Enclosure 3

San Onofre Nuclear Generating Station Probabilistic Risk Assessment,

Evaluation of Risk Significance of ILRT Extension Based on the NEI Approach

Revision 0

April 2005

Southern California Edison RSC 05-03

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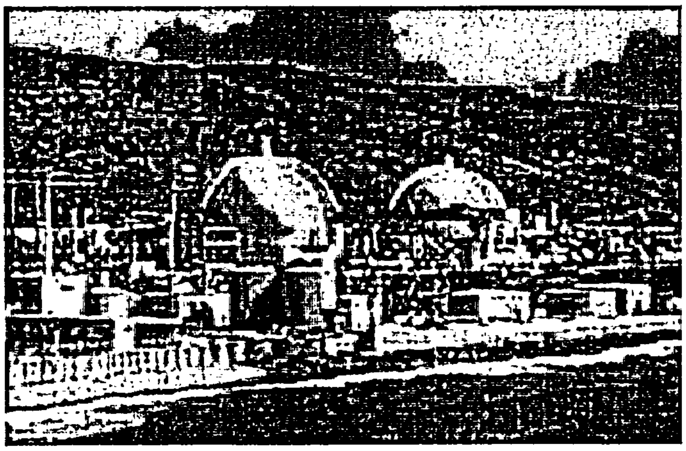

Evaluation of Risk Significance of ILRT Extension Based on the NEI Approach

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April 2005

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1.0 PURPOSE

The purpose of this report is to provide an alternative estimation of the change in risk associated with extending the Type A integrated leak rate test interval beyond the current 10 years required by 10 CFR 50, Appendix J, Option B at the San Onofre Nuclear Generating Station for both unit 2 and unit 3. Specifically, this report utilizes the methodology identified by the Nuclear Energy Institute (NEI)[1]. A completed assessment of the proposed change is documented in Reference 2 and serves as a basis for this document. The evaluation found in Reference 2 is consistent with similar assessments performed for the Comanche Peak[3] plant, the Indian Point 3 (IP3) plant, which was approved by the NRC[4,5], and for the Crystal River 3 (CR3) plant[6].

In addition to the NEI-based evaluation, this report also documents the performance of sensitivity studies related to the selection and application of dose estimates utilized in the calculation of risk parameters. Specific evaluations are performed to address evacuation and the selection of Class 6, 7 and 8 dose terms.

1.1 SUMMARY OF THE ANALYSIS

10 CFR 50, Appendix J allows individual plants to extend Type A surveillance testing requirements and to provide for performance-based leak testing. This report documents a risk-based evaluation of the proposed change of the integrated leak rate test (ILRT) interval for the San Onofre Nuclear Generating Station (SONGS). The proposed change would impact testing associated with the current surveillance tests for Type A leakage, procedure S02-V-3.12[7] for unit 2 and procedure S03-V-3.12[8] for unit 3. No change to Type B or Type C testing is proposed at this time.

This analysis utilizes the guidelines set forth in NEI 94-01[9], the methodology used in EPRI TR-104285[10] and NUREG-1493[11]. The NEI guidance also considers the submittals generated by other utilities. The assessment contained in this document utilizes the method set forth and utilizes metrics presented in Reference 1 supported by the metrics identified in Reference 9. The regulatory guidance on the use of probabilistic risk assessment (PRA) findings in support of a licensee request to a plant's licensing basis, RG 1.174[12] is also utilized.

This calculation evaluates the risk associated with various ILRT intervals as follows:

- 3 years – Interval based on the original requirements of 3 tests per 10 years.
- 10 years – This is the current test interval required for SONGS.
- 15 years – Proposed extended test interval, similar to IP3 request.

The analysis utilizes the SONGS PRA results utilized in Reference 2 in order to provide a consistent analysis and is based on information provided in References 13 and 14.

The release category and person-rem information is based on the analysis provided in Appendices B and C of Reference 2.

1.2 SUMMARY OF RESULTS/CONCLUSIONS

The specific results are summarized in Table 1 below. The Type A contribution to LERF is defined as the contribution from Class 3b.

