IES Utilities Inc.
200 First Street S.E.
P.O. Box 351
Cedar Rapids, IA 52406-0351
Telephone 319 398 8162
Fax 319 398 8192

IES UTILITIES

John F. Franz, Jr.
Vice President, Nuclear

July 3, 1996
NG-96-1397

Mr. William T. Russell, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-37
Washington, DC 20555-0001

Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License No: DPR-49
Request for Additional Information on Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves"

References: 1) Letter, J. Franz (IES) to W. Russell (NRC) dated February 13, 1996, NG-96-0351, 180 Day Response to Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves"
2) Letter, G. Kelly (NRC) to L. Liu dated May 31, 1996, Request for Additional Information on Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves"

File: A-101b

Dear Mr. Russell:

Reference 1 above provided our response to Generic Letter (GL) 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves." In Reference 2, your staff requested additional information in order for the staff to complete their review. The attachment to this letter provides the requested information regarding that response.

This letter contains the following new commitment:

> Acquire in-plant temperature data to verify assumptions made regarding the potential for pressure locking in the Residual Heat Removal Torus Suction Valves. This temperature measurement will be accomplished at the next available opportunity to initiate shutdown cooling and will be no later than Refueling Outage 14 which is scheduled to begin in Fall, 1996. Appropriate actions will be taken as necessary based on the results of this data.

A056

030101

Please contact this office if you have further questions regarding this matter.

This letter is true and accurate to the best of my knowledge and belief.

IES UTILITIES INC.

By John F. Franz
John F. Franz
Vice President, Nuclear

State of Iowa
County of Linn

Signed and sworn to before me on this 3rd day of July, 1996, by John F. Franz.

NOTARIAL SEAL IOWA NANCY S. FRANCK

Nancy S. Franck
Notary Public in and for the State of Iowa

9-28-98
Commission Expires

Attachment: Response to Request for Additional Information on Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves"

cc: R. Murrell
L. Liu
G. Kelly (NRC-NRR)
H. Miller (Region III)
NRC Resident Office
Docu

Response to Request for Additional Information on Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves"

NRC Request #1:

Valves MO2321, High Pressure Coolant Injection (HPCI) Inboard Torus Suction Isolation, and MO2516, Reactor Core Isolation Cooling (RCIC) Inboard Torus Suction, if flexible-wedge, split-wedge, or double-disk gate valves, may be potentially susceptible to thermally-induced pressure locking caused by heat transfer from the suppression pool during a design basis event. ***Has the licensee evaluated the potential for thermally-induced pressure locking caused by heat transfer from the suppression pool during a design basis event? If so, please provide this evaluation.***

IES Utilities Inc. Response:

Yes, our evaluation of valves MO2321 and MO2516 included the potential for thermally-induced pressure locking caused by heat transfer from the suppression pool during a design basis event.

MO2321 (HPCI Inboard Torus Suction Isolation) and MO2516 (RCIC Inboard Torus Suction Isolation) are motor-operated gate valves with flexible-wedge disks and Stellite seats.

Background:

The HPCI system is provided to ensure that the reactor is adequately cooled to meet the design bases in the event of a small break Loss Of Coolant Accident (LOCA) that does not result in the rapid depressurization of the reactor vessel. Additionally, HPCI provides a means for controlling reactor vessel pressure after the plant is shutdown.

The RCIC system is designed to ensure adequate core cooling in the event of reactor isolation from the Main Steam System accompanied by a loss of feedwater flow without requiring actuation of any Emergency Core Cooling System (ECCS). Additionally, RCIC provides a means for controlling reactor vessel pressure after the plant is shutdown.

Normal HPCI and RCIC suction is from the Condensate Storage Tanks (CSTs). HPCI and RCIC suction will switch to the torus (requiring MO2321 and MO2516 to open) on a CST low level. Additionally, HPCI will switch to the torus on a torus high level.

During a small break LOCA, Emergency Operating Procedure (EOP)-2 requires operators to initiate torus cooling at the maximum rate available at a torus water temperature of 95° F.

Discussion:

Analysis of pressure locking is dependent on torus temperature. The maximum heatup rate of the torus depends on the break size and the effectiveness of the torus cooling. The maximum heatup rate occurs for the case of a postulated stuck open safety relief valve (SRV). Assuming an initial torus temperature of 90° F, the torus water temperature at the time the suction to HPCI and RCIC would switch from the CSTs to the torus is calculated to be 143° F. This calculated value assumes a normal torus level at the start of the event, no torus cooling and the volume of water added to the torus solely coming from the SRV. Torus cooling would reduce this temperature somewhat but not significantly. A maximum torus water temperature of 140° F at the time of the switch is considered reasonable.

