your energy partner
OPPD
Omaha Public Power District

444 South 16th Street Mall
Omaha NE 68102-2247

May 21, 2003
LIC-03-0079

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

References:
1. Docket No. 50-285
2. Letter from OPPD (D. J. Bannister) to NRC (Document Control Desk) dated October 8, 2002, Fort Calhoun Station Unit No. 1 License Amendment Request, LAR – Risk-Informed One Time Increase in Integrated Leak Rate Test Surveillance Interval (LIC-02-0108)
3. Letter from NRC (A. B. Wang) to OPPD (R. T. Ridenoure) dated March 24, 2003, Request for Additional Information Related to Ft. Calhoun Station Integrated Leak Rate Test Surveillance Interval (TAC No. MB6473) (NRC-03-055)
4. Letter from OPPD (R. T. Ridenoure) to NRC (Document Control Desk) dated April 11, 2003, Response to Request for Additional Information, Integrated Leak Rate Testing Surveillance Interval Amendment Request (TAC No. MB6473) (LIC-03-0055)

SUBJECT: Supplemental Response to Request for Additional Information, Integrated Leak Rate Testing Surveillance Interval Amendment Request (TAC No. MB6473)

This letter provides the response to Question 6 of the Nuclear Regulatory Commission's (NRC's) Request for Additional Information (Reference 3) with regard to Omaha Public Power District's (OPPD's) request, "Fort Calhoun Station Unit No. 1 License Amendment Request, LAR – Risk-Informed One Time Increase in Integrated Leak Rate Test Surveillance Interval" (Reference 2). The responses to Questions 1 through 5 were submitted in Reference 4.

I declare under penalty of perjury that the forgoing is true and correct. (Executed on May 21, 2003). No commitments are made to the NRC in this letter.

A017

If you have any questions or require additional information, please contact Dr. R. L. Jaworski of the FCS Licensing staff at (402) 533-6833.

Sincerely,

R. T. Ridenoure
Division Manager
Nuclear Operations

RTR/RLJ/rlj

Attachment

c: E. W. Merschoff, NRC Regional Administrator, Region IV
A. B. Wang, NRC Project Manager
J. G. Kramer, NRC Senior Resident Inspector
Winston & Strawn

Response to NRC Request for Additional Information
Fort Calhoun Station, Unit 1
One Time Increase in Integrated Containment Leak Rate Test Interval

NRC Question 6:

Inspections of some reinforced and steel containments (e.g., North Anna, Brunswick, and D. C. Cook, Oyster Creek) have indicated degradation from the uninspectable (embedded) side of the steel shell and liner of primary containments. The major uninspectable areas of the Fort Calhoun Station (FCS) containment would include those at the liner concrete interface in the dome and the cylinder, and in the basemat liner embedded in the concrete. Please provide a quantitative assessment of the impact on large effluent release frequency (LERF) due to age related degradation in these areas, in support of the requested integrated leak rate test (ILRT) interval extension

OPPD Response:

An analysis, using the Calvert Cliffs Nuclear Power Plant (CCNPP) method (Reference A1), was performed to determine how containment liner corrosion affects the risk associated with extending the ILRT for Fort Calhoun Station.

The following issues were addressed:

- Differences between the containment basemat and the containment cylinder and dome;
- The historical liner flaw likelihood due to concealed corrosion;
- The impact of aging;
- The liner corrosion leakage dependency on containment pressure; and
- The likelihood that visual inspections will be effective at detecting a flaw.

<u>Assumptions</u>

A. Two corrosion events have been identified which could potentially result in liner corrosion. It is assumed that these events may be precursors for a larger containment leakage.

B. A half failure is assumed for basemat concealed liner corrosion due to the lack of identified failures (See Table 1, Step 1).

C. The success data was limited to 6 years to reflect the years since September 1996 when 10 CFR 50.55a started requiring visual inspection.

D. The liner flaw likelihood is assumed to double every five years.

E. The likelihood of the containment atmosphere reaching the outside atmosphere given a liner flaw exists is a function of the pressure inside the Containment. Even without the liner, the Containment is an excellent barrier. But as the pressure in Containment increases, cracks will form. If a crack occurs in the same region as a liner flaw, then the containment

atmosphere can communicate to the outside atmosphere. At low pressures, this crack formation is extremely unlikely. Near the point of containment failure, crack formation is virtually guaranteed. Anchored points of 0.1% at 20 psia and 100% at 200 psia were selected based on conservative representation of the failure probabilities and pressures provided in the FCS independent plant evaluation (IPE) structural analysis section. Intermediate failure likelihoods are determined through logarithmic interpolation. Sensitivity studies are included that decrease and increase the 20-psia anchor point by a factor of 10 (See Table 4 for sensitivity studies).

