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January 24, 2003
L-03-012

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Subject: Beaver Valley Power Station, Unit No. 1 and No. 2
BV-1 Docket No. 50-334, License No. DPR-66
BV-2 Docket No. 50-412, License No. NPF-73
Response to Request for Additional Information Concerning the License Amendment Request for a One-time Integrated Leak Rate Test Interval Extension

REFERENCES: 1. FENOC letter L-02-106, dated October 31, 2002, "Beaver Valley Power Station, Unit No. 1 and No. 2, License Amendment Request Nos. 299 and 171"

This letter provides the information requested during a telephone conference call between the NRC, FENOC and Westinghouse on November 21, 2002 regarding the Beaver Valley Power Station Integrated Leak Rate Test (ILRT) One-time Extension Request (Reference 1) and supplements the information provided in our submittal.

Specifically, FENOC was asked to provide additional risk analysis which includes revised dose impacts based on a more realistic dose calculation method and revised event class frequencies which reflect a more realistic apportionment of Class 3 frequency changes among the intact and late containment release states. Additionally, FENOC was asked to provide an assessment which considers the impact of potential containment liner leakage due to age-related degradation mechanisms similar to the analysis recently prepared by Constellation for Calvert Cliffs Nuclear Power Plant.

Attachments A and B provide the requested information for Beaver Valley Unit 1. Attachments C and D provide the requested information for Beaver Valley Unit 2. This information does not change the conclusions of the No Significant Hazards Consideration provided in Reference 1. There are no regulatory commitments associated with this response.

A017

NRC approval of the proposed amendment is requested by February 21, 2003, to support the spring 2003 refueling outage for Beaver Valley Unit 1. Once approved, the amendment shall be implemented within 60 days.

If there are any questions concerning this matter, please contact Mr. Larry R. Freeland, Manager, Regulatory Affairs/Performance Improvement at 724-682-5284.

I declare under penalty of perjury that the foregoing is true and correct. Executed on January 24, 2003.

Sincerely,

Mark B. Bezilla

Attachments:

A. *Alternative Assessment of Beaver Valley Unit 1 Integrated Leak Rate Test Interval Extension*
B. *Containment Liner Corrosion Analysis for Beaver Valley Unit 1*
C. *Alternative Assessment of Beaver Valley Unit 2 Integrated Leak Rate Test Interval Extension*
D. *Containment Liner Corrosion Analysis for Beaver Valley Unit 2*

c: Mr. D. S. Collins, NRR Project Manager
Mr. R. L. Clark, NRR Project Manager
Mr. D. M. Kern, NRC Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator
Mr. D. A. Allard, Director BRP/DEP
Mr. L. E. Ryan (BRP/DEP)

Attachment A
Letter L-03-012

Alternative Assessment of Beaver Valley Unit 1 Integrated Leak Rate Test Interval Extension

The License Amendment Request (LAR) submitted by FENOC Letter L-02-106, Beaver Valley Power Station, Unit No.1 and No. 2 License Amendment Request Nos. 299 and 171, dated October 31, 2002, from M. P. Pearson (FENOC) to U.S. Nuclear Regulatory Commission Document Control Desk utilizes the methodology contained in WCAP-15691, Revision 4, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," September 2002 (Reference 1) for the supporting technical justification for the request of a one-time extension of the Integrated Leak Rate Test (ILRT) interval from 10 to 15 years. Enclosures 4 and 5 of FENOC Letter L-02-106 (Reference 2) contained an alternate calculation based on a method previously approved by the NRC for other one-time 10 to 15 year ILRT extensions. A preliminary review of the Beaver Valley 1 and 2 submittal by the NRC identified that the application of the existing methodology to Beaver Valley Unit 1 resulted in over-estimating the population doses and liner leakage frequencies. The impact of these items was not expected to significantly impact the risk assessment. However, to address these comments, an alternative assessment has been prepared. Specifically, two changes were recommended: (1) replace the RADTRAD calculated doses with doses based on realistic consequence analysis tools, and (2) adjust the liner leakage frequency calculation to reflect a more realistic apportionment of the Class 3 frequency changes among the intact and late containment release states. These changes are discussed below.

Changes to the Model to Include a Realistic Dose Assessment

To establish realistic dose estimates, the Beaver Valley site was compared to the Surry and Zion sites studied in NUREG-1150. Based on this review, it was determined that a reasonable bounding intact containment release for Beaver Valley Unit 1 would be 2990 person-Rem.

Since the bypass results are included in the denominator of the risk ratios, a more realistic value of bypass releases was also determined to provide conservative risk ratios. This resulted in an estimate for Beaver Valley Unit 1 of 1.29E+7 person- Rem.

