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An Exelon/British Energy Company

10 CFR 50.90

5928-03-20050
March 19, 2003

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

Three Mile Island, Unit 1
Operating License No. DPR-50
NRC Docket No. 50-289

Subject: License Amendment Request No. 318
Integrated Leak Rate Test Deferral
Response to Request for Additional Information

Reference:
1. Letter from M. P. Gallagher (AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission, dated September 30, 2002
2. Letter from T. G. Colburn (U. S. Nuclear Regulatory Commission) to J. L. Skolds (AmerGen Energy Company), dated February 28, 2003

Dear Sir/Madam:

In the Reference 1 letter, AmerGen Energy Company (AmerGen), LLC, submitted License Amendment Request No. 318, in accordance with 10 CFR 50.90, requesting an amendment to the Technical Specifications of Operating License No. DPR-50, for Three Mile Island, Unit 1. This proposed change will revise Technical Specifications (TS) Section 6.8.5 ("Reactor Building Leakage Rate Testing Program") to reflect a one-time deferral of the scheduled performance of the next Type A Containment Integrated Leak Rate Test (ILRT) from October 2003 to no later than September 2008.

In response to our request, AmerGen received the Reference 2 Request for Additional Information. Attached is our response to this request.

Additionally, there are no commitments contained within this letter.

A017

If you have any questions or require additional information, please contact John Hufnagel at (610) 765-5507.

I declare under penalty of perjury that the foregoing is true and correct.

Respectfully,

03-19-03
Executed on

Michael P. Gallagher
Director, Licensing and Regulatory Affairs
AmerGen Energy Company, LLC

Attachments: 1 - Response to Request for Additional Information
2 - Attached Diagrams
3 - Sensitivity Calculation

cc: H. J. Miller, Administrator, Region I, USNRC
USNRC Senior Resident Inspector, TMI
T. Colburn, USNRC Senior Project Manager

ATTACHMENT 1

THREE MILE ISLAND
UNIT 1

Docket No. 50-289

License No. DPR-50

LICENSE AMENDMENT REQUEST NO. 318

Integrated Leak Rate Test Deferral – Response to Request for Additional Information

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Reference: Letter from M. P. Gallagher (AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission, dated September 30, 2002

Question 1:

Please provide specifics on what is the accessible surface of the containment liner that was examined. Sketches or drawings would be helpful.

Response:

As discussed in the Referenced submittal, in accordance with the ASME Boiler and Pressure Vessel Code, Section XI, Exam Category E-A, E1.11, TMI Unit 1 performs a Reactor Building containment liner general visual inspection of 100% of accessible surfaces (done every period). A review of prints and diagrams concludes that approximately 15% to 20% of the liner above the basemat is inaccessible for inspection. These areas include areas covered by concrete (structural members), behind ventilation ducts, covered by polar crane components, behind the elevator shaft, and covered by fuel transfer canal components. These locations would be representative of other locations that were inspected by the general visual inspection, and would not be any more susceptible to degradation than other locations inspected.

Attached to this response are diagrams TMI1-0011, and TMI1-0012, which identify containment liner inaccessible areas.

Question 2:

Please provide specifics on exam results including nondestructive examination exam data (surface and volumetric), trending information on corrosion and wall thickness measurements especially in the area of the moisture barrier interface.

Response:

As discussed in the Referenced submittal, during T1R13 (1999), 100% of the accessible portions of the containment building liner and moisture barrier interface were examined by NDE/ISI personnel in accordance with Section XI, Exam Category E-A, E1.11. Additionally, an augmented exam was conducted in accordance with the ASME Section XI IWE, Exam Category E-C, Item Number E4.12, which requires a volumetric exam each period. This examination identified five (5) areas where coating degradation has resulted in localized liner metal loss of 1/16" at the liner-to-concrete slab and moisture barrier (seal) interface (Elevation 281'). It was determined by Engineering through calculation, that the remaining liner wall thickness would afford the necessary

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

containment membrane/lining to ensure leak tightness. In order to preserve the remaining liner wall thickness, Engineering required coating repairs to be performed during T1R13 (1999), and a supplemental exam (VT-1) of these areas to be performed during T1R14 (2001). The supplemental exam (VT-1) was performed and the five (5) areas were found to be acceptable. As an additional part of the augmented exam, six (6) areas were marked for examination from the 281' elevation inside the Reactor Building. The liner thickness of these six (6) areas was found to be consistent with little to no wall loss.

There was also one (1) area where a round indication 1/16" x 1/16" deep was observed at Elev. 374' in the liner during T1R13 (1999). This indication was not the result of corrosion. It was determined by Engineering through calculation that the remaining liner wall thickness would afford the necessary containment membrane/lining to ensure leak tightness. A supplemental exam (VT-1) of this area was specified for T1R14 (2001 outage). The supplemental exam (VT-1) was performed and the area found to be acceptable.

In summary, the areas which had experienced some wall thinning were identified, analyzed and repaired as necessary to ensure an acceptable containment barrier still exists. Since the areas which had experienced reduced wall thickness due to corrosion have been recoated, and subsequent inspection has shown that the wall thinning has been arrested, no trending is being performed (and none is required).

