For Additional Information

This letter responds to the NRC request for additional information regarding pressure locking and thermal binding of safety-related gate valves.

This letter contains two commitments. Regarding MO2301-3, should final test results differ significantly from those assumed in the design calculations, a supplemental response to this request for additional information will be issued. Operator training on pressure locking modifications will be completed by December 31, 1996.

Should you have any further questions, please contact Marie Lenhart, 508-830-7937, in our Regulatory Affairs Department.

E T Boulette

E. T. Boulette

MTL/dmc/rai9507

Attachment: G.L. 95-07 Request For Additional Information

cc's: Next Page

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cc: Mr. Alan B. Wang, Project Manager
Project Directorate I-1
Office of Nuclear Reactor Regulation
Mail Stop: 14B2
1 White Flint North
11555 Rockville Pike
Rockville, MD 20852

U.S. Nuclear Regulatory Commission
Region I
475 Allendale Road
King of Prussia, PA 19406

Senior Resident Inspector
Pilgrim Nuclear Power Station

NRC Question #1

Valves MO1301-25, Reactor Core Isolation Cooling (RCIC) Suppression Pool Suction and MO2301-36, High Pressure Coolant Injection (HPCI) Suppression Pool Suction, may be potentially susceptible to thermally-induced pressure locking caused by heat transfer from the suppression pool during a design basis event. The licensee's submittal appears not to discuss this issue. Please provide any analysis or evaluation completed to address this scenario.

Response to Question #1 (reference 2)

- ***MO1301-25 RCIC Pump Suction from Suppression Pool (Inboard)***

Summary of Operation

Valve MO1301-25 connects the suction of the RCIC pump to the suppression pool. This valve is normally-closed with RCIC aligned to the condensate storage tank (CST) via MO1301-22. The safety function of this valve is to change the suction path from the CST to the suppression pool by remote manual opening.

Susceptibility to Pressure Locking

Bonnet Pressurization During Operation and Testing

MO1301-25 is located in the RCIC quadrant on the suction side of the RCIC pump. During RCIC system operation this normally closed valve would be subjected to RCIC pump suction pressure equal to ≈ 30 psig per reference 5.

The closed MO1301-25 would not be affected by a suppression pool bulk temperature of 178°F. Valve MO1301-25 is 25 ft (50 pipe diameters) away from the suppression pool. All piping between the suppression pool and MO1301-25 is uninsulated. Reference 8 verified the maximum suppression pool temperature will be reduced to local ambient temperature in the suction piping within approximately 10 pipe diameters (5 ft) due to heat transfer to the torus compartment. Therefore, the source suppression pool temperature could not be conducted to MO1301-25.

Pressure locking resulting from the effects of suppression pool bulk temperature increases is not anticipated.

- ***MO2301-36 HPCI Pump Suction from Suppression Pool (Inboard)***

Summary of Operation

Valve MO2301-36 connects the HPCI pump suction line to the suppression pool. The active safety function of this valve is to automatically open on high suppression pool level or low CST level. During normal operation this valve remains closed with HPCI pump suction lined up to the CST.

Susceptibility to Pressure Locking

Bonnet Pressurization During Operation and Testing

Valve MO2301-36 is located in the HPCI quadrant on the suction side of the HPCI pump. During HPCI system operation, this normally-closed valve will be subjected to HPCI pump suction pressure equal to ≈ 30 psig per reference 5.

The closed MO2301-36 would not be affected by a suppression pool bulk heatup to 178°F. Valve MO2301-36 is located approximately 60 ft (45 pipe diameters) from the suppression pool. All piping between the suppression pool and MO2301-36 is uninsulated. Reference 8 verified the maximum suppression pool temperature will be reduced to local ambient temperature in the suction piping within approximately 6 pipe diameters (8 ft) due to heat transfer to the torus compartment. Therefore, the source suppression pool temperature could not be conducted to MO2301-36.

Pressure locking resulting from the effects of suppression pool bulk temperature increases is not anticipated.

NRC Question #2

Please provide any analysis or evaluation completed for valve MO2301-3 HPCI Steam Isolation, with respect to potential pressure locking or thermal binding.