Changes to the Model to Apportion the Liner Release Frequencies

Liner leakage frequencies (Classes 3a and 3b of Reference 2) associated with the ILRT interval extension were revised to be dependent on non-LERF containment states only. The Class 3a and 3b contributions of the Reference 2 method were established by reducing the intact and late containment states. That is,

$$F\_{Class\ 3a} = P\_{3a}\ (FINTACT0 + FLATE0)$$
$$F\_{Class\ 3b} = P\_{3b}\ (FINTACT0 + FLATE0)$$

and

$$FINTACT\_{ADJ} = FINTACT0 - (F\_{Class\ 3a} + F\_{Class3b}) * FR$$
$$FLATE\_{ADJ} = FLATE0 - (F\_{Class\ 3a} + F\_{Class\ 3b}) * (1 - FR)$$

Where

P_{3a} = probability of a small containment liner leak associated with the ILRT Interval
P_{3b} = probability of a large containment liner leak associated with the ILRT Interval
FINTACT0 = Frequency of the initial intact release Class (per year)
FLATE0 = Frequency of the initial late severe accident release class (per year)
$F_{Class\ 3a}$ = Frequency of Class 3a releases (small liner leaks)
$F_{Class\ 3b}$ = Frequency of Class 3b releases (large liner leaks)
$FINTACT_{ADJ}$ = Frequency of the intact release class (per year) adjusted for liner leaks due to the ILRT interval
$FLATE_{ADJ}$ = Frequency of the late severe accident release class (per year) adjusted for liner leaks due to the ILRT interval

FR = FINTACT0 / (FINTACT0 + FLATE0)

Note that the release Class frequency definitions are summarized in Table 1.

The impact of this change is to create the Class 3a and 3b frequency from the intact and late states and to remove these new states from the intact and late states. Note that LERF goes up by the increase in Class 3b.

Table 1
Release Class Definitions

Release Class	Description
1	No containment failure
2	Large isolation failures
3	Liner leakages
4, 5	Other small isolation failures (LLRT)
6	Other isolation failures
7	Severe Accident Failures (Early and Late) not including bypass and loss of isolation containment states.
8	Bypass

Results of Revised Calculations

Results of the revised analyses are presented in Tables 2 through 4. As can be seen, use of more realistic dose estimates confirms the small radiological impact of liner releases.

Table 2
Beaver Valley Unit 1 Risk Evaluation
of Baseline ILRT Interval
(Three per Ten years)

Class	Frequency (per reactor-year)	Release (person-rem)	Risk (person-rem/year)
1	6.94E-06	L_a = 2.99E+03	0.02
2	1.19E-08	35 L_a = 1.05E+05	<0.01
3a	4.29E-06	10 L_a = 2.99E+04	0.13
3b	1.41E-06	35 L_a = 1.05E+05	0.15
6	1.11E-05	35 L_a = 1.05E+05	1.16
7	5.47E-05	100 L_a = 2.99E+05	16.37
8	6.54E-06	1.29E+07	84.37

Table 3
Beaver Valley Unit 1 Risk Evaluation
of Current ILRT Interval
(Once per Ten years)

Class	Frequency (per reactor-year)	Release (person-rem)	Risk (person-rem/year)
1	6.88E-6	L_a = 2.99E+03	0.02
2	1.19E-08	35 L_a = 1.05E+05	<0.01
3a	4.71E-6	10 L_a = 2.99E+04	0.14
3b	1.55E-6	35 L_a = 1.05E+05	0.16
6	1.11E-05	35 L_a = 1.05E+05	1.16
7	5.42E-5	100 L_a = 2.99E+05	16.22
8	6.54E-06	1.29E+07	84.37

Table 4
Beaver Valley Unit 1 Risk Evaluation of Proposed ILRT Interval (Once per Fifteen years)

Class	Frequency (per reactor-year)	Release (person-rem)	Risk (person-rem/year)
1	6.85E-6	L_a = 2.99E+03	0.02
2	1.19E-08	35 L_a = 1.05E+05	<0.01
3a	4.93E-6	10 L_a = 2.99E+04	0.15
3b	1.62E-6	35 L_a = 1.05E+05	0.17
6	1.11E-05	35 L_a = 1.05E+05	1.16
7	5.40E-5	100 L_a = 2.99E+05	16.14
8	6.54E-06	1.29E+07	84.37

Assessment of Change in LERF and % Risk Increase

Tables 5 and 6 present the comparisons of the change in LERF, person-rem increase, and change in % Risk (as measured by the person-rem increase) for the WCAP-15691, Revision 4 methodology (Reference 1), the methodology contained in Enclosures 4 and 5 of Reference 2, and the revised calculation discussed above.

Table 5
Comparison of the Beaver Valley Unit 1 Risk Metrics for Various ILRT Interval Assessment Approaches: Incremental Metrics Based on the ILRT Interval Extension from the Baseline to once per Fifteen years

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method (15-3/10)	4.47E-09	3.82	0.012%
NRC Approved Method (15-3/10)	2.68E-07	2.94	0.073%
Adjusted Crystal River Methodology (15-3/10)	2.11E-07	0.04	0.040%

Table 6
Comparison of the Beaver Valley Unit 1 Risk Metrics for Various ILRT Interval Assessment Approaches: Incremental Metrics Based on the ILRT Interval Extension from Ten to Fifteen years

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method (15-10)	1.91E-09	1.64	0.005%
NRC Approved Method (15-10)	8.92E-08	1.0	0.02%
Adjusted Crystal River Methodology (15-10)	7.03E-08	0.01	0.014%

CONCLUSIONS

Based on these revised calculations, the impact of the more realistic assessments confirms that the application of the methodology contained in Enclosures 4 and 5 of Reference 2 results in conservative predictions of the change in LERF and change in % Risk. Furthermore, the incremental LERF predictions for the ILRT extension from ten to fifteen years is below 1E-07 per year, and is considered small.

REFERENCES

1. WCAP-15691, Revision 4, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," September 2002.

2. Enclosures 4 and 5 of FENOC Letter L-02-106, Beaver Valley Power Station, Unit No.1 and No. 2 License Amendment Request Nos. 299 and 171, dated October 31, 2002, from M. P. Pearson (FENOC) to U.S. Nuclear Regulatory Commission Document Control Desk.