Question 3:

Please provide any other specific data and supporting information that the licensee may have used to conclude that there is no thinning of the liner and that the concrete interface is intact in all locations.

Response:

As discussed in the Referenced letter, the results of the previous visual and ultrasonic inspections of the liner (including coatings) and moisture barrier, and the results of previous integrated leak rate tests, provide confidence that the concrete liner is intact, and capable of performing its intended safety function. Results of the inspections described in Response 1did not identify any degradation that would result in failure of the primary containment.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Question 4:

Inspections of some reinforced and steel containments (e.g., North Anna, Brunswick, D. C. Cook, and 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 TMI-1 containment include the portion of the steel shell embedded in the basemat and the inaccessible areas between the steel liner and concrete containment. Please provide a quantitative assessment of the impact on large early release frequency (LERF) due to age-related degradation in these areas, in support of the requested ILRT Interval extension from 10 to 15 years.

Response:

Based on the detailed analysis contained in the Attachment 3 report, it has been determined that including the potential for age-related degradation corrosion effects in the ILRT assessment would not alter the conclusions from the original analysis. That is, there is only a minor change in the estimated LERF from extending the interval to 15 years from the original requirement by including the potential corrosion impacts. The potential corrosion impacts increase the estimated delta-LERF from 1.7E-7/yr to 1.9E-7/yr. This is still well below the Regulatory Guide 1.174 acceptance criteria threshold for "small" changes in risk of 1.0E-6, in which case applications will be considered only if it can be reasonably shown that the total LERF is less than 1.0E-05 per reactor year. The small impact on the internal events analysis would also lead to a small change in the external events analysis, such that the total LERF from including the impact of extending the ILRT interval to 15 years from both internal and external events would still be below the acceptance criteria of 1.0E-5/yr. This confirms that the proposed interval extension is acceptable from a risk basis.

Question 5:

Please provide an assessment of the impact of observed liner corrosion/thinning at the moisture barrier on the containment ultimate pressure capacity credited in the Level 2 probability risk assessment (i.e., the probability of containment over-pressure failure as a function of containment pressure). Discuss any relationship between those portions of the liner affected by the observed corrosion, and the most likely containment failure locations according to the ultimate pressure capacity analysis.

Response:

Based on the detailed results to this question contained in the Attachment 3 report (page 12), the conclusions to the ILRT extension assessment would not change.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Question 6:

The September 30, 2002, submittal states that the increase in LERF associated with a change in test frequency from 1 test in 10 years to 1 test in 15 years is 2.6E-7/year when both internal and external events are considered. Please provide the corresponding risk result assuming a change in test frequency from 3 tests in 10 years to 1 test in 15 years.

Response:

As discussed in the detailed response contained in Attachment 3 (page 13), the LERF value including external events from the 3-per-10 year ILRT interval column is 1.56E-07/yr, and the LERF value including external events 1-per-15 year ILRT interval column is 7.82E-07/yr. This leads to a calculated increase in LERF of 6.26E-07/yr. The value of 6.26E-07/yr still falls below the Regulatory Guide 1.174 acceptance criteria for "small" changes in risk of 1.0E-6.

Question 7:

Provide the technical justification for the assumption in the risk analysis that all release categories with fission product scrubbing (according to the general characteristics described in the notes to Table 2-2 in Attachment 4, to the September 30, 2002, application) will leave sufficient scrubbing such that these releases will not contribute to LERF. Include the definition of LERF used for this determination.

Response:

See detailed response in Attachment 3 (page 14).

ATTACHMENT 2

THREE MILE ISLAND
UNIT 1

Docket No. 50-289

License No. DPR-50

Attached Diagrams

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: DWG. NO. TMI1-0011, REV. 1 IWE COMPONENT ROLLOUT INSIDE CONTAINMENT LINER LOOKING OUT 0' TO 180' AZIMUTH WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER: TMI1-0011

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: DWG. NO. TMI1-0012, REV. 1 IWE COMPONENT ROLLOUT INSIDE CONTAINMENT LINER LOOKING OUT 0' TO 180' AZIMUTH WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER: TMI1-0012

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

ATTACHMENT 3

THREE MILE ISLAND
UNIT 1

Docket No. 50-289

License No. DPR-50

"Sensitivity Calculation for the ILRT Extension Risk Assessment in Response to RAI 4, and Response to RAIs 5, 6, and 7"

Three Mile Island Unit 1

SENSITIVITY CALCULATION FOR THE ILRT EXTENSION RISK ASSESSMENT IN RESPONSE TO RAI 4, AND RESPONSE TO RAIs 5, 6, AND 7

P0467030008-2164

Prepared by: Donald E. Vanover Date: 3/13/03

Reviewed by: Date: 3/13/03

Approved by: Date: 3/17/03

Accepted by: Date: 3/17/03

Revisions:

Rev.	Description	Preparer/Date	Reviewer/Date	Approver/Date

Background

A previous analysis [1] was performed to evaluate the risk impact of extending the Integrated Leak Rate Test (ILRT) interval for Three Mile Island Unit 1 (TMI-1). That analysis was performed using the recommended approach developed by NEI [2] for performing assessments of one-time extensions for Containment ILRT surveillance intervals. The increase in LERF due to extending the TMI-1 ILRT interval from 10 to 15 years was estimated in Reference [1] to be 7.1E-8 /yr. This is below the Regulatory Guide 1.174 [3] acceptance criteria for "very small" changes in risk of 1.0E-7. Additionally, the dose increase was estimated to be 8.8E-2 Person-rem /yr, and the conditional containment failure probability increase was estimated to be 0.4%. Both of these increases are also considered to be "very small" although no official acceptance criteria exist for these parameters.