F. The likelihood of leakage escape (due to crack formation) in the basemat region is considered to be 10 times less likely than the containment cylinder and dome region (See Table 1, Step 4).

G. A 5% visual inspection detection failure likelihood given the flaw is visible and a total detection failure likelihood of 10% is used.

H. All non-detectable containment over-pressurization failures are assumed to be large early releases.

I. Containment failure probabilities used for this calculation are based on the FCS specific Containment Fragility Curves.

J. The ILRT test pressure of 75 psia will bound the test failure condition for the Fort Calhoun Station.

K. The Base methodology uses continuous fits to estimate containment failure probabilities, whereas the CCNPP method used discrete addition.

Analysis

Table 1 presents the results of the analysis of the likelihood of non-detected containment leakage because of liner corrosion. The analysis considers the inspectable portion of the liner and the uninspectable portion of the liner. Approximately 86% of the interior surface of the Unit 1 containment liner is accessible for visual inspection. The 14% that are inaccessible for visual inspection include the fuel transfer tube shielded area, the area under the concrete floor, and the area behind the elevator shaft. The area under the concrete floor accounts for almost all of the inaccessible area.

Table 1
Liner Corrosion Base Case

Step	Description	Containment Cylinder and Dome 86%		Containment Basemat 14%	
1	**Historical Liner Flaw Likelihood** Failure Data: Containment location specific Success Data: Based on 70 steel-lined Containments and 6.0 years since the 10 CFR 50.55a requirement for periodic visual inspections of containment surfaces.	Events: 2 (Brunswick 2 and North Anna 2) 2/(70 * 6.0) = **4.76E-3**		Events: 0 Assume half a failure 0.5/(70 * 6.0) = **1.19E-3**	
2	**Age Adjusted Liner Flaw Likelihood** During 15-year interval, assumed failure rate doubles every five years (14.9% increase per year). The midpoint for 5th to 10th year was set to the historical failure rate	Year	Failure Rate	Year	Failure Rate
		1	1.93E-3	1	4.83E-4
		avg 5 – 10	4.76E-3	avg 5 – 10	1.19E-3
		15	1.35E-2	15	3.37E-3
		15 year avg = 5.55E-3		**15 year avg = 1.39E-3**	
3	**Increase in Flaw Likelihood Between 3 and 15 years** Uses aged adjusted liner flaw likelihood (Step 2), assuming failure rate doubles every five years. See Tables 5 and 6.	**7.87%**		**1.97%**	
4	**Likelihood of Breach in Containment given Liner Flaw** The upper end pressure is consistent with the Fort Calhoun Station Probabilistic Risk Assessment (PRA) Level 2 analysis. 0.1% is assumed for the lower end. Intermediate failure likelihoods are determined through logarithmically interpolation. The basemat failure likelihood is assumed to be 1/10 of the cylinder/dome analysis	Pressure (psia)	Likelihood of Breach	Pressure (psia)	Likelihood of Breach
		20	0.10%	20	0.01%
		75 (ILRT)	0.83%	75 (ILRT)	0.083%
		80	1.0%	80	0.10%
		120	4.6%	120	0.46%
		200	100%	200	10%
5	**Visual Inspection Detection Failure Likelihood**	**10%** 5% failure to identify visual flaws plus 5% likelihood that the flaw is not visible (not through-cylinder but could be detected by ILRT) All events have been detected through visual inspection. 5% visible failure detection is a conservative assumption.		**100%** Cannot be visually inspected.	
6	**Likelihood of Non-Detected Containment Leakage** (Steps 3 * 4* 5)	**0.0065%** 7.87% * 0.83% * 10%		**0.0016%** 1.97% * 0.083% * 100%	

The total likelihood of the corrosion-induced, non-detected containment leakage is the sum of Step 6 for the containment cylinder and dome and the containment basemat.

Total Likelihood of Non-Detected Containment Leakage = 0.0065% + 0.0016% = 0.0081%

The non-large early release frequency (LERF) containment over-pressurization failures for Fort Calhoun Station are estimated, based on the PRA, at 1.07E-05 per year. The non-LERF frequency is obtained by adding the Class 1 (intact) and late releases contribution from Class 7 (severe accident). If all non-detectable containment leakage events are considered to be LERF, then the increase in LERF associated with the liner corrosion issue is:

Increase in LERF (comparing a 3 in 10 year ILRT to a one in 15 years ILRT)
= 0.0081% * 1.07E-5= 8.7E-10 per year.