Attachment B
Letter L-03-012

Containment Liner Corrosion Analysis for Beaver Valley Unit 1

The methodology used for Calvert Cliffs Nuclear Power Plant Unit No. 1 (Reference 1) to determine the change in likelihood of detecting liner corrosion due to extending the ILRT, was also used for Beaver Valley Unit 1. This likelihood was then used to determine the resulting change in risk. The following issues are included in the assessment:

- 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 in detecting a flaw.

<u>Assumptions</u>

A. Two liner corrosion events have been identified industry wide that could potentially result in liner corrosion. It is assumed that these two events could be precursors for a large containment leak.

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 6.0 years to reflect the years following September 1996 when 10 CFR 50.55a initially required visual inspection. Additional success data was not used to limit the aging impact of this corrosion issue, even though inspections were being performed prior to this date and there is no evidence that liner corrosion issues were identified. (See Table 1, Step 1.)

D. The liner flaw likelihood is assumed to double every five years. This is based solely on engineering judgment and is included in this analysis to address the increased likelihood of corrosion as the liner ages. Sensitivity studies are included that address doubling this rate every 10 years and every two years. (See Table 1, Steps 2 and 3, and Tables 5 and 6.)

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. However, as the pressure in the 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 certain. Anchored points of 0.1% at 20 psia and 100% at 164.7 psia were selected. Intermediate failure likelihoods are determined by logarithmic interpolation. Consistent with Reference 1, the containment pressure for the corrosion LERF impact is based on the ILRT pressure for Beaver Valley Unit 1. This is bounded by 62 psia. Sensitivity studies are included that decrease and increase the 20 psia anchor point by a factor of 10. (See Table 4 for the 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 that the flaw is visible and a total detection failure likelihood of 10% are used. To date, all liner corrosion events have been detected through visual inspection. (See Table 1, Step 5.) Sensitivity studies are included that evaluate total detection failure likelihoods of 5% and 15%. (See Table 4 for the sensitivity studies.)

H. All non-detectable containment over-pressurization failures are assumed to be large early releases. This approach avoids a detailed analysis of containment failure timing and operator recovery actions.

I. The assumed ILRT test pressure of 62 psia conservatively bounds the test conditions for both Beaver Valley Units 1 and 2.

Analysis

Table 1 presents the results of the analysis of the likelihood of non-detected containment leakage due to liner corrosion. The analysis considers the inspectable portion of the liner and the uninspectable portion of the liner. Approximately 85% of the interior surface of the Unit 1 containment liner is accessible for visual inspection. The 15% that is inaccessible for visual inspection includes 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 85%		Containment Basemat 15%	
1	**Historical Liner Flaw Likelihood** Failure Data: Containment location specific Success Data: Based on 70 steel-lined containments and 6.0 years following 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 the 15-year interval, the assumed failure rate doubles every 5 years (14.9% increase per year). The midpoint for 5th to 10th year was set to the historical failure rate. (See Table 5 for an example.)	Year 1 avg 5 – 10 15	Failure Rate 1.93E-3 4.76E-3 1.35E-2	Year 1 avg 5 – 10 15	Failure Rate 4.83E-4 1.19E-3 3.37E-3
		15 year avg = 5.67E-3		**15 year avg = 1.42E-3**	
3	**Increase in Flaw Likelihood Between 3 and 15 years** Uses age adjusted liner flaw likelihood (Step 2), assuming the failure rate doubles every 5 years. See Tables 5 and 6.	7.87%		1.97%	
4	**Likelihood of Breach in Containment given a Liner Flaw** The upper end pressure is consistent with the Beaver Valley Unit 1 Probabilistic Risk Assessment (PRA) Level 2 analysis. 0.1% is assumed for the lower end. Intermediate failure likelihoods are determined by logarithmically interpolation. The basemat failure likelihood is assumed to be 1/10 of the cylinder/dome analysis	Pressure (psia) 20 62 (ILRT) 80 120 164.7	Likelihood of Breach 0.10% 0.77% 1.82% 12.2% 100%	Pressure (psia) 20 62 (ILRT) 80 120 164.7	Likelihood of Breach 0.01% 0.077% 0.18% 1.22% 10%

Table 1

Liner Corrosion Base Case

Step	Description	Containment Cylinder and Dome 85%	Containment Basemat 15%
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)	**0.0061%** 7.87% * 0.77% * 10%	**0.0015%** 1.97% * 0.077% * 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 = 0.0061% + 0.0015% = 0.0076%

The non-large early release frequency (LERF) containment over-pressurization failures for Beaver Valley Unit 1 are estimated, based on the PRA, at 6.63E-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 (ILRT 3 to 15 years) = 0.0076% * 6.63E-5 = 5.03E-9 per year.

<u>**Change in Risk**</u>

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. 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 License Amendment Request (LAR) submitted by FENOC Letter L-02-106, Beaver Valley Power Station, Unit No.1 and No. 2 License Amendment Request Nos. 299 and 171, dated October 31, 2002, from M. P. Pearson (FENOC) to U.S. Nuclear Regulatory Commission Document Control Desk addressed Item 1. The LAR contained calculated values of the increase in risk using the CEOG methodology (Reference 2) and a previously NRC-approved (Crystal River 3) methodology (Reference 3). Tables 2a and 2b list the key values.

