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DEC 0 5 2001

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station OP1-17
Washington, DC 20555

SUSQUEHANNA STEAM ELECTRIC STATION
SUPPLEMENT NO. 3 TO PROPOSED AMENDMENT NO. 241 TO LICENSE NPF-14 AND PROPOSED AMENDMENT NO. 206 TO LICENSE NPF-22: REQUEST FOR A ONE TIME DEFERRAL OF THE TYPE A CONTAINMENT INTEGRATED LEAK RATE TEST (ILRT) AND THE DRYWELL-TO-SUPPRESSION CHAMBER BYPASS LEAKAGE TEST SR 3.6.1.1.2
PLA-5408

Docket No. 50-387
and 50-388

Reference:
1. *PLA-5342, G. T. Jones (PPL) to USNRC, "Proposed Amendment No. 241 to License NPF-14 and Proposed Amendment No. 206 to License NPF-22: Request for a One Time Deferral of the Type A Containment Integrated Leak Rate Test (ILRT)," dated July 30, 2001.*
2. *PLA-5361, R. G. Byram (PPL) to USNRC, "Supplement to Proposed Amendment No 241 to License NPF-14 and Proposed Amendment No. 206 to License NPF-22: Request for a One Time Deferral of the Type A Containment Integrated Leak Rate Test (ILRT)," dated September 7, 2001.*
3. *Letter, R. G. Schaaf (USNRC) to R. G. Byram (PPL), "Susquehanna Steam Electric Station, Units 1 and 2 - Request for Additional Information Re: Deferral of Containment Integrated Leak Rate Testing (TAC Nos. MB2894 and MB2895)," dated October 5, 2001.*
4. *PLA-5380, R. G. Byram (PPL) to USNRC, "Supplement No. 2 to Proposed Amendment No. 241 to License NPF-14 and Proposed Amendment No. 206 to License NPF-22: Request for a One Time Deferral of the Type A Containment Integrated Leak Rate Test (ILRT)," dated October 16, 2001.*

The purpose of this letter is to support the NRC's continuing review of our requests for one time deferral of the Type A Containment Integrated Leak Rate Test (ILRT) and the Drywell-To-Suppression Chamber Bypass Leakage Test SR 3.6.1.1.2.

A017

Rec'd 12/19/01

On July 30, 2001, PPL Susquehanna, LLC (PPL) proposed revisions to the Susquehanna Steam Electric Station Units 1 and 2 Technical Specifications for NRC review. The revisions, if approved, would allow a one time deferral of the Type A Containment Integrated Leakage Rate Test (ILRT).

The PPL submittal (Reference 1) included a commitment to provide a risk assessment of the proposed action, which was forward to the NRC on September 7, 2001 (Reference 2). The NRC subsequently issued a request for additional information on October 5, 2001 (Reference 3), to which PPL responded in a letter dated October 16, 2001 (Reference 4).

The need for further information was identified during teleconferences between NRC and PPL on November 14, 25, and 26, 2001. This letter provides that information, which is contained in Attachment 1. To facilitate NRC review of our responses to Questions 2 and 3, PPL is forwarding a revision to the previously submitted risk assessment (Reference 2). PPL calculation EC-RISK-1081, Revision 1 is contained in Attachment 2.

Relative to the Type A test, the risk assessment concludes:

- The change in Type A test frequency from once-per-10 years to once-per-15 years increases the risk of those associated specific accident sequences by 0.3%. The risk impact on the total integrated plant risk for those accident sequences influenced by Type A testing is 0.02%. Therefore, the risk impact of the proposed change is negligible.

- Regulatory Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Regulatory Guide 1.174 defines very small changes in risk as increases in core damage frequency (CDF) below 1E-6/year and increases in Large Early Release Frequency (LERF) below 1E-7/year. Since the ILRT does not impact CDF, the relevant criterion is LERF. The increase in LERF resulting from a change in the Type A ILRT test interval from once-per-10 years to once-per-15 years is 3.93E-10/year. Because guidance in Regulatory Guide 1.174 defines very small changes in LERF as below 1E-07/year, increasing the ILRT interval from 10 to 15 years is not considered risk significant.

Relative to the drywell-to-suppression chamber bypass test (Reference Technical Specification SR 3.6.1.1.2), the risk assessment concludes:

- The risk increase on the total integrated plant risk by extending performance of the test from 10 years to 15 years is 0.04%. The increase in LERF is 7E-11/year. Based on the 1E-07/year threshold in Regulatory Guide 1.174, this is not considered risk significant.

Finally, Attachment 3 to this letter provides an updated No Significant Hazards Consideration (NSHC) Evaluation that reflects consideration of the supplemental information provided in this response. There is no effect on the previous determination that this revision does not:

- Involve a significant increase in the probability of occurrence or consequences of an accident previously evaluated;
- Create the possibility of a new or different kind of accident from any accident previously analyzed; or
- Involve a significant reduction in a margin of safety.

If you have any questions on this submittal, please contact Mr. M. H. Crowthers at (610) 774-7766.

Sincerely,

R. G. Byram

Attachments (3)

copy: NRC Region I
Mr. S. L. Hansell, NRC Sr. Resident Inspector
Mr. D. S. Collins, NRC Project Manager

BEFORE THE
UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of :

PPL Susquehanna, LLC: Docket No. 50-387

SUPPLEMENT NO. 3 TO PROPOSED AMENDMENT NO. 241
TO LICENSE NPF-14: ONE TIME DEFERRAL OF THE CONTAINMENT
INTEGRATED LEAK RATE TEST (ILRT) AND THE
DRYWELL-TO-SUPPRESSION
CHAMBER BYPASS LEAKAGE TEST SR 3.6.1.1.2
UNIT NO. 1

Licensee, PPL Susquehanna, LLC, hereby files supplement No. 3 to Proposed Amendment No. 241 in support of a revision to its Facility Operating License No. NPF-14 dated July 17, 1982.

This amendment involves a revision to the Susquehanna SES Unit 1 Technical Specifications.

PPL Susquehanna, LLC
By:

R. G. Byram
Sr. Vice-President and Chief Nuclear Officer

Sworn to and subscribed before me
this 5th day of December, 2001.

Notary Public

Notarial Seal
Nancy J. Lannen, Notary Public
Allentown, Lehigh County
My Commission Expires June 14, 2004

BEFORE THE
UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of :

PPL Susquehanna, LLC : Docket No. 50-388

SUPPLEMENT NO. 3 TO PROPOSED AMENDMENT NO. 206 TO LICENSE NPF-22: ONE TIME DEFERRAL OF THE CONTAINMENT INTEGRATED LEAK RATE TEST (ILRT) AND THE DRYWELL-TO-SUPPRESSION CHAMBER BYPASS LEAKAGE TEST SR 3.6.1.1.2 UNIT NO. 2

Licensee, PPL Susquehanna, LLC, hereby files supplement No. 3 to Proposed Amendment No. 206 in support of a revision to its Facility Operating License No. NPF-22 dated March 23, 1984.

This amendment involves a revision to the Susquehanna SES Unit 2 Technical Specifications.

PPL Susquehanna, LLC
By:

R. G. Byram
Sr. Vice-President and Chief Nuclear Officer

Sworn to and subscribed before me
this 5th day of December 2001.

Nancy J. Lannen
Notary Public

Notarial Seal
Nancy J. Lannen, Notary Public
Allentown, Lehigh County
My Commission Expires June 14, 2004

Attachment 1 to PLA-5408

Supplemental Information

SUPPLEMENTAL INFORMATION

The questions resulting from the November 14, 25, and 26, 2001 teleconferences and PPL's responses to each are provided below.

Question 1:

In response to NRC's Q3, you describe the SSES procedure for scheduling Type B tests. These tests are conducted to verify the adequacy of the associated seals, gaskets, and bolts. Because Type B test acceptance criteria allow a certain amount of leakage, some of the degradations of seals and gaskets, and flaws or corrosion of the bolts might not be detected. In addition, the Type B test frequency of certain penetrations could be as long as 10 years. Discuss how frequently ISI will be performed for these pressure-retaining components and why this frequency is adequate to ensure the integrity of seals, gaskets, and bolts?

PPL Response:

There is no separately scheduled ISI on any seal, gasket, or bolting component that is Type B tested per Appendix J of 10 CFR 50. Type B testing is performed on 16 O-rings, 35 electrical & instrumentation penetrations, and the airlock. Our testing strategy is adequate because the historical leakage rate for Type B penetrations (except the airlock) is close to zero. The administrative leakage limits for Type B tests are 0.5 standard liters per minute (SLM) except for the airlock, which has a separate Technical Specification limit of 16 SLM. The 0.5 SLM value is very small when compared to the leakage limit for primary containment of 1.0 La which is equivalent to 318 SLM. If the Type B rate exceeds the administrative limit during testing, the penetration will be repaired. Post maintenance testing is the Type B test. Though the test frequency can be as long as 10 years, should the penetration be disturbed for any reason, the Type B test is required to assure proper restoration. For example, the hatches used for access to primary containment are opened during outages. After the hatch is closed, the Type B test is conducted to assure that leakage is less than the administrative limit.

The PPL Appendix J program trends the data to allow identification of minor degradation before failure of any penetration occurs. PPL has 35 reactor years of combined operating experience under our Appendix J program.

Question 2:

In response to Q5, you discussed Class 3b sequences, where the maximum containment leakage rate is 35 La. For SSES, this would be approximately equivalent to a 1.0-inch-diameter hole through the containment liner. The corroded areas found recently in a BWR Mark I and a PWR dry containment were larger than this consideration. It is the inclusion of Class 7 sequences that would be applicable for the purpose. Based on their IPE, other licensees have considered containment failure probabilities under various pressure scenarios through their containment fragility calculations and included these probabilities in their risk consequence calculations related to their ILRT frequency extension request. Please provide a similar justification or discuss why such considerations are not necessary for, or applicable to, your ILRT frequency extension request.

PPL Response:

Attachment 2 to this correspondence contains a revised PPL analysis EC-RISK-1081. Appendix E of EC-RISK-1081 contains a containment fragility calculation.

The Appendix assumes in the Class 7 sequences, the possibility that the SSES containment liner is in a weakened condition and that this weakened condition is not detectable due to concealed corrosion. As a result of this assumption, the pressure at which this liner is assumed to fail is adjusted.

The analysis concludes that the total integrated plant risk due to corrosion of the containment liner from the concealed surface is 0.09%. There is no increase in LERF. Per RG 1.174 criteria, these results are not significant.

Question 3:

The SSES Drywell – Suppression Chamber Bypass Test is currently scheduled with the Type A test. Provide justification for extending this test to 15 years also.

PPL Response:

Appendix D of EC-RISK-1081 contained in Attachment 2 contains the justification. The analysis concludes that the increase in risk when compared to the RG 1.174 criteria is not significant.

Attachment 2 to PLA-5408

EC-RISK-1081

Revision 1

NUCLEAR ENGINEERING
CALCULATION / STUDY COVER SHEET and
DCS TRANSMITTAL SHEET

1. Page 1 of 95
Total Pages 96

➢2. TYPE: CALC ➢3. NUMBER: EC-RISK-1081 ➢4. REVISION: 1

5. TRANSMITTAL#: ______ *➢6. UNIT: 3 *➢7. QUALITY CLASS: N

➢9. DESCRIPTION: Risk Impact Assessment of Extending Containment ILRT Interval *➢8. DISCIPLINE: 3

SUPERSEDED BY: ______

10. Alternate Number: None 11. Cycle: NA

12: Computer Code or Model used: NA Fiche ☐ Dis ☐ Am't ______

13. Application: None

*➢14 *Affected Systems:* 059 , , , , ,
* If N/A then line 15 is mandatory

**➢15. NON-SYSTEM DESIGNATOR: RISK RADN
**If N/A then line 14 is mandatory

16. Affected Documents: None

☐ Lic. Doc Change Req'd

17. References: See body of calculation

18. Equipment / Component #: None

19. DBD Number: None

➢20. PREPARED BY	Michael A Adelizzi *Print Name*	Michael A Adelizzi 12/2/01 *Signature*
➢21. REVIEWED BY	Jack G Refling *Print Name*	Jack G. Refling 12/3/2001 *Signature*
➢21A. VERIFIED BY	NA *Print Name*	*Signature*
➢22. APPROVED BY	Casimir Kukielka *Print Name*	Casimir Kukielka 12/03/20[illegible] *Signature*
➢23. ACCEPTED BY PP&L / DATE	*Print Name*	*Signature / DATE*

TO BE COMPLETED BY DCS

NR-DCS SIGNATURE/DATE

ADD A NEW COVER PAGE FOR EACH REVISION
FORM NEPM-QA-0221-1, Revision 5, Page 1 of 2, ELECTRONIC FORM

* Verified Fields
➢ REQUIRED FIELDS

	ENGINEERING CALCULATION STUDY **REVISION DESCRIPTION SHEET**
REVISION NO: 1	**CALCULATION NUMBER:** EC-RISK-1081

This form shall be used to record the purpose or reason for the revision, indicate the revised pages and / or affected sections and give a short description of the revision. Check (x) the appropriate function to add, replace or remove the affected pages.

Revised Pages	Affected Sections	Add	Rpl	Rmv	Description / Purpose of Revision
ALL	ALL		X		Increased scope of calculation to include analysis of Drywell to
					Suppresssion Chamber Bypassm Test (Appendix D).
					Increased scope of calculation to include analysis of Containment
					fragiltiy (Appendix E).
					Main body of calculation has numerous changes. Class 1 leakage is
					always 1 La. CCFP is calculated. Note added to explain person-rem.
					No revision bars are used on new pages starting with page 63

REVISION TYPE: (check one)	☐ SUPERSEDED BY ____________ ☒ FULL REVISION ☐ PAGE FOR PAGE

Summary

Revisions to 10 CFR 50, Appendix J allow individual plants to extend Type A (ILRT) surveillance testing requirements from 3-in-10 years to once per 10 years. The revised Type A test frequency is based on an acceptable performance history defined as two consecutive periodic Type A tests at least 24 months apart in which the calculated performance leakage was less than normal containment leakage of 1.0 L_a.

The Susquehanna Steam Electric Station (SSES) selected the revised requirements as its testing program. SSES current 10 year Type A test is due to be performed during U1-12RIO (Spring 2002) and U2-11RIO (Spring 2003). However, SSES seeks a one-time exemption based on (1) the substantial cost savings of up to $2.4 million from eliminating the test from each outage, (2) flexibility to schedule the next ILRT during outages with turbine replacement, and (3) the belief that a rule change will be sought by the industry to extend the interval for Type A testing or eliminate the need for Type A testing.

To support the submittal to the NRC for this change, a risk assessment evaluation was performed to assess the risk impact of extending the current containment Type A integrated leak-rate test (ILRT) from a 10 year to a 15 year interval. The risk assessment followed the guidelines set forth in NEI 94-01, the methodology used in EPRI TR-104285 and the NRC regulatory guidance on the use of Probabilistic Risk Assessment (PRA) findings and risk insights in support of a licensee request for changes to a plants licensing basis, Reg. Guide 1.174.

Specifically the approach combined the use of the plants Individual Plant Examination (IPE) results and findings to the methodology described in ERPI TR-104285 to estimate plant risk on specific accident sequences impacted by Type A testing.

The change in plant risk was evaluated based on the change in the predicted person-rem/year frequency and Large Early Release Frequency (LERF).

The analysis examined the SSES IPE plant specific accident sequences in which the containment integrity remains intact or the containment is impaired. Specifically, the following were considered:

- Core damage sequences in which containment integrity is maintained. (Class 1)
- Large containment isolation failures due to random failures to close a containment path. (Class 2)
- Core damage sequences in which containment integrity is impaired due to random failures of plant components other than those associated with Type B or Type C test components, for example, hole in Primary Containment. (Class 3)

Small containment isolation 'failure-to-seal' events are not considered in this evaluation because the frequency is based on Type B and Type C testing program and the dose is accounted by Class 1 sequences. (Class 4 and 5)

- Core damage sequences in which containment integrity is impaired due to containment isolation failures of pathways left 'opened' following a plant post-maintenance test, for example, a valve failing to close following a valve stroke test. (Class 6)
- Containment failure induced by severe accident phenomena. (Class 7)
- Sequences in which Secondary Containment is bypassed. (Class 8)

The steps taken to perform this risk assessment evaluation are as follows:

Step 1 - Quantify the base-lined risk in terms of frequency per reactor year for each of the eight accident classes presented. (Table S-1)
Step 2 - Develop plant specific person-rem dose (population dose) per reactor year for each of the eight accident classes evaluated in EPRI TR-104285 (Table S-2.)
Step 3 - Evaluate risk impact of extending Type A test interval from 10-to-15 years.
Step 4 - Determine the change in risk in terms of LERF in accordance with Reg. Guide 1.174.

Table S-1
Mean Containment Frequencies Measures for 3 year test interval - Given Accident Class

Class	Description	Frequency (per Rx-year)
1	No Containment Failure	1.63E-07
2	Large Containment Isolation Failures (Failure-to-close)	5.35E-10
3a	Small Isolation Failures (Hole in Primary Containment)	2.39E-08
3b	Large Isolation Failures (Hole in Primary Containment)	7.85E-09
4	Small Isolation Failure – failure to seal (Type B Test)	NA
5	Small Isolation Failure – failure to seal (Type C Test)	NA
6	Containment Isolation Failures (dependent failures, personnel errors)	8.60E-10
7	Severe Accident Phenomena Induced Failure (Early and Late Failures)	1.60E-07
8	Secondary Containment Bypassed	1.75E-08
~~Core~~ Damage		3.74E-07

Table S-2
Person-Rem Measures - Given Accident Class (10)

Class	Description	Person-Rem (50-Miles)
1	No Containment Failure – 1 La	3.29E+05
2	Large Containment Isolation Failures (Failure-to-close) – 35 La	4.38E+05
3a	Small Isolation Failures (Hole in Primary Containment) – 10 La	4.41E+05
3b	Large Isolation Failures (Hole in Primary Containment) – 35 La	4.38E+05
4	Small Isolation Failure – failure to seal (Type B Test)	Not Analyzed
5	Small Isolation Failure – failure to seal (Type C Test)	Not Analyzed
6	Containment Isolation Failures (dependent failures, personnel errors) – 35 La	4.38E+05
7	Severe Accident Phenomena Induced Failure (Early and Late Failures) – 100 La	6.27E+06
8	Secondary Containment Bypassed – 100 La	4.24E+06

Note: The integrated population dose consequences (Person-rem) for Classes 2,3b,and 6 with 35 La leakage are slightly less than those for class 3a with 10 La because of the fact that the leakage from secondary containment pathway is filtered, whereas the secondary containment bypass leakage and MSIV leakage pathways are not filtered, and that a fixed radioactive source term inventory is available for leakage.

When the release rate from primary containment to secondary containment is varied from 10La to 35La, while the secondary containment bypass leakage and MSIV leakage rates are held constant, there is an increase in the removal of radioactivity in the filtered secondary containment pathway, and hence less total radioactivity becomes available to flow through the secondary containment bypass leakage and MSIV leakage pathways. This results in a nonlinear impact to the integrated population dose over the 30 day analytical time frame.

Said in another way, when the leak rate from primary containment to secondary containment is increased from 10La to 35La, the release to the environment through this filtered flow path increases. However, since the amount of radioactivity in the primary containment is a constant amount, the more radioactivity that leaks to secondary containment and is subsequently filtered, less remaining radioactivity is available to flow through the unfiltered secondary containment bypass leakage and MSIV leakage route. This results in the slightly lower population dose consequences for the two leakage rates depicted in the study.

The impact associated with extending the Type A ILRT test frequency interval, measured as percent change with respect to the total integrated risk is presented in Table S-3 below.

Table S-3
Summary of Risk impact on Extending Type A ILRT Test Frequency

Class	Risk Impact (Base)	Risk Impact (10-years)	Risk Impact (15-years)
1,3a,and 3b	5.9% of integrated value based on 1La normal containment leakage for Class 1, 10La for Class 3a and 35La for Class 3b 0.0676 person-rem/yr	5.9% of integrated value based on 1 La normal containment leakage for Class 1, 10La for Class 3a and 35La for Class 3b 0.0680 person-rem/yr	5.9% of integrated value based on 1 La normal containment leakage for Class 1, 10La for Class 3a and 35La for Class 3b 0.0682 person-rem/yr
Total Integrated Risk	1.1474 person-rem/yr	1.1478 person-rem/yr	1.1479 person-rem/yr

The conclusions regarding the assessment of the plant risk associated with extending the Type A ILRT test frequency from 10 years to 15 years are as follows:

1. The risk assessment associated with implementation of a one-time exemption in extending the containment Type A ILRT from 10 years to 15 years predicts a slight increase in risk when compared to that estimated from current requirements. The change in risk for Classes 1, 3a and 3b as measured by person-rem/year increases by 0.3%. Also, the total integrated plant risk for those accident sequences influenced by Type A testing, given the change from a once per 10 years test interval to a once per 15 years test interval increases by 0.02%. This value is a negligible increase in risk.

2. Reg. Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Reg. Guide 1.174 defines very small changes in risk as resulting in increases of core damage frequency (CDF) below 1.0E-06/year and increases in LERF below 1.0E-07/year. Since the ILRT does not impact CDF, the relevant criterion is LERF. The increase in LERF resulting from a change in the Type A ILRT test interval from once per 10 year test interval to once per 15 year test interval is 3.93E-10/yr. Since guidance in Reg. Guide 1.174 defines very small changes in LERF as below 1.0E-07/yr, increasing the ILRT interval to 15 years is therefore not risk significant.