Table 1
Summary of Risk Impact on Extending Type A ILRT Test Frequency

	Risk Impact for 3-years (baseline)	Risk Impact for 10-years (current requirement)	Risk Impact for 15-years
Total integrated risk (person-rem/yr)	35.459	35.462	35.465
Type A testing risk (person-rem/yr)	0.001	0.005	0.007
% total risk (Type A / total)	0.004%	0.014%	0.021%
Type A LERF (Class 3b) (per year)	1.40E-8	4.65E-8	6.98E-8
Changes due to extension from 10 years (current)			
Δ Risk from current (Person-rem/yr)			2.26E-3
% Increase from current (Δ Risk / Total Risk)			0.006%
Δ LERF from current (per year)			2.33E-8
Δ CCFP from current			0.455%
Changes due to extension from 3 years (baseline)			
Δ Risk from baseline (Person-rem/yr)			5.42E-3
% Increase from baseline (Δ Risk / Total Risk)			0.015%
Δ LERF from baseline (per year)			5.58E-8
Δ CCFP from baseline			1.093%

The results are discussed below:

- The person-rem/year increase in risk contribution from extending the ILRT test frequency from the current once-per-ten-year interval to once-per-fifteen years is 0.002 person-rem/year.
- The risk increase in LERF from extending the ILRT test frequency from the current once-per-10-year interval to once-per-15 years is 2.33E-8/yr.
- The change in conditional containment failure probability (CCFP) from the current once-per-10-year interval to once-per-15 years is 0.455%.
- The change in Type A test frequency from once-per-ten-years to once-per-fifteen-years increases the risk impact on the total integrated plant risk by only 0.006%. Also, the change in Type A test frequency from the original three-per-ten-years to once-per-fifteen-years increases the risk only 0.015%. Therefore, the risk impact when compared to other severe accident risks is negligible.
- 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 10^{-6}/yr and increases in LERF below 10^{-7}/yr. 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 a once-per-ten-years to a once per-fifteen-years is 2.33E-8. Guidance in Reg. Guide 1.174 defines very small changes in LERF as below 10^{-7}/yr, increasing the ILRT interval from 10 to 15 years is therefore considered non-risk significant and the results support this determination. In addition, the change in LERF resulting from a change in the Type A ILRT test interval from a three-per-ten-years to a once per-fifteen-years is 5.58E-8/yr, is also below the guidance.
- R.G. 1.174 also encourages the use of risk analysis techniques to help ensure and show that the proposed change is consistent with the defense-in-depth philosophy. Consistency with defense-in-depth philosophy is maintained by demonstrating that the balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation. The change in conditional containment failure probability was estimated to be 0.455% for the proposed change and 1.093% for the cumulative change of going from a test interval of 3 in 10 years to 1 in 15 years. These changes are small and demonstrate that the defense-in-depth philosophy is maintained.

In reviewing these results the SONGS analysis demonstrates that the change in plant risk is small as a result of this proposed extension of ILRT testing. The change in LERF defined in the analysis for both the baseline and the current cases is within the acceptance criterion.

In addition to the baseline assessment, two sensitivity exercises are included. The first sensitivity examines the risk impact of the ILRT extension when external events are included. This analysis is provided in Appendix A. The second sensitivity study is presented in Appendix B and examines how different assumptions related to evacuation and Class 6, 7 and 8 population dose could impact the baseline analysis results.

2.0 DESIGN INPUTS

The SONGS PRA is intended to provide "best estimate" results that can be used as input when making risk informed decisions. The PRA provides the most recent results for the SONGS PRA. The inputs for this calculation come from the information documented in the SONGS PRA and the level 2 update (References 14 and 15). The SONGS plant damage states are summarized in Table 2.