For TMI-1, an additional evaluation of the potential impact on the risk assessment results from external events was performed since the calculated delta-LERF value from extending the ILRT interval from 10 to 15 years was close to 1.0E-7/yr, and since the delta-LERF value, if measured from the original requirement, was determined to be slightly above 1.0E-7/yr (1.7E-7/yr) which falls below the Regulatory Guide 1.174 [3] acceptance criteria for "small" changes in risk of 1.0E-6. In that case, Regulatory Guide 1.174 [3] states that when the calculated increase in LERF is in the range of 1.0E-06/yr to 1.0E-07/yr, applications will be considered only if it can be reasonably shown that the total LERF is less than 1.0E-05 per reactor year. The analysis in Appendix A of Reference [1] conservatively applied the results from the TMI-1 IPEEE to estimate the external events impact, and showed that the delta-LERF was still less than 1.0E-6/yr and that the total LERF from including the impact of extending the ILRT interval to 15 years from both internal and external events is 5.1E-6/yr. This value is below the acceptance criteria of 1.0E-5/yr, which confirmed that the proposed interval extension is acceptable from a risk basis.

Based on the original conservative assessment of the external events impact, that did not change the conclusion that the ILRT interval change is acceptable on a risk basis, the focus of this sensitivity study is limited to the internal events impact. The results of the TMI-1 internal events analysis reported in Reference [1] are summarized in Table 1 for reference purposes. Note that, per the NEI Guidance and the definition of the EPRI categories, only the frequencies of Categories 1, 3a, and 3b are impacted by changes in the ILRT testing frequencies. Additionally, based on discussions with NRC personnel on other ILRT extension submittals, the reported delta-LERF values are measured from the original 3-in-10 year requirement instead of the current 1-in-10 year requirement.

Table 1
TMI-1 ILRT Cases: Base, 3 to 10, and 3 to 15 Yr Extensions

EPRI Class	Base Case 3 Years			Extend to 10 Years (Current TMI-1 Requirement)			Extend to 15 Years		
	CDF/Yr	Per-Rem	Per-Rem/Yr	CDF/Yr	Per-Rem	Per-Rem/Yr	CDF/Yr	Per-Rem	Per-Rem/Yr
1	1.77E-05	4.32E+02	7.63E-03	1.52E-05	4.32E+02	6 56E-03	1.34E-05	4.32E+02	5.79E-03
2	5.35E-08	7.06E+05	3.78E-02	5.35E-08	7.06E+05	3.78E-02	5 35E-08	7.06E+05	3.78E-02
3a-S[1]	5 41E-07	4.21E+03	2.28E-03	1.80E-06	4.21E+03	7.58E-03	2.70E-06	4.21E+03	1.14E-02
3a-U[2]	4.27E-07	8.70E+04	3.71E-02	1.42E-06	8.70E+04	1.24E-01	2.13E-06	8.70E+04	1.86E-01
3b-S[1]	5 41E-08	1.47E+04	7.97E-04	1.80E-07	1.47E+04	2.65E-03	2.70E-07	1.47E+04	3.98E-03
3b-U[2]	4.27E-08	3.04E+05	1.30E-02	1.42E-07	3.04E+05	4.33E-02	2.13E-07	3.04E+05	6.49E-02
4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7	1.86E-05	4.40E+05	8.20E+00	1.86E-05	4.40E+05	8.20E+00	1.86E-05	4.40E+05	8.20E+00
8	2.24E-06	1.18E+06	2.66E+00	2.24E-06	1.18E+06	2.66E+00	2.24E-06	1.18E+06	2.66E+00
Total	3 97E-05		10.95	3.97E-05		11.08	3.97E-05		11.16
ILRT Dose Rate from 3a and 3b			5.32E-02			1.77E-01			2.66E-01
% of Total			0.49%			1.60%			2.38%
Total Delta Dose Rate (3 to 15 yr)									**2.11E-01**
LERF from 3b[3]			4.27E-08			1.42E-07			2.13E-07
Delta LERF (3 to 15 yr)									**1.71E-07**
CCFP %			53.04%			53.61%			54.02%
Delta CCFP % (3 to 15 yr)									**0.98%**

[1] This represents the portion of the release category that would be scrubbed (-S) due to the availability and use of containment sprays, and utilizes person-rem results from the TMI-specific MACCS2 calculations consistent with that assumption.

[2] This represents the portion of the release category that would be un-scrubbed (-U), and utilizes person-rem results from the TMI-specific MACCS2 calculations consistent with that assumption.

[3] As described in Reference [1], only the un-scrubbed portion of Release Category 3b represents a potential LERF contributor.

Recently, the NRC issued a series of Requests for Additional Information (RAIs) in response to the one-time relief request for the ILRT surveillance interval. The RAI for TMI-1 related to the risk assessment is provided below.