1.0 OBJECTIVE

Provide a risk impact assessment on extending the plant's Integrated Leak Rate Test (ILRT) interval from 10 to 15 years. The risk assessment will be performed in accordance with the guidelines set forth in NEI 94-01 (1), the methodology used in EPRI TR-104285 (2), and the NRC regulatory guidance on the use of Probabilistic Risk Assessment (PRA) findings and risk insights in support of a licensee request for changes to a plant's licensing basis, Reg. Guide 1.174 (3).

Reg. Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. This calculation will demonstrate that the increased risk to the public (person-rem / year) is insignificant. This calculation will demonstrate per Reg. Guide 1.174 that the change in risk increases CDF less than 1E-06/year and increases LERF less than 1E-07/year.

The results and findings from the SSES Individual Plant Examination (IPE) (4) are used for this risk assessment calculation.

2.0 CONCLUSION

The conclusions regarding the assessment of the plant risk associated with extending the Type A ILRT test frequency from 10 years to 15 years are as follows:

1. The risk assessment associated with implementation of a one-time exemption in extending the containment Type A ILRT from 10 years to 15 years predicts a slight increase in risk when compared to that estimated from current requirements. The change in risk for Classes 1, 3a and 3b as measured by person-rem/year increases by 0.3%. Also, the total integrated plant risk for those accident sequences influenced by Type A testing, given the change from a once per 10 years test interval to a once per 15 years test interval increases by 0.02% This value is a negligible increase in risk.

2. Reg. Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Reg. Guide 1.174 defines very small changes in risk as resulting in increases of core damage frequency (CDF) below 1.0E-06/year and increases in LERF below 1.0E-07/year. Since the ILRT does not impact CDF, the relevant criterion is LERF. The increase in LERF resulting from a change in the Type A ILRT test interval from once per 10 year test interval to once per 15 year test interval is 3.93E-10/yr. Since guidance in Reg. Guide 1.174 defines very small changes in LERF as below 1.0E-07/yr, increasing the ILRT interval to 15 years is therefore not risk significant.

3.0 ASSUMPTIONS

1. Containment leak rates greater than 2 La but less than 35 La indicate an impaired containment. The leak rate is considered 'small'. These releases have a break opening of 1-inch or less diameter.

2. Containment leak rates greater than 35 La indicate a containment breach. This leak rate is considered 'large'.

3. Containment leak rates less than 2 La indicate an intact containment. This leak rate is considered as 'negligible'.

4. The maximum containment leakage for Class 1 sequences is 1 La.

5. The maximum containment leakage for Class 2 sequences is 35 La.

6. The maximum containment leakage for Class 3a sequences is 10 La.

7. The maximum containment leakage for Class 3b sequences is 35 La.

8. The maximum containment leakage for Class 6 sequences is 35 La.

9. The maximum containment leakage for Class 7 sequences is 100 La.

10. The maximum containment leakage for Class 8 sequences is 100 La

11. Total CDF equals 3.74E-07 / year. This represents the IPE value of 2.14E-07 / year plus 1.60E-07 / year which is 50% of the COPF (Prior to Core Damage). Not all COPF sequences lead to core damage. A sensitivity analysis shows that relative increased dose to the public varies from 0.01% if all COPF sequences lead to core damage to 0.12% if no COPF sequences lead to core damage (4).

4.0 METHOD

A simplified bounding analysis approach for evaluating the change in risk associated with increasing the interval from 10 years to 15 years for Type A test was used. This approach is similar to that presented in EPRI TR104285 (2) and NUREG-1493 (5). Namely, the analysis performed examined SSES IPE (4) plant specific accident sequences in which the containment integrity remains intact or the containment is impaired. Specifically, the following were considered:

- Core damage sequences in which containment integrity is maintained. (Class 1)

- Large containment isolation failures due to random failures to close a containment path. (Class 2)
- Core damage sequences in which containment integrity is impaired due to random failures of plant components other than those associated with Type B or Type C test components, for example, hole in Primary Containment. (Class 3)
- Small containment isolation 'failure-to-seal' events are not considered in this evaluation because the frequency is based on Type B and Type C testing program and the dose is accounted by Class 1 sequences. (Class 4 and 5)
- Core damage sequences in which containment integrity is impaired due to containment isolation failures of pathways left 'opened' following a plant post-maintenance test, for example, a valve failing to close following a valve stroke test. (Class 6)
- Containment failure induced by severe accident phenomena. (Class 7)
- Sequences in which Secondary Containment is bypassed. (Class 8)
- Table 1 presents the SSES IPE frequencies for the accident classes.

The steps taken to perform this risk assessment evaluation are as follows:

Step 1 - Quantify the base-lined risk in terms of frequency per reactor year for each of the eight accident classes presented in Table 1.
Step 2 - Develop plant specific person-rem dose (population dose) per reactor year for 3 year test interval for each of the eight accident classes evaluated in EPRI TR-104285 (2) and presented in Table 2.
Step 3 - Evaluate risk impact of extending Type A test interval from 10 to15 years.
Step 4 - Determine the change in risk in terms of Large Early Release Frequency (LERF) in accordance with Reg. Guide 1.174 (3)

Step 1 - Quantify the base-lined risk in terms of frequency per reactor year.

This step involves the review of the SSES IPE (4). The IPE characterizes the response of the containment to important severe accident sequences. The IPE used in this evaluation is based on important phenomena and systems-related events identified in NUREG-1335 (9).

As previously described, the extension of the Type A interval does not influence those accident progressions that involve large containment isolation failures, Type B or Type C testing, or containment failure induced by severe accident phenomena. As a result, the plant design was reviewed for applicable isolation failures and their impact on the overall plant risk. Also, a simplified model to predict the likelihood of having a small/large breach in the containment liner that is undetected by the Type A ILRT test was developed.

SSES examined the five issues associated with containment isolation in NUREG-1335 (9):

(1) the identity of pathways that could significantly contribute to containment isolation failure,
(2) the signals required to automatically isolate the containment penetration,
(3) the potential generating signals for all initiating events,
(4) the examination of testing and maintenance procedures, and
(5) the quantification of each containment isolation mode.

These issues were addressed as follows:

1) <u>Pathways that could significantly contribute to containment isolation failure.</u> Significant fission product release to the environment may occur through containment penetrations that communicate directly with the containment atmosphere and exceed 1 inch in diameter. It will be noted that this latter piping diameter criterion excludes from further consideration valves in piping that interacts directly with the containment atmosphere and has a diameter of 1 inch or less. The rationale for this exclusion is that containment leakage through smaller diameter piping will not preclude further containment pressurization, and, in any case, any release of fission products from a pipe 1 inch or less will be small and therefore pose a minimal public risk.

Piping that communicates directly with the Reactor Pressure Vessel (RPV) was not considered in the containment isolation failure analysis because such failures are considered to be failures of the pressure boundary between the RCS and low pressure systems (i.e., an interfacing system LOCA). In addition, manual valves were not examined in this review of containment isolation valve failures as their failures are considered passive and therefore most unlikely. Penetrations that are hydraulically tested are excluded because they are expected to remain full of water during the accident.

Based on the above, 27 lines were selected for examination as potential fission product release paths (Appendix A) (13).

2&3) <u>The signals required to automatically isolate the containment penetration and potential generating signals for all initiating events</u>. This analysis is for Class 2 failures. Containment isolation signals, including those generated by unique plant initiators, required to automatically isolate the containment penetration, were not modeled in detail. They were, however, addressed in the containment isolation analysis as a containment isolation failure event.

The total failure probability is the sum of the probability for each penetration.

Penetration failure = open factor * demand failure probability * failure of operator to isolate.

Open factor is less than 1.0 for penetrations that are normally closed but are allowed to open during operation. Penetrations X-25, X-26, X-201A, and X-202 are allowed to be open for 90 hours per year (1%). Penetrations X-204A, and X-204B are allowed to be open for 876 hours per year (10%). Penetrations X-39A, X-39B, X-205A, and X-205B are not opened except for testing, so a value of 0.1% was applied. (Appendix A)

The 1.0 E-03/demand-failure probability selected for this event is conservative. (15)

Failure of operator to isolate an open penetration is 1.0E-01. This is the industry standard. (14)

4) <u>The examination of testing and maintenance procedures.</u> IST program procedures perform testing and inspections for valves. Failures caused by these procedures can be test restoration errors or testing not identifying that the valve will not isolate (Class 6). Failure probabilities attributed to valve test and maintenance procedures were given the value of 2.3E-03 (12). Given control room indication of valve positions to prevent restoration errors and valve failure rates, this value is conservative.

5) <u>The quantification of each containment isolation mode</u>. The containment isolation analysis considered failure modes for normally open valves that fail to close on demand, and operator action in closing normally open valves. Normally closed valves that fail to remain closed had no effect on the analysis given the low probability of such events.

For this analysis, the question on containment isolation was modified to include the probability of a hole in primary containment at the time of core damage. Two basic events were included in the containment isolation analysis These are Event Class 3a (small hole) and Event Class 3b (large hole). (This event models the Class 3 sequence depicted in EPRI TR-104285 (2).

To calculate the probability that a hole in primary containment will be large (Event Class 3b), data in NUREG-1493 (5) was used. The data found in NUREG-1493 states that 144 ILRTs were conducted. The largest reported leak rate from those 144 tests was 21 times the allowable leakage rate (La). Since 21 La, does not constitute a large release (refer to the write-up in Step 4), no large releases have occurred based on the 144 ILRTs reported in NUREG-1493 (5).

To estimate the failure probability given that no failures have occurred, a conservative estimate is obtained from the 95th percentile of the chi-squared distribution (16). In statistical theory, the chi-squared distribution can be used for statistical testing, goodness-of-fit tests, and evaluating s-confidence. The chi-squared distribution is really a family of distributions, which range in shape from that of the exponential to that of the normal distribution. Each distribution is identified by the degrees of freedom, v. For time truncated tests (versus failure-truncated tests), an estimate of the probability of a large leak using the chi-squared distribution can be calculated as chi-squared (95^{th}) (v = 2n+2)/2N, where n represents the number of large leaks and N represents the number of ILRTs performed to date. With no large leaks (n = 0) in 144 events (N = 144) and chi-squared (95^{th}) (2) = 5.99, the 95^{th} percentile estimate of the probability of a large leak is calculated as 5.99/(2*144) = 0.021.

To calculate the probability that a hole in primary containment will be small (Event Class 3a), data in NUREG-1493 (5) was used. The data found in NUREG-1493 states that 144 ILRTs were conducted. The data reported that 23 of 144 tests had allowable leak rates in excess of 1.0La. However, of these 23 'failures' only 4 were found by an ILRT. The other failures were found by Type B and C testing, or by errors in test alignments. Therefore, the number of failures considered for 'small releases' are 4-of-144. Similar to the event Class 3b probability, the estimated failure probability for small release is found by using the chi-squared distribution. The chi-squared distribution is calculated by n=4 (number of small leaks) and N=144 (number of events) which yields a chi-squared (10) =18.3070. Therefore, the 95^{th} percentile estimate of the probability of a small leak is calculated as 18.3070/(2*144) = 0.064.

After modifying the containment isolation analysis and including the respective 'large' and 'small' hole in primary containment leak rate probabilities, the SSES IPE was quantified to predict the eight severe accidents class frequencies for 3 year testing interval presented in Table 1 and described below.

Class 1 Sequences. This group consists of all core damage accident progression bins for which the containment remains intact. This frequency is the total CDF minus the frequency of all other accident classes. The frequency per year for 3 year testing interval is 1.63E-07 / year. For this analysis the associated maximum containment leakage for this group is 1.0 La for 3 year test interval.

Class 2 Sequences. This group consists of all core damage accident progression bins for which a pre-existing leakage due to failure to isolate the containment occurs. These sequences are dominated by failure-to-close of large (>1-inch diameter) containment isolation valves. The frequency per year for these sequences is determined as follows:

CLASS_2_FREQUENCY = PROB (large CI) * CDF

Where:
PROB (large CI) = random large containment isolation failure probability (i.e. large valves)

= 1.43E-03 Appendix A

CDF = SSES IPE core damage frequency = 3.74E-07 Appendix B

CLASS_2_FREQUENCY = 1.43E-03 * 3.74E-07
CLASS_2_FREQUENCY = 5.35E-10 / year

For this analysis the associated maximum containment leakage for this group is 35 La.

Class 3 Sequences. This group consists of all core damage accident progression bins for which a pre-existing leakage in the containment structure (i.e. containment liner) exists. The containment leakage for these sequences can be either small (2La to 35La) or large (>35La).

The respective frequencies per year are determined as follows:

CLASS_3A_FREQUENCY = PROB (Class_3a) * CDF

CLASS_3B_FREQUENCY = PROB (Class_3b) * CDF

Where:
PROB (Class_3a) = probability of small pre-existing containment liner leakage
= 0.064 (see above write-up)

PROB (Class_3b) = probability of large pre-existing containment liner leakage
= 0.021 (see above write-up)

CLASS_3A_FREQUENCY = 0.064 * 3.74E-07
CLASS_3A_FREQUENCY = 2.39E-08 / year

CLASS_3B_FREQUENCY = 0.021 * 3.74E-07
CLASS_3B_FREQUENCY = 7.85E-09 / year

For this analysis the associated maximum containment leakage for Class 3a is 10 La and for Class 3b is 35 La.

Class 4 Sequences. This group consists of all core damage accident progression bins for which a failure-to-seal containment isolation failure of Type B test components occurs. Because these failures are detected by Type B tests, this group is not evaluated any further.

Class 5 Sequences. This group consists of all core damage accident progression bins for which a failure-to-seal containment isolation failure of Type C test components occurs. Because these failures are detected by Type C tests, this group is not evaluated any further.

Class 6 Sequences. This group is similar to Class 2. These are sequences that involve core damage accident progression bins for which a failure-to-seal containment leakage due to failure to isolate the containment occurs. These sequences are dominated by misalignment of containment isolation valves following a test/maintenance evolution.

The frequency per year for these sequences is determined as follows:

CLASS_6_FREQUENCY = PROB (large T&M) * CDF

Where:
PROB (large T&M) = random large containment isolation failure probability due to valve misalignment
= 2.3E-03 (12)

CLASS_6_FREQUENCY = 2.3E-03 * 3.74E-07
= 8.60E-10 / year

For this analysis the associated maximum containment leakage for this group is 35La.

Class 7 Sequences. This group consists of all core damage accident progression bins in which containment failure induced by severe accident phenomena occurs. For this analysis the associated maximum containment leakage for this group is 100 La.

CLASS_7_FREQUENCY = CFL + CFE + (0.5 *COPF)

Where:

CFL = Late Containment Failure = 1.02E-10
CFE = Large Early Release Frequency = 1.95E-10
COPF = Containment Over Pressure Failure (prior to core damage) = 3.2E-07

50% of the COPF is assigned to Class 7. There are some events that will not have a release because the event ends before core damage occurs.

Therefore,

CLASS_7_FREQUENCY = 1.02E-10 + 1.95E-10 + (0.5 * 3.2E-07)
= 1.60E-07 / year

Class 8 Sequences. This group consists of all core damage accident progression bins in which secondary containment bypass occurs.

CLASS_8_FREQUENCY = ISLOCA + SC_ Byp

ISLOCA = Interfacing System LOCA = 1.0E-08 (4)
SC_Byp = Secondary Containment Bypasses = CDF * 2% = 3.74E-07 * 0.02
= 7.48E-09 (4,Vol 6, p.13)

Therefore,

CLASS_8_FREQUENCY = 1.0E-08 + 7.48E-09
= 1.75E-08 / year

Note: for this class the maximum release is based on 100 La.

Table 1

Mean Containment Frequencies Measures For 3 Year Testing Interval - Given Accident Class

Class	Description	Frequency (per Rx-year)
1	No Containment Failure	1.63E-07
2	Large Containment Isolation Failures (Failure-to-close)	5.35E-10
3a	Small Isolation Failures (Hole in Primary Containment)	2.39E-08
3b	Large Isolation Failures (Hole in Primary Containment)	7.85E-09
4	Small Isolation Failure – failure to seal (Type B Test)	NA
5	Small Isolation Failure – failure to seal (Type C Test)	NA
6	Containment Isolation Failures (dependent failures, personnel errors)	8.60E-10
7	Severe Accident Phenomena Induced Failure (Early and Late Failures)	1.60E-07
8	Containment Bypassed (Secondary Containment Bypass Leakage)	1.75E-08
Core Damage		3.74E-07

Step 2 - Develop plant specific person-rem dose (population dose) per reactor year

Plant-specific release analysis was performed to evaluate the person-rem doses to the population, within a 50 mile radius from the plant (11).

The classes analyzed cover a range of containment behaviors ranging from the case of no containment failure to cases of containment bypass and severe accident-induced failure. The dose calculations were performed using the MACCS2 code system, with input based upon BWR source terms developed from NUREG-1465 research. (10)

The values are summarized in Table 2 below.

Table 2
Person-Rem Measures - Given Accident Class (10)

Class	Description	Person-Rem (50-Miles)
1	No Containment Failure – 1 La	3.29E+05
2	Large Containment Isolation Failures (Failure-to-close) – 35 La	4.38E+05
3a	Small Isolation Failures (Hole in Primary Containment) – 10 La	4.41E+05
3b	Large Isolation Failures (Hole in Primary Containment) – 35 La	4.38E+05
4	Small Isolation Failure – failure to seal (Type B Test)	Not Analyzed
5	Small Isolation Failure – failure to seal (Type C Test)	Not Analyzed
6	Containment Isolation Failures (dependent failures, personnel errors) – 35 La	4.38E+05
7	Severe Accident Phenomena Induced Failure (Early and Late Failures) – 100 La	6.27E+06
8	Containment Bypassed (Secondary Containment Bypass Leakage) – 100 La	4.24E+06

Note: The integrated population dose consequences (Person-rem) for Classes 2,3b,and 6 with 35 La leakage are slightly less than those for class 3a with 10 La because of the fact that the leakage from secondary containment pathway is filtered, whereas the secondary containment bypass leakage and MSIV leakage pathways are not filtered, and that a fixed radioactive source term inventory is available for leakage.

When the release rate from primary containment to secondary containment is varied from 10La to 35La, while the secondary containment bypass leakage and MSIV leakage rates are held constant, there is an increase in the removal of radioactivity in the filtered secondary containment pathway, and hence less total radioactivity becomes available to flow through the secondary containment bypass leakage and MSIV leakage pathways. This results in a nonlinear impact to the integrated population dose over the 30 day analytical time frame.

Said in another way, when the leak rate from primary containment to secondary containment is increased from 10La to 35La, the release to the environment through this filtered flow path increases. However, since the amount of radioactivity in the primary containment is a constant amount, the more radioactivity that leaks to secondary containment and is subsequently filtered, less remaining radioactivity is available to flow through the unfiltered secondary containment bypass leakage and MSIV leakage route. This results in the slightly lower population dose consequences for the two leakage rates depicted in the study.

The above results when combined with the results presented in Table 1 yields the SSES Mean Consequence Measures for 3-Year Test Interval for given accident class. These results are presented in Table 3 below.

Table 3
Mean Consequence Measures for 3-Year Test Interval - Given Accident Class

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr
1	No Containment Failure	1.63E-07	3.29E+05	5.36E-02
2	Large Containment Isolation Failures (Failure-to-close)	5.35E-10	4.38E+05	2.34E-04
3a	Small Isolation Failures (Hole in Primary Containment)	2.39E-08	4.41E+05	1.06E-02
3b	Large Isolation Failures (Hole in Primary Containment)	7.85E-09	4.38E+05	3.44E-03
4	Small Isolation Failure – failure to seal (Type B Test)	NA	NA	0.0
5	Small Isolation Failure – failure to seal (Type C Test)	NA	NA	0.0
6	Containment Isolation Failures (dependent failures, personnel errors)	8.60E-10	4.38E+05	3.77E-04
7	Severe Accident Phenomena Induced Failure (Early and Late Failures)	1.60E-07	6.27E+06	1.01E+00
8	Containment Bypassed (Secondary Containment Bypass Leakage)	1.75E-08	4.24E+06	7.41E-02
	Total	3.74E-07		1.1474E+00

Based on the above values, the percent risk contribution ($\%Risk_{BASE}$) for Class 1 and Class 3 is as follows:

$$\%Risk = ((Class\ 1 + Class\ 3a + Class\ 3b) / Total) * 100$$

Where:
Class 1 = 5.36E-02 person-rem / year
Class 3a = 1.06E-02 person-rem / year
Class 3b = 3.44E-03 person-rem / year
Total = 1.1474 person-rem / year

$$\%Risk = ((5.36E\text{-}02 + 1.06E\text{-}02 + 3.44E\text{-}03) / 1.1474) * 100$$
$$= 5.9\%$$

Therefore, the total baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 5.9%.

