CP&L

Carolina Power & Light Company
Harris Nuclear Plant
PO Box 165
New Hill NC 27562

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United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

SHEARON HARRIS NUCLEAR POWER PLANT
DOCKET NO. 50-400/LICENSE NO. NPF-63
SUPPLEMENT TO RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER 95-07, "PRESSURE-LOCKING AND THERMAL-BINDING OF SAFETY-RELATED POWER-OPERATED GATE VALVES"

Dear Sir or Madam:

By letter dated April 14, 1999, the NRC requested that Carolina Power & Light Company (CP&L) respond to a request for additional information regarding Generic Letter 95-07, "Pressure-Locking and Thermal-Binding of Safety-Related Power-Operated Gate Valves," for the Harris Nuclear Plant (HNP). By letter dated September 29, 1999, CP&L provided the requested information. In response to a November 18, 1999 teleconference with the NRC, CP&L is providing supplemental information to the September 29 response.

A written report providing the supplemental information is enclosed. Questions regarding this matter may be referred to Mr. J. H. Eads at (919) 362-2646.

Sincerely,

Johnny H Eads for

D. B. Alexander
Manager, Regulatory Affairs
Harris Plant

AEC

Enclosure

c: Mr. J. B. Brady (NRC Senior Resident Inspector, HNP)
Mr. R. J. Laufer (NRR Project Manager, HNP)
Mr. L. A. Reyes (NRC Regional Administrator, Region II)

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DOCKET NO. 50-400/LICENSE NO. NPF-63
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Requested Information Item 1

Your August 19, 1996 submittal states that the following valves are susceptible to pressure-locking and that a calculation was used to demonstrate that the valves would operate during pressure-locking conditions.

1SI-3	Boron Injection Tank Outlet
1SI-4	Boron Injection Tank Outlet
1SI-52	High Head Safety Injection (HHSI) to Reactor Coolant System Cold Leg
1RC-113	Pressurizer Power Operated Relief Block Valve
1RC-115	Pressurizer Power Operated Relief Block Valve
1RC-117	Pressurizer Power Operated Relief Block Valve
1SI-86	Normal HHSI to Reactor Coolant System Hot Leg
1SI-107	Alternate HHSI to Reactor Coolant System Hot Leg
1SI-359	Low Head Safety Injection to Reactor Coolant System Hot Leg

The calculation assumed that leakage over a 6.5 hour period would partially depressurize the bonnet of the valves susceptible to thermally induced pressure-locking (1SI-86, 1SI-107, and 1SI-359). This leakage rate was based on testing performed by Commonwealth Edison (ComEd). You also stated that the calculation that is used to predict the thrust required to open the valves during a pressure-locking condition is a simplified version of the ComEd pressure-locking methodology that was developed by ComEd to demonstrate that these valves would operate during pressure-locking conditions.

During a telephone conversation conducted on April 8, 1999, you stated that you are no longer using the ComEd leak rate test results nor the ComEd pressure-locking prediction methodology to demonstrate that valves will operate during pressure-locking conditions. Explain your current methodology that is being used to demonstrate that valves will operate during pressure-locking conditions. Include in the discussion the margin between actuator capability and the calculated thrust value when using your new pressure-locking prediction methodology, any limitations associated with the use of your new methodology, and any diagnostic test equipment accuracy requirements.

Response 1

The current Harris Nuclear Plant (HNP) methodology to demonstrate the above valves will operate under hydraulic pressure-locking conditions involves the addition of a calculated pressure-locking force (PLF) to the measured unwedging force determined by MOV diagnostic testing. This total required unwedging force is then compared to the actuator capability and the most limiting thrust (i.e., valve weak link, actuator torque rating, etc.). The PLF was developed using the Commonwealth Edison (ComEd) Pressure Locking Analysis Program, PRESLOK, as documented in Westinghouse report WOG-96-050, Calculation V-EC-1606. Additional restrictions are described in a ComEd letter to the NRC dated May 29, 1998.

Attachment 1 contains more detailed information regarding the restrictions from this letter and how they were applied to the subject valves. To assure that the PLF is included in future evaluations or calculations for these valves, HNP calculation, "Evaluation of Unwedging Thrust & Torque For Safety-Related, Motor-Operated Gate Valves Susceptible to Pressure Locking" has been prepared to document the use and results of the ComEd methodology. Also, the MOV post-test evaluation procedure will require that future test data evaluations consider the effect of PLF.