Request for Additional Information No. 4:

Inspections of some reinforced and steel containments (e.g., North Anna, Brunswick, D. C. Cook and 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 TMI containment include the portion of the steel shell embedded in the basemat and the inaccessible areas between the steel liner and concrete containment. Please provide a quantitative assessment of the impact on LERF due to age related degradation in these areas, in support of the requested ILRT interval extension from 10 to 15 years.

The analysis that follows addresses the risk assessment portion of this RAI. The responses to RAIs 5, 6, and 7 are included following the analysis.

Discussion of Industry Events and Their Relationship to TMI-1

As noted above, industry incidents have been identified that relate to this issue. This section summarizes the applicability of the known events and issues as they relate to TMI-1.

- North Anna 2 (wood/lumber left in concrete in contact with steel liner) and Brunswick 2 (glove left in concrete in contact with steel liner) incidents

  TMI-1 Response – These events could be applicable to the TMI-1 containment design as well.

- D.C. Cook 2 incident (LER indicates that a hole in containment was a result of an inadequate repair to the steel liner. It was identified during containment inspections and repaired.)

  TMI-1 Response - This represents a workmanship issue, not degradation.

- Oyster Creek incident (significant corrosion in the sand cushion region)

  TMI-1 Response – TMI does not have a liner that sits up against a sand cushion, therefore it would not be susceptible to the same corrosion process due to the trapped moisture in the sand causing corrosion on the liner.

- Catawba/McGuire incident (Corrosion at ice condenser and 2 inch floor gap filled with cork)

  TMI-1 Response – TMI-1 does not have an ice condenser or a two inch floor gap filled with cork)

Age Related Degradation Analysis

The analysis utilizes a similar approach to that outlined in the Calvert Cliffs assessment [4] to estimate the likelihood and risk-implication of degradation-induced leakage occurring undetected in containment visual examinations during the extended test interval. Similar to Calvert Cliffs, the TMI-1 containment structure consists of a post-tensioned reinforced concrete cylinder and spherical dome. A massive reinforced concrete slab supports the cylinder, and the interior surfaces are completely lined with welded steel plate to form a leak tight membrane.

Each of the analysis steps is described below with their relationship to the Calvert Cliffs analysis noted where applicable.

The following approach is used to determine the change in likelihood, due to extending the ILRT, of detecting corrosion of the containment steel shell. This likelihood is then used to determine the resulting change in risk. Consistent with the Calvert Cliffs analysis, the following issues are addressed:

- Differences between the containment floor and other regions of containment;
- The historical steel shell flaw likelihood due to concealed corrosion;
- The impact of aging;
- The corrosion leakage dependency on containment pressure; and
- The likelihood that visual inspections will be effective at detecting a flaw.

<u>Assumptions</u>

A. The Oyster Creek incident is assumed to be not applicable to TMI-1 for a concealed shell failure in the floor. (See Table 2, Step 1.) Consistent with the Calvert Cliffs analysis, no applicable events were identified and 0.5 failures are assumed. Assuming 0.5 failures when 0 failures have occurred is a typical PRA approach.

B. The two events used to estimate the wall liner flaw probability in the Calvert Cliffs analysis (i.e., North Anna 2 and Brunswick 2) are also assumed to be applicable to TMI-1.

C. For consistency with the Calvert Cliffs analysis, the estimated historical flaw probability is calculated using a 5.5 year data period to reflect the years since September 1996 when 10 CFR 50.55a started requiring 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 have been performed since the time frame of the Calvert Cliffs analysis), and there is no evidence that additional corrosion issues were identified. (See Table 2, Step 1.)

D. Consistent with the Calvert analysis, the corrosion-induced flaw likelihood is assumed to double every five years. This is based solely on judgment and is included in this analysis to address the increase in likelihood of corrosion as the steel shell ages. Sensitivity studies are included that address doubling this rate every 10 years and every two years. (See Table 2, Steps 2 and 3.)

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 at TMI-1. 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. In the Calvert Cliffs analysis, estimates of the likelihood of the containment atmosphere reaching the environment were made based on comparing the ILRT test pressure to the containment fragility curve. This resulted in a 1.1% base case probability that an undetected flaw in the wall liner would lead to leakage to the atmosphere. For this analysis, it is noted that the TMI-1 best estimate minimum capacity of the building (136.8 psig) and the ILRT test pressure of 50.6 psig are both comparable to the Calvert Cliffs' values, and a conservative 10% likelihood of failure is used for the base case analysis for TMI-1. Sensitivity evaluations for this assumption are also explored (See Table 4 for sensitivity studies).

F. Consistent with the Calvert Cliffs analysis, 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. Consistent with the Calvert analysis, a 5% visual inspection detection failure likelihood given the flaw is visible and a 5% likelihood of a non-detectable flaw is used. Therefore, a total undetected flaw probability of 10% is assumed in the base case analysis. (See Table 2, Step 5.) Sensitivity studies are included that evaluate total detection failure likelihood of 5% and 15%, respectively. (See Table 4 for sensitivity studies.) Additionally, it should be noted that to date, all liner corrosion events have been detected through visual inspection and repaired.