Based on the above values, the Conditional Containment Failure Probability (CCFP) for baseline risk is as follows:

$$CCFP = 1 - (Class\ 1 + Class\ 3a) / CDF$$

Where:
Class 1 = 1.63E-07 / year
Class 3a = 2.39E-08 / year
CDF = 3.74E-07 / year

$$CCFP = 1 - (1.63E\text{-}07 + 2.39E\text{-}08) / 3.74E\text{-}07$$
$$= 5.00E\text{-}01$$

Step 3 - Evaluate risk impact of extending Type A test interval from 10-to-15 years

According to NUREG-1493 (5), relaxing the Type A ILRT interval from 3-in-10 years to 1-in-10 years will increase the average time that a leak detectable only by an ILRT goes undetected from 18 to 60 months. (The average time for undetection is calculated by multiplying the test interval by 0.5 and multiplying by 12 to convert from "years" to "months"). If the test interval is extended to 1 in 15 years, the average time that a leak detectable only by an ILRT test goes undetected increases to 90 months (1/2 * 15 * 12). Since ILRTs only detect about 3% of leaks (the rest are identified during LLRTs), the result for a 10 year ILRT interval is a 10% increase in the overall probability of leakage. This value is determined by multiplying 3% and the ratio of the average time for undetection for the increased ILRT test interval (60 months) to the baseline average time for undetection of 18 months. For a 15 year test interval, the result is a 15% increase in the overall probability of leakage (i.e., 3 * 90/18). Thus, increasing the ILRT test interval from 10 years to 15 years results in a 5% increase in the overall probability of leakage.

Risk Impact due to 10 year Test Interval

As previously stated, Type A tests impact only Class 1 and Class 3 sequences.

For Class 1 sequences, the increased probability of not detecting excessive leakage has no impact on the frequency of occurrence. The leakage rate remains at 1 La.

For Class 3 sequences, the release magnitude is not impacted by the change in test interval. (small or large liner opening remains the same, even though the probability of not detecting the liner opening increases). Thus, only the frequency of Class 3 sequences is impacted. Therefore, for Class 3 sequences, the risk contribution is determined by multiplying the Class 3 accident frequency by the increase in probability of leakage of 1.1. (Recall that for a 10-year interval there is a 10% increase on the overall probability of leakage). The results of this calculation are presented in Table 4 below.

Table 4
Mean Consequence Measures for 10-Year Test Interval - Given Accident Class

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr (50-Miles)
1	No Containment Failure	1.60E-07	3.29E+05	5.26E-02
2	Large Containment Isolation Failures (Failure-to-close)	5.35E-10	4.38E+05	2.34E-04
3a	Small Isolation Failures (Hole in Primary Containment)	2.63E-08	4.41E+05	1.16E-02
3b	Large Isolation Failures (Hole in Primary Containment)	8.64E-09	4.38E+05	3.78E-03
4	Small Isolation Failure – failure to seal (Type B Test)	NA	NA	0.0
5	Small Isolation Failure – failure to seal (Type C Test)	NA	NA	0.0
6	Containment Isolation Failures (dependent failures, personnel errors)	8.60E-10	4.38E+05	3.77E-04
7	Severe Accident Phenomena Induced Failure (Early and Late Failures)	1.60E-07	6.27E+06	1.01E+00
8	Containment Bypassed (Secondary Containment Bypass Leakage)	1.75E-08	4.24E+06	7.41E-02
Core Damage	All Containment Event Tree Endstates	3.74E-07		1.1478E+00

Based on the above values, the Type A 10-year test frequency percent risk contribution ($\%Risk_{10}$) for Class 1 and Class 3 is as follows:

$$\%Risk = ((Class\ 1 + Class\ 3a + Class\ 3b) / Total) * 100$$

Where:
Class 1 = 5.26E-02 person-rem / year
Class 3a = 1.16E-02 person-rem / year
Class 3b = 3.78E-03 person-rem / year
Total = 1.1478 person-rem / year

$$\%Risk = ((5.26E\text{-}02 + 1.16E\text{-}02 + 3.78E\text{-}03) / 1.1478) * 100$$
$$= 5.9\%$$

Therefore, the total Type A 10 year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 5.9%.

The percent risk increase ($\Delta\%Risk_{10}$) due to a ten-year ILRT over the baseline case is as follows:

$$\text{Delta \%Risk} = ((\text{Total-10} - \text{Total-base}) / \text{Total-base}) * 100$$

Where:

Total-base = total person-rem / year for baseline interval = 1.1474 person-rem / year
Total-10 = total person-rem / year for 10-year interval = 1.1478 person-rem / year

$$\text{Delta \%Risk} = ((1.1478 - 1.1474) / 1.1474) * 100$$
$$= 0.03\%$$

Therefore, the increase in risk contribution because of relaxed ten-year ILRT test frequency from 3-in-10 years is 0.03%

Based on the above values, the Conditional Containment Failure Probability (CCFP) for 10 year testing interval is as follows:

$$\text{CCFP} = 1 - (\text{Class 1} + \text{Class 3a}) / \text{CDF}$$

Where:
Class 1 = 1.60E-07 / year
Class 3a = 2.63E-08 / year
CDF = 3.74E-07 / year

$$\text{CCFP} = 1 - (1.60\text{E-}07 + 2.63\text{E-}08) / 3.74\text{E-}07$$
$$= 5.02\text{E-}01$$

The percent CCFP increase ($\Delta\%CCFP_{10}$) due to a ten-year ILRT over the baseline case is as follows:

$$\text{Delta \%CCFP} = ((\text{CCFP-10} - \text{CCFP-base}) / \text{CCFP-base}) * 100$$

Where:

CCFP-base = CCFP for baseline interval = 5.00E-01
CCFP-10 = CCFP for 10-year interval = 5.02E-01

$$\text{Delta \%CCFP} = ((5.02\text{E-}01 - 5.00\text{E-}01) / 5.00\text{E-}01) * 100$$

= 0.42%

Therefore, the increase in CCFP because of relaxed ten-year ILRT test frequency from 3-in-10 years is 0.42%

Risk Impact due to 15 year Test Interval

The risk contribution for a 15 year interval is similar to the 10 year interval. The difference is in the increase in probability of leakage value. For this case the value is 15 percent or 1.15. (Recall that for a 10-year interval there is a 10% increase on the overall probability of leakage). In addition, the containment leakage used for the 10 year test interval for both Class 1 and Class 3 are used in the 15 year interval evaluation. The results for this calculation are presented in Table 5.

Table 5
Mean Consequence Measures for 15-Year Test Interval - Given Accident Class

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr (50-Miles)
1	No Containment Failure	1.58E-07	3.29E+05	5.21E-02
2	Large Containment Isolation Failures (Failure-to-close)	5.35E-10	4.38E+05	2.34E-04
3a	Small Isolation Failures (Hole in Primary Containment)	2.75E-08	4.41E+05	1.21E-02
3b	Large Isolation Failures (Hole in Primary Containment)	9.03E-09	4.38E+05	3.96E-03
4	Small Isolation Failure – failure to seal (Type B Test)	NA	NA	0.0
5	Small Isolation Failure – failure to seal (Type C Test)	NA	NA	0.0
6	Containment Isolation Failures (dependent failures, personnel errors)	8.60E-10	4.38E+05	3.77E-04
7	Severe Accident Phenomena Induced Failure (Early and Late Failures)	1.60E-07	6.27E+06	1.01E+00
8	Containment Bypassed (Secondary Containment Bypass Leakage)	1.75E-08	4.24E+06	7.41E-02
Core Damage	All Containment Event Tree Endstates	3.74E-07		1.1479E+00

Based on the above values, the Type A 15-year test frequency percent risk contribution (%Risk) for Class 1 and Class 3 is as follows:

$$\%Risk = ((Class\ 1 + Class\ 3a + Class\ 3b) / Total) * 100$$

Where:
Class 1 = 5.21E-02 person-rem / year
Class 3a = 1.21E-02 person-rem / year
Class 3b = 3.96E-03 person-rem / year
Total = 1.1479 person-rem / year

$$\%Risk = ((5.21E\text{-}02 + 1.21E\text{-}02 + 3.96E\text{-}03) / 1.1479) * 100$$
$$= 5.9\%$$

Therefore, the total Type A 15-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 5.9%.

The percent increase in risk (in terms of person-rem/yr) of these associated specific sequences is computed as follows:

Delta %Risk = ((Class 1,3-15 – Class 1,3-10) / Class 1,3-10) * 100

Where:
Class1,3-10 = total person-rem / year for Class 1 & 3 for 10 year interval = 0.0680 person-rem / year
Class 1,3-15 = total person-rem / year for Class 1 & 3 for 15 year interval = 0.0682 person-rem / year

Delta %Risk = ((0.0682 – 0.0680) / 0.0680) * 100
= 0.3%

Therefore, the change in Type A test frequency from once per 10 years to once per 15 years increases the risk of those associated specific accident sequences by 0.3%.

The percent increase on the total integrated plant risk for these accident sequences is computed as follows.

Delta %Risk = ((Total-15 – Total-10) / Total-10) * 100

Where:

Total-15 = total person-rem / year for 15 year interval = 1.1479 person-rem / year
Total-10 = total person-rem / year for 10 year interval = 1.1478 person-rem / year

Delta %Risk = ((1.1479 – 1.1478) / 1.1478) * 100
= 0.02%

Therefore, the risk impact on the total integrated plant risk for these accident sequences influenced by Type A testing is only 0.02%.

The percent risk increase ($\Delta\%Risk_{15}$) due to a fifteen-year ILRT over the baseline case is as follows:

Delta %Risk = ((Total-15 – Total-base) / Total-base) * 100

Where:

Total-15 = total person-rem / year for 15 year interval = 1.1479 person-rem / year

Total-base = total person-rem / year for 3 year interval = 1.1474 person-rem / year

Delta %Risk = ((1.1479 – 1.1474) / 1.1474) * 100
= 0.05%

Therefore, the total increase in risk contribution associated with relaxing the ILRT test frequency from three in ten years to once-per-fifteen years is 0.05%

Based on the above values, the Conditional Containment Failure Probability (CCFP) for 15 year testing interval is as follows:

CCFP = 1 – (Class 1 + Class 3a) / CDF

Where:
Class 1 = 1.58E-07 / year
Class 3a = 2.75E-08 / year
CDF = 3.74E-07 / year

CCFP = 1 – (1.58E-07 + 2.75E-08) / 3.74E-07
= 5.03E-01

The percent CCFP increase ($\Delta\%CCFP_{15}$) due to a fifteen-year ILRT over the baseline case is as follows:

Delta %CCFP = ((CCFP-15 – CCFP-base) / CCFP-base) * 100

Where:

CCFP-base = CCFP for baseline interval = 5.00E-01
CCFP-15 = CCFP for 15-year interval = 5.03E-01

Delta %CCFP = ((5.03E-01 – 5.00E-01) / 5.00E-01) * 100
= 0.63%

Therefore, the increase in CCFP because of relaxed fifteen-year ILRT test frequency from 3-in-10 years is 0.63%

The percent CCFP increase ($\Delta\%CCFP_{15}$) due to a 15-year ILRT over the 10-year ILRT is as follows:

Delta %CCFP = ((CCFP-15 – CCFP-10) / CCFP-10) * 100

Where:

CCFP-15 = CCFP for 15-year interval = 5.03E-01
CCFP-10 = CCFP for 10-year interval = 5.02E-01

Delta %CCFP = ((5.03E-01 – 5.02E-01) / 5.02E-01) * 100
= 0.21%

Therefore, the increase in CCFP because of relaxed 15-year ILRT test frequency from 10 years is 0.21%

Step 4 - Determine the change in risk in terms of Large Early Release Frequency (LERF)

The one time extension of increasing the Type A test interval involves establishing the success criteria for a large release. This criteria is based on two prime issues:

1) The containment leak rate versus breach size, and

2) The impact on risk versus leak rate.

SSES evaluated the effect of containment leak size on the containment leak rate (Appendix C). In addition, Oak Ridge National Laboratory (ORNL) (7) completed a study evaluating the impact of leak rates on public risk using information from WASH-1400 (8) as the basis for its risk sensitivity calculations.

For SSES, 1 La = 1% weight / day = 320 Standard Liters per minute (SLM) (13)
Therefore, 35 La = 11,200 SLM

From Appendix C, mass flow from a 1 inch pipe with 60 psia in containment is 0.474 lbm/sec.

The weight density of nitrogen is .0727 pounds / cubic feet (17)
The weight density of air is .0752 pounds / cubic feet (17)
The weight density of steam is .1394 pounds / cubic feet (saturated at 60 psia) (18)

Use value for nitrogen because it has the lowest density. This is a conservative assumption because the containment will not be 100% nitrogen.

Leakage Rate (SLM) =
(0.474 lb. /sec.) (1/0.0727 cubic feet / lb.) (60 sec. / min.) (28.32 liter / min.) (17)

= 11,100 SLM

Therefore, a 1 inch pipe will leak approximately 35 La.

Based upon the information provided by SSES and ORNL, it is judged that small leaks resulting from a severe accident (that are deemed not to dominate public risk) can be defined as those that change risk by less than 5%. This definition would include leaks of less than 35%/day. Based on the SSES data, a 35%/day containment leak rate equates to a diameter leak of greater than 1 inches. Therefore, this study defines small leakage as containment leakage resulting from an opening of 1 inch pipe diameter or less and large leakage as greater 1 inch pipe diameter.

Impact on Large Early Release Frequency (LERF)

The risk impact associated with extending the ILRT interval involves the potential that a core damage event that normally would result in only a small radioactive release from containment could in fact result in a large release due to failure to detect a pre-existing leak during the relaxation period. For this evaluation only Class 3 sequences have the potential to result in large releases if a pre-existing leak were present. Class 1 sequences are not considered as potential large release pathways because for these sequences the containment remains intact. Therefore, the containment leak rate is expected to be small (less than 1 La). A larger leak rate would imply an impaired containment, such as classes 2, 3, 6 and 7.

Late releases are excluded regardless of the size of the leak because late releases are, by definition, not a LERF event. The frequency of Class 3b sequences (Table 4) is used to calculate the LERF increase for SSES. Sequences in the SSES IPE (4), which result in large releases (e.g., large isolation valve failures), are not impacted because a LERF will occur regardless of the presence of a pre-existing leak. The Class 3b frequency, based on a 10 year test interval is 8.64E-09 / year

Reg. Guide 1.174 (3) provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Reg. Guide 1.174 (3) defines very small changes in risk as resulting in increases of core damage frequency (CDF) below 1E-06/yr and increases in LERF below 1E-07/yr. Since the ILRT does not impact CDF, the relevant metric is LERF. Calculating the increase in LERF requires determining the impact of the ILRT interval on the leakage probability.

As described in Step 3, extending the ILRT interval from once-per-10 years to once-per-15 years will increase the average time that a leak detectable only by an ILRT goes undetected from 60 to 90 months. Since ILRTs only detect about 3% of leaks (the rest are identified during LLRTs), the result for a 15-yr ILRT interval is a 15% increase in the overall probability of leakage (3 * 90/18) versus 10% for a 10-yr ILRT interval. Thus, increasing the ILRT test interval from 10 years to 15 years results in a 5% increase in the overall probability of leakage. The increase in LERF is 3.93E-10 / year. Since guidance in Reg. Guide 1.174 defines very small changes in LERF as below 1E-07/yr, increasing the ILRT interval to 15 years is non-risk significant.

It should be noted that if the risk increase is measured from the original 3-in-10-year interval, the increase in LERF is 1.18E-09 / year. This value is also below the 1E-07/yr screening criterion in Reg. Guide 1.174).

5.0 RESULTS

1. The baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 5.9%.
2. Type A 10-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 5.9%.
3. Type A 15-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 5.9%.
4. The total integrated increase in risk contribution from extending the ILRT test frequency from the current 10-year interval to 15 years is 0.02%
5. The total integrated increase in risk contribution from extending the ILRT test frequency from the original 3-year interval to 15 years is 0.05%
6. The increase in CCFP from extending the ILRT test frequency from the current 10-year interval to 15 years is 0.21%
7. The increase in CCFP from extending the ILRT test frequency from the original 3-year interval 15 years is 0.63%
8. The risk increase in LERF from extending the ILRT test frequency from the current 10-year interval to 15 years is 3.93E-10 / year.
9. The risk increase in LERF from the original 3-year interval to 15 years is 1.18E-09 / year.
10. Other results are summarized in Table 6.

Table 6

Summary of Risk Impact on Extending Type A ILRT Test Frequency

Class	Risk Impact (Base)	Risk Impact (10-years)	Risk Impact (15-years)
1,3a,and 3b	5.9% of integrated value based on 1La normal containment leakage for Class 1, 10La for Class 3a and 35La for Class 3b 0.0676 person-rem/yr	5.9% of integrated value based on 2 La normal containment leakage for Class 1, 10La for Class 3a and 35La for Class 3b 0.0680 person-rem/yr	5.9% of integrated value based on 2 La normal containment leakage for Class 1, 10La for Class 3a and 35La for Class 3b 0.0682 person-rem/yr
Total Integrated Risk	1.1474 person-rem/yr	1.1478 person-rem/yr	1.1479 person-rem/yr

DATA

From reference (11) a summary of the population at SSES is presented in Table 7. From reference (10), radiological releases and accident class description used in this evaluation are presented in Table 8 and 9 below. Table 8 depicts the whole body dose to the population as person-rem within 50 miles.

Table 7
SSES Population (11)

Distance (Miles)	Population
0-10	61,343
10-20	261,900
20-30	351,200
30-40	419,000
40-50	553,600
Total	1,647,043

Table 8
SSES Population Dose (10)

Class	Dose (person-rem)	La
1	3.29E+05	1.0
1	3.63E+05	2.0
2	4.38E+05	35
3a	4.41E+05	10
3b	4.38E+05	35
6	4.38E+05	35
7	6.27E+06	100
8	4.24E+06	1.0
8	4.22E+06	2.0

Table 9
Accident Class Description (10)

CLASS	DESCRIPTION	Core Activity Release per NUREG-1465	Primary to Secondary Containment Leakage Rate (1,2)	Remarks
1	No Containment Failure	Gap Release + Early In-Vessel	1.0La ; 2.0La	Release to Primary Containment; SGTS functional
2	Large Containment Isolation Failure	Gap Release + Early In-Vessel	35.0La	Release to Primary Containment; SGTS functional
3a	Small Isolation Failure	Gap Release + Early In-Vessel	10.0La	Release to Primary Containment; SGTS functional
3b	Large Isolation Failure	Gap Release + Early In-Vessel	35.0La	Release to Primary Containment; SGTS functional
4	Small Isolation Failure – Type B Penetration	Gap Release + Early In-Vessel	N/A	N/A
5	Small Isolation Failure – Type C Penetration	Gap Release + Early In-Vessel	N/A	N/A
6	Containment Isolation Failures – (dependent failures, personel error)	Gap Release + Early In-Vessel	35.0La	Release to Primary Containment; SGTS functional
7	Severe Accident Induced Failure	Gap Release + Early In-Vessel + Ex-Vessel + Late In-Vessel	100.0La	Release to Primary Containment with No SGTS Filtration; Reactor Building Leakage Rate = 100%/day of free volume
8	Containment Bypassed	Gap Release + Early In-Vessel	1.0La ; 2.0La with additional 100.0La secondary containment bypass	Release to Primary Containment; SGTS functional on 1.0La and 2.0La; No SGTS Filtration of 100La

Notes:
(1) La = total primary to secondary containment leakage rate = 1%/day
(2) Analysis shall include 9 SCFH secondary containment bypass leakage as part of the total primary containment leakage rate unless otherwise specified. Analysis shall also include 300 SCFH MSIV leakage taking credit for the Isolated Condenser Treatment Method (ICTM).

6.0 REFERENCES

1. NEI 94-01, "Industry Guideline for Implementing Performance-Based Option of 10 CFR Part 50, Appendix J, July 26, 1995, Revision 0

2. EPRI TR-104285, "Risk Assessment of Revised Containment Leak Rate Testing Intervals" August 1994.

3. Regulatory Guide 1.174, " An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis" July 1998.

4. Susquehanna Steam Electric Station Individual Plant Examination.

5. NUREG-1493, "Performance-Based Containment Leak-Test Program, July 1995.

6. Deleted

7. Burns, T.J., "Impact of Containment Building Leakage on LWR Accident Risk", Oak Ridge National Laboratory, NUREG/CR-3539, April 1984.

8. United States Nuclear Regulatory Commission, Reactor Safety Study, WASH-1400, October 1975.

9. United States Nuclear Regulatory Commission, "Individual Plant Examination: Submittal Guidance," NUREG-1335, August 1989.

10. EC-RADN-1110, Rev. 0, Calculation of the Whole Body Population Dose Associated with Integrated Leak Rate Test (ILRT) Extension Risk Assessment for PPL Susquehanna Using MACCS2

11. FSAR Table 2.1-20 Population Distribution 2000, 0-50 Miles

12. EC-RISK-1063, Rev 0, Evaluation of Operator Actions for Application in the Susquehanna Individual Plant Examination, p. 35

13. NDAP-QA-0412, Rev 6, Leakage Rate Test Program.

14. Gertman, D. & Blackman, H (1994) Human reliability & safety analysis data handbook. New York: Wiley, 163

15. NEDC-31677P-A, Technical Specification Improvement Analysis for BWR Isolation Actuation Instrumentation, July 1990, Table 5-1.

16. ANSI/IEEE Std 352-1975, IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Protection Systems

17. Crane Technical Paper No. 410, Flow of Fluids, 1982

18. ASME Steam Tables, 5th Edition, 1983

19. PLA-4424, R.G. Byram (PPL) to USNRC Document Control Desk, "Proposed Amendment No. 194 to License NPF-14 and Proposed Amendment No. 152 to License NPF-22: Drywell to Suppression Chamber Bypass Testing," dated February 23, 1996.

20. PLA-4475, R.G. Byram (PPL) to USNRC Document Control Desk, "Response to NRC Request for Additional Information: Drywell to Suppression Chamber Bypass Testing," dated June 28, 1996.