During the original susceptibility review, it was determined that 1SI-359, Low Head Safety Injection to Reactor Coolant System Hot Leg, could potentially be susceptible to pressure-locking conditions and was therefore included within the scope of GL 95-07. During further review of the HNP licensing basis for 1SI-359, it was determined that failure of this valve to open during the transfer of Safety Injection from cold leg recirculation/injection to hot leg recirculation/injection had been previously evaluated due to the lack of redundancy of the subject valve. If 1SI-359 were to fail to open, the residual heat removal (RHR) system would be realigned to the cold leg injection flow path, thus maintaining adequate flow to the core. Boron precipitation would be prevented by flow from the operating charging safety injection pump (CSIP). The transfer of RHR back to the cold leg injection flow path is currently included in the associated Emergency Operating Procedure and Section 6.3.2 of the HNP Final Safety Analysis Report (FSAR). Since failure of 1SI-359 to open due to a potential pressure-locking condition does not represent an unanalyzed failure mode, it has been removed from the scope of the HNP GL 95-07 evaluation.

Table 1 below shows the PLF, the total required unwedging force and actuator capability for each of the applicable valves covered by this question. Modifications are planned for Refueling Outage 9 (RFO-9) in Spring 2000 to improve long-term margins for six of the eight subject valves, as indicated in Table 1. The specifics of the modifications are currently under plant review and thus subject to change. The modifications for 1SI-52, 86 and 107 are planned at present to include replacing the existing SMB-000 actuators with SMB-00 actuators, replacing the 10 ft-lb, 1700 rpm motors with 15 ft-lb, 1700 rpm motors, and changing the actuator gear ratios from 36.5:1 to 109:1 by replacing the motor pinion and wormshaft gearing. The modifications for 1RC-113, 115 and 117 are planned to include changing the motor pinion and wormshaft gearing such that overall actuator ratio increases from 41:1 to 109:1.

Table 1. Current Configuration Actuator Margins

Valve	**Pressure Locking Force** (lbs.)	**Corrected Measured Static Unwedging Force** (lbs.)	**Total Required Unwedging Force** (lbs.)	**Actuator Capability** (lbs.)	**Unwedging Margin** (%)	**Most Limiting Thrust** (lbs.)	**Thrust Margin** (%)
1SI-3	4000	877	4877	17523	259.3	17126	251.2
1SI-4	3640	1765	5405	17240	219.0	17240	219.0
1SI-52[1]	881	4567	5449	6301	15.6	6301	15.6
1SI-86[1]	3659	5956	9615	10464	8.8	10464	8.8
1SI-107[1]	2451	2092	4543	6380	40.4	6380	40.4
1RC-113[1]	4721	5976[2]	10697	12138	13.5	12138	13.5
1RC-115[1]	4721	5976[2]	10697	11975	11.9	11975	11.9
1RC-117[1]	4721	5976[2]	10697	12335	15.3	12335	15.3

Notes:
1. Margin-enhancement modifications and testing are scheduled for RFO-9.
2. Valve-specific test data not available for calculated unwedging force. This value is the maximum unwedging force of a group of 10 other 3" Westinghouse flex-wedge gate valves.

Table 2 below indicates the estimated results of the planned modifications. Capability estimates are based on calculated values after the planned modifications. Pressure locking force calculations are based on bounding valve factor values. Development of "Required Margin" is discussed in Attachment 1.

Table 2. Estimated Results of Planned Modifications on Actuator Margins

Valve	**Pressure Locking Force** (lbs.)	**Corrected Measured Static Unwedging Force** (lbs.)	**Total Required Unwedging Force** (lbs.)	**Actuator Capability** (lbs.)	**Unwedging Margin** (%)	**Most Limiting Thrust** (lbs.)	**Thrust Margin** (%)	**Required Margin** (%)
1SI-52	6114	4567	10681	28487	166.7	17126	60.3	29.1
1SI-86	7307	5956	13263	28749	116.8	17126	29.1	16.2
1SI-107	12013	2092	14105	28985	105.5	17126	21.4	15.3
1RC-113	4721	5976	10697	27294	155.2	17126	60.1	29.3
1RC-115	4721	5976	10697	26933	151.8	17126	60.1	29.3
1RC-117	4721	5976	10697	27732	159.3	17126	60.1	29.3

Conclusion

The results of applying the ComEd methodology to the subject valves demonstrate that they will operate during pressure-locking conditions. The planned modifications will enhance the long-term actuator margins for six of the valves, providing further assurance that they will be capable of operating in pressure-locking conditions.

EVALUATION AND APPLICATION OF VALVE PRESSURE LOCKING TEST RESULTS

Background

In response to NRC Generic Letter 95-07, Carolina Power and Light Company (CP&L) originally based the evaluation of nine potentially susceptible valves on type-testing. In 1996, 3" and 10" Westinghouse 1500 lb. flex-wedge gate valves were tested for hydraulic pressure-locking forces and bonnet pressure decay rates. These valves were selected due to their similarity to the subject plant valves. Valves 1SI-3, 4, 52, 86, 107 and 1RC-113, 115, 117 are 3" Westinghouse 1500 lb. flex-wedge gate valves with either SMB-000, SB-00, or SMB-0 actuators. The 10" valve was tested to assess potential pressure locking conditions for 1SI-359. This valve has since been removed from the scope of GL 95-07 as discussed in Response 1.