Table 2a

LAR Submittal with Updated Values (from 3/10 years to 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	4.47E-09	3.82	0.012%
NRC Approved Method	2.68E-07	2.94	0.073%
Adjusted Crystal River 3 Methodology	2.11E-07	0.04	0.040%

Table 2b

LAR Submittal with Updated Values (from 10 years to 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	1.91E-09	1.64	0.005%
NRC Approved Method	8.92E-08	1.00	0.02%
Adjusted Crystal River 3 Methodology	7.03E-08	0.01	0.014%

Liner Corrosion

Including the risk associated with liner corrosion, this supplement shows an additional small increase in LERF of 5.03E-9 when increasing the ILRT from a 3/10 to a 15 year interval. Thus, Table 2a is modified as follows:

Table 3a

Updated Values Including the Impact of Liner Corrosion (from 3/10 years to 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	4.47E-09	3.82	0.012%
CEOG Method with Liner Corrosion	9.49E-09	4.68	0.015%
NRC-Approved Method	2.68E-07	2.94	0.073%
NRC-Approved Method with Liner Corrosion	2.73E-07	2.98	0.074%
Adjusted Crystal River Methodology	2.11E-07	0.04	0.040%
Adjusted Crystal River Methodology with Liner Corrosion	2.16E-07	0.04	0.041%

Table 3b, below shows an additional small increase in LERF of 3.1E-9, when increasing the ILRT from a 10 year to a 15 year interval. Thus, Table 2b is modified as follows:

Table 3b

Updated Values Including the Impact of Liner Corrosion (from 10 years to 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	1.91E-09	1.64	0.005%
CEOG Method with Liner Corrosion	5.01E-09	2.17	0.007%
NRC-Approved Method	8.92E-08	1.00	0.02%
NRC-Approved Method with Liner Corrosion	9.23E-08	1.02	0.025%
Adjusted Crystal River Methodology	7.03E-08	0.01	0.014%
Adjusted Crystal River Methodology with Liner Corrosion	7.34E-08	0.02	0.02%

Visual Inspections

The LAR submittal did not fully credit the benefit of the Subsection IWE visual inspections. Visual inspections following the 1996 change in the ASME Code are considered to be more effective in detecting flaws. In addition, the flaws that are of concern for LERF are considerably larger than those associated with 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.

Impact of Improved Visual Inspections

The containment performance data used for both the CEOG method and the NRC-approved method is contained in NUREG-1493. This data is prior to 1994. An amendment to 10 CFR 50.55a became effective on September 9, 1996. This amendment, by endorsing the use of Subsections IWE and IWL of Section XI of the ASME Boiler & Pressure Vessel 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 after September 1996 much more likely than prior to September 1996 using visual inspections.

Visual inspection improvements directly reduce the delta LERF increases as calculated in the CEOG method and NRC-approved method. The first ASME Section XI subsection IWE inspection of the Beaver Valley Unit 1 containment liner was performed in conjunction with the containment structural integrity inspection in the Spring of 2000. The internal containment structural integrity inspection is scheduled to be performed again in the Spring of 2003. The next Unit 1 containment IWE inspection is scheduled for 2006.

Table 7 illustrates the benefit of visual inspection improvements on the delta 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 the flaw being not detectable [not-through-wall]), then the increased ILRT LERF frequency could be reduced by 23.5%. 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	**Base Case** 0.77/0.077	**Base Case** 10%	**Base Case** 100%	**Base Case** 5.03E-9
Doubles every 2 years	Base	Base	Base	5.52E-8
Doubles every 10 years	Base	Base	Base	2.48E-9
Base	Base point 10 times lower (0.16/0.016)	Base	Base	1.02E-9
Base	Base point 10 times higher (3.8/0.38)	Base	Base	2.48E-8
Base	Base	5%	Base	3.02E-9
Base	Base	15%	Base	7.04E-9
Lower Bound				
Doubles every 10 years	Base point 10 times lower (0.16/0.016)	5%	10%	3.00E-11
Upper Bound				
Double every 2 years	Base point 10 times higher (3.8/0.38)	15%	100%	3.82E-7

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	Effectiveness of Visual Inspection	NRC Approved Method without Liner Corrosion Considered Delta LERF	NRC Approved Method with Liner Corrosion Considered Delta LERF	CEOG Method without Liner Corrosion Considered Delta LERF	CEOG Method with Liner Corrosion Considered Delta LERF	Alternate Crystal River Methodology without Liner Corrosion Considered Delta LERF	Alternate Crystal River Methodology with Liner Corrosion Considered Delta LERF
Pre-1996 Inspection Approach (Base Case)	0.00%	2.68E-07	2.73E-07	4.47E-09	9.49E-09	2.11E-07	2.16E-07
Post-1996 with Visual Inspections Perfectly Accurate	85.00%	4.0E-08	4.1E-08	6.70E-10	1.4E-09	3.2E-08	3.2E-08
Post-1996 with Visual Inspections 95% Accurate	80.75%	5.2E-08	5.3E-08	8.60E-10	1.8E-09	4.0E-08	4.1E-08
Post-1996 with Visual Inspections 95% Accurate and 5% chance of Undetectable Leakage	76.50%	6.3E-08	6.4E-08	1.05E-09	2.2E-09	4.9E-08	5.1E-08
Post-1996 with Visual Inspections 80% accurate and a 5% Chance of Undetectable Leakage	63.75%	9.7E-08	9.9E-08	1.62E-09	3.4E-09	7.6E-08	7.8E-08

Conclusion

Considering the benefit of improved visual inspections after September 1996, the increase in risk is considered to be less than 1E-7 for LERF. Changes less than 1E-7 are considered small per Regulatory Guide 1.174. The one-time extension of the ILRT interval to 15 years is considered an acceptable risk increase.