21. Letter, C. Poslusny to R. G. Byram, "Susquehanna Steam Electric Station, Units 1 and 2 (TAC Nos. M94922 and M94923)," dated September 6, 1996.

22. Gertman, D. & Blackman, H (1994) Human reliability & safety analysis data handbook. New York: Wiley, 161

23. ANSI/IEEE Std 352-1975, IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Protection Systems

24. FSAR 6.2.1.1.5 Suppression Pool Bypass Effects

25. NUREG/CR-6706, Capacity of Steel and Concrete Containment Vessels With Corrosion Damage. (2001)

26. Scientech-NUS (1998) Commercial Nuclear Power Plants 20th Edition.

27. 324-990427 Through wall corrosion found in two places on the drywell liner. Source: www.inpo.org

28. 339-990922 Containment liner defect caused by wood embedded in concrete. Source: www.inpo.org

29. NRC Information Notice 97-10, "Liner Plate Corrosion in Concrete Containments".

30. Parks, M.B., Horschel, D.S., von Riesemann, W.A. & Costello, J.F. (1991). Summary of NRC-Sponsored Research on Containment Integrity. Prepared for International Conference on Structural Mechanics in Reactor Technology, Tokyo, Japan, August 18-23, 1991.

31. Proj. ID: 99-01047 Task ID:2 Action Item Assignment from Brunswick Nuclear Plant.

32. Technical Report NPE-89-001, The PP&L Approach to Risk Management and Risk Assessment. Revision 2 (1989)

33. NUREG/CR-2886, "The In-Plant Reliability Data Base for Nuclear Plant Components: Interim Data Report – the Pump Component (1982)

Appendix A
Penetrations Failure to Close Data

No.	Penetration	Description	Max Size (in)	Normal Status	Open Factor	Isolation Logic Failure	Operator Failure to Close	Probability
1	X-19	Instrument Gas	3	Open	1	0.001	0.1	1.00E-04
2	X-23	Closed Cooling Water Supply	4	Open	1	0.001	0.1	1.00E-04
3	X-24	Closed Cooling Water Return	4	Open	1	0.001	0.1	1.00E-04
4	X-25	Drywell & Suppression Chamber Purge Supply	24	Closed	0.01	0.001	0.1	1.00E-06
5	X-201A	Drywell & Suppression Chamber Purge Supply	18	Closed	0.01	0.001	0.1	1.00E-06
6	X-26	Drywell Purge Exhaust	2	Closed	0.01	0.001	0.1	1.00E-06
7	X-26	Drywell Purge Exhaust	24	Closed	0.01	0.001	0.1	1.00E-06
8	X-39A	RHR Containment Spray	12	Closed	0.001	0.001	0.1	1.00E-07
9	X-39B	RHR Containment Spray	12	Closed	0.001	0.001	0.1	1.00E-07
10	X-53	Chilled Water Supply	8	Open	1	0.001	0.1	1.00E-04
11	X-54	Chilled Water Return	8	Open	1	0.001	0.1	1.00E-04
12	X-55	Chilled Water Supply	8	Open	1	0.001	0.1	1.00E-04
13	X-56	Chilled Water Return	8	Open	1	0.001	0.1	1.00E-04
14	X-72A	Floor & Equipment Drain	3	Closed	0.01	0.001	0.1	1.00E-06
15	X-85A	Chilled Water to Recirc Pump	3	Open	1	0.001	0.1	1.00E-04

16	X-85B	Chilled Water from Recirc Pump	3	Open	1	0.001	0.1	1.00E-04
17	X-86A	Chilled Water to Recirc Pump	3	Open	1	0.001	0.1	1.00E-04
18	X-86B	Chilled Water from Recirc Pump	3	Open	1	0.001	0.1	1.00E-04
19	X-87	Instrument Gas	2	Open	1	0.001	0.1	1.00E-04
20	X-202	Suppression Chamber Purge Exhaust	2	Closed	0.01	0.001	0.1	1.00E-06
21	X-202	Suppression Chamber Purge Exhaust	18	Closed	0.01	0.001	0.1	1.00E-06
22	X-204A	RHR Pump Test Line and Containment Spray	18	Closed	0.1	0.001	0.1	1.00E-05
23	X-205A	RHR Pump Test Line and Containment Spray	6	Closed	0.001	0.001	0.1	1.00E-07
24	X-204B	RHR Pump Test Line and Containment Spray	18	Closed	0.1	0.001	0.1	1.00E-05
25	X-204B	RHR Pump Test Line and Containment Spray	6	Closed	0.001	0.001	0.1	1.00E-07
26	X-244	HPCI Vacuum Breaker	3	Open	1	0.001	0.1	1.00E-04
27	X-245	RCIC Vacuum Breaker	2	Open	1	0.001	0.1	1.00E-04
	Total							**1.43E-03**

Appendix B

Spreadsheets

Summary of IPE Results - with normal maintenance

Plant Status	Frequency per 15 months	Frequency per 12 months
Initiating Event	2.43E+00	1.94E+00
CD-UO-COK	1.66E-07	1.33E-07
CD-OH-COK	1.01E-07	8.10E-08
Total CD	2.67E-07	**2.14E-07**
CD-HPVF	7.97E-10	6.37E-10
CD-LPVF-COK	3.72E-10	2.97E-10
Total Vessel Failure	1.17E-09	9.35E-10
CD-UO-ECF	2.79E-11	2.23E-11
CM-VF-COTF	2.15E-10	1.72E-10
LERF	2.43E-10	1.95E-10
CM-VOK-COPF	7.66E-11	6.13E-11
CM-VF-COPF	5.11E-11	4.09E-11
Late Cont. Failure	1.28E-10	1.02E-10
COPF Prior to Core Damage		
COPF	4.0E-07	3.20E-07
50% of COPF	2.0E-07	**1.60E-07**
Add Total CD to 50% COPF to account for CD after Containment Failure		**3.74E-07**

SSES - 3 year ILRT interval

Class	Description	EPRI analysis	Probability (P) Frequency (/12 month)	Consequence (C) Person-Rem to 50 miles	Risk (P x C) Person-rem/yr	Basis Frequency
1	No Containment Failure - use 1 La	relevant	1.63E-07	3.29E+05	5.36E-02	Core Damage Frequency minus frequency of other classes. CDF = 3.74E-7
2	Large containment isolation failure - use 35 La	Random failures to close - Type A not relevant	5.35E-10	4.38E+05	2.34E-04	1.43E-3 times CDF - method based on failure of Containment Isolation of penetrations > 1 inch
3a	Small isolation failure - use 10La	relevant	2.39E-08	4.41E+05	1.06E-02	0.064 times CDF - based on NUREG ILRT results of 4 small failures out of 144 tests - 95th percentile of Chi squared distribution
3b	Large isolation failure - use 35La	relevant	7.85E-09	4.38E+05	3.44E-03	0.021 times CDF - IP3 method based on NUREG ILRT results of 0 large failures out of 144 tests - 95th percentile of Chi squared distribution
4	Small isolation failure (Type B penetration)	Based on Type B frequency - not relevant	0	0	0.0	
5	Small isolation failure (Type C penetration)	Based on Type C frequency - not relevant	0	0	0.0	
6	Containment isolation failures (dependent failures, personnel error) -	Based on ISI/IST program - Type A test	8.60E-10	4.38E+05	3.77E-04	2.3E-3 times CDF - EC-RISK-1063

	use 35 La	does not affect				
7	Severe Accident induced failure - use 100 La	Type A test does not affect - not relevant	1.60E-07	6.27E+06	1.01E+00	SSES PRA results for LERF, Late Containment Failure, and 50% of Containment Over Pressure Failure (prior to core damage)
8	Secondary Containment bypassed - use 100 La	Type A test does not affect - not relevant	1.75E-08	4.24E+06	7.41E-02	ISLOCA plus Containment Bypass
Core Damage			3.74E-07		1.1474E+00	

SSES - 10 year ILRT interval

Class	Description	EPRI analysis	Probability (P) Frequency (/12 month)	Consequence (C) Person-Rem to 50 miles	Risk (P x C) Person-rem/yr	Basis Frequency
1	No Containment Failure - use 1 La	relevant	1.60E-07	3.29E+05	5.26E-02	Same as 3 year - Core Damage Frequency minus frequency of other classes
2	Large containment isolation failure - use 35 La	Random failures to close - Type A not relevant	5.35E-10	4.38E+05	2.34E-04	Same as 3 year
3a	Small isolation failure - use 10 La	relevant	2.63E-08	4.41E+05	1.16E-02	3 year value times 1.10 - increased probability of failure - average time that leakage goes undetected increases from 18 to 60 months and 3% historical failure rate. (.03 * 60 / 18) = 0.10
3b	Large isolation failure - use 35La	relevant	8.64E-09	4.38E+05	3.78E-03	3 year value times 1.10 - increased probability of failure - average time that leakage goes undetected increases from 18 to 60 months and 3% historical failure rate. (.03 * 60 / 18) = 0.10
4	Small isolation failure (Type B penetration)	Based on Type B frequency - not relevant	0	0	0.0	
5	Small isolation failure (Type C penetration)	Based on Type C frequency -	0	0	0.0	

		not relevant				
6	Containment isolation failures (dependent failures, personnel error) - use 35 La	Based on ISI/IST program - Type A test does not affect	8.60E-10	4.38E+05	3.77E-04	Same as 3 year
7	Severe Accident induced failure - use 100 La	Type A test does not affect - not relevant	1.60E-07	6.27E+06	1.01E+00	Same as 3 year
8	Secondary Containment bypassed - use 100 La	Type A test does not affect - not relevant	1.75E-08	4.24E+06	7.41E-02	Same as 3 year
Core Damage			3.74E-07		1.1478E+00	

SSES - 15 year ILRT interval

Class	Description	EPRI analysis	Probability (P) Frequency (/12 month)	Consequence (C) Person-Rem to 50 miles	Risk (P x C) Person-rem/yr	Basis Frequency
1	No Containment Failure - use 1 La	relevant	1.58E-07	3.29E+05	5.21E-02	Core Damage Frequency minus frequency of other classes
2	Large containment isolation failure - use 35 La	Random failures to close - Type A not relevant	5.35E-10	4.38E+05	2.34E-04	Same as 3 year
3a	Small isolation failure - use 10La	relevant	2.75E-08	4.41E+05	1.21E-02	3 year value times 1.15 - increased probability of failure - average time that leakage goes undetected increases from 18 to 90 months and 3% historical failure rate. (.03 * 90 / 18) = 0.15
3b	Large isolation failure - use 35La	relevant	9.03E-09	4.38E+05	3.96E-03	3 year value times 1.15 - increased probability of failure - average time that leakage goes undetected increases from 18 to 90 months and 3% historical failure rate. (.03 * 90 / 18) = 0.15
4	Small isolation failure (Type B penetration)	Based on Type B frequency - not relevant	0	0	0.0	

5	Small isolation failure (Type C penetration)	Based on Type C frequency - not relevant	0	0	0.0	
6	Containment isolation failures (dependent failures, personnel error) - use 35 La	Based on ISI/IST program - Type A test does not affect	8.60E-10	4.38E+05	3.77E-04	Same as 3 year
7	Severe Accident induced failure - use 100 La	Type A test does not affect - not relevant	1.60E-07	6.27E+06	1.01E+00	Same as 3 year
8	Secondary Containment bypassed - use 100 La	Type A test does not affect - not relevant	1.75E-08	4.24E+06	7.41E-02	Same as 3 year
Core Damage			3.74E-07		1.1479E+00	

Summary Results

	Base line - 3 year interval	10 year interval	15 year interval
Total Person-rem per year	1.1474	1.1478	1.1479
Increase over 3 year		0.03%	0.05%
Increase over 10 year			0.02%
Class 1 & 3 total	0.0676	0.0680	0.0682
Class 1 & 3 Increase over 3 year		0.5%	0.8%
Class 1 & 3 Increase over 10 year			0.3%
CCFP	5.00E-01	5.02E-01	5.03E-01
CCFP Increase over 3 year		0.42%	0.63%
CCFP Increase over 10 year			0.21%
Class 1 & 3 portion of total	5.9%	5.9%	5.9%
Total Increase over 3 year		0.03%	0.05%
Total Increase over 10 year			0.02%
LERF (Class 3b)	7.85E-09	8.64E-09	9.03E-09
Increase over 3 year		7.85E-10	1.18E-09
Increase over 10 year			3.93E-10
Increase over 3 year (%)		10.0%	15.0%
Increase over 10 year (%)			4.5%

Appendix C

Leakage Rate Calculation

The in-house CONTAIN code was used to model this primary containment leaking process.

C.1 Assumptions and Input

There are three cells in the CONTAIN model. They are:

Cell #1	Wetwell
Cell #2	Drywell
Cell #3	Atmosphere

The flow path between cells is modeled as engineered vent. The engineered vent from Cell #2 to Cell #3 is an 1 inch diameter hole in the primary containment wall between the drywell and the secondary containment atmosphere.

It is assumed that after a loss of decay heat removal accident, steam discharged
into the suppression pool displaced all nitrogen from the wetwell into the drywell.
The initial wetwell pressure is 60 psia. There is saturated steam in the airspace. The initial drywell pressure is also 60 psia. There are nitrogen and steam in its airspace.

C.1.1 The center of mass elevation of cells

Cell #1
Assume the suppression pool depth is 24 ft. The pool surface elevation is
SPEL = 648 + 24 = 672 ft
ELEVCL(1) = 672 + [(704 - 3.5) -672] / 2 = 686.25 ft
= 209.17 m[1]

Cell #2
The center of mass of drywell airspace is assumed at one-third height of its volume

[1] SSES DAR Fig.1-1.

$$ELEVCL(2) = 704 + 87.75 / 3 = 733.25 \text{ ft} = 223.5 \text{ m (Ref. 1)}$$

Cell #3

The center of mass of this atmosphere cell is assumed to be the same as that of drywell

$$ELEVCL(3) = 223.5 \text{ m}$$

C.1.2 Engineered Vent From Cell #2 to Cell #3

The flow path is an one inch hole in the drywell wall.

VAREA = cross-sectional area of vent = $A_p = \pi/4 \text{ in}^2 = .00545 \text{ ft}^2 = .00051 \text{ m}^2$

The length of flow path is

L = drywell wall thickness $\cong$ 6 ft = 1.83 m

VAVL = A_p / L = .00051 / 1.83 = .00028 m

VCFC = vent flow loss coefficient = Kp + Ken + Kex
where
Kp = loss coefficient of 1" hole = f_T x L / Dp
For an one inch hole in concrete wall it is assumed that the friction factor is $f_T = 0.05$
Dp = 1" = .0833 ft
Kp = 0.05 x 6 / 0.0833 = 3.6
Ken = loss coefficient for pipe entrance = 0.5 (p.A-29 of Ref. 2)[2]
Kex = loss coefficient for pipe exit = 1.0 (p.A-29 of Ref. 2)

VCFC = 3.6+ 0.5 + 1.0 = 5.1

VCOSN = cosine of the angle between the vent axis and the vertical direction = 0.

VDPF = pressure difference to open the vent in the forward direction

[2] Crane, Technical Paper No.410

= 100 Pa (assumed)
VDPB = pressure difference to open the vent in the backward direction
= 100 Pa (assumed)

VELEVB = elevation of the vent at the FROM cell = 223.5 m (assumed)

VELEVF = elevation of the vent at the TO cell = 223.5 m (assumed)

C.1.3 Suppression Pool Vent Flow Path

The input data is the same as in vac11$.dat of Ref.3.[3]

C.1.4 Vacuum Breaker Flow Path

The input data is the same as in vac11$.dat of Ref.3.

C.1.5 Cell Data

C.1.5.1 Cell #2-Drywell

Upper cell input data:

According to Ref.4,[4]
Free volume of airspace = Vdw = 239600 ft^3= 6785 m^3
Height of airspace = Hair = 26.75 m
Number of Lb-moles of nitrogen = N_{N2} = 554.28
Mass of nitrogen = M_{N2} = 15520 lbm = 7040 kg

It is assumed that after the loss of decay heat removal accident, all nitrogen in the wetwell was driven into the drywell. Before the accident there was 365.27 lb-moles or 4639 kg of nitrogen in the wetwell. (Ref.4) After the accident in the drywell:

N_{N2} = 554.28 + 365.27 = 919.55 lb-moles

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[3] Calculation No. EC-THYD-1032.
[4] Calculation No. EC-THYD-1001.

M_{N2} = 7040 + 4639 = 11679 kg

Assume drywell temperature, Tdw = 252°F = 395.37°K , then

Partial pressure of nitrogen = P_{N2} = 919.55 x 10.731 x (460 + 252) / 239600 = 29.32 psia
Partial pressure of water vapor = P_{H2OV} = saturation pressure at 252°F
= 30.88 psia
Then v_g = specific volume = 13.375 ft^3 / lbm
Mass of water vapor in upper cell = M_{H2OV} = 239600 / 13.375
= 17914 lbm = 8125.7 kg
Pdw = 29.32 + 30.88 = 60.2 psia

Lower cell input data:

Surface area of pool = Apl = 451 m^2 (Ref.4)
The following input values are arbitrarily assumed to initiate the drywell pool:
Temperature of pool = Tpl = 252°F = 395.37°K
Water mass in pool = M_{H2OL} = 1.0 kg

C.1.5.2 Cell #1-Wetwell
From Ref.4, when the suppression pool level is 24 ft,
Free volume of wetwell airspace = Vww = 148590 ft^3 = 4208 m^3
Suppression pool volume = Vp = 131550 ft^3
Total volume of wetwell = Vt = Vww + Vp = 280140 ft^3

Assume wetwell pressure is Pww = 60 psia and wetwell temperature equal to saturation temperature of water at 60 psia
Tww = 292.71°F = 417.99°K
Then v_g = specific volume = 7.1736 ft^3 / lbm
Mass of water vapor in upper cell = M_{H2OV} = 148590 / 7.1736
= 20713 lbm = 9395.6 kg
Assume suppression pool temperature = Tpl = Tww = 292.71°F = 417.99°K
Then v_f = specific volume = .017383 ft^3 / lbm
Water mass in the suppression pool = M_{H2OL} = 131550 / .017383
= 7567700 lbm = 3.43E6 kg

C.1.5.3 Cell #3-Atmosphere

The following input values are assumed for this cell:

Cell volume = V3 = 1.0E8 m^3 = 3.53E9 ft^3
Cell height = Hair = 1.0E3 m
Initial cell pressure = P3 = 1.014E5 Pa = 14.7 psia
Initial cell temperature = Tair = 305.4°K = 90°F
Initial mole fraction of nitrogen = 0.79
Initial mole fraction of oxygen = 0.21
Total number of Lb-moles of gases = Nt
= 14.7 x 3.53E9 / [10.731 x (90 + 460)] = 8.792E6
Initial mass of nitrogen = M_{N2} = 0.79 x 8.792E6 x 28 = 1.945E8 lbm
Initial mass of oxygen = M_{O2} = 0.21 x 8.792E6 x 32 = 5.908E7 lbm

C.1.6 Input File

The input file is vent4e.dat.

C.1.7 Results

The partial output of the CONTAIN run is listed in Section C.1.8. It can be seen there that the maximum flow rate of engineered vent from Cell #2 to Cell #3 within the first ten minutes is about 0.215 kg/sec or **0.474 lbm/sec**. This is the estimated leakage rate through an one inch hole in the primary containment wall.