Due to NRC concerns with the methodology developed from type-testing, the eight 3" Westinghouse valves were re-evaluated using the pressure-locking prediction methodology developed by Commonwealth Edison (ComEd). Several restrictions for the use of this method were documented in a letter from ComEd to the NRC dated May 29, 1998. Applicability of these restrictions is discussed below.

Evaluation

This evaluation is divided into three sections. The "Bonnet Pressure Decay Data" section develops an adjusted bonnet pressure for use in determining the PLF for valves 1SI-86 and 107. The "Method Restrictions" Section discusses the restrictions associated with the methodology and applicability to the analyzed valves. The "Valves With Unequal Upstream and Downstream Pressures" section describes how the unbalanced conditions for valves 1SI-52 and 1RC-113, 115 and 117 were evaluated.

Bonnet Pressure Decay Data: Once a gate valve bonnet has trapped pressure, this pressure has been observed to decay over time. The decay rates are difficult to reliably predict, however, without testing a similar valve under similar conditions. The CP&L bonnet pressure decay testing is considered bounding for the installed valves because the test was conducted on new valves essentially identical to the installed valves. The condition of the new valve seats and disks would be expected to contain bonnet pressure better than a valve that has been in service for over 12 years.

The test data showed a decay rate of approximately 3 psi/minute for the 3" valve at a reactor coolant system (RCS) pressure of approximately 2250 psig. The 3" valve was also tested with 1000 psi in the bonnet and showed a decay rate of 0.7 psi/minute which was rounded to 1 psi/minute for lower pressures. From the original susceptibility evaluation for valves 1SI-86 and 107, they could have normal charging safety injection pump (CSIP) discharge pressure (2750 psi) trapped in the bonnet following a loss of coolant accident (LOCA). The bonnet pressure will decay over a band from 2750 psig to approximately 1600 psig. The average pressure of approximately 2200 psi is close to the pressure for which the above 3 psi/min rate was obtained. Using the 3 psi/min decay rate gives a total decay in 6.5 hours of 1170 psi. The corresponding bonnet pressure would be 1580 psig. This value for bonnet pressure was used to determine the resulting pressure-locking forces for 1SI-86 and 107 in Table 1 of Response 1.

The use of pressure decay for valves 1SI-86 and 107 is only intended to demonstrate operability in the short term. These valves are scheduled for margin-enhancing modifications in RFO-9. The pressure-locking forces presented in Table 2 of Response 1 are based on bonnet pressure without the use of pressure decay.

Method Restrictions: As discussed in the May 29, 1998 ComEd letter to the NRC, the following restrictions must be considered when using the prediction methodology.

a) **The methodology was validated for flex wedge gate valves and cannot be used for split wedge gate valves.** All of the valves contained in this analysis are Westinghouse flex wedge gate valves. Therefore, they are included in the scope of the validation performed.

b) **Additional margin must be included for valves with flexible bodies. Stiff bodied valves are defined as gate valves whose pressure class is greater than 600 lbs. For lower pressure class valves, the valve body is considered to be flexible and test data indicates that an additional 20% margin be added to the required margin for the prediction to be considered adequate.** All of the valves addressed in this calculation are 1500 lb. class Westinghouse flex wedge gate valves. Therefore, they are exempt from this additional margin restriction.

c) **An accurate measurement (±15%) of the unseating load must be available.** The unwedging value measurements for all of the subject valves were made using equipment with an uncertainty of 9% or less, which is within the bounds of this constraint. (The unwedging value used for 1RC-113, 115, and 117 was taken from the highest measured value of a group of similar valves. The uncertainty for the chosen value was also within the allowed uncertainty.)

d) **A conservative seat friction coefficient must be used which should be obtained from testing or grouping.** The methodology provides a means for determining seat friction coefficient from the valve factor. Most of the valve factors used for this analysis were based on valve-specific test data, corrected for measurement uncertainty, and are therefore considered to be conservative. Analysis was also performed using default group valve factors in determining approximate unwedging margins which will exist after actuator modifications scheduled for RFO-9. For valves which a valve-specific valve factor was unavailable (1RC-113, 115, and 117), default values based on grouping and similar valve types were utilized.