References

1. Letter from C. H. Cruse, (CCNPP) to U.S. Nuclear Regulatory Commission Document Control Desk, "Response to Request for Additional Information Concerning the License Amendment Request for a One-Time Integrated Leak Rate Test Extension, Calvert Cliffs Nuclear Power Plant Unit No. 1 Docket No. 50-317, March 27, 2002.

2. WCAP-15691, Revision 4, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," September 2002.

3. Enclosures 4 and 5 of FENOC Letter L-02-106, Beaver Valley Power Station, Unit No.1 and No. 2 License Amendment Request Nos. 299 and 171, dated October 31, 2002, from M. P. Pearson (FENOC) to U.S. Nuclear Regulatory Commission Document Control Desk.

Attachment C
Letter L-03-012

Alternative Assessment of Beaver Valley Unit 2 Integrated Leak Rate Test Interval Extension

The License Amendment Request (LAR) submitted by FENOC Letter L-02-106, Beaver Valley Power Station, Unit No.1 and No. 2 License Amendment Request Nos. 299 and 171, dated October 31, 2002, from M. P. Pearson (FENOC) to U.S. Nuclear Regulatory Commission Document Control Desk utilizes the methodology contained in WCAP-15691, Revision 4, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," September 2002 (Reference 1) for the supporting technical justification for the request of a one-time extension of the Integrated Leak Rate Test (ILRT) interval from 10 to 15 years. Enclosures 4 and 5 of FENOC Letter L-02-106 (Reference 2) contained an alternate calculation based on a method previously approved by the NRC for other one-time 10 to 15 year ILRT extensions. A preliminary review of the Beaver Valley 1 and 2 submittal by the NRC identified that the application of the existing methodology to Beaver Valley Unit 1 resulted in over-estimating the population doses and liner leakage frequencies. The impact of these items was not expected to significantly impact the risk assessment. However, to address these comments, an alternative assessment has been prepared. Specifically, two changes were recommended: (1) replace the RADTRAD calculated doses with doses based on realistic consequence analysis tools, and (2) adjust the liner leakage frequency calculation to reflect a more realistic apportionment of the Class 3 frequency changes among the intact and late containment release states. These changes are discussed below.

Changes to the Model to Include a Realistic Dose Assessment

To establish realistic dose estimates, the Beaver Valley site was compared to the Surry and Zion sites studied in NUREG-1150. Based on this review, it was determined that a reasonable bounding intact containment release for Beaver Valley Unit 2 would be 2990 person-Rem.

Since the bypass results are included in the denominator of the risk ratios, a more realistic value of bypass releases was also determined to provide conservative risk ratios. This resulted in an estimate for Beaver Valley Unit 2 of 1.29E+7 person- Rem.

Changes to the Model to Apportion the Liner Release Frequencies

Liner leakage frequencies (Classes 3a and 3b of Reference 2) associated with the ILRT interval extension were revised to be dependent on non-LERF containment states only. The Class 3a and 3b contributions of the Reference 2 method were established by reducing the intact and late containment states. That is,

$$F\_{\text{Class 3a}} = P\_{3a}\,(\text{FINTACT0} + \text{FLATE0})$$
$$F\_{\text{Class 3b}} = P\_{3b}\,(\text{FINTACT0} + \text{FLATE0})$$

and

$$\text{FINTACT}\_{\text{ADJ}} = \text{FINTACT0} - (F\_{\text{Class 3a}} + F\_{\text{Class3b}}) * \text{FR}$$
$$\text{FLATE}\_{\text{ADJ}} = \text{FLATE0} - (F\_{\text{Class 3a}} + F\_{\text{Class 3b}}) * (1 - \text{FR})$$

Where

$P_{\_3a}$ = probability of a small containment liner leak associated with the ILRT Interval
$P_{\_3b}$ = probability of a large containment liner leak associated with the ILRT Interval
FINTACT0 = Frequency of the initial intact release Class (per year)
FLATE0 = Frequency of the initial late severe accident release class (per year)
$F_{\_Class\ 3a}$ = Frequency of Class 3a releases (small liner leaks)
$F_{\_Class\ 3b}$ = Frequency of Class 3b releases (large liner leaks)
$FINTACT_{\_ADJ}$ = Frequency of the intact release class (per year) adjusted for liner leaks due to the ILRT interval
$FLATE_{\_ADJ}$ = Frequency of the late severe accident release class (per year) adjusted for liner leaks due to the ILRT interval

FR = FINTACT0 / (FINTACT0 + FLATE0)

Note that the release Class frequency definitions are summarized in Table 1.

The impact of this change is to create the Class 3a and 3b frequency from the intact and late states and to remove these new states from the intact and late states. Note that LERF goes up by the increase in Class 3b.