C.1.8 Partial CONTAIN Output

```
1
□
     INPUT <<<<<
<<<<< ECHO
□
     INPUT <<<<< &&                          vent4e.dat
<<<<< ECHO
     INPUT <<<<< CDC
<<<<< ECHO
     INPUT <<<<< EOI
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && ***** Global Input.  This input is common to all cells
***************|      <<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<< CONTROL  NCELLS=3     && Number of cells
|      <<<<< ECHO
     INPUT <<<<<          NTITL=1      && Number of title cards
|      <<<<< ECHO
     INPUT <<<<<          NTZONE=4     && Number of time zones
|      <<<<< ECHO
     INPUT <<<<<          NUMTBG=1     && Number of global tables used
|      <<<<< ECHO
     INPUT <<<<<          MAXTBG=4     && Max # of entries used in global
table option     |      <<<<< ECHO
     INPUT <<<<<          NENGV=1
<<<<< ECHO
     INPUT <<<<< EOI &&
|      <<<<< ECHO
     INPUT <<<<< &&  *************** End of General Data
*********************************|      <<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && ***** Global Material Data.  This input is used in all
cells **********|      <<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<< MATERIAL                 && Keyword that initiates material      |
block          |      <<<<< ECHO
     INPUT <<<<<          COMPOUND  H2 O2 N2 CO2 H2OL H2OV SS CONC CO FE ZR
UO2 SIO2 FEO        <<<<< ECHO
     INPUT <<<<<                    SIO2 FEO ZRO2 CAO CR2O3 MNO PU U MGO K2O
<<<<< ECHO
     INPUT <<<<<          FP-NAMES     CSI  CSOH  SR  PI
<<<<< ECHO
     INPUT <<<<<          USERDEF      && Keyword to initiate specification of
<<<<< ECHO
     INPUT <<<<<                       && user-defined materials
<<<<< ECHO
```

```
     INPUT <<<<<                    CSTEEL   && Name assigned to carbon steel
<<<<< ECHO
     INPUT <<<<<                 USERDAT     && Keyword to begin specification of
carbon steel          <<<<< ECHO
     INPUT <<<<<                             && properties.
<<<<< ECHO
     INPUT <<<<<                    CSTEEL   && Name of material
<<<<< ECHO
     INPUT <<<<<                    SOLID    && Phase of material
<<<<< ECHO
     INPUT <<<<<                    MOLEW    && Keyword for specifying molec wt (use
value for Fe)       <<<<< ECHO
     INPUT <<<<<                    55.85    && Molec wt. (Use value for Fe)
<<<<< ECHO
     INPUT <<<<<                    RHO      && Keyword indicating density input
follows                <<<<< ECHO
     INPUT <<<<<                    2        && No. of temp-density pairs
<<<<< ECHO
     INPUT <<<<<                    273.15  7857.  && Temp (K),  Density (kg/m**3)
<<<<< ECHO
     INPUT <<<<<                    475.    7857.  && Temp (K),  Density (kg/m**3)
<<<<< ECHO
     INPUT <<<<<                    COND     && Keyword for specifying thermal
conductivity            <<<<< ECHO
     INPUT <<<<<                    2        && No. of Temp-Conductivity pairs
<<<<< ECHO
     INPUT <<<<<                    273.15  34.86  && Temp (K),  Conductivity (W/m-
K)                   <<<<< ECHO
     INPUT <<<<<                    475.    34.86  && Temp (K),  Conductivity (W/m-
K)                   <<<<< ECHO
     INPUT <<<<<                    ENTH     && Keyword for specifying enthalpy
input                    <<<<< ECHO
     INPUT <<<<<                    2        && No. of Temp-Enth pairs
<<<<< ECHO
     INPUT <<<<<                    273.15  0.0    && Temp (K), Enthalpy (J/kg)
<<<<< ECHO
     INPUT <<<<<                    475.    90348. && Temp (K), Enthalpy (J/kg)
<<<<< ECHO
     INPUT <<<<<                    SPH      && Keyword for specifying specific heat
<<<<< ECHO
     INPUT <<<<<                    2        && No. of Temp-Sp Heat pairs
<<<<< ECHO
     INPUT <<<<<                    273.15  447.6  && Temp (K), Sp Heat (J/kg-K)
<<<<< ECHO
     INPUT <<<<<                    475.    447.6  && Temp (K), Sp Heat (J/kg-K)
<<<<< ECHO
     INPUT <<<<<                EOI
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<< &&  *************** End of Material Data
*********************************|       <<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
```

```
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && ***** Title block
*****************************************************|      <<<<< ECHO
     INPUT <<<<< TITLE && Put Title below
|      <<<<< ECHO
     INPUT <<<<<      FLOW RATE FROM DRYWELL AT 60 PSIA THROURH 1 INCH HOLE
|     <<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<< && **************** End of Title Block
***********************************|      <<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && ************ Time Step Data
********************************************|      <<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<< TIMES           &&
|      <<<<< ECHO
     INPUT <<<<<           1.E5   && cput   = CPU time limit (seconds)
|      <<<<< ECHO
     INPUT <<<<<            0.    && tstart = Problem Start time (sec)
|      <<<<< ECHO
     INPUT <<<<<            .01   && timinc = Maximum time step size (sec)
|      <<<<< ECHO
     INPUT <<<<<            0.2   && edtdto = Max interval for writing data to
tapes (sec) |     <<<<< ECHO
     INPUT <<<<<           5.   && tstop  =  End Time of Time Zone (sec)
|      <<<<< ECHO
     INPUT <<<<<           0.1 10.0  365.  && Second Time Zone
<<<<< ECHO
     INPUT <<<<<           .01  0.2  375.
<<<<< ECHO
     INPUT <<<<<           0.1  40.   600.
<<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<< && **************** End of Time Step Data
*******************************|      <<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && ******* Edit Frequency
*************************************************|      <<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<< SHORTEDT=100   && Short edit printed every
(SHORTEDT)*(timinc) seconds     |     <<<<< ECHO
```

```
      INPUT <<<<< LONGEDT=1     && Long edit printed every (LONGEDT)*(edtdto)
 seconds        |      <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<< && *************** End of Edit Frequency Data
 ****************************|      <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< && ****** Specify Type of Output
 *****************************************|      <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<< PRLOW-CL  && Print detailed output from lower cell
 |      <<<<< ECHO
      INPUT <<<<< PRFLOW    && Print detailed output from intercell flow
 |      <<<<< ECHO
      INPUT <<<<< PRENGSYS  && Print detailed output for engineered systems
 |      <<<<< ECHO
      INPUT <<<<<   PRAER2    && Print output of aerosol model for structures
 |      <<<<< ECHO
      INPUT <<<<<   PRFISS2   && Output of fission product behavior for
 structures         |      <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<< && ******* End of Output Description Section
 *****************************|      <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< && ****** Specify the reactor type
 ****************************************|      <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<< THERMAL  && Water-cooled reactor
 |      <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<< && ******* End of reactor-type data
 ***************************************|      <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< &&
 <<<<< ECHO
      INPUT <<<<< && ******* Suppression Pool Vent Flow Path Model
 ************************|      <<<<< ECHO
```

```
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<< SPVENT  && Activates the model
 |      <<<<< ECHO
      INPUT <<<<<         NWET=1         && Cell # containing the wetwell pool
 |      <<<<< ECHO
      INPUT <<<<<         NDRY=2         && Cell # representing the drywell
 |      <<<<< ECHO
      INPUT <<<<<         NSVNTS=82      && Number of downcomer vent pipes
 |      <<<<< ECHO
      INPUT <<<<<         AVNT=0.274     && Flow area of a single vent pipe
(m**2)          |        <<<<< ECHO
      INPUT <<<<<         VNTLEN=13.87   && Vertical extent of the vent pipe (m)
 |      <<<<< ECHO
      INPUT <<<<<         ELEVNT=3.66    && height of vent opening above bottom
of pool (m)    |      <<<<< ECHO
      INPUT <<<<<         DPDRY=1.E4     && DP for area ramping of gas flow area
(Pa)           |      <<<<< ECHO
      INPUT <<<<<         DPWET=1.E4     && DP for area ramping of gas flow area
(Pa)           |      <<<<< ECHO
      INPUT <<<<<         FDW=2.17       && loss coeff for liq flow from DW to WW
 |      <<<<< ECHO
      INPUT <<<<<         FWD=2.17       && loss coeff for liq flow from WW to DW
 |      <<<<< ECHO
      INPUT <<<<< EOI                    &&
 |      <<<<< ECHO
      INPUT <<<<< && **************** End of SP Vent Data
**********************************|       <<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ****** Data for Flow Path Model
***************************************|       <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<< FLOWS     &&
 |      <<<<< ECHO
      INPUT <<<<<       AVL(1,2)=0.163 && Ratio of flow path area to length (WW
to DW) (m) |      <<<<< ECHO
      INPUT <<<<<       CFC(1,2)=3.57  && Flow loss coefficient (WW to DW)
 |      <<<<< ECHO
      INPUT <<<<<       VAR-AREA(1,2)  && Specifies table for flow from (WW to
DW)        |      <<<<< ECHO
      INPUT <<<<<       FLAG=2         && use linear interp in table below
 |      <<<<< ECHO
      INPUT <<<<<       VAR-X=DELTA-P  && Delta-p is independent variable (Pa)
 |      <<<<< ECHO
      INPUT <<<<<       X=4            && Specify 4 values of Delta-p
 |      <<<<< ECHO
      INPUT <<<<<            -1.E9     &&
 |      <<<<< ECHO
      INPUT <<<<<            0.345E4   &&
 |      <<<<< ECHO
      INPUT <<<<<            1.943E4   &&
 |      <<<<< ECHO
```

```
     INPUT <<<<<             1.E9      &&
|      <<<<< ECHO
     INPUT <<<<<       VAR-Y=AREA      && Flow area is dependent variable
|      <<<<< ECHO
     INPUT <<<<<       Y=4             && Specify 4 values of flow area (m**2)
|      <<<<< ECHO
     INPUT <<<<<             0.        &&
|      <<<<< ECHO
     INPUT <<<<<             0.        &&
|      <<<<< ECHO
     INPUT <<<<<             0.762     &&
|      <<<<< ECHO
     INPUT <<<<<             0.762     &&
|      <<<<< ECHO
     INPUT <<<<< EOI                   &&
|      <<<<< ECHO
     INPUT <<<<<       IMPLICIT        && Implicit integr method for flow calc
<<<<< ECHO
     INPUT <<<<<       DROPOUT         && Remove suspended liquid coolant from
atmosphere          <<<<< ECHO
     INPUT <<<<<         ELEVCL(1)=209.17
<<<<< ECHO
     INPUT <<<<<         ELEVCL(2)=223.5
<<<<< ECHO
     INPUT <<<<<         ELEVCL(3)=223.5
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< ENGVENT
<<<<< ECHO
     INPUT <<<<<         FROM = 2      TO= 3
<<<<< ECHO
     INPUT <<<<<         VAREA = .00051
<<<<< ECHO
     INPUT <<<<<         VAVL = .00028
<<<<< ECHO
     INPUT <<<<<         VCFC =  5.1
<<<<< ECHO
     INPUT <<<<<         VCOSN = 0.0
<<<<< ECHO
     INPUT <<<<<         VDPB = 100.
<<<<< ECHO
     INPUT <<<<<         VDPF = 100.
<<<<< ECHO
     INPUT <<<<<         VELEVB = 223.5
<<<<< ECHO
     INPUT <<<<<         VELEVF = 223.5
<<<<< ECHO
     INPUT <<<<< EOI
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && *************  End of Data for Flow Path Model
************************|       <<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && ************ Input Data for Cell #1 (Wetwell)
*************************|       <<<<< ECHO
```

```
      INPUT <<<<< &&
 |       <<<<< ECHO
      INPUT <<<<< CELL=1    && Specifies the cell number
 |       <<<<< ECHO
      INPUT <<<<<         CONTROL   && Allocates storage space for cell 1
 |       <<<<< ECHO
      INPUT <<<<<         JPOOL=1   && Indicates presence of pool layer
 |       <<<<< ECHO
      INPUT <<<<< EOI               &&
 |       <<<<< ECHO
      INPUT <<<<< && ************ End of Control Parameters
*********************************|       <<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ******* Additional Data for Cell 1
*************************************|       <<<<< ECHO
      INPUT <<<<< TITLE      && Next line is title for cell 1
 |       <<<<< ECHO
      INPUT <<<<<    WETWELL CELL WITH WATER POOL (Cell 1)
<<<<< ECHO
      INPUT <<<<< GEOMETRY               && Geometry for Wetwell is on next two
lines          |       <<<<< ECHO
      INPUT <<<<<              4208.     && Volume of Wetwell air space (m**3)
 |       <<<<< ECHO
      INPUT <<<<<              8.69      && Height of wetwell air space (m)
 |       <<<<< ECHO
      INPUT <<<<< ATMOS                  && Initial atmosphere cond in WW air
space          |       <<<<< ECHO
      INPUT <<<<<                 1      && Number of materials in atmosphere
 |       <<<<< ECHO
      INPUT <<<<<               0.0      && Pressure will be calculated from eqn
of state      |       <<<<< ECHO
      INPUT <<<<<             417.99     && Gas temperature (K)
 |       <<<<< ECHO
      INPUT <<<<<        H2OV=9395.6     && Initial mass of water vapor in WW air
space (kg)   |       <<<<< ECHO
      INPUT <<<<< EOI
<<<<< ECHO
      INPUT <<<<< &&
 |       <<<<< ECHO
      INPUT <<<<< && **** End of Data Block for Wetwell air Space
***************************|       <<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ****** Heat Transfer Options for Wetwell
*******************************|     <<<<< ECHO
      INPUT <<<<< &&
 |       <<<<< ECHO
      INPUT <<<<<    CONDENSE   && Natural conv. and condensation HT is
modelled                     <<<<< ECHO
      INPUT <<<<<    HT-TRAN    &&
 |     <<<<< ECHO
      INPUT <<<<<           ON  && Atmosphere to Structure heat transfer is ON
 |       <<<<< ECHO
```

```
     INPUT <<<<<           ON  && Heat trans from pool to substructure (at
const T) is ON  |      <<<<< ECHO
     INPUT <<<<<           OFF && Inter-layer heat trans in pool is OFF.
|      <<<<< ECHO
     INPUT <<<<<           ON  && Pool to Air space heat trans is ON.
|      <<<<< ECHO
     INPUT <<<<<           ON  && Radiative heat transfer is ON.
|      <<<<< ECHO
     INPUT <<<<< && ******* End of Heat Transfer Description for Cell 1
*******************|      <<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<<    OVERFLOW=1
<<<<< ECHO
     INPUT <<<<< && **** Input for Pool Model in Wetwell
**********************************|      <<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<< LOW-CELL  && Input for suppression pool follows
|      <<<<< ECHO
     INPUT <<<<<    GEOMETRY  490.2  && surface area of lower cell (m**2)
|      <<<<< ECHO
     INPUT <<<<<    POOL             && Initial configuration of pool layer
follows        |     <<<<< ECHO
     INPUT <<<<<        TEMP=417.99  && Initial temperature of pool (K)
|      <<<<< ECHO
     INPUT <<<<<        COMPOS=1     && number of initial materials in the
pool           |      <<<<< ECHO
     INPUT <<<<<        H2OL=3.43E6  && Initial mass of liq water in pool (kg)
|         <<<<< ECHO
     INPUT <<<<<        PHYSICS      && Physics options for supp pool model
|      <<<<< ECHO
     INPUT <<<<<        BOIL         && Pool boiling is modelled
|      <<<<< ECHO
     INPUT <<<<< EOI                 && End of supp pool data
|      <<<<< ECHO
     INPUT <<<<< EOI                 &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && ****** Substructure Boundary Condition for Supp Pool
*****************|      <<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<<    BC=300.  && Temperature of layer beneath suppression pool
|      <<<<< ECHO
     INPUT <<<<<    EOI      &&
|      <<<<< ECHO
     INPUT <<<<< && ***************** End of Subpool layer
*******************************|      <<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && *******CELL DATA FOR DRYWELL
*****************************************|      <<<<< ECHO
```

```
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<<  CELL=2           && Cell #2 is the Drywell
 |      <<<<< ECHO
      INPUT <<<<<        CONTROL    && Allocates storage space for cell 2
 |      <<<<< ECHO
      INPUT <<<<<        NAENSY=1   && Number of engineered systems
<<<<< ECHO
      INPUT <<<<<        JPOOL =1   && Indicates presence of pool layer
<<<<< ECHO
      INPUT <<<<<  EOI              &&
 |      <<<<< ECHO
      INPUT <<<<< && ****************** End of Control Data for Drywell
******************|       <<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ************* TITLE FOR CELL 2
****************************************|       <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<<   TITLE
<<<<< ECHO
      INPUT <<<<<      DRYWELL CELL
<<<<< ECHO
      INPUT <<<<< &&
***********************************************************************|
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ********** GEOMETRIC DATA FOR DRYWELL
*********************************|       <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<<    GEOMETRY         &&
 |      <<<<< ECHO
      INPUT <<<<<              6785.   && Drywell volume (m**3)
 |      <<<<< ECHO
      INPUT <<<<<                26.75 && Characteristic height of the drywell
(m)            |       <<<<< ECHO
      INPUT <<<<< &&
***********************************************************************|
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ************ DRYWELL ATMOSPHERE DATA
*********************************|       <<<<< ECHO
      INPUT <<<<< &&
 |      <<<<< ECHO
      INPUT <<<<<    ATMOS=2      && Number of materials in the atmosphere
 |      <<<<< ECHO
      INPUT <<<<<        0.0      && Initial drywell pressure will be calculated
<<<<< ECHO
      INPUT <<<<<        395.37   && Initial gas temperature (K)
 |      <<<<< ECHO
```

```
     INPUT <<<<<    H2OV=8125.7 && Initial mass of water vapor (kg)
|       <<<<< ECHO
     INPUT <<<<<    N2=11679.
<<<<< ECHO
     INPUT <<<<< EOI
<<<<< ECHO
     INPUT <<<<< &&
**********************************************************************|
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && *************** Heat transfer options for DW  walls
*******************|      <<<<< ECHO
     INPUT <<<<< &&
|       <<<<< ECHO
     INPUT <<<<<    CONDENSE     && Natural Conv and Condensation HT is
modelled               <<<<< ECHO
     INPUT <<<<<    HT-TRAN      ON  OFF  OFF  ON  ON
<<<<< ECHO
     INPUT <<<<< &&
**********************************************************************|
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<<
<<<<< ECHO
     INPUT <<<<<     ENGINEER   FLOV  1  2  1  17.07
<<<<< ECHO
     INPUT <<<<<        OVERFLOW   2  1  0.4572
<<<<< ECHO
     INPUT <<<<<     EOI
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<<     OVERFLOW=2
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<<    LOW-CELL
<<<<< ECHO
     INPUT <<<<<      GEOMETRY  451.
<<<<< ECHO
     INPUT <<<<<      POOL
<<<<< ECHO
     INPUT <<<<<        TEMP=395.37
<<<<< ECHO
     INPUT <<<<<        COMPOS=1   H2OL=1.0
<<<<< ECHO
     INPUT <<<<<        PHYSICS   BOIL   EOI
<<<<< ECHO
     INPUT <<<<<      EOI
<<<<< ECHO
     INPUT <<<<<     EOI
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
```

```
      INPUT <<<<< && *******CELL DATA FOR ATMOSPHERRE
**************************************|      <<<<< ECHO
      INPUT <<<<< &&
|       <<<<< ECHO
      INPUT <<<<<  CELL=3          && Cell #3 is atmosphere
|       <<<<< ECHO
      INPUT <<<<<        CONTROL   && Allocates storage space for cell #3
|       <<<<< ECHO
      INPUT <<<<<  EOI             &&
|       <<<<< ECHO
      INPUT <<<<< && ******************* End of Control Data for Cell #3
*******************|      <<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ************* TITLE FOR CELL #3
***************************************|      <<<<< ECHO
      INPUT <<<<< &&
|       <<<<< ECHO
      INPUT <<<<<   TITLE
<<<<< ECHO
      INPUT <<<<<     ATMOSPHERE CELL
<<<<< ECHO
      INPUT <<<<< &&
***********************************************************************|
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ********** GEOMETRIC DATA FOR CELL #3
*********************************|      <<<<< ECHO
      INPUT <<<<< &&
|       <<<<< ECHO
      INPUT <<<<<    GEOMETRY        &&
|       <<<<< ECHO
      INPUT <<<<<            1.0E8   && Cell #3 volume (m**3)
|       <<<<< ECHO
      INPUT <<<<<            1.0E3   && Characteristic height of Cell #3
(m)             |      <<<<< ECHO
      INPUT <<<<< &&
***********************************************************************|
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< &&
<<<<< ECHO
      INPUT <<<<< && ************ CELL #3 ATMOSPHERE DATA
**********************************|      <<<<< ECHO
      INPUT <<<<< &&
|       <<<<< ECHO
      INPUT <<<<<    ATMOS=2     && Number of materials in the atmosphere
|       <<<<< ECHO
      INPUT <<<<<      1.014E5   && Initial cell pressure (Pa)
<<<<< ECHO
      INPUT <<<<<        305.37  && Initial gas temperature (K)
|       <<<<< ECHO
      INPUT <<<<<    N2=0.79     && Initial mole fraction of nitrogen in Cell
<<<<< ECHO
```

```
     INPUT <<<<<    O2=0.21      && Initial mole fraction of oxygen in Cell
<<<<< ECHO
     INPUT <<<<< EOI
<<<<< ECHO
     INPUT <<<<< &&
***********************************************************************|
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<< && *************** Heat transfer options for heat structures
*************|       <<<<< ECHO
     INPUT <<<<< &&
|      <<<<< ECHO
     INPUT <<<<<    CONDENSE     && Natural Conv and Condensation HT is
modelled                  <<<<< ECHO
     INPUT <<<<<    HT-TRAN      ON   ON   ON   ON   ON
<<<<< ECHO
     INPUT <<<<< &&
***********************************************************************|
<<<<< ECHO
     INPUT <<<<< &&
<<<<< ECHO
     INPUT <<<<<    EOF
<<<<< ECHO


    ENGINEERED VENT FLOW CONDITIONS     AT TIME =         .000 (S)

         FROM CELL     TO CELL     FLOW (KG/S)  VELOCITY (M/S)   AREA (M**2)

               2           3      0.00000E+00    0.00000E+00    0.00000E+00


 >>>>> ENG. VENT <  1> BETWEEN CELLS <  2> AND <  3> IS BEING OPENED AT TIME=
1.00000E-02
   >


    ENGINEERED VENT FLOW CONDITIONS     AT TIME =        1.000 (S)

         FROM CELL     TO CELL     FLOW (KG/S)  VELOCITY (M/S)   AREA (M**2)

               2           3      2.14885E-01    1.45889E+02    5.10000E-04


    ENGINEERED VENT FLOW CONDITIONS     AT TIME =        3.000 (S)

         FROM CELL     TO CELL     FLOW (KG/S)  VELOCITY (M/S)   AREA (M**2)

               2           3      2.14878E-01    1.45887E+02    5.10000E-04

    ENGINEERED VENT FLOW CONDITIONS     AT TIME =      600.000 (S)

         FROM CELL     TO CELL     FLOW (KG/S)  VELOCITY (M/S)   AREA (M**2)

               2           3      2.10025E-01    1.43561E+02    5.10000E-04
```

Appendix D

Drywell to Suppression Chamber Bypass Test Calculation

Summary

The risk increase on the total integrated plant risk by extending Drywell to Suppression Chamber Bypass Test (Bypass Test) from 10 years to 15 years is 0.04%. The increase in LERF is 7E-11 / year. Per RG 1.174, both of these increases are not significant.