e) **Conservative values for stem factors should be used when determining available margin.** Stem factors used for this evaluation are based on bounding values as determined by the HNP calculation, "Determination of MOV Stem Factors." These values are generally based on a coefficient of friction (COF) of 0.168, which has been determined to be conservatively bounding for unwedging evaluations. The last as-tested opening stem factors for five of the valves evaluated were less than the default value for a COF of 0.168. Since valve-specific test data was not available for the RC valves, a more conservative COF of 0.20 was used.

f) **This methodology should not be used if the predicted bonnet pressure exceeds the pressure/temperature rating for the valve design.** The predicted bonnet pressures for the subject valves do not exceed the pressure ratings for the valve design based on American Society of Mechanical Engineers (ASME) Code allowable stresses. Therefore, the intent of this constraint has been met.

g) **The methodology was developed and validated for balanced and near balanced pressure-locking conditions. A balanced or near balance condition was identified to be a situation in which the following equation was met:**

$$|Pup - Pdown| < Pbonnet - \left(\frac{Pup + Pdown}{2}\right)$$

This condition was satisfied for four of the eight valves evaluated. For those valves which do not meet this constraint, additional margin requirements have been imposed as discussed in the following section. In addition to the increased margin requirement, additional conservatism was incorporated in the selection of valve and stem factors.

<u>Valves with Unequal Upstream and Downstream Pressures:</u> Valves 1RC-113, 115 and 117 have a potential for a 2235 psi bonnet pressure with 1700 psi upstream and 0 psi downstream during a steam generator tube rupture scenario. Valve 1SI-52 has the potential for a 2750 psi bonnet pressure (normal CSIP discharge pressure) with 2200 psi upstream (CSIP discharge pressure during LOCA injection mode) and 0 psi downstream (RCS pressure during LOCA). As a result, these four valves do not meet the definition above for near balanced conditions. Since this could result in a potentially non-conservative prediction of pressure-locking forces, the model predictions were reviewed for the worst case unbalanced conditions (i.e., unwedging under dynamic conditions, where the bonnet pressure and upstream pressure would be equal and downstream pressure would be essentially zero). This review was performed for ten 3" Westinghouse valves which had been dynamically tested and the results are presented in the table below.

Valve	**Static O9 Force**[1] (lbs.)	**Bonnet/Upstream Pressure** (psig)	**Downstream Pressure** (psig)	**Dynamic O9 Force**[1] (lbs.)	**Predicted O9 Force**[1] (lbs.)	**Error**[2] (%)
1CS-214	4437	2778	22	7216	5781	-24.81
1CS-235	4936	2760	15	6087	7321	16.86
1CS-238	2080	2762	6	3010	2367	-27.18
1SI-1	1795	2744	36.6	3809	3268	-16.54
1SI-2	1421	2726	36.6	2802	3646	23.16
1SI-3	804	2642	0	1530	1855	17.53
1SI-4	1513	2812	0	1992	2405	17.18
1SI-52	3444	2695	35	3568	3679	3.02
1SI-86	2222	2734	35	3321	3971	16.37
1SI-107	2928	2725	22.5	6459	7723	16.37

Notes:
1. The O9 Force is the unwedging thrust.
2. The % Error was calculated as: [(Predicted - Measured)/Predicted]*100.

Under-predictions result in a negative % Error. The worst under-prediction from the tested valves was used to determine the "Required Margin." The May 29, 1998 ComEd letter to the NRC defined Required Margin as: $[(\text{Model Errors})^2 + \text{Unseating Ratio} * (\text{Static Meas. Error})^2]^{1/2}$, where

a) Model Errors include model uncertainty and static unseating variations,
b) Unseating Ratio = (Static Unseating Load) / (Press. Locking Unseating Load), and
c) Static Measurement Error = the instrument uncertainty associated with the diagnostic test equipment used to determine the static pullout force.

The results of the ComEd testing discussed in the May 29, 1998 letter indicated that the Model Errors were approximately ±10%. For conservatism in the HNP evaluation, ±15% was used as the model error for analysis of balanced pressure locking conditions (valves 1SI-3, 4, 86 & 107). For analysis of unbalanced conditions (valves 1RC-113, 115, 117 & 1SI-52), the maximum prediction error of 27.18% was used as the model error. The static unseating measurement uncertainty applied to each valve was determined from the accuracy of the associated static test. The resulting "Required Margin" values are provided in Table 2 of Response 1. (Note: "Required Margins" are not presented for 1SI-3 and 4. These valves were determined to have very high unwedging margin, which greatly exceeds the associated "Required Margin.")

Conclusion

Estimates of actuator margin have been determined, as presented in Tables 1 and 2 of Response 1, by utilizing the methodology constraints, in conjunction with results of the unbalanced condition analysis and conservative inputs to the model. The use of pressure decay, as stated above, was limited to the short term analysis for valves 1SI-86 and 107. Therefore, the results for these valves, presented in Table 2 of Response 1, are also considered to be conservative.