Thermal analyses have been performed to determine the water temperature at MO2321 and MO2516 assuming a torus water temperature of 140° F. The air supply to the torus room is approximately 30,000 cfm. Assuming an air supply temperature of 85° F, the ambient torus room temperature is calculated to be about 100° F when the torus is at 140° F. Results of thermal analyses for MO2321 and MO2516 are summarized below.

MO2321 HPCI Inboard Torus Suction Isolation. MO2321, which is normally closed, is located below and 64" from the torus nozzle. As such, heating of MO2321 is by conduction only. For the above conditions, the temperature at MO2321 is calculated to be 1° F above the ambient air temperature. Assuming an ambient air temperature of 100° F the water temperature at MO2516 is about 101° F which is not considered sufficient to cause thermally-induced pressure locking.

MO2516 RCIC Inboard Torus Suction Isolation. MO2516, which is normally closed is located below and 40" from the torus nozzle. Assuming conduction only, the temperature at MO2516 is calculated to be 3° F above the ambient air temperature. Assuming an ambient air temperature of 100° F, the water temperature at MO2516 is about 103° F which is not considered sufficient to cause thermally-induced pressure locking.

NRC Request #2:

The licensee has provided an evaluation of the susceptibility of MO2202, HPCI Steam Supply Valve, to thermal binding, which states that the increase in coefficient of friction associated with cooldown is compensated by a reduction in pressure force. The licensee's submittal does not specify that this valve is a flexible-wedge, solid-wedge, or split-wedge design. ***Please specify the type of valve disk. Has the licensee completed any testing or analysis (beyond the referenced EPRI testing) to verify the assertion that the decrease in pressure compensates for the increase in coefficient of friction? The staff requests a more detailed description of the thermal binding evaluation results.***

In addition, if this valve is a flexible-wedge or split-wedge gate valve, has the licensee addressed the potential for steam condensate to enter the bonnet during power

operation, and subsequent thermally-induced pressure locking during a design basis event?

IES Utilities Inc. Response:

HPCI Steam Supply Valve MO2202 is a 10"-600# motor-operated gate valve with a flexible-wedge disk and Stellite seats.

In standby (normally open), MO2202 is subjected to dry steam at 1000 psig. During depressurization of the reactor vessel from 1000 psig to 150 psig the reactor coolant system temperature will decrease from 545° F to 365° F. Coefficient of friction data for Stellite on Stellite is given in EPRI Report TR-103229-V2, Appendix E, *Algorithm for Determining Friction Coefficient Between Gate Valve Internal Parts*. The coefficient of friction for Stellite on Stellite is a function of the contact stress and temperature of the Stellite bearing surfaces. The coefficient of friction decreases with increasing temperature.

Estimated values of coefficients of friction for Stellite on Stellite at 545° F and 365° F were obtained by interpolation from Table 5.1-1 of the above mentioned EPRI report.

Coefficient of Friction for Stellite on Stellite

Stress (ksi)	T = 545° F		T = 365° F		Increase	
	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal
5	0.436	0.301	0.496	0.369	14%	23%
10	0.436	0.278	0.496	0.343	14%	23%
25	0.414	0.224	0.439	0.264	6%	18%
50	0.400	0.180	0.400	0.180	0%	0%

As shown in the above table, the largest increase in the coefficient of friction in going from 545° F to 365° F occurs for low contact stresses and is less than 25 percent. On this basis, the friction force between the disk and valve would increase by a maximum factor of 1.25. However, during this time, the pressure force across the disk would decrease by a factor of 6.67 (i.e., 1000 ÷ 150). Thus, during depressurization of the reactor vessel the decrease in the pressure force across the valve disk will be greater than the increase in the friction force. Therefore, MO2202 is not considered susceptible to thermal binding during depressurization of the reactor vessel. This evaluation is based entirely on the results of coefficient of friction tests documented in the EPRI report. IES Utilities Inc. has not performed any tests independent of EPRI.

Condensation of steam in the HPCI steam supply line during normal power operation would drain to a drain pot located just upstream of MO2202. It is not credible for steam condensate to enter the bonnet during normal power operation. Therefore, MO2202 is not considered susceptible to thermally-induced pressure locking.