Please note that the current approved ILRT test interval at Fort Calhoun Station is one ILRT every ten years. The above increase in LERF is greater than it would be when comparing to the one in ten year frequency currently in effect.

Change in Risk

The risk of extending the ILRT from 3 in 10 years to 1 in 15 years is small and estimated as being less than 1E-7 per year. It is evaluated by considering the following elements:

1. The risk associated with the failure of the Containment due to a pre-existing containment breach at the time of core damage (Class 3 events).
2. The risk associated with liner corrosion that could result in an increased likelihood that containment over-pressurization events become LERF events.
3. The likelihood that improved visual inspections (frequency and quality) will be effective in discovering liner flaws that could lead to LERF.

These elements are discussed in detail below.

Pre-existing Containment Breach

The original submittal addressed Item 1. The submittal calculated values of the increase in risk using the Combustion Engineering Owners Group (CEOG) method (Reference A2) and a previously NRC-approved method (Reference A3). The ILRT interval for Fort Calhoun Station is currently once in ten years. Reference A3 indicated that extending this interval from once in ten years (i.e., the current interval) into once in fifteen years (the proposed interval) would result in a LERF increase from 1.226E-09 per year to 1.407E-08 per year. When measured from the original Appendix J inspection interval (i.e., three times in ten years), the increase in each risk metrics is somewhat larger. Table 2 lists the changes in risk metrics associated with extending the ILRT to a once in fifteen years interval as compared to the original Appendix J reference condition (i.e., three times in ten years).

Table 2

Original Submitted with Updated Values

(from three times in ten years (3/10) to once per 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	2.86E-09	0.06	0.80%
NRC Approved Method	4.22E-08	0.01	0.16%

Liner Corrosion

The original submittal did not fully address the risk associated with liner corrosion. Table 3, below shows an additional small increase in LERF of 0.87E-9 from going from a 3/10 to a 15 year ILRT interval. Thus, Table 2 is modified as follows:

Table 3

Updated Values with Corrosion Impact

(from three times in ten years (3/10) to once per 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	2.86E-09	0.060	0.80%
CEOG Method with Liner Corrosion	3.73E-09	0.063	0.84%
NRC-Approved Method	4.22E-08	0.0140	0.160%
NRC-Approved Method with Liner Corrosion	4.31E-08	0.0141	0.161%

Visual Inspections

The original submittal did not fully address the benefit of the Subsection IWE visual inspections. Visual inspections following the 1996 change in the ASME Code are believed to be more effective in detecting containment liner flaws. In addition, the flaws that are of concern for LERF are considerably larger than those of concern for successfully passing the ILRT. Integrated leakage rate test failures have occurred even though visual inspections have been performed. However, the recorded ILRT flaw sizes for these failed tests are much smaller than that for LERF. Therefore, it is likely that future inspections would be effective in detecting the larger flaws associated with a LERF.

IWL of Section XI of the ASME B&PV Code, provides detailed requirements for ISI of Containment Structures. Inspection (which includes examination, evaluation, repair, and replacement) of the concrete containment liner plate, in accordance with the 10 CFR 50.55a requirements, involves consideration of the potential corrosion areas. Although the improvement gained by this requirement varies from plant to plant, it is believed that this requirement makes the detection of flaws post-September 1996 much more likely than pre-September 1996 using visual inspections.

Visual inspection improvements directly reduce the Δ LERF increases as calculated in the CEOG method and NRC-approved method. A VT General inspection was completed on the liner during the 2001 Refueling Outage and will be repeated during the 2003 Refueling Outage scheduled to commence September 12, 2003. A more thorough detailed visual examination is performed on any area with evidence of degradation.

Table 7 illustrates the benefit of visual inspection improvements on the Δ LERF calculations:

If the improved inspections (additional inspection, improved effectiveness, and larger flaw size) were 90% effective in detecting the flaws in the visible regions of the containment (5% for failure to detect and 5% for flaw not detectable [not-through-wall]), then the increased ILRT LERF frequency could be reduced by 22.6%. See Table 7 for additional sensitivity cases. This would result in a LERF increase of less than 1E-7.

Sensitivity Studies

The following cases were developed to gain an understanding of the sensitivity of this analysis to the various key parameters.