Table 2
SONGS Plant Damage States

Plant Damage State	Representative Sequence	Frequency (/yr)
PDS 1	Transient with loss of secondary heat removal	6.81E-6
PDS 2	Transient with loss of secondary heat removal, and loss of containment spray recirculation	1.71E-7
PDS 3	Transient with loss of secondary heat removal, and loss of containment heat removal	2.66E-7
PDS 4	Transient/SSL with loss of HPSI in recirculation	1.51E-9
PDS 5	Transient/SSL with loss of HPSI in recirculation, and loss of containment heat removal	0.00E+0
PSD 6	Transient/SSL with loss of HPSI in recirculation, loss of secondary heat removal, and loss of containment spray recirculation	2.18E-7
PDS 7	Transient with loss of HPSI/LPSI injection and loss of containment heat removal	1.20E-6
PDS 8	Transient with loss of HPSI/LPSI injection, loss of secondary heat removal and loss of containment heat removal	2.17E-7
PDS 9	Small LOCA with loss of containment spray recirculation	3.65E-10
PDS 10	Small LOCA with loss of containment heat removal	7.38E-7
PDS 11	Small LOCA with loss of secondary heat removal	2.19E-7
PDS 12	Small LOCA with loss of HPSI recirculation	2.43E-7

Table 2 (Continued)
SONGS Plant Damage States

Plant Damage State	Representative Sequence	Frequency (/yr)
PDS 13	Small LOCA with loss of HPSI recirculation, and loss of containment spray recirculation	5.32E-6
PDS 14	Small LOCA with loss of HPSI recirculation, and loss of containment heat removal	1.56E-8
PDS 15	Small LOCA with loss of HPSI recirculation and loss of secondary heat removal	4.40E-9
PDS 16	Small LOCA with loss of HPSI recirculation, loss of secondary heat removal, and loss of containment spray recirculation	6.24E-8
PDS 17	Small LOCA with loss of HPSI recirculation, loss of secondary heat removal, and loss of containment heat removal	5.99E-7
PDS 18	Small LOCA with loss of HPSI/LPSI injection	1.92E-7
PDS 19	Large/medium LOCA with loss of core heat removal	1.28E-6
PDS 20	Large/medium LOCA with loss of core heat removal, and loss of containment spray recirculation	1.08E-9
PDS 21	Large/medium LOCA with loss of core and containment heat removal	4.06E-9
PDS 22	Large/medium LOCA with loss of HPSI recirculation	2.00E-7
PDS 23	Large/medium LOCA with loss of HPSI recirculation, and loss of containment spray recirculation	1.59E-9
PDS 24	Large/medium LOCA with loss of HPSI recirculation, and loss of containment heat removal	8.40E-9
PDS 25	Large/medium LOCA with loss of HPSI/LPSI injection	1.93E-9
PDS 26	Transient/LOCA with loss of containment isolation and heat removal	1.14E-8
PDS 27	Interfacing system LOCA (ISLOCA) initiating event	5.61E-8
PDS 28	Steam generator tube rupture (SGTR) initiating event, no stuck open relief valve (SORV)	1.48E-8
PDS 29	Steam generator tube rupture (SGTR) initiating event, with stuck open relief valve (SORV)	1.25E-8

Table 2 (Continued)
SONGS Plant Damage States

Plant Damage State	Representative Sequence	Frequency (/yr)
TOTAL		1.795E-5

In order to develop the person-rem dose associated with a plant damage state it is necessary to associate each plant damage state with an associated release of radionuclides and from this information to calculate the associated dose.

The IP3 submittal (Reference 4) utilizes a multiplication factor to adjust the design basis leakage value (L_a) that is based on generic information that relates dose to leak size. The CR3 submittal (Reference 6) utilized plant-specific dose estimates based on the predicted level 2 analysis results.

The SONGS PRA (References 14 and 15) contains the necessary information to convert the plant damage states to release categories. Using this information, the plant damage states are mapped to the six release categories: B, D, G, L, T, and W. In addition, the fraction of intact containment cases is determined using the split fraction information contained in References 13 and 14.