NRC Request #3:

In Attachment 1 to GL 95-07, the NRC staff requested that licensees include considerations of the potential for gate valves to undergo pressure locking or thermal binding during surveillance testing. During workshops on GL 95-07 in each Region, the NRC staff stated that if closing a safety-related power-operated gate valve for test or surveillance defeats the capability of the safety system or train, the licensee should perform one of the following within the scope of GL 95-07:

a) *Verify that the valve is not susceptible to pressure locking or thermal binding while closed,*

b) *Follow plant technical specifications for the train/system while the valve is closed,*

c) *Demonstrate that the actuator has sufficient capacity to overcome these phenomena, or*

d) *Make appropriate hardware and/or procedural modifications to prevent pressure locking and thermal binding.*

The staff stated that normally open, safety-related power-operated gate valves which are closed for test or surveillance but must return to the open position should be evaluated within the scope of GL 95-07. The licensee's submittal states that evaluation for pressure locking and thermal binding is not required for valves which are normally open that are closed only for stroke testing and then subsequently opened. This appears to be inconsistent with the recommendations of GL 95-07. ***Please discuss how the licensee has addressed this specific concern of GL 95-07.***

IES Utilities Inc. Response:

GL 95-07 requested licensees to 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 analysis as appropriate, and take needed corrective actions, to ensure that the susceptible valves identified are capable of performing their intended safety function(s) under all modes of plant operation, including test configuration. Attachment 1 to GL 95-07, "Guidance for Addressing Pressure Locking and Thermal Binding of Power-Operated Gate Valves," summarizes one acceptable approach to addressing pressure locking and thermal binding of gate valves within the scope of the accompanying generic letter. Item 2 of Attachment 1 states "Perform a further analysis of the safety-related, power-operated gate valves identified as susceptible to either pressure locking or thermal binding to ensure all such valves can open to perform their safety function under all modes of plant operation, including test configuration."

IES Utilities Inc. performed evaluations in accordance with the guidance of the GL and its attachments. Specifically, the scope of our GL 95-07 evaluation includes only safety-related power-operated gate valves. As stated in correspondence with your staff[1], the design basis of power-operated gate valves that are required to re-align during "secondary modes of operation" (e.g., surveillance testing) does not include system recovery to perform an accident mitigation function. Therefore, these types of motor operated valves are not considered safety-related and are not within the scope of the DAEC GL 89-10 program or GL 95-07 evaluation.

<u>NRC Request 4</u>:

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 had an adverse impact on plant safety due to incomplete or incorrect evaluation of potential affects 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.***

<u>IES Utilities Inc. Response</u>:

Design modifications completed (or planned) have been evaluated for potential effects on plant safety. These evaluations, conducted by plant engineering and approved by plant management, considered such items as system operability, containment isolation functions, local leak rate testing requirements, industry operating experience, and effect on transient analysis. The evaluations concluded that no adverse effects result from the modification of these valves. These evaluations are documented and available for review.

As stated in our 180 day response to GL 95-07, MO1905, LPCI 'B' Loop Inboard Injection, was identified as being potentially susceptible to pressure locking and is scheduled to be modified during the next refueling outage (RFO 14 in Fall 1996). In the interim, MO1905 has been re-aligned to be normally open and the LPCI 'B' Outboard Injection, MO1904, has been closed for system isolation. MO1904 is a motor-operated

---

1

1) Letter, T. Hsia (NRC) to IES Utilities Inc., "Summary of Meeting Held on September 22, 1994, Extension of Generic Letter 89-10 Program Schedule at Duane Arnold," Dated October 12, 1994
2) Letter J. Franz (IES) to W. Russell (NRC), "Generic Letter 89-10 Program," NG-94-4017, Dated November 30, 1994
3) Letter, J. Franz (IES) to W. Russell (NRC), "Response to Request for Additional Information Regarding Removal of Certain Motor-Operated Valves from the DAEC Generic Letter 89-10 Program," NG-95-0815, Dated March 10, 1995
4) Letter, J. Franz (IES) to W. Russell (NRC), "Generic Letter 89-10 Program Scope," NG-96-0522, Dated March 18, 1996

globe valve and is not subject to the pressure locking phenomena. With this valve lineup, LPCI operability is maintained. The change to the system lineup has been incorporated into simulator scenarios.

Additionally, the necessity for training will be evaluated as a result of changes that will be made to applicable maintenance procedures based upon modifications made to valves (e.g., drilled holes) in accordance with our procedure revision process.

Additional Discussions:

During a recent review of engineering evaluations conducted for the 180 day response, we determined that certain assumptions used to determine that the Residual Heat Removal (RHR) Torus Suction Valves (MO1913, MO1921, MO2012, MO2015) were not susceptible to thermally induced pressure locking require in-plant data verification. Therefore, we are now considering that these valves may be subject to pressure locking due to bonnet heating from the reactor coolant flowing through the shutdown cooling branch (and partially mixing with the torus suction branch) and may not be able to be opened as required to manually re-align from Shutdown Cooling to Low Pressure Coolant Injection.

An engineering evaluation has concluded that these valves do not present an operability concern at this time and the actual temperature at the bonnet will be measured to determine the extent (if any) of mixing while placing shutdown cooling on line. This evaluation is documented and available for review. This temperature measurement will be accomplished at the next available opportunity to initiate shutdown cooling and will be no later than Refueling Outage 14 which is scheduled to begin in Fall, 1996. Appropriate actions will be taken as necessary based on the results of this data.