Analysis

Table 2
TMI-1 Age Related Degradation Analysis Steps

<table>
<tr><th>Step</th><th>Description</th><th colspan="2">Containment Walls</th><th colspan="2">Containment Floor</th></tr>
<tr><td>1</td><td>Historical Steel Liner Flaw Likelihood

Failure Data: Containment location specific (applicable events and derived failure values are consistent with Calvert Cliffs analysis)</td><td colspan="2">Events: 2
(4 industry events, North Anna and Brunswick events assumed applicable to TMI-1)
2/(70 * 5.5) = 5.2E-3
(Based on 70 units with liners over 5.5 years)</td><td colspan="2">Events: 0
(1 industry event at Oyster Creek assumed not applicable to TMI-1, assume 0.5 failures)
0.5/(70 * 5.5) = 1.3E-3
(Based on 70 units with liners over 5.5 years)</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Age Adjusted Steel Liner Flaw Likelihood
During 15-year interval, assume flaw likelihood doubles every five years (14.9% increase per year). The average for 5th to 10th year is set to the historical failure rate (consistent with Calvert Cliffs analysis).</td><td>Year

1
avg 5-10
15</td><td>Flaw Likelihood
2.1E-3
5.2E-3
1.4E-2</td><td>Year

1
avg 5-10
15</td><td>Flaw Likelihood
5.0E-4
1.3E-3
3.5E-3</td></tr>
<tr><td colspan="2">15 year average =
6.27E-3</td><td colspan="2">15 year average =
1.57E-3</td></tr>
</table>

Table 2
TMI-1 Age Related Degradation Analysis Steps

Step	Description	Containment Walls	Containment Floor
3	**Flaw Likelihood at 3, 10, and 15 years** Cumulative age adjusted liner flaw likelihood (Step 2), assuming failure rate doubles every five years (consistent with Calvert Cliffs analysis – See Table 6 of Reference [4]), for the 3 year, 10 year, and 15 year points in time.	**7.10E-3 (at 3 years)** **4.06E-2 (at 10 years)** **9.40E-2 (at 15 years)** (Note that the Calvert analysis presents the delta between 3 and 15 years of 8.7% to utilize in the estimation of the delta-LERF value. For this analysis, however, the values are calculated based on the 3, 10, and 15 year intervals consistent with the original evaluation shown in Table 1, and then the delta-LERF values are determined from there.)	**1.78E-3 (at 3 years)** **1.02E-2 (at 10 years)** **2.35E-2 (at 15 years)** (Note that the Calvert analysis presents the delta between 3 and 15 years of 2.2% to utilize in the estimation of the delta-LERF value. For this analysis, however, the values are calculated based on the 3, 10, and 15 year intervals consistent with the original evaluation shown in Table 1, and then the delta-LERF values are determined from there.)
4	**Likelihood of Breach in Containment Given Liner Flaw** Assume that a flaw in the wall leads to containment failure during the severe accident progression 10% of the time (compared to 1.1% in the Calvert Cliffs analysis). The floor failure probability is assumed to be 1% (compared to 0.11% in the Calvert analysis).	**10%** (Assume that all breaches will result in EPRI Release Class 3b given an applicable core damage event.)	**1%** (Assume that all breaches will result in EPRI Release Class 3b given an applicable core damage event.)

Table 2
TMI-1 Age Related Degradation Analysis Steps

Step	Description	Containment Walls	Containment Floor
5	**Visual Inspection Detection Failure Likelihood** Utilize assumptions consistent with Calvert Cliffs analysis.	**10%** 5% failure to identify visible flaws plus 5% likelihood that the flaw is not visible (not through-wall but could be detected by ILRT) All industry 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 Corrosion-Induced Containment Leakage** (Steps 3 * 4* 5)	**7.10E-5 (at 3 years)** 7.10E-3 * 10% * 10% **4.06E-4 (at 10 years)** 4.06E-2 * 10% * 10% **9.40E-4 (at 15 years)** 9.40E-2 * 10% * 10%	**1.78E-5 (at 3 years)** 1.78E-3 * 1% * 100% **1.02E-4 (at 10 years)** 1.02E-2 * 1% * 100% **2.35E-4 (at 15 years)** 2.35E-2 * 1% * 100%

The total likelihood of the corrosion-induced, non-detected containment leakage is the sum of Step 6 for the containment walls and the containment floor as summarized below.

<u>Cumulative Likelihood of Non-Detected Containment Leakage due to Corrosion</u>

At 3 years: 7.10E-5 + 1.78E-5 = 8.88E-5
At 10 years: 4.06E-4 + 1.02E-4 = 5.08E-4
At 15 years: 9.40E-4 + 2.35E-4 = 1.18E-3

Table 3 then shows the results of the updated ILRT assessment including the potential impact from non-detected containment leakage scenarios assuming that all of the candidate sequences result in EPRI Class 3b. Note that the impact of including the potential for corrosion-induced leakages compared to the original analysis [1] results are noted in parenthesis.

As discussed previously, the calculated factors shown above are applied to the applicable scrubbed and un-scrubbed candidate core damage accidents. For example, the base case Class 3b frequencies (including the potential of non-detected liner flaws leading to containment leakage) is calculated as follows:

- Per Table 1, the EPRI Class 3b-scrubbed frequency for the 3-year base case is 5.41E-8/yr, and the 3b-unscrubbed frequency is 4.27E-8/yr.