Since the SONGS PRA contains the necessary release fraction information, an approach similar to the CR3 submittal is utilized that better reflects the specific release conditions for SONGS. The SONGS PRA (References 13 and 14) release categories are defined by the release fraction of major radionuclides. These are extrapolated to dose using the approach presented in Reference 2. This approach has been presented in other licensing submittals (References 3 and 16) and is consistent with the method used in the CR3 submittal (Reference 6). The intact containment dose is developed in Reference 2 and is consistent with the approach used in Reference 3. The release category dose information is presented in Table 3.

Table 3
Release Category Radionuclide Fraction

Release Category	Frequency (/yr)	Noble Gas[1]	Iodine[1]	Cesium[1]	Tellurium[1]	Strontium[1]	Total Dose
IC-1 (S)	1.50E-5	NA[2]	NA	NA	NA	NA	2.22E+2[3]
B[4]	5.06E-7	6.50E-2	1.00E-3	1.00E-3	6.00E-9	3.00E-7	1.98E+5
D[5]	1.25E-8	9.74E-1	5.50E-2	3.30E-2	7.00E-3	2.00E-6	5.90E+6
G[6]	1.56E-7	5.48E-1	2.00E-2	2.00E-2	2.10E-2	6.00E-4	2.93E+6
L[7]	1.24E-6	1.00E+0	4.00E-3	7.00E-3	2.00E-4	2.00E-6	2.05E+6
T[8]	5.61E-8	9.98E-1	8.42E-1	8.42E-1	7.70E-2	2.00E-3	8.61E+7
W[9]	9.83E-7	1.00E+0	1.20E-1	1.21E-1	4.00E-5	3.00E-7	1.36E+7

1. Contributing fission product groups are discussed in Reference 2.
2. Release fractions not necessary for this calculation.
3. Intact containment representing design basis leakage (Reference 2).
4. Release category B is defined by containment bypassed with less than 0.1% of volatiles released.
5. Release category D is defined by containment bypassed with up to 10% of volatiles released.
6. Release category G is defined by early or isolation failure, containment failure prior to or at vessel failure with up to 10% of volatiles released.
7. Release category L is defined by late containment failure with up to 1% of volatiles released.
8. Release category T is defined by containment bypassed with greater than 10% of volatiles released.
9. Release category W is defined by late containment failure with more than 10% of volatiles released.

Other inputs to this calculation include ILRT test data from NUREG-1493 (Reference 11) and the EPRI report (Reference 10) and are referenced in the body of the calculation.

3.0 ASSUMPTIONS

1. The maximum containment leakage for EPRI Class 1 (Reference 10) sequences is 1 L_a (Type A acceptable leakage) because a new Class 3 has been added to account for increased leakage due to Type A inspections.

2. The maximum containment leakage for Class 3a (Reference 1) sequences is 10 L_a based on the NEI guidance and previously approved methodology (References 3, 4 and 6).

3. The maximum containment leakage for Class 3b sequences is 35 L_a based on the NEI guidance (Reference 1) and previously approved methodology (References 3, 4 and 6).

4. Class 3b is conservatively categorized LERF based on the NEI guidance and previously approved methodology (References 3, 4 and 6).

5. Containment leakage due to EPRI Classes 4 and 5 are considered negligible based on the

NEI guidance and the previously approved methodology (References 3, 4 and 6).

6. The containment releases are not impacted with time.

7. The containment releases for EPRI Classes 2, 6, 7 and 8 are not impacted by the ILRT Type A Test frequency. These classes already include containment failure with release consequences equal or greater than those impacted by Type A.

8. Because EPRI Class 8 sequences are containment bypass sequences, potential releases are directly to the environment. Therefore, the containment structure will not impact the release magnitude.

4.0 CALCULATIONS

This calculation applies the SONGS PRA release category information in terms of frequency and person-rem estimates to estimate the changes in risk due to increasing the ILRT test interval. The changes in risk are assessed consistent with the guidance provided in the NEI interim guidance document (Reference 1). This approach considers other similar analyses presented in EPRI TR-104285 (Reference 10) and NUREG-1493 (Reference 11).

The detailed calculations performed to support this report were of a level of mathematical significance necessary to calculate the results recorded. However, the tables and illustrational calculation steps presented may present rounded values to support readability.