Table 1
Release Class Definitions

Release Class	Description
1	No containment failure
2	Large isolation failures
3	Liner leakages
4, 5	Other small isolation failures (LLRT)
6	Other isolation failures
7	Severe Accident Failures (Early and Late) not including bypass and loss of isolation containment states.
8	Bypass

Results of Revised Calculations

Results of the revised analyses are presented in Tables 2 through 4. As can be seen, use of more realistic dose estimates confirms the small radiological impact of liner releases.

Table 2
Beaver Valley Unit 2 Risk Evaluation
of Baseline ILRT Interval
(Three per Ten years)

Class	Frequency (per reactor-year)	Release (person-rem)	Risk (person-rem/year)
1	4.91E-06	L_a = 2.99E+03	0.01
2	2.16E-09	35 L_a = 1.05E+05	<0.01
3a	7.76E-07	10 L_a = 2.99E+04	0.02
3b	2.55E-07	35 L_a = 1.05E+05	0.03
6	5.43E-08	35 L_a = 1.05E+05	0.01
7	6.70E-06	100 L_a = 2.99E+05	2.00
8	3.75E-06	1.29E+07	48.38

Table 3
Beaver Valley Unit 2 Risk Evaluation
of Current ILRT Interval
(Once per Ten years)

Class	Frequency (per reactor-year)	Release (person-rem)	Risk (person-rem/year)
1	4.87E-06	L_a = 2.99E+03	0.01
2	2.16E-09	35 L_a = 1.05E+05	<0.01
3a	8.54E-07	10 L_a = 2.99E+04	0.03
3b	2.80E-07	35 L_a = 1.05E+05	0.03
6	5.43E-08	35 L_a = 1.05E+05	0.01
7	6.64E-06	100 L_a = 2.99E+05	1.99
8	3.75E-06	1.29E+07	48.38

Table 4
Beaver Valley Unit 2 Risk Evaluation
of Proposed ILRT Interval
(Once per Fifteen years)

Class	Frequency (per reactor-year)	Release (person-rem)	Risk (person-rem/year)
1	4.84E-06	L_a = 2.99E+03	0.01
2	2.16E-09	35 L_a = 1.05E+05	<0.01
3a	8.93E-07	10 L_a = 2.99E+04	0.03
3b	2.93E-07	35 L_a = 1.05E+05	0.03
6	5.43E-08	35 L_a = 1.05E+05	0.01
7	6.61E-06	100 L_a = 2.99E+05	1.98
8	3.75E-06	1.29E+07	48.38

Assessment of Change in LERF and % Risk Increase

Tables 5 and 6 present the comparisons of the change in LERF, person-rem increase, and change in % Risk (as measured by the person-rem increase) for the WCAP-15691, Revision 4 methodology (Reference 1), the methodology contained in Enclosures 4 and 5 of Reference 2, and the revised calculation discussed above.

Table 5
Comparison of the Beaver Valley Unit 2 Risk Metrics for Various ILRT Interval Assessment Approaches: Incremental Metrics Based on the ILRT Interval Extension from the Baseline to once per Fifteen years

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method (15-3/10)	3.16E-09	2.70	0.052%
NRC Approved Method (15-3/10)	5.17E-08	0.54	0.030%
Adjusted Crystal River Methodology (15-3/10)	3.82E-08	0.0075	0.015%

Table 6
Comparison of the Beaver Valley Unit 2 Risk Metrics for Various ILRT Interval Assessment Approaches: Incremental Metrics Based on the ILRT Interval Extension from Ten to Fifteen years

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method (15-10)	1.35E-09	1.15	0.022%
NRC Approved Method (15-10)	1.72E-08	0.18	0.010%
Adjusted Crystal River Methodology (15-10)	1.27E-08	0.0025	0.005%

CONCLUSIONS

Based on these revised calculations, the impact of the more realistic assessments confirms that the application of the methodology contained in Enclosures 4 and 5 of Reference 2 results in conservative predictions of the change in LERF and change in % Risk. Furthermore, the incremental LERF predictions for the ILRT extension from ten to fifteen years is below 1E-07 per year, and is considered small.

REFERENCES

1. WCAP-15691, Revision 4, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," September 2002.

2. Enclosures 4 and 5 of FENOC Letter L-02-106, Beaver Valley Power Station, Unit No.1 and No. 2 License Amendment Request Nos. 299 and 171, dated October 31, 2002, from M. P. Pearson (FENOC) to U.S. Nuclear Regulatory Commission Document Control Desk.

Containment Liner Corrosion Analysis for Beaver Valley Unit 2

The methodology used for Calvert Cliffs Nuclear Power Plant Unit No. 1 (Reference 1) to determine the change in likelihood of detecting liner corrosion due to extending the ILRT, was also used for Beaver Valley Unit 2. This likelihood was then used to determine the resulting change in risk. The following issues are included in the assessment:

- 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 in detecting a flaw.

<u>Assumptions</u>

A. Two liner corrosion events have been identified industry wide that could potentially result in liner corrosion. It is assumed that these two events could be precursors for a large containment leak.

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 6.0 years to reflect the years following September 1996 when 10 CFR 50.55a initially required visual inspection. Additional success data was not used to limit the aging impact of this corrosion issue, even though inspections were being performed prior to this date and there is no evidence that liner corrosion issues were identified. (See Table 1, Step 1.)

D. The liner flaw likelihood is assumed to double every five years. This is based solely on engineering judgment and is included in this analysis to address the increased likelihood of corrosion as the liner ages. Sensitivity studies are included that address doubling this rate every 10 years and every two years. (See Table 1, Steps 2 and 3, and Tables 5 and 6.)