Response to Question #2 (reference 4)

- ***MO2301-3 HPCI Steam to Turbine Isolation Valve***

Summary of Operation

This valve is the steam admission valve to the HPCI turbine and opens automatically on HPCI initiation. The active safety function of this valve is to automatically open to initiate HPCI operation.

Susceptibility to Thermal Binding

Thermal Binding Evaluation

MO2301-3 is normally closed and is opened during testing or initiation of the HPCI system. During HPCI system operation the valve is exposed to main steam temperature and pressure. Following closure of the valve, the MO2301-3 should remain heated as some steam flow into the line continues to make up condensate removed by the drain pot. The valve is located approximately 1 ft off of the vertical run to the drain pot. Due to this close proximity, adequate conductive heat should maintain valve body temperatures equal to steam temperature. Therefore, the valve will not cool down under conditions that require it to be operable.

Susceptibility to Pressure Locking

High Energy Line Break (HELB) Response Evaluation

MO2301-3 is located in the HPCI Pump Room. Any failure of HPCI steam piping would result in HPCI system isolation. Under this scenario, MO2301-3 would not be required to perform a safety function. All other HELBs result in room ambient temperatures that are less than the temperature of the valve while exposed to HPCI system conditions (reference 9).

Bonnet Pressurization During Operation and Testing

Any pressurization of MO2301-3 will remain equal to upstream steam inlet pressure while valves MO2301-4 and MO2301-5 (HPCI Turbine Steam Supply Inboard/Outboard Isolation Valves) are open. In this case, no pressure differential (ΔP) would exist between the bonnet and the upstream side of the valve when it is required to open. Similarly, steam in the bonnet will not cool down and form condensate during normal operation since the valve will remain heated by the inlet steam.

Following the closure of valves MO2301-4 and MO2301-5 for extended periods of time, condensate may collect in the bonnet cavity of MO2301-3 due to cool down of any trapped steam. With the high pressure steam source removed, in-leakage to the bonnet cavity would not be anticipated. If cycling of MO2301-3 is not performed, the trapped condensate would be reheated once valves MO2301-4 and MO2301-5 are re-opened. Assuming no leak-off of the trapped condensate, reheating the bonnet due to steam contact following the opening of valves MO2301-4 and MO2301-5 should return the condensate to steam equal in pressure to the line pressure. Under this condition, with no ΔP between the bonnet and upstream piping, pressure locking would not be expected.

During RFO10 (spring 1995), modifications to MO2301-3 were completed to address Generic Letter 89-10 concerns. The following changes were included:

- Replaced valve (new design)
- Replaced operator - SMB-1 to SB-2 (with compensating spring pack)
- Replaced motor - 60 ft-lb to 80 ft-lb
- Changed gearing 22.68 to 44.0

Although MO2301-3 is not considered susceptible to thermal binding, modifications to address GL89-10 are considered beneficial as they relate to reference 1. For example, installation of a compensating spring pack will further reduce inertial closing forces on MO2301-3 thus minimizing over seating the valve disc.

Thermal effects testing is currently being conducted by General Electric on a prototype valve of similar design to MO2301-3. Preliminary test data indicates significant pullout loads exist when testing a valve disc with higher stiffness characteristics. This test data will be evaluated and correlated to the actual hardware installed at Pilgrim. Should our evaluation of the General Electric test data identify a significant difference in the parameters assumed in Pilgrim's GL89-10 design calculations, a supplemental response to this RAI will be issued.

NRC Question #3

Through review of operational experience feedback, the staff is aware of instances where licensees have completed design or procedural modifications to preclude pressure locking or thermal binding which may have an adverse impact on plant safety due to incomplete or incorrect evaluation of the potential effects of these modifications. Please describe evaluations and training for plant personnel that have been conducted for each design or procedural modification completed to address potential pressure locking or thermal binding concerns.

Response to Question #3

A total of 12 design or procedural modifications were completed to eliminate susceptibility to pressure locking. No design or procedural modifications were required to address thermal binding.

Each pressure locking modification implemented at PNPS required issuance of a plant design change (PDC). The PDC included a detailed analysis of design adequacy as well as a safety evaluation that reviewed the safety significance of the modification and verified no unreviewed safety issues existed. Both the PDC and safety evaluation are technically reviewed by the engineering group and reviewed and approved by the Operations Review Committee.