4.1 CALCULATIONAL STEPS

The analysis employs the steps provided in Reference 1 and uses risk metrics presented in Reference 12 to evaluate the impact of a proposed change on plant risk. These measures are the change in release frequency, the change in risk as defined by the change in person-rem, the change in LERF and the change in the conditional containment failure probability.

Reference 12 also lists the change in core damage frequency as a measure to be considered. Since the testing addresses the ability of the containment to maintain its function, the proposed change has no measurable impact on core damage frequency. Therefore, this attribute remains constant and has no risk significance.

The overall analysis process is outlined below:

- Define and quantify the baseline plant damage classes and person-rem estimates.
- Calculate baseline leakage rates and estimate probability to define the analysis baseline.
- Develop baseline population dose (person-rem) and population dose rate (person-rem/yr).
- Modify Type A leakage estimate to address extension of the Type A test frequency and calculate new population dose rates, LERF and conditional containment failure probability.

- Compare analysis metrics to estimate the impact and significance of the increase related to those metrics.

The first step in the analysis is to define the baseline plant damage classes and person-rem dose measures. Plant damage state information is developed using the SONGS PRA (References 14 and 15) results. The plant damage state information and the results of the containment analysis are used to define the representative sequences. The population person-rem dose estimates for the key plant damage classes are based on the application of the method described in Reference 2.

The product of the person-rem for the plant damage classes and the frequency of the plant damage state is used to estimate the annual person-rem for the plant damage state. Summing these estimates produces the annual person-rem dose based on the sequences defined in the PRA.

The PRA plant damage state definitions considered isolation failures due to Type B and Type C faults and examine containment challenges occurring after core damage and/or reactor vessel failure. These sequences are grouped into key plant damage classes. Using the plant damage state information, bypass, isolation failures and phenomena-related containment failures are identified. Once identified, the sequence was then classified by release category definitions specified in Reference 10. With this information developed, the PRA baseline inputs are completed.

The second step expands the baseline model to address Type A leakage. The PRA did not directly address Type A (liner-related) faults and this contribution must be added to provide a complete baseline. In order to define leakage that can be linked directly to the Type A testing, it is important that only failures that would be identified by Type A testing exclusively be included.

Reference 1 provides the estimate for the probability of a leakage contribution that could only be identified by Type A testing based on industry experience. This probability is then used to adjust the intact containment category of the SONGS PRA to develop a baseline model including Type A faults.

The release, in terms of person-rem, is developed based on information contained in Reference 2 and is estimated as a leakage increase relative to allowable dose (L_a) defined as part of the ILRT.

The predicted probability of Type A leakage is then modified to address the expanded time between testing. This is accomplished by a ratio of the existing testing interval and the proposed test interval. This assumes a constant failure rate and that the failures are randomly dispersed during the interval between the test.

The change due to the expanded interval is calculated and reported in terms of the change in release due to the expanded testing interval, the change in the population person-rem and the change in large early release frequency. The change in the conditional containment failure probability is also developed. From these comparisons, a conclusion is drawn as to the risk significance of the proposed change.

Using this process, the following were performed:

1. Map the SONGS release categories into the 8 release classes defined by the EPRI Report (Reference 10).
2. Calculate the Type A leakage estimate to define the analysis baseline.
3. Calculate the Type A leakage estimate to address the current inspection frequency.
4. Modify the Type A leakage estimates to address extension of the Type A test interval.
5. Calculate increase in risk due to extending Type A inspection intervals.
6. Estimate the change in LERF due to the Type A testing.
7. Estimate the change in conditional containment failure probability due to the Type A testing.

4.2 SUPPORTING CALCULATIONS

Step 1: Map the Level 3 release categories into the 8 release classes defined by the EPRI Report

EPRI Report TR-104285 (Reference 10) defines eight (8) release classes as presented in Table 4.