- As shown in Reference [1], the TMI-1 CDF associated with candidate accidents that are scrubbed is 2.00E-05/yr, and the CDF associated with the candidate accidents that are un-scrubbed is 1.58E-5/yr.

- The increase in the Base Case Class 3b-scrubbed frequency due to the concealed flaw corrosion issue is calculated as 2.00E-5/yr * 8.88E-5 = 1.78E-9/yr, where 8.88E-5 was previously shown to be the cumulative likelihood of non-detected containment leakage due to corrosion at 3 years. Similarly, the 3b-unscrubbed frequency due to the concealed flaw issue is calculated as 1.58E-5/yr * 8.88E-5 = 1.40E-9/yr.

- The Base Case Class 3b-scrubbed frequency including the concealed flaw age degradation corrosion issue is then calculated as 5.41E-8/yr + 1.78E-9/yr = 5.59E-8/yr, and the 3b-unscrubbed frequency is 4.27E-8/yr + 1.40E-9/yr = 4.41E-8/yr.

Table 3
Final Results Including Age Related Degradation Analysis
TMI-1 ILRT Cases: Base, 3 to 10, and 3 to 15 Yr Extensions

EPRI Class	Base Case 3 Years			Extend to 10 Years (Current TMI-1 Requirement)			Extend to 15 Years		
	CDF/Yr	Per-Rem	Per-Rem/Yr	CDF/Yr	Per-Rem	Per-Rem/Yr	CDF/Yr	Per-Rem	Per-Rem/Yr
1	*1.77E-05*	*4.32E+02*	*7.63E-03*	*1.52E-05*	*4.32E+02*	*6.55E-03*	*1.34E-05*	*4.32E+02*	*5.77E-03*
2	5.35E-08	7.06E+05	3.78E-02	5.35E-08	7.06E+05	3.78E-02	5.35E-08	7.06E+05	3.78E-02
3a-S[1]	*5.41E-07*	*4.21E+03*	*2.28E-03*	*1.80E-06*	*4.21E+03*	*7.58E-03*	*2.70E-06*	*4.21E+03*	*1.14E-02*
3a-U[2]	*4.27E-07*	*8 70E+04*	*3.71E-02*	*1.42E-06*	*8.70E+04*	*1.24E-01*	*2.13E-06*	*8.70E+04*	*1.86E-01*
3b-S[1]	*5.59E-08*	*1.47E+04*	*8.23E-04*	*1.90E-07*	*1.47E+04*	*2.81E-03*	*2.94E-07*	*1.47E+04*	*4.33E-03*
3b-U[2]	*4.41E-08*	*3.04E+05*	*1.34E-02*	*1.50E-07*	*3 04E+05*	*4.57E-02*	*2.32E-07*	*3 04E+05*	*7.06E-02*
4	n/a	n/a	n/a	N/a	n/a	n/a	n/a	n/a	n/a
5	n/a	n/a	n/a	N/a	n/a	n/a	n/a	n/a	n/a
6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7	1.86E-05	4.40E+05	8.20E+00	1.86E-05	4.40E+05	8.20E+00	1.86E-05	4.40E+05	8.20E+00
8	2.24E-06	1.18E+06	2.66E+00	2.24E-06	1.18E+06	2.66E+00	2.24E-06	1.18E+06	2.66E+00
Total	3.97E-05		10.95	3.97E-05		11.08	3.97E-05		11.17
ILRT Dose Rate from 3a and 3b			5 36E-02 (+4.5E-04)			1.80E-01 (+2.6E-03)			2.72E-01 (+6.0E-03)
% of Total			0.49% (+0.004%)			1.62% (+0.02%)			2.43% (+0.05%)
Total Delta Dose Rate (3 to 15 yr)									**2.16E-01 (+5.5E-03)**
LERF from 3b[3]			4.41E-08 (+1.4E-9)			1.50E-07 (+8.0E-9)			2.32E-07 (+1.9E-08)
Delta LERF (3 to 15 yr)									**1.88E-07 (+1.7E-08)**
CCFP %			53 05% (+0.01%)			53.65% (+0.05%)			54.12% (+0.10%)
Delta CCFP % (3 to 15 yr)									**1.07% (+0.09%)**

[1] This represents the portion of the release category that would be scrubbed (-S) due to the availability and use of containment sprays, and utilizes person-rem results from the TMI-specific MACCS2 calculations consistent with that assumption.

[2] This represents the portion of the release category that would be un-scrubbed (-U), and utilizes person-rem results from the TMI-specific MACCS2 calculations consistent with that assumption.

[3] As described in Reference [1], only the un-scrubbed portion of Release Category 3b represents a potential LERF contributor.