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. However, as the pressure in the 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 certain. Anchored points of 0.1% at 20 psia and 100% at 164.7 psia were selected. Intermediate failure likelihoods are determined by logarithmic interpolation. Consistent with Reference 1, the containment pressure for the corrosion LERF impact is based on the ILRT pressure for Beaver Valley Unit 2. This is bounded by 62 psia. Sensitivity studies are included that decrease and increase the 20 psia anchor point by a factor of 10. (See Table 4 for the 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 that the flaw is visible and a total detection failure likelihood of 10% are used. To date, all liner corrosion events have been detected through visual inspection. (See Table 1, Step 5.) Sensitivity studies are included that evaluate total detection failure likelihoods of 5% and 15%. (See Table 4 for the sensitivity studies.)

H. All non-detectable containment over-pressurization failures are assumed to be large early releases. This approach avoids a detailed analysis of containment failure timing and operator recovery actions.

I. The assumed ILRT test pressure of 62 psia conservatively bounds the test conditions for both Beaver Valley Units 1 and 2.

Analysis

Table 1 presents the results of the analysis of the likelihood of non-detected containment leakage due to liner corrosion. The analysis considers the inspectable portion of the liner and the uninspectable portion of the liner. Approximately 85% of the interior surface of the Unit 2 containment liner is accessible for visual inspection. The 15% that is inaccessible for visual inspection includes 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 85%		Containment Basemat 15%	
1	**Historical Liner Flaw Likelihood** Failure Data: Containment location specific Success Data: Based on 70 steel-lined containments and 6.0 years following 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 the 15-year interval, the assumed failure rate doubles every 5 years (14.9% increase per year). The midpoint for 5th to 10th year was set to the historical failure rate. (See Table 5 for an example.)	Year 1 avg 5 – 10 15	Failure Rate 1.93E-3 4.76E-3 1.35E-2	Year 1 avg 5 – 10 15	Failure Rate 4.83E-4 1.19E-3 3.37E-3
		15 year avg = 5.67E-3		**15 year avg = 1.42E-3**	
3	**Increase in Flaw Likelihood Between 3 and 15 years** Uses age adjusted liner flaw likelihood (Step 2), assuming the failure rate doubles every 5 years. See Tables 5 and 6.	**7.87%**		**1.97%**	
4	**Likelihood of Breach in Containment given a Liner Flaw** The upper end pressure is consistent with the Beaver Valley Unit 2 Probabilistic Risk Assessment (PRA) Level 2 analysis. 0.1% is assumed for the lower end. Intermediate failure likelihoods are determined by logarithmically interpolation The basemat failure likelihood is assumed to be 1/10 of the cylinder/dome analysis	Pressure (psia) 20 62 (ILRT) 80 120 164.7	Likelihood of Breach 0.10% 0.77% 1.82% 12.2% 100%	Pressure (psia) 20 62 (ILRT) 80 120 164.7	Likelihood of Breach 0.01% 0 077% 0.18% 1.22% 10%

Table 1

Liner Corrosion Base Case

Step	Description	Containment Cylinder and Dome 85%	Containment Basemat 15%
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)	**0.0061%** 7.87% * 0.77% * 10%	**0.0015%** 1.97% * 0 077% * 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 = 0.0061% + 0.0015% = 0.0076%

The non-large early release frequency (LERF) containment over-pressurization failures for Beaver Valley Unit 2 are estimated, based on the PRA, at 1.17E-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 (ILRT 3 to 15 years) = 0.0076% * 1.17E-5 = 8.85E-10 per year.

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. 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 License Amendment Request (LAR) submitted by FENOC Letter L-02-106, Beaver Valley Power Station, Unit No.1 and No. 2 License Amendment Request Nos. 299 and 171, dated October 31, 2002, from M. P. Pearson (FENOC) to U.S. Nuclear Regulatory Commission Document Control Desk addressed Item 1. The LAR contained calculated values of the increase in risk using the CEOG methodology (Reference 2) and a previously NRC-approved (Crystal River 3) methodology (Reference 3). Tables 2a and 2b list the key values.

Table 2a

LAR Submittal with Updated Values (from 3/10 years to 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	3.16E-09	2.70	0.052%
NRC Approved Method	5.17E-08	0.54	0.030%
Adjusted Crystal River 3 Methodology	3.82E-08	7.5E-03	0.015%

Table 2b

LAR Submittal with Updated Values (from 10 years to 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	1.35E-09	1.15	0.022%
NRC Approved Method	1.72E-08	0.18	0.010%
Adjusted Crystal River 3 Methodology	1.27E-08	2.5E-03	0.005%

Liner Corrosion

Including the risk associated with liner corrosion, this supplement shows an additional small increase in LERF of 8.85E-10 when increasing the ILRT from a 3/10 to a 15 year interval. Thus, Table 2a is modified as follows:

Table 3a

Updated Values Including the Impact of Liner Corrosion (from 3/10 years to 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	3.16E-09	2.70	0.052%
CEOG Method with Liner Corrosion	4.04E-09	2.85	0.055%
NRC-Approved Method	5.17E-08	0.54	0.030%
NRC-Approved Method with Liner Corrosion	5.25E-08	0.55	0.030%
Adjusted Crystal River Methodology	3.82E-08	7.5E-03	0.015%
Adjusted Crystal River Methodology with Liner Corrosion	3.91E-08	7.6E-03	0.015%