Table 4
Containment Failure Classifications (from Reference 10)

Failure Classification	Description	Interpretation for Assigning SONGS Release Category
1	Containment remains intact with containment initially isolated	Intact containment bins
2	Dependent failure modes or common cause failures	Isolation faults that are related to a loss of power or other isolation failure mode that is not a direct failure of an isolation component
3	Independent containment isolation failures due to Type A related failures	Isolation failures identified by Type A testing
4	Independent containment isolation failures due to Type B related failures	Isolation failures identified by Type B testing
5	Independent containment isolation failures due to Type C related failures	Isolation failures identified by Type C testing
6	Other penetration failures	Other faults not previously identified
7	Induced by severe accident phenomena	Early containment failure sequences as a result of hydrogen burn or other early phenomena
8	Bypass	Bypass sequence or SGTR

Table 5 presents the SONGS release category mapping for these eight accident classes. Person-rem per year is the product of the frequency and the person-rem.

Table 5
SONGS PRA Release Category Grouping to EPRI Classes (as described in Reference 10)

Class	Description	Release Category	Frequency	Person-Rem	Person-Rem/yr
1	No containment failure	IC-1 (S)	1.50E-5	2.22E+2	3.33E-3
2	Large containment isolation failures	None	ε[1]		
3a	Small isolation failures (liner breach)	None	Not addressed		0.00E+0
3b	Large isolation failures (liner breach)	None	Not addressed		0.00E+0
4	Small isolation failures - failure to seal (type B)	None	ε		
5	Small isolation failures - failure to seal (type C)	None	ε		
6	Containment isolation failures (dependent failure, personnel errors)	G	1.56E-7	2.93E+6	4.57E-1
7	Severe accident phenomena induced failure (early and late)	L, W	2.22E-6	7.80E+6[2]	1.73E+1
8	Containment bypass	B, D, T	5.75E-7	3.07E+7[2]	1.77E+1
		Total	1.795E-5		3.5456E+1

1. ε represents a probabilistically insignificant value.
2. The value presented represents an average of the contributing release categories.

Step 2: Calculate the Type A leakage estimate to define the analysis baseline (3 year test interval)

As displayed in Table 5 the SONGS PRA did not identify any release categories specifically associated with EPRI Classes 3, 4, or 5. Therefore each of these classes must be evaluated for applicability to this study.

Class 3:

Containment failures in this class are due to leaks such as liner breaches that could only be detected by performing a Type A ILRT. In order to determine the impact of the extended testing interval, the probability of Type A leakage must be calculated.

In order to better assess the range of possible leakage rates, the Class 3 calculation is divided into two classes. Class 3a is defined as a small liner breach and Class 3b is defined as a large liner breach. This division is consistent with the NEI guidance (Reference 1) and the previously approved methodology (References 3, 4 and 6). The calculation of Class 3a and Class 3b probabilities is presented below.

Calculation of Class 3a Probability

The data presented in NUREG-1493 (Reference 11) is also used to calculate the probability that a liner leak will be small (Class 3a). 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 $1.0L_a$. However, of the 23 events that exceeded the test requirements, only 4 were found by an ILRT, the others were found by Type B and C testing or were identified as errors in test alignments.

Data presented in Reference 1, taken since 1/1/1995, increases this database to a total of 5 Type A leakage events in total of 182 events. Using the data a mean estimate for the probability of leakage is determined for Class 3a as shown in Equation 1.

$$p_{Class3a} = \frac{5}{182} = 0.0275 \qquad \text{(eq. 1)}$$

This probability, however, is based on three tests over a 10-year period and not the one per ten-year frequency currently employed at SONGS (References 7 and 8). The probability (0.0275) must be adjusted to reflect this difference and is adjusted in step 3 of this calculation.

Multiplying the CDF times the probability of a Class 3a leak develops the Class 3a frequency contribution in accordance with guidance provided in Reference 2. This is conservative since part of the CDF already includes LERF sequences. The CDF for SONGS is 1.795E-5/yr as presented in Table 5.