In addition, prior to modification selection, design and test engineering representatives met to discuss any potential issues associated with valve testing and changes to local leak rate test (LLRT) procedures which may be required. Modification options were also discussed with operations personnel to determine effect (if any) on existing operating procedures. Final modification selection considered installation, testing, and operational impact.

To address the issue of pressure locking, BECo implemented one of four solutions for each valve:

<u>Disc Drilling</u>

MO1301-49 RCIC Inboard Injection Valve
MO1400-25A Core Spray 'A' Loop Inboard Injection Valve
MO1400-25B Core Spray 'B' Loop Inboard Injection Valve
MO2301-8 HPCI Inboard Injection Valve

For each of these valves, a 1/8" to 1/4" hole was drilled through the high pressure (reactor vessel) disc half. The addition of this hole allows for continuous communication between the valve bonnet cavity and process piping. Any change to reactor vessel pressure will change the bonnet cavity pressure. In all cases, an LLRT is completed to verify leak tightness in the opposite direction of the normal flow path. As a result, during testing, leakage by the first (drilled) seat would occur, and the test would tend to further seat the intact seat. This is consistent with the wedge gate valve design which does not rely on the first disc for sealing.

For each of these valves, there are operational configurations which could allow leakage through the valve resulting in additional flow to the vessel. During 150# and quarterly RCIC and HPCI testing, a ΔP as high as 200 psig may exist across valves MO1301-49 and MO2301-8. If this ΔP is significant enough to push the intact disc face off of the valve seat, leakage through the drilled disc half will result. This minor leakage of condensate into the vessel (< 5 gpm) would have no affect on the quarterly test or plant operation, and would stop following test completion.

Similarly, for valves MO1400-25A/B, a ΔP of ≈ 130 psig may exist across these valves while the reactor is shutdown/depressurized and while the keep-fill system remains in operation. If this ΔP is significant enough to push the intact disc face off of the valve seat, leakage through the drilled disc half will result. This minor leakage of condensate into the vessel (<10 gpm) would eventually result in excess inventory requiring removal; however, it will have no adverse effect on shutdown operations.

Reference 10 was completed to evaluate those operating scenarios where upstream pressure exceeds downstream pressure. Reference 10 evaluated all four drilled valves and determined the ΔP under these conditions is inadequate to unseat the intact disc half.

Disc drilling modifications are passive and require no operator interaction.

Bonnet Vent Line Modification

MO1001-29A RHR 'A' Loop Inboard Low Pressure Coolant Injection Valve
MO1001-29B RHR 'B' Loop Inboard Low Pressure Coolant Injection Valve

For each of these valves the existing bonnet vent line was connected to the downstream piping. This allows for continual communication between the bonnet cavity and reactor vessel pressure.

Each equalizing line installed includes a check valve, two isolation valves and a test connection. The check valve was installed to maintain both seating surfaces during LLRT of each LPCI valve. If leak tight, the check valve will not allow between-seat pressurization via the vent path during testing, and only leakage past both disc faces will be measured during LLRT. However, the check valve does not form a containment boundary. Leakage by the closed check valve will only allow a direct path into the bonnet and between the discs halves. This modification requires periodic testing of the check valve to verify forward flow capabilities are maintained. In addition, the modification requires the new equalizing line isolation valves be manually locked open.

As with the valves that were drilled, there are operational configurations which could allow leakage through the valve resulting in additional flow to the vessel. Specifically, while the vessel is shutdown and depressurized, a ΔP of $\approx$ 100 psig across the valve may exist while the valve is closed and subjected to keep-fill pressure. This ΔP acts in the reverse direction from that normally experienced during operation. If the ΔP is significant enough to off-seat the intact disc, leakage past valves MO1001-29A/B will occur via the vent path. Such leakage, over time, may require draining of excess inventory. Unlike the drilled valves, bonnet vent line isolation valves could be closed to isolate reverse flow.

Reference 10 was completed to evaluate this operating scenario and determined ΔP under these conditions is inadequate to unseat the intact disc half of either valve, MO1001-29A or MO1001-29B.