Table 3b, below shows an additional small increase in LERF of 5.46E-10, when increasing the ILRT from a 10 year to a 15 year interval. Thus, Table 2b is modified as follows:

Table 3b

Updated Values Including the Impact of Liner Corrosion (from 10 years to 15 years)

Method	LERF Increase	Person-rem/yr increase	Percentage Increase in Person-rem/yr
CEOG Method	1.35E-09	1.15	0.022%
CEOG Method with Liner Corrosion	1.90E-09	1.24	0.024%
NRC-Approved Method	1.72E-08	0.18	0.010%
NRC-Approved Method with Liner Corrosion	1.78E-08	0.18	0.010%
Adjusted Crystal River Methodology	1.27E-08	2.50E-03	0.005%
Adjusted Crystal River Methodology with Liner Corrosion	1.32E-08	2.56E-03	0.005%

Visual Inspections

The LAR submittal did not fully credit the benefit of the Subsection IWE visual inspections. Visual inspections following the 1996 change in the ASME Code are considered to be more effective in detecting flaws. In addition, the flaws that are of concern for LERF are considerably larger than those associated with 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.

Impact of Improved Visual Inspections

The containment performance data used for both the CEOG method and the NRC-approved method is contained in NUREG-1493. This data is prior to 1994. An amendment to 10 CFR 50.55a became effective on September 9, 1996. This amendment, by endorsing the use of Subsections IWE and IWL of Section XI of the ASME Boiler & Pressure Vessel 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 after September 1996 much more likely than prior to September 1996 using visual inspections.

Visual inspection improvements directly reduce the delta LERF increases as calculated in the CEOG method and NRC-approved method. The first ASME Section XI subsection IWE inspection of the Beaver Valley Unit 2 containment liner was performed in conjunction with the containment structural integrity inspection in the Fall of 2000. The next Unit 2 containment IWE inspection is scheduled for the Fall of 2003.

Table 7 illustrates the benefit of visual inspection improvements on the delta 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 the flaw being not detectable [not-through-wall]), then the increased ILRT LERF frequency could be reduced by 23.5%. See Table 7 for additional sensitivity cases. In all 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	**Base Case** 0.77/0.077	**Base Case** 10%	**Base Case** 100%	**Base Case** 8.85E-10
Doubles every 2 years	Base	Base	Base	9.73E-09
Doubles every 10 years	Base	Base	Base	4.36E-10
Base	Base point 10 times lower (0.16/0.016)	Base	Base	1.79E-10
Base	Base point 10 times higher (3.8/0.38)	Base	Base	4.37E-09
Base	Base	5%	Base	5.31E-10
Base	Base	15%	Base	1.24E-09
Lower Bound				
Doubles every 10 years	Base point 10 times lower (0.16/0.016)	5%	10%	5.29E-12
Upper Bound				
Double every 2 years	Base point 10 times higher (3.8/0.38)	15%	100%	6.73E-08

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	Effectiveness of Visual Inspections	NRC Approved Method without Liner Corrosion Considered Delta LERF	NRC Approved Method with Liner Corrosion Considered Delta LERF	CEOG Method without Liner Corrosion Considered Delta LERF	CEOG Method with Liner Corrosion Considered Delta LERF	Alternate Crystal River Methodology without Liner Corrosion Considered Delta LERF	Alternate Crystal River Methodology with Liner Corrosion Considered Delta LERF
Pre-1996 Inspection Approach (Base Case)	0.00%	5.17E-08	5.25E-08	3.16E-09	4.04E-09	3.82E-08	3.91E-08
Post-1996 with Visual Inspections Perfectly Accurate	85.00%	7.7E-09	7.9E-09	4.7E-10	6.1E-10	5.7E-09	5.9E-09
Post-1996 with Visual Inspections 95% Accurate	80.75%	9.9E-09	1.0E-08	6.1E-10	7.8E-10	7.4E-09	7.5E-09
Post-1996 with Visual Inspections 95% Accurate and 5% chance of Undetectable Leakage	76.50%	1.2E-08	1.2E-08	7.4E-10	9.5E-10	9.0E-09	9.2E-09
Post-1996 with Visual Inspections 80% accurate and a 5% Chance of Undetectable Leakage	63.75%	1.9E-08	1.9E-08	1.1E-09	1.5E-09	1.4E-08	1.4E-08

Conclusion

Considering the benefit of improved visual inspections after September 1996, the increase in risk is less than 1E-7 for LERF. Changes less than 1E-7 are considered small per Regulatory Guide 1.174. The one-time extension of the ILRT interval to 15 years is considered an acceptable risk increase.

References

1. Letter from C. H. Cruse, (CCNPP) to U.S. Nuclear Regulatory Commission Document Control Desk, "Response to Request for Additional Information Concerning the License Amendment Request for a One-Time Integrated Leak Rate Test Extension, Calvert Cliffs Nuclear Power Plant Unit No. 1 Docket No. 50-317, March 27, 2002.

2. WCAP-15691, Revision 4, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," September 2002.

3. Enclosures 4 and 5 of FENOC Letter L-02-106, Beaver Valley Power Station, Unit No.1 and No. 2 License Amendment Request Nos. 299 and 171, dated October 31, 2002, from M. P. Pearson (FENOC) to U.S. Nuclear Regulatory Commission Document Control Desk.