Therefore the frequency of a Class 3a failure is calculated as:

$$FREQ_{class3a} = PROB_{class3a} \times CDF = 0.0275 \times 1.795E\text{-}5/yr = 4.93E\text{-}7/yr \qquad \text{(eq. 2)}$$

Calculation of Class 3b Probability

To calculate the probability that a liner leak will be large (Class 3b) use was made of the data presented in the calculation of Class 3a. Of the events identified in NUREG-1493 (Reference 11), the largest reported leak rate from those 144 tests was 21 times the allowable leakage rate (L_a). Since 21 L_a does not constitute a large release, no large releases have occurred based on the

144 ILRTs reported in NUREG-1493. The additional data point was also not considered to constitute a large release.

To estimate the failure probability given that no failures have occurred, the guidance provided in Reference 1 suggests the use of a non-informative prior. This approach essentially updates a uniform distribution (no bias) with the available evidence (data) to provide a better estimation of an event.

A beta distribution is typically used for the uniform prior with the parameters α=0.5 and β=1. This is then combined with the existing data (no Class 3b events, 182 tests) using Equation 3.

$$p_{Class3b} = \frac{n+\alpha}{N+\beta} = \frac{0+0.5}{182+1} = \frac{0.5}{183} = 0.00273 \qquad \text{(eq. 3)}$$

where: N is the number of tests, n is the number of events (faults) of interest, α, β are the parameters of the non-informative prior distribution. From this solution, the frequency for Class 3b is generated using Equation 4 and is adjusted appropriately in step 3.

$FREQ_{class3b} = PROB_{class3b}$ x CDF = 0.00273 x 1.795E-5/yr = 4.91E-8/yr (eq. 4)

Class 4:

This group consists of all core damage accident accidents for which a failure-to-seal containment isolation failure of Type B test components occurs. By definition, these failures are dependent on Type B testing, and Type A testing will not impact the probability. Therefore this group is not evaluated any further, consistent with the approved methodology.

Class 5:

This group consists of all core damage accident accidents for which a failure-to-seal containment isolation failure of Type C test components occurs. By definition, these failures are dependent on Type C testing, and Type A testing will not impact the probability. Therefore this group is not evaluated any further, consistent with the approved methodology.

Class 6:

The Class 6 group is comprised of isolation faults that occur as a result of the accident sequence progression. The leakage rate is not considered large by the PRA definition and therefore it is placed into Class 6 to represent a small isolation failure and identified in Table 5 as Class 6.

$FREQ_{class6}$ = 1.56E-7/yr (eq. 5)

Class 1:

Although the frequency of this class is not directly impacted by Type A testing, the PRA did not model Class 3 failures, and the frequency for Class 1 should be reduced by the estimated frequencies in the new Class 3a and Class 3b in order to preserve the total CDF. The revised Class 1 frequency is therefore:

$FREQ_{class1} = FREQ_{class1} - (FREQ_{class3a} + FREQ_{class3b})$ (eq. 6)

$FREQ_{class1} = 1.50E\text{-}5/yr - (4.93E\text{-}7/yr + 4.91E\text{-}8/yr) = 1.45E\text{-}5/yr$

Class 2:

The SONGS PRA did not identify any contribution to this group above the quantification truncation.

Class 7:

The frequency of Class 7 is the sum of those release categories identified in Table 5 as Class 7.

$FREQ_{class7} = 2.22E\text{-}6/yr$ (eq. 7)

Class 8:

The frequency of Class 8 is the sum of those release categories identified in Table 5 as Class 8.

$FREQ_{class8} = 5.75E\text{-}7/yr$ (eq. 8)

Table 6 summarizes the above information by the EPRI defined classes. This table also presents dose exposures calculated using the methodology described in Reference 2. For Class 1, 3a and 3b, the person-rem is developed based on the design basis assessment of the intact containment as developed in Reference 2.

The Class 3a and 3b doses are represented as $10L_a$ and $35L_a$ respectively. Table 6 also presents the person-rem frequency data determined by multiplying the failure class frequency by the corresponding exposure.