The vacuum breaker leakage test and stringent acceptance criteria, combined with the negligible non-vacuum breaker leakage area, and thorough periodic visual inspection provide an equivalent level of assurance as the Bypass Test that the drywell-to-suppression chamber bypass leakage can be measured and an adverse condition detected prior to LOCA. Additionally, operator action to use containment sprays will mitigate the consequences of a bypass area failure during a small break LOCA.

Therefore, containment integrity during a LOCA is maintained for the proposed change, and testing at the revised interval does not impact plant safety margins.

A. Objective

Provide a risk impact assessment on extending the plant's Drywell to Suppression Chamber Bypass Test interval from 10 to 15 years. This risk assessment is performed separate from the Type A Test assessment in the main body of the calculation. The risk assessment will be performed in accordance with the guidelines set forth in NEI 94-01 (1), the methodology used in EPRI TR-104285 (2), and the NRC regulatory guidance on the use of Probabilistic Risk Assessment (PRA) findings and risk insights in support of a licensee request for changes to a plant's licensing basis, Reg. Guide 1.174 (3).

Reg. Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. This calculation will demonstrate that the increased risk to the public (person-rem / year) is insignificant. This calculation will demonstrate per Reg. Guide 1.174 that the change in risk increases CDF less than 1E-06/year and increases LERF less than 1E-07/year.

The results and findings from the SSES Individual Plant Examination (IPE) (4) are used for this risk assessment calculation.

B. Conclusion

The conclusions regarding the assessment of the plant risk associated with extending the Drywell to Suppression Chamber Bypass Test frequency from 10 years to 15 years are as follows:

1. The risk assessment associated with implementation of a one-time exemption in extending the containment Bypass Test from 10 years to 15 years predicts a slight increase in risk when compared to that estimated from current requirements. The change in risk for Class 7 as measured by person-rem/year increases by 0.04%. Also, the total integrated plant risk for those accident sequences influenced by Drywell to Suppression Chamber Bypass Test, given the change from a once per 10 years test interval to a once per 15 years test interval increases by 0.04%. This value is an insignificant increase in risk.

2. Reg. Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Reg. Guide 1.174 defines very small changes in risk as resulting in increases of core damage frequency (CDF) below 1.0E-06/year and increases in LERF below 1.0E-07/year. Since the Drywell to Suppression Chamber Bypass Test does not impact CDF, the relevant criterion is LERF. The increase in LERF resulting from a change in the Drywell to Suppression Chamber Bypass Test interval from once per 10 year test interval to once per 15 year test interval is 7.21E-11/yr. Since guidance in Reg. Guide 1.174 defines very small changes in LERF as below 1.0E-07/yr, increasing the ILRT interval to 15 years is therefore not risk significant.

	Base line - 3 year interval	Results 10 year interval	15 year interval
Total (person-rem per year)	1.147	1.148	1.149
Increase over 3 year		0.07%	0.11%
Increase over 10 year			0.04%
Class 7 (person-rem per year)	1.005	1.006	1.006
Class 7 Increase over 3 year		0.09%	0.13%
Class 7 Increase over 10 year			0.04%
LERF	1.60E-07	1.60E-07	1.61E-07
Increase over 3 year		1.44E-10	2.16E-10
Increase over 10 year			7.21E-11

C. Assumptions

1. Same as Section 3.0.
2. Type A ILRT is performed at 3 year intervals. This assumption is used in order to assess the risk impact based on Bypass Test interval alone.

D. Method

The following steps are used to perform the analysis:

1. Discuss design basis
2. Technical justification of change
3. Risk assessment of change

Steam Bypass Design Basis (19)(24)

During a small break LOCA, potential leak paths between the drywell and suppression chamber airspace could result in excessive containment pressures, since the steam flow into the airspace would bypass the vapor suppression capabilities of the pool. Potential sources of bypass leakage are the drywell-to-suppression chamber vacuum breakers, penetrations in the diaphragm floor, and cracks in the diaphragm floor/liner plate, cross-connected piping systems and downcomers located in the suppression chamber airspace. The containment pressure response to the postulated bypass leakage can be mitigated by manually actuating the containment sprays. Procedures specify suppression chamber spray actuation at a drywell pressure greater than 1.72 psig and drywell sprays after 13 psig. For a 0.0535 ft^2 bypass leakage path, it takes 22.6 minutes for the suppression chamber to pressurize from 30 psig to 53 psig.

Technical Justification for Linking The Drywell-To-Suppression Chamber Bypass Test Frequency to the ILRT Frequency (19)

The proposed change aligns the test frequency for the drywell-to-suppression chamber bypass test (currently 10 years) to an interval which coincides with the test frequency for the Type A ILRT. This has the potential to decrease the bypass test frequency from 10 years to a maximum of once per 15 years, depending on ILRT testing results, and the results from drywell-to-suppression chamber bypass testing. The safety significance of this change can be addressed by evaluating whether there is a reduction in the ability to detect an adverse bypass flow condition due to the increased time duration between bypass tests proposed by the change.

Potential bypass leakage originates from three flow paths:

1. Non-vacuum breaker sources such as leakage through the diaphragm floor penetrations (SRV discharge line and downcomers), cracks in the diaphragm floor/liner plate, cracks in the downcomers that pass through the suppression pool airspace.
2. Cross-Connected Piping Systems.
3. The five sets of drywell-to-suppression chamber containment vacuum breakers.

Each potential flow path is evaluated for the proposed change.

Non-Vacuum Breaker components

A periodic visual examination of the diaphragm slab and non-vacuum breaker components assesses the integrity of the bypass boundary. The visual examination of the diaphragm slab is conducted using the same methodology and at the same frequency as the visual inspection of the containment structure, per Regulatory Guide 1.163. This inspection is conducted three times within the ten year testing interval.

Cross Connected Piping Systems

The systems with piping external to the containment that are a potential source of drywell-to-suppression chamber bypass leakage are listed below:

1. Containment vent and purge lines (18" and 24" diameter; two flow paths)
2. Drywell and suppression chamber spray lines (12" and 6" diameter; two flow paths)
3. N_2 pressurization lines (1" diameter; one flow path)
4. H_2 and O_2 analyzer lines (1" diameter; four flow paths)
5. Containment instrument gas lines (1" and 3" diameter; one flow path)

The potential bypass leakage through the above flow paths is expected to be minimal compared to the Technical Specification allowable bypass leakage (0.77 in^2). The cross-connected piping are isolated from the containment by the drywell and suppression chamber containment isolation valves. All flow paths have multiple, in-series containment isolation valves that are designed to meet leakage criteria specified in 10CFR50 Appendix J Option B. The Technical Specifications require periodic local leak rate testing (LLRT) to ensure that the valves comply with the Primary Containment Leakage Rate Testing Program. Therefore, leakage from the drywell-to-suppression chamber airspace can only occur via leakage through multiple containment isolation valves.

Containment Vacuum Breaker Flow Area

The remaining and most likely source of potential bypass leakage are the five sets of containment vacuum breakers. Each set consists of two vacuum breakers in series, flange mounted to a tee off the downcomers in the suppression chamber airspace.

The drywell-to-suppression chamber vacuum breaker leakage test per SR 3.6.1.1.3 is completed when a Bypass Test per SR 3.6.1.1.2 is not performed. The proposed change allows for decreased drywell-to-suppression chamber bypass testing. This would then require a vacuum breaker leak test to be performed every refuel outage except when a combined ILRT/bypass test is performed per 10 CFR 50 Appendix J Option B.

a. The expected leakage through the vacuum breakers based on the acceptance criteria of 30% of the Technical Specification limit (0.001605 sq. ft.) and hypothetical vacuum breaker test conditions has been calculated. The acceptable total vacuum breaker leakage is 1,580,000 sccm or 55.8 scfm.

   The highest total vacuum breaker leakage measured to date is 97,782 sccm or 6.2% of the allowable leakage (see Table D-1).

b. Each individual set of vacuum breakers will have a leakage area of less than or equal to twice the acceptable evenly distributed vacuum breaker leakage from a. above (12% of Technical Specification limit). This allows a leakage area of less than or equal to 0.000642 sq. ft. for an individual set of vacuum breakers. The criteria is stipulated to identify individual sets of vacuum breakers with higher leakage area, while maintaining some allowance for non-uniformity in leakage between vacuum breaker sets.

   Based on calculations of expected vacuum breaker leakage, the allowable leakage flow rate would be 632,000 sccm or 22.3 scfm for an individual vacuum breaker set.

   The largest leakage flow rate measured to date is 85,726 sccm or 13.6% of the allowable leakage (see Table D-1).

No drywell vacuum breakers have failed the leakage test or required corrective action due to leakage since the testing was started in 1993. A failure to meet the total leakage area criteria in a. or b. above requires corrective action to reduce the vacuum breaker leakage area to below the acceptance criteria. If either acceptance criteria in a. or b. is exceeded, then a root cause evaluation will be conducted to determine why the vacuum breaker leakage area exceeded the criteria.

Table D-1

Drywell to Suppression Chamber Vacuum Breaker Leakage Rate Test Results (sccm)

Unit 1

Date	PSV15704A1&2	PSV15704B1&2	PSV15704C1&2	PSV15704D1&2	PSV15704E1&2	TOTAL
10/27/1993	91	12875	88	17643	699	31396
04/21/1995 *	1126	886	85726	81	9963	97782
10/01/1996	4	763	7200	1066	19850	28883
05/12/1998	976	20	21	1019	20	2056
04/15/2000	810	20	20	2849	646	4345

* Leakage around downcomer test plate gasket for PSV15704C1&2

Unit 2

Date	PSV25704A1&2	PSV25704B1&2	PSV25704C1&2	PSV25704D1&2	PSV25704E1&2	TOTAL
05/05/1994	4178	17	4992	577	558	10322
09/29/1995	5800	31	415	0	435	6681
04/03/1997	9168	336	454	16	444	10418
04/06/1999	20000	34	648	34	637	21353
04/10/2001	13488	712	179	213	213	14805

Risk Assessment

The following steps are used for the risk assessment:

1. Calculate risk for 3 year bypass test interval.
2. Determine sequences that require bypass area in accordance with design basis.
3. Calculate probability of failure of bypass area.
4. Calculate probability of operator failure to use containment sprays.
5. Calculate risk for 10 year bypass test interval.
6. Calculate risk for 15 year bypass test interval.
7. Calculate change in LERF

Step 1 - Calculate risk for 3 year bypass test interval.

Table D-2 is the same as Table 3 in Section 4.0 of the main calculation. The basis for Table 3 is explained in Section 4.0.

The Bypass Test affects only accident sequences that are part of Class 7 because a bypass area failure may result in loss of containment that is grouped as a Severe Accident. For Class 7, Tables D-2, D-3, and D-4 carry extra decimal places to show the small differences as the risk analysis progresses.

Table D-2
Mean Consequence Measures for 3-Year Bypass Test Interval

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr
1	No Containment Failure	1.63E-07	3.29E+05	5.36E-02
2	Large Containment Isolation Failures (Failure-to-close)	5.35E-10	4.38E+05	2.34E-04
3a	Small Isolation Failures (Hole in Primary Containment)	2.39E-08	4.41E+05	1.06E-02
3b	Large Isolation Failures (Hole in Primary Containment)	7.85E-09	4.38E+05	3.44E-03
4	Small Isolation Failure – failure to seal (Type B Test)	NA	NA	0.0
5	Small Isolation Failure – failure to seal (Type C Test)	NA	NA	0.0
6	Containment Isolation Failures (dependent failures, personnel errors)	8.60E-10	4.38E+05	3.77E-04
7	Severe Accident Phenomena Induced Failure (Early and Late Failures)	1.6030E-07	6.27E+06	1.0051E+00
8	Containment Bypassed (Secondary Containment Bypass Leakage)	1.75E-08	4.24E+06	7.41E-02
	Total	3.74E-07		1.1474E+00

Step 2 - Determine sequences that require bypass area in accordance with design basis

The bypass area analysis is performed in order to maintain pressure suppression function during a small break LOCA. Loss of pressure suppression function results in Containment Over Pressure Failure (COPF) prior to core damage. Per the IPE (4), small and medium break LOCA are the initiating events for 30% of the sequences that lead to COPF.

The list contains the cutsets from the PRA that cause COPF. The sum of the cutsets that initiate as a small break LOCA (S1) and medium break LOCA (S2) is 1.18E-07. The total COPF is 4.00E-07. Therefore, the fraction of COPF that bypass area is relevant is 30%.

S2	CCFRHR	DHRpmpR	4.75E-09
S2	ESWCCF	DHRpmpR	4.75E-09
S2	CCFRHRSW	DHRpmpR	4.62E-09
S2	RHRBES	RHRHTX2	1.31E-09
S2	RHRBKS	RHRHTX2	1.31E-09
S2	RHRBMS	RHRHTX2	1.31E-09

[redacted]	RHRSW1A	RHRSW2A	RHRBFS				7.06E-10	
[redacted]	RHRSW1B	RHRSW2B	RHRHTX2				7.06E-10	
[redacted]	RHRSW1B	RHRSW2B	RHRBNS				7.06E-10	
[redacted]	RHRSW1B	RHRSW2B	RHRBPS				7.06E-10	
[redacted]	RHRSW1B	RHRSW2B	RHRBKS				9.19E-11	
[redacted]	RHRSW1B	RHRSW2B	RHRBMS				9.19E-11	
[redacted]	RHRSW1B	RHRSW2B	RHRBES				9.19E-11	
[redacted]	RHRSW1B	RHRSW2B	RHRHTEXI				9.12E-11	
[redacted]	ESWA	ESWB	ESWC	ESWD	DHRpmpR		3.32E-11	
[redacted]	ESWBPA	ESWBPB					2.59E-11	
[redacted]	ESWSNA	ESWBPB					2.59E-11	
[redacted]	ESWBPA	ESWSNB					2.59E-11	
[redacted]	ESWSNA	ESWSNB					2.59E-11	
[redacted]	ESWBPA	ESWBPB	DHRpmpR				2.59E-12	
[redacted]	ESWSNA	ESWBPB	DHRpmpR				2.59E-12	
[redacted]	ESWBPA	ESWSNB	DHRpmpR				2.59E-12	
[redacted]	ESWSNA	ESWSNB	DHRpmpR				2.59E-12	
[redacted]	RHRBES	RHRHTX2					1.19E-08	
[redacted]	RHRBKS	RHRHTX2					1.19E-08	
[redacted]	RHRBMS	RHRHTX2					1.19E-08	
[redacted]	RHRHTEXI	RHRBFS					1.18E-08	
[redacted]	RHRHTEXI	RHRBNS					1.18E-08	
[redacted]	RHRHTEXI	RHRBPS					1.18E-08	
[redacted]	RHRHTEXI	RHRHTX2					1.18E-08	
[redacted]	CCFRHR	MCR					4.31E-09	
[redacted]	ESWCCF	MCR					4.31E-09	
[redacted]	CCFRHRSW	MCR					4.19E-09	
[redacted]	ESWBPA	ESWBPB					2.35E-10	
[redacted]	ESWSNA	ESWBPB					2.35E-10	
[redacted]	ESWBPA	ESWSNB					2.35E-10	
[redacted]	ESWSNA	ESWSNB					2.35E-10	
[redacted]	ESWA	ESWB	ESWC	ESWD	MCR		3.01E-11	
[redacted]	ESWBPA	ESWBPB	MCR				2.35E-12	
[redacted]	ESWSNA	ESWBPB	MCR				2.35E-12	
[redacted]	ESWBPA	ESWSNB	MCR				2.35E-12	
[redacted]	ESWSNA	ESWSNB	MCR				2.35E-12	[redacted]
RBCCW	OCTIA	ESWCCF	OCTIALT				4.33E-13	
RBCCW	OCTIA	RHRHTX2	RHRPAS	RHRPCS	MC		4.03E-13	
RBCCW	OCTIA	RHRHTEX1	RHRPBS	RHRPDS	MC		4.03E-13	
RBCCW	TBCCWrun	ESWCCF	TBCCWstart				2.07E-14	
RBCCW	OCTIA	RHRHTX2	RHRSW1A	RHRSW2A	OCTIALT		6.43E-15	
RBCCW	OCTIA	ESWA	ESWB	ESWC	ESWD	OCTIALT	3.03E-15	
RBCCW	RHRHTEX1	RHRSW1A	RHRSW2A	OCTIA	OCTIALT		8.32E-16	
RBCCW	OCTIA	RHRHTX2	ESWA	ESWB	ESWC	ESWD	7.17E-17	
RBCCW	OCTIA	RHRHTEX1	ESWA	ESWB	ESWC	ESWD	7.13E-17	
LOOP	ESWCCF	NR26					6.88E-09	
LOOP	CCFRHR	NR26					6.70E-09	
LOOP	CCFRHRSW	NR26					6.70E-09	
LOOP	_4DG	DGE	NR26	DGR26			3.56E-09	
~~LOOP~~	~~RHRSW1A~~	~~RHRSW2A~~	~~RHRBFS~~	~~NR26~~			1.02E-10	
LOOP	RHRSW1B	RHRSW2B	RHRHTX2	NR26			1.02E-10	

LOOP	RHRSW1B	RHRSW2B	RHRBNS	NR26			1.02E-10
LOOP	RHRSW1B	RHRSW2B	RHRBPS	NR26			1.02E-10
LOOP	ESWA	ESWB	ESWC	ESWD	NR26		4.82E-11
LOOP	RHRSW1B	RHRSW2B	RHRBKS	NR26			1.33E-11
LOOP	RHRSW1B	RHRSW2B	RHRBMS	NR26			1.33E-11
LOOP	RHRSW1B	RHRSW2B	RHRBES	NR26			1.33E-11
LOOP	RHRSW1B	RHRSW2B	RHRHTEXI	NR26			1.32E-11
LOOP	ESWA	ESWB	ESWC	ESWD	NR26	DGR26	6.75E-12
LOOP	ESWBPA	ESWBPB	NR26				3.75E-12
LOOP	ESWSNA	ESWBPB	NR26				3.75E-12
LOOP	ESWBPA	ESWSNB	NR26				3.75E-12
LOOP	ESWSNA	ESWSNB	NR26				3.75E-12
_LA204	_A201	ESWB					6.43E-08
_LA203	_A202	ESWA					6.43E-08
_LA202	_A203	ESWA					6.43E-08
_LA201	_A204	ESWB					6.43E-08
TBCCW	ESWA	ESWB	ESWC	ESWD	RHRvlvR		1.02E-13
TBCCW	RHRHTX2	RHRPAS	RHRPCS	RWCUPMP			4.73E-16
TBCCW	RHRBES	RHRHTX2	RWCUPMP				2.34E-16
TBCCW	RHRBKS	RHRHTX2	RWCUPMP				2.34E-16
TBCCW	RHRBMS	RHRHTX2	RWCUPMP				2.34E-16
TBCCW	RHRHTEXI	RHRBFS	RWCUPMP				2.32E-16
TBCCW	RHRHTEXI	RHRBNS	RWCUPMP				2.32E-16
TBCCW	RHRHTEXI	RHRBPS	RWCUPMP				2.32E-16
TBCCW	RHRHTEXI	RHRHTX2	RWCUPMP				2.32E-16
TBCCW	RHRHTX2	RHRSW1A	RHRSW2A	RWCUPMP			1.26E-16
TBCCW	RHRHTEX1	RHRSW1B	RHRSW2B	RWCUPMP			1.63E-17
TBCCW	RHRHTEX1	CCFRHRP	RWCUPMP				1.16E-17
TBCCW	RHRHTX2	ESWA	ESWB	ESWC	ESWD	RWCUPMP	8.41E-20
TBCCW	RHRHTEX1	ESWA	ESWB	ESWC	ESWD	RWCUPMP	8.36E-20
T2_	MC	RHRBMS	RHRBPS	RWCUpath	RHRvlvR		4.03E-11
T2_	MC	RHRHTEXI	RHRHTX2	RWCUpath			4.00E-11
T2_	TBCCWrun	TBCCWstart	RHRHTEXI	RHRHTX2			2.64E-11
T2_	TBCCWrun	RHRBMS	RHRBPS	RWCUpath	RHRvlvR	TBCCWstart	2.66E-14
T2_	MC	RHRHTEXI	RHRHTX2	RWCUPMP			2.32E-14
T2_	RHRHTEX1	RHRHTX2	SW	RWCUpath	RHRvlvR		6.81E-16
T2_	MC	RHRBMS	RHRBPS	RWCUpmp	RHRvlvR		2.34E-17
T2_	RHRHTEX1	RHRHTX2	SW	RWCUpmp	RHRvlvR		3.95E-19
T1_	RHRBMS	RHRBPS	RWCUpath	RHRvlvR			7.06E-13
T1_	RHRBMS	RHRBPS	RWCUpmp	RHRvlvR			4.09E-16
Total							4.00E-07 [redacted]

Step 3 - Calculate probability of failure of bypass area

Per PLA-4424, Susquehanna conducted 15 Drywell to Suppression Chamber Bypass Tests between 1982 and 1992. There were no failures of the bypass area during any of these tests. (19)

To estimate the failure probability given that no failures have occurred, a conservative estimate is obtained from the 95th percentile of the chi-squared distribution (16). In statistical theory, the chi-squared distribution can be used for statistical testing, goodness-of-fit tests, and evaluating s-confidence. The chi-squared distribution is really a family of distributions, which range in shape from that of the exponential to that of the normal distribution. Each distribution is identified by the degrees of freedom, v. For time truncated tests (versus failure-truncated tests), an estimate of the probability of a large leak using the chi-squared distribution can be calculated as chi-squared (95^{th}) (v = 2n+2)/2N, where n represents the number of large leaks and N represents the number of Drywell to Suppression Chamber Bypass Tests performed to date. With no large leaks (n = 0) in 15 events (N = 15) and chi-squared (95^{th}) (2) = 5.99, the 95^{th} percentile estimate of the probability of a large leak is calculated as 5.99/(2*15) = 0.20.