Table 4
Liner Corrosion Sensitivity Cases

Age (Step 2)	Containment Breach (Step 4)	Visual Inspection & Non-Visual Flaws (Step 5)	Likelihood Flaw is LERF*	LERF Increase
Base Case Doubles every 5 years	Baseline	10%	100%	**8.69E-10**
Doubles every 2 years	Same as Base	Base	Base	**9.56E-09**
Doubles every 10 years	Same as Base	Base	Base	**4.28E-10**
Base	Base point 10 times lower	Base	Base	**1.76E-10**
Base	Base point 10 times higher	Base	Base	**4.30E-09**
Base	Same as Base	5%	Base	**5.22E-10**
Base	Same as Base	15%	Base	**1.22E-09**
Lower Bound				
Doubles every 10 years	Base point 10 times lower	5%	10%	**5.19E-12**
Upper Bound				
Double every 2 years	Base point 10 times higher	15%	100%	**6.62E-08**

* Probability that flaw is large enough to cause a large release.

Table 5
Flaw Failure Rate as a Function of Time

Year	Failure Rate (FR)	Success Rate (1-FR)
0	1.68E-03	9.98E-01
1	1.93E-03	9.98E-01
2	2.22E-03	9.98E-01
3	2.55E-03	9.97E-01
4	2.93E-03	9.97E-01
5	3.37E-03	9.97E-01
6	3.87E-03	9.96E-01
7	4.44E-03	9.96E-01
8	5.10E-03	9.95E-01
9	5.86E-03	9.94E-01
10	6.73E-03	9.93E-01
11	7.74E-03	9.92E-01
12	8.89E-03	9.91E-01
13	1.02E-02	9.90E-01
14	1.17E-02	9.88E-01
15	1.35E-02	9.87E-01

Table 6
Failure Rate

Years	Success Rate (SR)	Failure Rate (1-SR)
1 to 3	9.94E-01	0.63%
1 to 10	9.64E-01	3.64%
1 to 15	9.15E-01	8.50%

Δ = 8.50% - 0.63% = 7.87% (delta between 1 in 3 years to 1 in 15 years)

Table 7
Benefit of Visual Inspection Improvements

	Factor Improvement due to Visual Inspections	NRC Approved Method Δ LERF	NRC Approved Method w/Liner Corrosion Considered Δ LERF	CEOG Method Δ LERF	CEOG Method w/Liner Corrosion Considered Δ LERF
Pre-1996 Inspection Approach (Base Case)	0.00%	4.22E-08	4.31E-08	2.86E-09	3.73E-09
Post-1996 with Visual Inspections Perfectly Accurate	86.00%	5.9E-09	6.0E-09	4.0E-10	5.2E-10
Post-1996 with Visual Inspections 95% Accurate	81.7%	7.7E-09	7.9E-09	5.2E-10	6.8E-10
Post-1996 with Visual Inspections 95% Accurate and 5% chance of Undetectable Leakage	77.40%	9.5E-09	9.7E-09	6.5E-10	8.4E-10
Post-1996 with Visual Inspections 80% accurate and a 5% Chance of Undetectable Leakage	64.5%	1.5E-08	1.5E-08	1.0E-09	1.3E-09

Conclusion

Considering the benefit of improved visual inspections post-1996, the increase in risk is considered to be less than 1E-7 per year for LERF even when measured from the initial Appendix J baseline of inspection (i.e., three times in ten years). Changes less than 1.0E-7 per-year are considered insignificant according to Regulatory Guide 1.174. The one-time extension of the ILRT interval from 1-in-10 years (the currently approved interval) to 1-in-15 years is considered an acceptable risk increase.

References

A1. Letter, C. Cruse, Calvert Cliffs Nuclear Power Plant (CCNPP) to Document Control Desk, "Response to Request for Additional Information Concerning the License Amendment Request for a one-time Integrated Leak Rate Extension," Calvert Cliffs Nuclear Power Plant (Docket No. 50-317), March 27, 2002.

A2. WCAP-15691, Revision 3, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," CEOG Task 2027, September 2002. Transmitted via Letter from D. J. Bannister (OPPD) to NRC, "Fort Calhoun Station Unit 1 License Amendment Request, Risk-Informed One-Time Increase in Integrated Leak Rate Test Surveillance Interval," dated October 8, 2002.

A3. LIC-02-0108, "Fort Calhoun Station Unit No. 1 License Amendment Request, Risk Informed One-Time Increase in Integrated Leak Rate Test Surveillance Interval," D. J Bannister (OPPD) to USNRC, October 8, 2002