Based on the results in Table 3, it can be seen that including the potential for age-related degradation corrosion effects in the ILRT assessment would not alter the conclusions from the original analysis. That is, there is only a minor change in the estimated LERF from extending the interval to 15 years from the original requirement by including the potential corrosion impacts. The potential corrosion impacts increase the estimated delta-LERF from 1.7E-7/yr to 1.9E-7/yr. This is still well below the Regulatory Guide 1.174 [3] acceptance criteria threshold for "small" changes in risk of 1.0E-6, in which case applications will be considered only if it can be reasonably shown that the total LERF is less than 1.0E-05 per reactor year. The small impact on the internal events analysis would also lead to a small change in the external events analysis, such that the total LERF from including the impact of extending the ILRT interval to 15 years from both internal and external events would still be below the acceptance criteria of 1.0E-5/yr. This confirms that the proposed interval extension is acceptable from a risk basis.

Sensitivity Studies

Additional sensitivity cases were also developed to gain an understanding of the sensitivity of this analysis to the various key parameters. These results are summarized in Table 4.

Table 4
Concealed Flaw Age Related Degradation Corrosion Sensitivity Cases

Age (Step 2)	**Containment Breach (Step 4)**	**Visual Inspection & Non-Visual Flaws (Step 5)**	**Likelihood Flaw is EPRI Class 3b**	**LERF Increase From Corrosion (3 to 15 years)**	**Total LERF Increase From ILRT Extension (3 to 15 years)**
Base Case Doubles every 5 yrs	**Base Case** (10% Wall, 1% Floor)	**Base Case** 10%	**Base Case** 100%	**Base Case** 1.72E-08	**Base Case** 1.88E-07
Doubles every 2 yrs	Base	Base	Base	3.92E-08	2.10E-07
Doubles every 10 yrs	Base	Base	Base	1.45E-08	1.85E-07
Base	*(100% Wall, 10% Floor)*	Base	Base	1.72E-07	3.42E-07
Base	*(1% Wall, 0.1% Floor)*	Base	Base	1.72E-09	1.72E-07
Base	Base	*15%*	Base	2.40E-08	1.95E-07
Base	Base	*5%*	Base	1.03E-08	1.81E-07
Lower Bound					
Doubles every 10 yrs	(1% Wall, 0.1% Floor)	5%	Base	8.68E-10	1.72E-07
Upper Bound					
Doubles every 2 yrs	(100% Wall, 10% Floor)	15%	Base	5.49E-07	7.20E-07

Response to RAIs 5, 6, and 7

Additional RAIs were also received from the NRC regarding the initial risk assessment. Responses to those additional RAIs are also included here.

> Request for Additional Information No. 5:
>
> Please provide an assessment of the impact of observed liner corrosion/thinning at the moisture barrier on the containment ultimate pressure capacity credited in the Level 2 probabilistic risk assessment (i.e., the probability of containment over-pressure failure as a function of containment pressure). Discuss any relationship between those portions of the liner affected by the observed corrosion, and the most likely containment failure locations according to the ultimate pressure capacity analysis.

Response to RAI No. 5

The TMI-1 containment structure consists of a post-tensioned reinforced concrete cylinder and spherical dome. A massive reinforced concrete slab supports the cylinder, and the interior surfaces are completely lined with welded steel plate to form a leak tight membrane. The liner is 1/4" thick at the base, and is 3/8" thick in the cylinder and dome regions.

In the Level 2 probabilistic risk assessment for TMI-1, the ultimate containment pressure capacity analysis [5] is based on a thorough and detailed comparison of the TMI-1 containment structure with the Oconee containment structure, and evaluates the ultimate capacity of the TMI-1 containment relative to Oconee. Based on that comparison, the Oconee fragility curves were deemed appropriate for use directly in the Level 2 analysis to evaluate the TMI-1 containment capacity and probability of failure.

In the ultimate containment pressure analysis, the determining failure mechanism is yielding in the hoop post tensioning tendons in the middle of the cylinder walls. As part of that analysis, it was determined that the strains on the liner itself would be minimal and that the liner would function elasto-plastically as a membrane during containment overpressure events. As such, the liner at TMI-1 does not play a critical role in determining the ultimate containment pressure capacity. Additionally, the observed locations for corrosion and thinning of the liner (i.e., at the 281' floor elevation) are not located near the most likely failure location in the middle of the cylinder wall.

In summary, The TMI-1 liner does not directly contribute to the ultimate containment capacity. However, it does help to provide a leak tight barrier during containment overpressure events. As stated in the analysis in response to RAI No. 4, even without the liner, the containment is an excellent barrier at TMI-1. But as the pressure in containment increases, cracks will form in the concrete. 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. In the Calvert Cliffs analysis [4], estimates of the likelihood of the containment atmosphere reaching the environment were made based on comparing the ILRT test pressure to the containment fragility curve. This resulted in a 1.1% base case probability that an undetected flaw in the wall liner would lead to leakage to the atmosphere. For the analysis for TMI-1 in response to RAI No. 4, it was found that the conclusions for the ILRT extension assessment would not change even with a very conservative base case assumption that liner flaws would lead to containment breach 10% of the time.

> Request for Additional Information No. 6:
> The September 30, 2002 submittal states that the increase in LERF associated with a change in test frequency from 1 test in 10 years to 1 test in 15 years is 2.6E-7/year when both internal and external events are considered. Please provide the corresponding risk results assuming a change in test frequency from 3 tests in 10 years to 1 test in 15 years.