Step 4 - Calculate probability of operator failure to use containment sprays

The operators have permission to use suppression chamber sprays when drywell pressure exceeds 1.72 psig and drywell sprays when drywell pressure exceeds 13 psig. As stated above, analysis indicates that it takes 22 minutes to for containment to reach 53 psig from 30 psig given a 0.0535 sq. ft. bypass area. 53 psig is the containment design pressure. The operators have permission to use containment sprays before 30 psig and ultimate containment strength is 140 psig. The size of the bypass area can be larger than design basis value, so we use 20 minutes as the success criteria for operator action to initiate containment sprays to bound the scenario. The failure rate for this operator action is 0.0045. Table 5-46 on page 161(22) is used for probability of failure to manually operate critical component. This table is appropriate because operation of containment sprays is a manual operation that is authorized in the Emergency Operation Procedures.

Step 5 - Calculate risk for 10 year bypass test interval

The probability of Class 7 changes by the following factors:

Fraction of sequences in Class 7 that Bypass area impacts – 0.3 (from Step 2)
Probability of Bypass Failure based on testing history – 0.2 (from Step 3)
Probability of operator failure to use containment sprays – 0.0045 (from Step 4)
Increased probability of failure because average time that bypass area goes undetected increases from 18 months (1/2 of 3 years) to 60 months (1/2 of 10 years) – 60 / 18 = 3.33

Total increase = 0.3 x 0.2 x 0.0045 x 3.33 = 0.0009 See Table D-3.

Table D-3
Mean Consequence Measures for 10-Year Bypass Test Interval

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr (50-Miles)
1	No Containment Failure	1.63E-07	3.29E+05	5.36E-02
2	Large Containment Isolation Failures (Failure-to-close)	5.35E-10	4.38E+05	2.34E-04
3a	Small Isolation Failures (Hole in Primary Containment)	2.39E-08	4.41E+05	1.06E-02
3b	Large Isolation Failures (Hole in Primary Containment)	7.85E-09	4.38E+05	3.44E-03
4	Small Isolation Failure – failure to seal (Type B Test)	NA	NA	0.0
5	Small Isolation Failure – failure to seal (Type C Test)	NA	NA	0.0
6	Containment Isolation Failures (dependent failures, personnel errors)	8.60E-10	4.38E+05	3.77E-04
7	Severe Accident Phenomena Induced Failure (Early and Late Failures)	1.6044E-07	6.27E+06	1.0060E+00
8	Containment Bypassed (Secondary Containment Bypass Leakage)	1.75E-08	4.24E+06	7.41E-02
Core Damage	All Containment Event Tree Endstates	3.74E-07		1.1483E+00

The percent risk increase ($\Delta\%Risk_{10}$) due to a ten-year Bypass Test over the baseline case is as follows:

Delta %Risk = ((Total-10 – Total-base) / Total-base) * 100

Where:

Total-base = total person-rem / year for baseline interval = 1.1474 person-rem / year
Total-10 = total person-rem / year for 10-year interval = 1.1483 person-rem / year

Delta %Risk = ((1.1483 – 1.1474) / 1.1474) * 100
= 0.08%

Therefore, the increase in risk contribution because of relaxed ten-year Bypass test frequency from 3-in-10 years to 1-in-10 years is 0.08%.

Step 6 - Risk Impact due to 15 year Test Interval

The probability of Class 7 changes by the following factors:

Fraction of sequences in Class 7 that Bypass area impacts – 0.3 (from Step 2)
Probability of Bypass Failure based on testing history – 0.2 (from Step 3)
Probability of operator failure to use containment sprays – 0.0045 (from Step 4)
Increased probability of failure because average time that bypass area goes undetected increases from 18 months (1/2 of 3 years) to 90 months (1/2 of 15 years) – 90 / 18 = 5.0

Total increase = 0.3 x 0.2 x 0.0045 x 5.0 = 0.00135 See Table D-4.

Table D-4
Mean Consequence Measures for 15-Year Bypass Test Interval

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr (50-Miles)
1	No Containment Failure	1.63E-07	3.29E+05	5.36E-02
2	Large Containment Isolation Failures (Failure-to-close)	5.35E-10	4.38E+05	2.34E-04
3a	Small Isolation Failures (Hole in Primary Containment)	2.39E-08	4.41E+05	1.06E-02
3b	Large Isolation Failures (Hole in Primary Containment)	7.85E-09	4.38E+05	3.44E-03
4	Small Isolation Failure – failure to seal (Type B Test)	NA	NA	0.0
5	Small Isolation Failure – failure to seal (Type C Test)	NA	NA	0.0
6	Containment Isolation Failures (dependent failures, personnel errors)	8.60E-10	4.38E+05	3.77E-04
7	Severe Accident Phenomena Induced Failure (Early and Late Failures)	1.6051E-07	6.27E+06	1.0064E+00
8	Containment Bypassed (Secondary Containment Bypass Leakage)	1.75E-08	4.24E+06	7.41E-02
Core Damage	All Containment Event Tree Endstates	3.74E-07		1.1487E+00

The percent increase on the total integrated plant risk for these accident sequences is computed as follows.

Delta %Risk = ((Total-15 – Total-10) / Total-10) * 100

Where:

Total-15 = total person-rem / year for 15 year interval = 1.1483 person-rem / year
Total-10 = total person-rem / year for 10 year interval = 1.1487 person-rem / year

Delta %Risk = ((1.1487 – 1.1483) / 1.1483) * 100
= 0.04%

Therefore, the risk impact on the total integrated plant risk for these accident sequences influenced by Bypass testing is only 0.04%.

The percent risk increase ($\Delta\%Risk_{15}$) due to a fifteen-year ILRT over the baseline case is as follows:

$$\text{Delta \%Risk} = ((\text{Total-15} - \text{Total-base}) / \text{Total-base}) * 100$$

Where:

Total-15 = total person-rem / year for 15 year interval = 1.1487person-rem / year
Total-base = total person-rem / year for 3 year interval = 1.1474 person-rem / year

$$\text{Delta \%Risk} = ((1.1487 - 1.1474) / 1.1474) * 100$$
$$= 0.11\%$$

Therefore, the total increase in risk contribution associated with relaxing the Bypass test frequency from three in ten years to once-per-fifteen years is 0.11%

Step 7 - Calculate change in LERF

The risk impact associated with extending the Bypass Test interval involves the potential that a core damage event that normally would result in only a small radioactive release from containment could in fact result in a large release due to failure to detect a pre-existing bypass area during the relaxation period. For this evaluation only Class 7 sequences have the potential to result in large releases if a pre-existing bypass area were present.

Reg. Guide 1.174 (3) provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Reg. Guide 1.174 (3) defines very small changes in risk as resulting in increases of core damage frequency (CDF) below 1E-06/yr and increases in LERF below 1E-07/yr. Since the Bypass Test does not impact CDF, the relevant metric is LERF. Calculating the increase in LERF requires determining the impact of the Bypass Test interval on the leakage probability.

As described in Step 6, extending the Bypass Test interval from once-per-10 years to once-per-15 years will increase the average time that a bypass area detectable only by a Bypass Test goes undetected from 60 to 90 months. LERF is calculated by calculating the increase in probability for Class 7 between 10 years and 15 years. The increase in LERF is 7E-11 / year. Since guidance in Reg. Guide 1.174 defines very small changes in LERF as below 1E-07/yr, increasing the Bypass Test interval to 15 years is non-risk significant.

It should be noted that if the risk increase is measured from the original 3-in-10-year interval, the increase in LERF is 2E-10 / year. This value is also below the 1E-07/yr screening criterion in Reg. Guide 1.174.

E. Results

The risk increase on the total integrated plant risk by extending Bypass testing from 10 years to 15 years is 0.04%. The increase in LERF is 7E-11 / year. Per RG 1.174, both of these increases are not significant.

The vacuum breaker leakage test and stringent acceptance criteria, combined with the negligible non-vacuum breaker leakage area, and thorough periodic visual inspection provide an equivalent level of assurance as the Bypass Test that the drywell-to-suppression chamber bypass leakage can be measured and an adverse condition detected prior to LOCA. Additionally, operator action to use containment sprays will mitigate the consequences of a bypass area failure during a small break LOCA.

Therefore, containment integrity during a LOCA is maintained for the proposed change, and testing at the revised interval does not impact plant safety margins.

Appendix E

Containment Fragility Calculation

Summary

The risk increase on the total integrated plant risk due to corrosion of the containment liner from the concealed surface is 0.09%. There is no increase in LERF. Both of these increases are not significant.

A. Objective

Provide a risk impact assessment on containment degradation due to corrosion of the containment liner from the concealed surface (concealed corrosion). This risk assessment is required as part of justification for extending the plant's Type A Test interval from 10 to 15 years. This risk assessment is performed separate from the Type A Test assessment in the main body of the calculation. The risk assessment will be performed in accordance with the guidelines set forth in NEI 94-01 (1), the methodology used in EPRI TR-104285 (2), and the NRC regulatory guidance on the use of Probabilistic Risk Assessment (PRA) findings and risk insights in support of a licensee request for changes to a plant's licensing basis, Reg. Guide 1.174 (3).

Reg. Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. This calculation will demonstrate that the increased risk to the public (person-rem / year) is insignificant. This calculation will demonstrate per Reg. Guide 1.174 that the change in risk increases CDF less than 1E-06/year and increases LERF less than 1E-07/year.

The results and findings from the SSES Individual Plant Examination (IPE) (4) are used for this risk assessment calculation.

B. Conclusion

The conclusions regarding the assessment of the plant risk associated with concealed corrosion are as follows:

1. The risk assessment associated with concealed corrosion from 10 years to 15 years predicts a slight increase in risk when compared to that estimated from current requirements. The change in risk for Class 7 as measured by person-rem/year increases by 0.11%. Also, the total integrated plant risk for those accident sequences influenced by concealed corrosion, given the change from 10 year test interval to a 15 year test interval increases by 0.09%. This value is an insignificant increase in risk.

2. Reg. Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Reg. Guide 1.174 defines very small changes in risk as resulting in increases of core damage frequency (CDF) below 1.0E-06/year and

increases in LERF below 1.0E-07/year. Since the concealed corrosion does not impact CDF, the relevant criterion is LERF. The increase in LERF resulting from concealed corrosion from 10 year test interval to 15 year test interval is 0.00 / year because containment does not fail until 22 hours after the initiating event which does not result in an early release. Since guidance in Reg. Guide 1.174 defines very small changes in LERF as below 1.0E-07/yr, increasing the ILRT interval to 15 years is therefore not risk significant.

	Base line - 3 year interval	Results 10 year interval	15 year interval
Total (person-rem per year)	1.3622	1.3641	1.3653
Increase over 3 year		0.13%	0.23%
Increase over 10 year			0.09%
Class 7 (person-rem per year)	1.2168	1.2187	1.2201
Class 7 Increase over 3 year		0.2%	0.3%
Class 7 Increase over 10 year			0.11%

C. Assumptions

1. Same as Section 3.0.
2. Type A ILRT and Drywell to Suppression Chamber Bypass Test are performed at 3 year intervals. This assumption is used in order to assess the risk impact based on concealed corrosion alone.
3. The Type A ILRT will not damage containment due to concealed corrosion. NUREG/CR-6706 (25) predicts that containment failure pressure with 50% corrosion of the liner is reduced 20% from failure pressure with no corrosion. The failure pressure for Susquehanna is 155 psia (4). A 20% reduction results in a failure pressure of 124 psia. The ILRT pressure is 60 psia.
4. The Type A ILRT will not detect through wall corrosion. If the liner has 100% corrosion, the containment failure pressure is based on the reinforcing bar stresses. NUREG/CR-6706 (25) predicts that exterior hoop reinforcing bars yield at 75 psia and interior hoop reinforcing bars yield at 110 psia. The ILRT pressure is 60 psia. Therefore, the ILRT leakage results may be acceptable with a hole in the containment liner.

D. Method

The following steps are used to perform the analysis:

1. Concealed corrosion discussion

2. Risk assessment of concealed corrosion

Concealed Corrosion Discussion

Corrosion damage has been found in approximately one-third of existing nuclear power plant containments, with the number increasing steadily. (25) Most of the corrosion found to date has started on the visible surface of the containment. Recent reports at Brunswick 2 (April 27,1999) and North Anna 2 (September 23,1999) identified 100% corrosion through the containment liner (27,28). The corrosion initiated from the concealed side of the liner due to debris left during construction. Both of these containments are similar to Susquehanna because they are steel lined concrete containments (26). Like Susquehanna, the steel liner is flush to the concrete structure.

The SSES primary containment is inspected in accordance with the requirements of ASME Section XI Subsection IWE and IWL. These visual inspections include the interior liner and the exterior concrete surfaces. As of April 2001, all inspections of both Unit 1 and Unit 2 primary containment for the first inspection period are complete and no degradation was identified. These inspections provide reasonable assurance that corrosion on the visible surface will be identified and corrected before containment strength is affected. However, corrosion that starts on the concealed surface may not be found before the damage affects containment strength.

In 1987 (30), the NRC sponsored a test of a 1:6 scale reinforced concrete containment model. A steel liner was incorporated into the model to provide a leak tight pressure boundary. For the overpressurization test, no significant leakage was detected until the pressure reached 135 psig. At 135psig, the leakage was measure at 11% mass per day. The test was terminated at 145 psig when leakage exceeded 5000% mass per day. The scale model liner had no corrosion. This scale model is similar to the Susquehanna containment design of a reinforced concrete containment with a steel liner attached to the concrete. This test validates the Susquehanna containment ultimate strength of 140 psig and indicates that a non-degraded containment will remain leak tight almost until failure.

Chapter 7 of NUREG/CR-6706 (25) is analyses of typical reinforced concrete containment using finite element analysis. This analysis includes degradation due to corrosion. The analysis uses 0%, 10%, 25%, and 50% degradation. With no degradation, the exterior hoop reinforcing bars yielded at 75 psia, the interior hoop reinforcing bars yielded at 110 psia, and the liner yielded at 150 psia. This analysis shows that the exterior concrete cracks first, followed by the interior concrete, and finally the steel liner.

NUREG/CR-6706 (25) performs analyses with 3 different values of degradation in three locations. The conclusion is that degradation of the liner attached to the concrete with studs can degrade the ultimate strength of the containment by 20% when the liner is corroded by 50%.

A decision needs to be made concerning the effect of 100% degradation in the containment liner on containment strength. The entire concrete structure will not crack and the rebar will not reach yield strength until 110 psia. Therefore, the conclusion is that containment in the model will not fail and become a Severe Accident (Class 7) with 100% degradation of the liner unless accident pressure reaches 110 psia. This represents a 30% reduction of strength from 0% corrosion analysis.

Chapter 8 of NUREG/CR-6706 (25) is analyses of typical prestressed concrete containment with a steel liner that is continuously attached to the concrete with channel and angle iron. Without degradation, the containment strength is 143 psia. However, the conclusion is that degradation of the liner that is continuously attached to the concrete can degrade the ultimate strength of the containment from 0% to 10% when the liner is corroded.

Susquehanna containment liner is continuously attached to the concrete instead of anchored with studs, however, the containment is not prestressed. Therefore, for this analysis, we will use 20% degradation of containment strength.

The containment liner is considered the leak proof membrane. The leakage rate out of containment with 100% degradation in the liner is not known from analysis or scale testing. However, when Brunswick 2 found 100% degradation of the containment liner, they conducted an as-found local leak rate test on the liner defects. The test was conducted at 55 psia. The total leakage through the 3 defects was 168 SCFH. This leakage was added to their containment leakage summation. The total leakage remained below the maximum allowed leakage rate (La) of 266.3 SCFH. Brunswick 2 concluded that primary containment integrity was maintained with the 100% degradation. (31)

The Brunswick event supports the conclusion that 100% degradation of the liner is part of Class 1 accidents (no containment failure) and Class 3 accidents (Hole in primary containment) accidents as discussed in the main body calculation if accident pressure remains less than the pressure that will fail containment. The leakage rate for Class 1 is 1 La, the leakage rate for Class 3a is 10 La, and the leakage rate for Class 3b is 35 La.

Risk Assessment of Concealed Corrosion

The Severe Accident (Class 7) frequency in the original calculation was based on containment failure at 155 psia (140 psig). With 100% degradation of the liner present, containment will fail at a lower pressure. Based on previous discussion, 20% reduction of containment strength is appropriate. For this analysis, containment will fail at 124 psia due to 100% degradation of the liner.

The following steps are used for the risk assessment:

1. Determine sequences that are affected by lower containment strength and recalculate PRA.
2. Calculate risk for 3 year concealed corrosion test interval.
3. Calculate risk for 10 year concealed corrosion test interval.
4. Calculate risk for 15 year concealed corrosion test interval.
5. Calculate change in LERF

Step 1 - Determine sequences that are affected by lower containment strength and recalculate PRA

The IPE (4) determined that containment fails due to overpressure during station blackout sequences and loss of decay heat removal sequences.

The PRA has inputs for recovery of offsite power, recovery of diesel generator, and repair of pump for decay heat removal.

Time of containment failure is important for this analysis. The increased risk is due to containment failure occurring earlier when corrosion is present. Calculate the revised containment failure time as follows.

Time to reach 155 psia

The containment with no corrosion fails at 155 psia. The elevated pressure is due to decay heat from the core and is the result of water vapor. The saturated temperature for 155 psia is 361 F. The bulk temperature of the suppression pool is 353 F because 8 F difference accounts for temperature stratification in the suppression pool.

1. Calculate the mass of steam added to the suppression pool as follows (Ref 32, p.157):

Mass of steam added (lbm) =

$$\frac{\text{Mass of suppression pool (initial) x (final enthalpy of water – initial enthalpy of water)}}{\text{(final enthalpy of steam – final enthalpy of water)}}$$

Mass of suppression pool (initial) = 7,940,000 lbm
(This represents 7,600,000 lbm initially plus 340,000 lbm from the initial blowdown of the RPV to the suppression pool. This blowdown is included to account for a rapid depressurization associated with the HCTL.)

Final enthalpy of water = 325 BTU/lbm
Initial enthalpy of water = 106 BTU/lbm
(The suppression pool water temperature after the initial blowdown is 138 F)

Final enthalpy of steam = 1194 BTU/lbm

Mass of steam added (lbm) =

$$\frac{7{,}940{,}000 \text{ lbm} \times (325 - 106) \text{ BTU/lbm}}{(1194-325) \text{ BTU/lbm}} = 2.00E{+}06 \text{ lbm}$$

2. Calculate the energy of steam added to the suppression pool as follows:

Total energy added to pool (MW-sec) =

Mass of steam added x (Final enthalpy of steam – ((Final enthalpy of water + Initial enthalpy of water) x 0.5) x 0.00106 MW-sec/BTU

Mass of steam added = 2.00E+06 lbm
Final enthalpy of steam = 1194 BTU/lbm
Final enthalpy of water = 325 BTU/lbm
Initial enthalpy of water = 106 BTU/lbm

Total energy added to pool (MW-sec) =

= 2.00E+06 lbm x (1194 – ((325 + 106) x 0.5) BTU/lbm x 0.00106 MW-sec/BTU
= 2.08E+06 MW-sec

3. Time to 155 psia is calculated based on Eric Haskin Tabular Decay Heat (Ref 32, p.351)

Cumulative power of 2.08E+06 MW-sec added to the suppression pool takes 25.6 hours

4. Calculate probability of not recovering power or decay heat removal pump.

The probability of not recovering offsite power in 25.6 hours is Sum (25.6) No Obtuse Lines / Sum (0) No Obtuse Lines = 0.2359E-03 / 0.566E-01 = 4.2E-03 (Ref 4, p.A-237)

The probability of not recovering a diesel generator in 25.6 hours is 1.7E-01 (Ref 4, Table C.2-4)

The probability of not recovering decay heat removal pump in 25.6 hours is 5.4E-01

Probability = EXP (-(25.6 – 12) hrs / 22.3 hrs)

EXP = e raised to power in ( )
Planning time = 12 hours (Ref 4)
Mean time to repair a pump is 22.3 hours (Ref 33, Table 11).