Bonnet Relief Valve Modification

MO1001-34A RHR 'A' Loop Torus Cooling/Spray Block Valve
MO1001-34B RHR 'B' Loop Torus Cooling/Spray Block Valve

The packing chamber of each of these valves was modified to allow communication between the bonnet cavity and packing leak-off. The lower set of packing was removed and a slotted lantern bushing was installed. Valves MO1001-34A/B were determined to be susceptible to pressure locking resulting from the heating of trapped bonnet cavity water following a high energy line break (HELB). Any pressurization of the bonnet cavity will extend out through the packing leak-off to a thermal relief valve. The relief valve setpoint selected is above the RHR pump shutoff head, but below the maximum operating pressure of MO1001-34A/B.

The relief valves have been added to the PNPS IST program and will be tested on a routine basis.

This modification is passive and requires no operator interaction.

Procedural Change

MO1001-7A RHR Pump 'A' Torus Suction Valve
MO1001-7B RHR Pump 'B' Torus Suction Valve
MO1001-7C RHR Pump 'C' Torus Suction Valve
MO1001-7D RHR Pump 'D' Torus Suction Valve

A change to the RHR system operating procedure was made to eliminate pressure locking susceptibility of the RHR pump torus suction valves. Valves MO1001-7A/B/C/D remain open during normal operation when aligned for low pressure coolant injection (LPCI). During RHR shutdown cooling (SDC) operation, one loop is isolated and is in close proximity to the SDC flow path. A large differential temperature will exist between the closed MO1001-7A/C (B/D) valves and the SDC flow path allowing for heat-up to occur. If re-alignment to LPCI mode were required while reactor temperature remains high, opening of these valves may be affected.

To eliminate pressure locking susceptibility, the RHR system operating procedure (reference 11) was revised to require bonnet cavity draining immediately following closure of MO1001-7A/C (B/D). This is accomplished by opening existing body drains of the two closed RHR valves. Draining the water from the bonnet eliminates susceptibility, and no valve in-leakage would be expected due to typically low upstream and downstream pressure when entering SDC (< 20 psig). If SDC is entered at higher pressure (75 psig max) and disc flexing occurs, the bonnet cavity will fill with water at the same pressure/temperature as the system and heat-up causing pressurization will not occur.

This modification is non-passive and requires operator action during re-alignment from LPCI mode to the SDC mode.

A review of PNPS Training Department records regarding all pressure locking design modifications and procedural changes found the following:

- A training module was created for INPO SOER 84-7, Pressure Locking of Valves (and Thermal Binding). This module is delivered to operations personnel approximately once every two years as part of their continuing training and focuses on valves in general and issues associated with valve operation.
- As stated above, generic training on pressure locking of valves has been provided to plant operators. Modifications completed for pressure locking were reviewed by training personnel. Due to the passive nature of these modifications, no new knowledge, skills, or abilities were identified. A generic description of these modifications is scheduled in the first routine operator training class after the annual requalification exam (last quarter 1996).
- Continuing training of operators on procedures require instructors review all precautions and limitations associated with system procedures. A discussion of the pressure locking scenario is provided in precautions section of reference 11. Similar to the pressure locking modifications, no new skill or knowledge is required when operators are draining MO1001-7A/C (B/D) bonnets, and therefore specific training on MO1001-7A/B/C/D was not required.

References

1. Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves"

2. Calculation M600 Rev. 3, "Motor-Operated Valve Pressure Locking and Thermal Binding Evaluation"

3. BECo Letter #96-013, "Pilgrim's 180-Day Response to Generic Letter 95-07"

4. Calculation M553 Rev. 4, "Maximum Pressure Differential for DC MOVs"

5. Specification M300 Rev. E39, "PNPS Specification for Piping"

6. Plant Specific Technical Guidelines

7. General Electric Report NEDC-2089-P, "PNPS Unit 1 Suppression Pool Temperature Response"

8. Calculation M664 Rev. 0, "Suppression Pool Temperature Effects on MO1301-25 and MO2301-36"

9. Specification E536 Rev. 4, "Environmental Parameters for Use in the Environmental Qualification of Electrical Equipment"

10. Calculation M665 Rev. 0, " Unwedging ΔP for Gate Valves Modified for Pressure Locking"

11. PNPS Procedure 2.2.19 Rev. 57, "Residual Heat Removal"