Response to RAI No. 6

From Table A-7 of the September 30, 2002 submittal, the increase in LERF from changing the test frequency from 3 tests in 10 years to 1 test in 15 years can be obtained by comparing the Release Category 3b (unscrubbed) values in the 3-per-10 year ILRT interval column to the 1-per-15 year ILRT interval column. As such, the LERF value including external events from the 3-per-10 year ILRT interval column is 1.56E-07/yr, and the LERF value including external events 1-per-15 year ILRT interval column is 7.82E-07/yr. This leads to a calculated increase in LERF of 6.26E-07/yr.

The value of 6.26E-07/yr still falls below the Regulatory Guide 1.174 [3] acceptance criteria for "small" changes in risk of 1.0E-6. In that case, Regulatory Guide 1.174 [3] states that when the calculated increase in LERF is in the range of 1.0E-06/yr to 1.0E-07/yr, applications will be considered only if it can be reasonably shown that the total

LERF is less than 1.0E-05 per reactor year. The analysis in Appendix A of Reference [1] conservatively applied the results from the TMI-1 IPEEE to estimate the external events impact, and showed that the delta-LERF was still less than 1.0E-6/yr and that the total LERF from including the impact of extending the ILRT interval to 15 years from both internal and external events is 5.1E-6/yr. This value is below the acceptance criteria of 1.0E-5/yr, which confirmed that the proposed interval extension is acceptable from a risk basis.

> Request for Additional Information No. 7:
> Provide the technical justification for the assumption in the risk analysis that all release categories with fission product scrubbing (according to the general characteristics described in the notes to Table 2-2 in Attachment 4 to the September 30, 2002 application) will leave sufficient scrubbing such that the releases will not contribute to LERF. Include the definition of LERF used for this determination.

Response to RAI No. 7

The TMI-1 LERF contribution has historically been determined from the sum of Release Categories RC102, RC104, RC202, RC204, RC302, RC304, RC305, RC306, RC402, RC404, RC406, RC408, RC501, and RC502. These release categories represent unscrubbed SGTRs, interfacing system LOCAs, containment isolation failures, and early containment overpressure failures, and have been considered as potential LERF contributors for TMI-1 analyses in the past based on generally accepted qualitative considerations. This was the assumption that was used in the analysis performed for ILRT interval extension.

In the revised Level 3 analysis for TMI-1 [6] developed for use in the ILRT extension assessment, if alternative LERF criteria were utilized (such as more than 1 calculated early fatality from the MACCS2 analysis), then the LERF contributions would be limited to the RC200 and RC300 series release categories. If this assumption were utilized instead of the historical TMI-1 LERF release category assumptions, then RC203 would have been added to the total reported LERF, but RC102, RC104, RC404, RC501, and RC502 would not have been considered as LERF scenarios (excluding the zero frequency release categories). This would have resulted in a net decrease in the total calculated reported LERF in the ILRT analysis, and the conclusions would not have changed.

As far as the delta-LERF reported in the ILRT extension assessment, Release Category 3b (unscrubbed) is conservatively characterized as a LERF scenario even though the calculated person-rem is an order of magnitude below the calculated person-rem for the RC200 and RC300 series results. As such, it is highly unlikely that the entire spectrum of scenarios defined by Release Category 3b (unscrubbed) would lead to an early fatality, and as such, its characterization as a LERF scenario is also conservative. Even with this conservatism, the analysis presented for the ILRT interval extension assessment provides a bounding analysis consistent with the NEI Guidance methodology [2] that shows that the proposed ILRT interval extension has a minimal impact on plant risk.

Summary and Conclusions

This analysis provides a sensitivity evaluation of considering potential corrosion impacts within the framework of the ILRT interval extension risk assessment. The analysis confirms that the ILRT interval extension has a minimal impact on plant risk. Additionally, a series of parametric sensitivity studies regarding the potential age related corrosion effects on the steel liner also indicate that even with very conservative assumptions, the conclusions from the original analysis would not change. That is, the ILRT interval extension is judged to have a minimal impact on plant risk and is therefore acceptable.

References

[1] *Risk Assessment for TMI Unit 1 to Support ILRT (Type A) Interval Extension Request*, ERIN Report No. P0467020022-2011, July 2002.

[2] *Interim Guidance for Performing Risk Impact Assessments In Support of One-Time Extensions for Containment Integrated Leakage Rate Test Intervals,* Developed for NEI by John M. Gisclon, EPRI Consultant, William Parkinson and Ken Canavan, Data Systems and Solutions, November 2001.

[3] *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,* Regulatory Guide 1.174, July 1998.

[4] *Response to Request for Additional Information Concerning the License Amendment Request for a One-Time Integrated Leakage Rate Test Extension,* Letter from Mr. C. H. Cruse (Calvert Cliffs Nuclear Power Plant) to NRC Document Control Desk, March 27, 2002.

[5] *TMI-1 Containment Capacity, Duke Power Company Oconee Nuclear Station Comparison*, Duke Engineering and Services, Inc., April 15, 1992.

[6] Vanover, D.E., "Use of Generic B&W Owners Group Level 3 PRA Results for Three Mile Island Unit 1 in the ILRT Extension Risk Assessment", TMI Calculation No. C-110-900-E-220-178, Rev. 0, June 2002.