5. Calculate revised PRA using the following inputs:

Probability that Offsite power not recovered in 25.6 hour.
NR26 = 4.2E-03

Probability of Failure to recover diesel generator at 25.6 hours
DGR26 = 1.7E-01

Probability of Failure to repair a pump used for decay heat removal at 25.6 hours
DHRpmpR = 5.4E-01

Table E-1
PRA Results with Containment Failure at 155 psia

Summary of Results - with normal maintenance and failure of containment at 155 psia

Plant Status	Frequency per 15 months	Frequency per 12 months
Initiating Event	2.43E+00	1.94E+0
CD-UO-COK	1.66E-07	1.33E-7
CD-OH-COK	1.01E-07	8.10E-8
Total CD	2.67E-07	2.14E-7
CD-HPVF	7.97E-10	6.37E-10
CD-LPVF-COK	3.72E-10	2.97E-10
Total Vessel Failure	1.17E-09	9.35E-10
CD-UO-ECF	2.79E-11	2.23E-11
CM-VF-COTF	2.15E-10	1.72E-10
LERF	2.43E-10	1.95E-10
CM-VOK-COPF	8.40E-11	6.72E-11
CM-VF-COPF	5.20E-11	4.16E-11
Late Cont. Failure	1.36E-10	1.09E-10

COPF Prior to Core Damage

COPF	4.64E-07	3.71E-7
50% of COPF	2.32E-07	1.85E-7
Add Total CD to 50% COPF to account for CD after Containment Failure		3.99E-7

Note: The CDF for 155 psia (3.99E-07 / year) is slightly different than the CDF in used in Section 4.0 (3.74E-07 / year). This is because there are some other mitigating measures such as mass addition to suppression pool that are not included in concealed corrosioin analysis. The analysis is performed using the same inputs except as noted. The delta CDF between 155psia (3.99E-07 / year) and 124 psia (4.08E-07) is the critical value and the results are appropriate.

Time to reach 124 psia

The containment with corrosion fails at 124 psia. The elevated pressure is due to decay heat from the core and is the result of water vapor. The saturated temperature for 124 psia is 344 F. The bulk temperature of the suppression pool is 336 F because 8 F difference accounts for temperature stratification in the suppression pool..

1. Calculate the mass of steam added to the suppression pool as follows (Ref. 32, p.157):

Mass of steam added (lbm) =

$$\frac{\text{Mass of suppression pool (initial) x (final enthalpy of water – initial enthalpy of water)}}{\text{(final enthalpy of steam – final enthalpy of water)}}$$

Mass of suppression pool (initial) = 7,940,000 lbm
(This represents 7,600,000 lbm initially plus 340,000 lbm from the initial blowdown of the RPV to the suppression pool. This blowdown is included to account for a rapid depressurization associated with the HCTL.)

Final enthalpy of water = 307 BTU/lbm
Initial enthalpy of water = 106 BTU/lbm
(The suppression pool water temperature after the initial blowdown is 138 F)
Final enthalpy of steam = 1191BTU/lbm

Mass of steam added (lbm) =

$$\frac{\text{7,940,000 lbm x (307 – 106) BTU/lbm}}{\text{(1191-307) BTU/lbm}} = \text{1.81E+06 lbm}$$

2. Calculate the energy of steam added to the suppression pool as follows:

Total energy added to pool (MW-sec) =

Mass of steam added x (Final enthalpy of steam – ((Final enthalpy of water + Initial enthalpy of water) x 0.5) x 0.00106 MW-sec/BTU

Mass of steam added = 1.81E+06 lbm
Final enthalpy of steam = 1191 BTU/lbm
Final enthalpy of water = 307 BTU/lbm
Initial enthalpy of water = 106 BTU/lbm

Total energy added to pool (MW-sec) =

= 1.81E+06 lbm x (1191 – ((307 + 106) x 0.5) BTU/lbm x 0.00106 MW-sec/BTU
= 1.88E+06 MW-sec

3. Time to 124 psia is calculated based on Eric Haskin Tabular Decay Heat (Ref 32, p.351)

Cumulative power of 1.88E+06 MW-sec added to the suppression pool takes 22.3 hours

4. Calculate probability of not recovering power or decay heat removal pump.

The probability of not recovering offsite power in 22.3 hours is Sum (22.3) No Obtuse Lines / Sum (0) No Obtuse Lines = 0.3123E-03 / 0.566E-01 = 5.5E-03 (Ref 4, p.A-237)

The probability of not recovering a diesel generator in 22.3 hours is 1.7E-01 (Ref 4, Table C.2-4)

The probability of not recovering decay heat removal pump in 22.3 hours is 6.3E-01

Probability = EXP (-(22.3 – 12) hrs / 22.3 hrs)

EXP = e raised to power in ( )
Planning time = 12 hours (Ref 4)
Mean time to repair a pump is 22.3 hours (Ref 33, Table 11).

5. Calculate revised PRA using the following inputs:

Probability that Offsite power not recovered in 22.3 hour.
NR26 = 5.5E-03

Probability of Failure to recover diesel generator at 22.3hours
DGR26 = 1.7E-01

Probability of Failure to repair a pump used for decay heat removal at 22.3 hours
DHRpmpR = 6.3E-01

Table E-2
PRA Results with Containment Failure at 124 psia

Summary of Results - with normal maintenance and failure of containment at 155 psia

Plant Status	Frequency per 15 months	Frequency per 12 months
Initiating Event	2.43E+00	1.94E+0
CD-UO-COK	1.66E-07	1.33E-7
CD-OH-COK	1.01E-07	8.10E-8
Total CD	2.67E-07	2.14E-7
CD-HPVF	7.97E-10	6.37E-10
CD-LPVF-COK	3.72E-10	2.97E-10
Total Vessel Failure	1.17E-09	9.35E-10
CD-UO-ECF	2.79E-11	2.23E-11
CM-VF-COTF	2.15E-10	1.72E-10
LERF	2.43E-10	1.95E-10
CM-VOK-COPF	1.09E-10	8.76E-11
CM-VF-COPF	6.38E-11	5.11E-11
Late Cont. Failure	1.73E-10	1.39E-10
COPF Prior to Core Damage		
COPF	4.84E-07	3.87E-7
50% of COPF	2.42E-07	1.94E-7
Add Total CD to 50% COPF to account for CD after Containment Failure		4.08E-7

Determine change in Class 7 frequency

Class 7 accidents are almost entirely composed of COPF sequences. Use 50% of COPF because not all containment failures occur with core damage.

From Table E-1, the Class 7 frequency with containment failure at 155 psia at 25.6 hours is 1.856E-07 / year.

From Table E-2, the Class 7 frequency with containment failure at 124 psia at 22.3 hours is 1.936E-07 / year.

Failure rate of 100% degradation of containment liner is based on 2 events among 70 plants in 5 years. The 2 events are Brunswick 2 and North Anna 2 (27,28). The 70 plants are based on industry data base of steel lined concrete containments (26). The 5 years is based on changes to 10 CFR50.55a that require periodic visual inspections of containment surfaces since September 1996 (29).

Failure rate = 2 events / (70 plants x 5 years) = 0.005714 / year

The revised Class 7 frequency =

((1 – EXP (- failure rate x time)) x Class 7 frequency at 124psia) +
(EXP (- failure rate x time) x Class 7 frequency at 155psia)

The results are as follows:

Time	Class 7 frequency	Delta from Class 7 frequency at 155 psia
3 yr	1.857E-07	1.36E-10
10 yr	1.860E-07	4.44E-10
15 yr	1.863E-07	6.57E-10

Step 3 - Calculate risk for 3 year concealed corrosion.

Table E-3 is derived the same way as Table 3 in Section 4.0 of the main calculation. The derivation for the Table is explained in Section 4.0.

Based on Table E-2, the CDF is changed to 4.08E-07, the LERF is changed to 1.95E-10, and Late Containment Failure is changed to 1.39E-10. The concealed corrosion affects only accident sequences that are part of Class 7 because a liner failure may result in loss of containment that is grouped as a Severe Accident. For Class 7, Tables

E-3, E-4 and E-5 carries extra decimal places to show the small differences as the risk analysis progresses.

Also, the probability of Class 7 is increased by the following factor:

1.36E-10 / year is the increased frequency that a corrosion failure will occur in 3 years and cause containment to fail at 124 psia.

Table E-3
Mean Consequence Measures for 3-Year Concealed Corrosion Interval

Class	Description	EPRI analysis	Probability (P) Frequency (/12 month)	Consequence (C) Person-Rem to 50 miles	Risk (P x C) Person-rem/yr	Basis Frequency
1	No Containment Failure - use 1 La	relevant	1.60E-07	3.29E+05	5.25E-02	Core Damage Frequency minus frequency of other classes. CDF = 4.08E-7
2	Large containment isolation failure - use 35 La	Random failures to close - Type A not relevant	5.83E-10	4.38E+05	2.56E-04	1.43E-3 times CDF - method based on failure of Containment Isolation of pentrations > 1 inch
3a	Small isolation failure - use 10La	relevant	2.61E-08	4.41E+05	1.15E-02	0.064 times CDF - based on NUREG ILRT results of 4 small failures out of 144 tests - 95th percentile of Chi squared distribution
3b	Large isolation failure - use 35La	relevant	8.57E-09	4.38E+05	3.75E-03	0.021 times CDF - IP3 method based on NUREG ILRT results of 0 large failures out of 144 tests - 95th percentile of Chi squared distribution
4	Small isolation failure (Type B penetration)	Based on Type B frequency - not relevant	0	0	0.0	
5	Small isolation failure (Type C penetration)	Based on Type C frequency - not relevant	0	0	0.0	
6	Containment isolation failures (dependent failures, personnel error) - use 35 La	Based on ISI/IST program - Type A test does not affect	9.38E-10	4.38E+05	4.11E-04	2.3E-3 times CDF - EC-RISK-1063
7	Severe Accident induced failure - use 100 La	Type A test does not affect - not relevant	1.941E-07	6.27E+06	1.22E+00	SSES PRA results for LERF, Late Containment Failure, and 50% of Containment Over Pressure Failure (prior to core damage) plus 1.36E-10 increase for concealed corrosion
8	Secondary Containment bypassed - use 100 La	Type A test does not affect - not relevant	1.82E-08	4.24E+06	7.70E-02	ISLOCA plus Containment Bypass
Core Damage			4.08E-07		1.3622E+00	

Step 4 - Calculate risk for 10 year Concealed Corrosion Interval

The probability of Class 7 is increased by the following factor:

4.44E-10 / year is the increased frequency that a corrosion failure will occur in 10 years and cause containment to fail at 124 psia.

Table E-4
Mean Consequence Measures for 10-Year Concealed Corrosion Interval

Class	Description	EPRI analysis	Probability (P) Frequency (/12 month)	Consequence (C) Person-Rem to 50 miles	Risk (P x C) Person-rem/yr	Basis Frequency
1	No Containment Failure - use 1 La	relevant	1.59E-07	3.29E+05	5.24E-02	Same as 3 year - Core Damage Frequency minus frequency of other classes
2	Large containment isolation failure - use 35 La	Random failures to close - Type A not relevant	5.83E-10	4.38E+05	2.56E-04	Same as 3 year
3a	Small isolation failure - use 10 La	relevant	2.61E-08	4.41E+05	1.15E-02	Same as 3 year
3b	Large isolation failure - use 35La	relevant	8.57E-09	4.38E+05	3.75E-03	Same as 3 year
4	Small isolation failure (Type B penetration)	Based on Type B frequency - not relevant	0	0	0.0	
5	Small isolation failure (Type C penetration)	Based on Type C frequency - not relevant	0	0	0.0	
6	Containment isolation failures (dependent failures, personnel error) - use 35 La	Based on ISI/IST program - Type A test does not affect	9.38E-10	4.38E+05	4.11E-04	Same as 3 year
7	Severe Accident induced failure - use 100 La	Type A test does not affect - not relevant	1.944E-07	6.27E+06	1.22E+00	Same as 3 year except 4.44E-10 added for concealed corrosion
8	Secondary Containment bypassed - use 100 La	Type A test does not affect - not relevant	1.82E-08	4.24E+06	7.70E-02	Same as 3 year
Core Damage			4.08E-07		1.3641E+00	

The percent risk increase ($\Delta\%Risk_{10}$) due to a ten-year Concealed Corrosion over the baseline case is as follows:

$$\text{Delta \%Risk} = ((\text{Total-10} - \text{Total-base}) / \text{Total-base}) * 100$$

Where:

Total-base = total person-rem / year for baseline interval = 1.3622 person-rem / year
Total-10 = total person-rem / year for 10-year interval = 1.3641 person-rem / year

$$\text{Delta \%Risk} = ((1.3641 - 1.3622) / 1.3622) * 100 = 0.13\%$$

Therefore, the increase in risk contribution because of concealed corrosion from 3 years to 10 years is 0.13%

Step 5 - Risk Impact due to 15 year Concealed Corrosion Interval

The probability of Class 7 is increased by the following factor:

6.57E-10 / year is the increased frequency that a corrosion failure will occur in 15 years and cause containment to fail at 124 psia.

Table E-5
Mean Consequence Measures for 15-Year Concealed Corrosion Interval

Class	Description	EPRI analysis	Probability (P) Frequency (/12 month)	Consequence (C) Person-Rem to 50 miles	Risk (P x C) Person-rem/yr	Basis Frequency
1	No Containment Failure - use 1 La	relevant	1.59E-07	3.29E+05	5.23E-02	Core Damage Frequency minus frequency of other classes
2	Large containment isolation failure - use 35 La	Random failures to close - Type A not relevant	5.83E-10	4.38E+05	2.56E-04	Same as 3 year
3a	Small isolation failure - use 10La	relevant	2.61E-08	4.41E+05	1.15E-02	Same as 3 year
3b	Large isolation failure - use 35La	relevant	8.57E-09	4.38E+05	3.75E-03	Same as 3 year
4	Small isolation failure (Type B penetration)	Based on Type B frequency - not relevant	0	0	0.0	
5	Small isolation failure (Type C penetration)	Based on Type C frequency - not relevant	0	0	0.0	
6	Containment isolation failures (dependent failures, personnel error) - use 35 La	Based on ISI/IST program - Type A test does not affect	9.38E-10	4.38E+05	4.11E-04	Same as 3 year
7	Severe Accident induced failure - use 100 La	Type A test does not affect - not relevant	1.946E-07	6.27E+06	1.22E+00	Same as 3 year except 6.57E-10 added for concealed corrosion
8	Secondary Containment bypassed - use 100 La	Type A test does not affect - not relevant	1.82E-08	4.24E+06	7.70E-02	Same as 3 year
Core Damage			4.08E-07		1.3653E+00	

The percent increase on the total integrated plant risk for these accident sequences is computed as follows.

$$\text{Delta \%Risk} = ((\text{Total-15} - \text{Total-10}) / \text{Total-10}) * 100$$

Where:

Total-15 = total person-rem / year for 15 year interval = 1.3653 person-rem / year
Total-10 = total person-rem / year for 10 year interval = 1.3641 person-rem / year

$$\text{Delta \%Risk} = ((1.3653 - 1.3641) / 1.3641) * 100$$
$$= 0.09\%$$

Therefore, the increase in risk contribution because of concealed corrosion from 10 years to 15 years is 0.09%

The percent risk increase ($\Delta\%Risk_{15}$) due to a fifteen-year concealed corrosion over the baseline case is as follows:

$$\text{Delta } \%Risk = ((\text{Total-15} - \text{Total-base}) / \text{Total-base}) * 100$$

Where:

Total-15 = total person-rem / year for 15 year interval = 1.3653person-rem / year
Total-base = total person-rem / year for 3 year interval = 1.3622 person-rem / year

$$\text{Delta } \%Risk = ((1.3653 - 1.3622) / 1.3622) * 100$$
$$= 0.23\%$$

Therefore, the increase in risk contribution because of concealed corrosion from 3 years to 15 years is 0.23%

Step 6 - Calculate change in LERF

The risk impact associated with concealed corrosion involves the potential that a core damage event that normally would result in only a small radioactive release from containment could in fact result in a large release due to failure to detect a pre-existing containment liner failure during the relaxation period. For this evaluation only Class 7 sequences have the potential to result in large releases if a pre-existing corrosion were present.

Reg. Guide 1.174 (3) provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Reg. Guide 1.174 (3) defines very small changes in risk as resulting in increases of core damage frequency (CDF) below 1E-06/yr and increases in LERF below 1E-07/yr. Since the concealed corrosion does not impact CDF, the relevant metric is LERF. Calculating the increase in LERF requires determining the impact of the concealed corrosion on the leakage probability.

The analysis described that the containment will not fail for 22 hours due to concealed corrosion. Containment failure at 22 hours is not early in the event. Therefore, the increase in LERF is 0.0 / year.

E. Results

The risk increase on the total integrated plant risk due to corrosion of the containment liner from the concealed surface is 0.09%. There is no increase in LERF. Both of these increases are not significant.

Attachment 3 to PLA-5408

Revised No Significant Hazards Considerations Evaluation

(Units 1 & 2)

NO SIGNIFICANT HAZARDS CONSIDERATION EVALUATION (REVISED)

PPL Susquehanna, LLC has evaluated the proposed amendment and determined that it involves no significant hazards considerations. According to 10 CFR 50.92 (c) a proposed amendment to an operating license involves no significant hazards considerations if operation of the facility with the proposed amendment would not:

- Involve a significant increase in the probability of occurrence or consequences of an accident previously evaluated;
- Create the possibility of a new or different kind of accident from any previously analyzed; or
- Involve a significant reduction in a margin of safety.

PPL Susquehanna, LLC proposes to:

Revise SSES Unit 1 Technical Specifications (TS) 5.5.12, Containment Leakage Rate Testing Program," by revising the end of the first paragraph and adding Section a. as follows:

... September 1995, as modified by the following exception:

a. NEI 94-01-1995, Section 9.2.3: The first Type A test performed after the May 4, 1992 Type A test shall be performed no later than May 3, 2007.

Revise SSES Unit 2 Technical Specifications (TS) 5.5.12, Containment Leakage Rate Testing Program," by revising the end of the first paragraph and adding Section a. as follows:

... September 1995, as modified by the following exception:

a. NEI 94-01-1995, Section 9.2.3: The first Type A test performed after the October 31, 1992 Type A test shall be performed no later than October 30, 2007.

Concurrently, the frequency of SR 3.6.1.1.2 is also deferred. This SR is performed to determine that the drywell-to-suppression chamber leakage is within limits. The SR is performed as part of the Type A test evolution and thus is required whenever the Type A test is performed.

The determination that the criteria set forth in 10 CFR 50.92 are met for this amendment is provided below:

1. Does the proposed change involve a significant increase in the probability of occurrence or consequences of an accident previously evaluated?

   The frequency of Type A testing does not change the probability of an event that results in core damage or vessel failure. Primary containment is the engineered feature that contains the energy and fission products from evaluated events. The SSES IPE documents events that lead to containment failure. The frequency of events that lead to containment failure does not change because it is not a function of the Type A test interval. Containment failure is a function of loss of safety systems that shutdown the reactor, provide adequate core cooling, provide decay heat removal, and loss of drywell sprays.

   Similarly, the frequency of the SR 3.6.1.1.2 bypass test does not change the probability of an event that results in core damage or vessel failure since they are not a function of the bypass test.

   The consequences of the evaluated accidents are the amount of radioactivity that is released to secondary containment and subsequently to the public. Normally, extending a test interval increases the probability that a Structure, System, or Component will fail. However, NUREG-1493, Performance-Based Containment Leak-Test Program, states that calculated risk in BWR's is very insensitive to the assumed leakage rates. The remaining testing and inspection programs provide the same coverage as these tests, and will maintain leakage at appropriately low levels. Any leakage problems will be identified and repairs will be made. Additionally, the containment is continuously monitored during power operation. Anomalies are investigated and resolved. Thus there is a high confidence that integrity will be maintained independent of the Type A test and SR 3.6.1.1.2 bypass test frequency.

   Therefore, this proposed amendment does not involve a significant increase in the probability of occurrence or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously analyzed?

   Primary containment is designed to contain energy and fission products during and after an event. The SSES IPE identifies events that lead to containment failure. The proposed revision to the Type A and SR 3.6.1.1.2 test interval does not change this list of events. There are no physical changes being made to the plant and there are no changes to the operation of the plant that could introduce a new failure mode creating an accident or affecting mitigation of an accident.

   Therefore, this proposed amendment does not involve a possibility of a new or different kind of accident from any previously analyzed.

3. Does the proposed change involve a significant reduction in a margin of safety?

   The proposed revision to Technical Specifications adds a one-time extension to the current interval for Type A and SR 3.6.1.1.2 testing. The current frequency of 10 years, based on past performance, would be extended on a one time basis to 15 years from the last tests.

   The NUREG-1493 generic study of the effects of extending containment leakage testing found that a 20-year interval in Type A leakage testing resulted in an imperceptible increase in risk to the public. NUREG-1493 found that, generically, the design containment leakage rate contributes about 0.1% to individual risk and that increasing the Type A test interval would have minimal affect on this risk since 95% of the potential leakage paths are detected by Type B and Type C testing. Technical Specifications require that the maximum allowable primary containment leakage rate is less than 1% primary containment air weight per day. During unit startup following Type B and Type C testing, leakage rate acceptance criteria must be less than 0.6% primary containment air weight per day (Technical Specification 5.5.12). Therefore, Type B and Type C testing combined with visual inspection programs will maintain containment leakage at appropriately low levels.

   PPL has determined by calculation the total integrated risk increase from extending the Type A test from 10 to 15 years is 0.02%. LERF increases by 3.93 E-10/year. These increases are not risk significant.

   The risk increase on total integrated plant risk by extending the SR 3.6.1.1.2 bypass test from 10 to 15 years is 0.04%. The increase in LERF is 7E-11/year. These increases are not risk significant.

The vacuum breaker leakage test and stringent acceptance criteria, combined with the negligible non-vacuum breaker leakage area and thorough periodic visual inspection, provide an equivalent level of assurance as the SR 3.6.1.1.2 bypass test.

Therefore, these changes do not involve a significant reduction in margin of safety.

Based upon the above, the proposed amendment does not involve a significant hazards consideration.