Table 6
Baseline Risk Profile

Class	Description	Frequency (/yr)	Person-rem (calculated)[1]	Person-rem (from L_a factors)	Person-rem (/yr)
1	No containment failure	1.45E-5		2.22E+2[2]	3.21E-3
2	Large containment isolation failures	ε[3]			
3a	Small isolation failures (liner breach)	4.93E-7		2.22E+3[4]	1.09E-3
3b	Large isolation failures (liner breach)	4.91E-8		7.77E+3[5]	3.81E-4
4	Small isolation failures - failure to seal (type B)	ε			
5	Small isolation failures - failure to seal (type C)	ε			
6	Containment isolation failures (dependent failure, personnel errors)	1.56E-7	2.93E+6		4.57E-1
7	Severe accident phenomena induced failure (early and late)	2.22E-6	7.80E+6[6]		1.73E+1
8	Containment bypass	5.75E-7	3.07E+7[6]		1.77E+1
	Total	1.795E-5			3.5459E+1

1. From Table 3 using the method presented in Reference 2.
2. 1 times L_a dose value calculated in Reference 2.
3. ε represents a probabilistically insignificant value.
4. 10 times L_a.
5. 35 times L_a.
6. The value presented represents an average of the contributing release categories..

The percent risk contribution due to Type A testing is defined as follows:

$\%Risk_{BASE} = [(Class3a_{BASE} + Class3b_{BASE}) / Total_{BASE}] \times 100$ (eq. 9)

Where:

$Class3a_{BASE}$ = Class 3a person-rem/year =1.09E-3 person-rem/year

$Class3b_{BASE}$ = Class 3b person-rem/year = 3.81E-4 person-rem/year

$Total_{BASE}$ = total person-rem year for baseline interval = 3.5459E+1 person-rem/year (Table 6)

$\%Risk_{BASE}$ = [(1.09E-3 + 3.81E-4) / 35.459] x 100 = **0.004%** (eq. 10)

Step 3: Calculate the Type A leakage estimate to address the current inspection interval

The current surveillance testing requirements as proposed in NEI 94-01 (Reference 9) for Type A testing and allowed by 10 CFR 50, Appendix J is at least once per 10 years 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 $1.0L_a$).

According to References 1 and 11, extending 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. Multiplying the testing interval by 0.5 and multiplying by 12 to convert from "years" to "months" calculates the average time for an undetected condition to exist.

The increase for a 10-yr ILRT interval is the ratio of the average time for a failure to detect for the increased ILRT test interval (from 18 months to 60 months) multiplied by the existing Class 3a probability as shown in Equation 11.

$$p_{Class3a}(10y) = 0.0275 \times \left(\frac{60}{18}\right) = 0.0916 \qquad \text{(eq. 11)}$$

A similar calculation is performed for the Class 3b probability as presented in Equation 12.

$$p_{Class3b}(10y) = 0.00273 \times \left(\frac{60}{18}\right) = 0.0091 \qquad \text{(eq. 12)}$$

<u>Risk Impact due to 10-year Test Interval</u>

Based on the previously approved methodology (References 3, 4 and 6) and the NEI guidance (Reference 1), the increased probability of not detecting excessive leakage due to Type A tests directly impacts the frequency of the Class 3 sequences.

Consistent with Reference 1 the risk contribution is determined by multiplying the Class 3 accident frequency by the increase in the probability of leakage. Additionally the Class 1 frequency is adjusted to maintain the overall core damage frequency constant. The results of this calculation are presented in Table 7 below.

Table 7
Risk Profile for Once in Ten Year Testing

Class	Description	Frequency (/yr)	Person-rem [2]	Person-rem (/yr)
1	No Containment Failure[1]	1.32E-5	2.22E+2	2.929E-3
2	Large Containment Isolation Failures	ε[3]		
3a	Small Isolation Failures (Liner breach)	1.64E-6	2.22E+3	3.650E-3
3b	Large Isolation Failures (Liner breach)	1.64E-7	7.77E+3	1.270E-3
4	Small isolation failures - failure to seal (type B)	ε		
5	Small isolation failures - failure to seal (type C)	ε		
6	Containment Isolation Failures (dependent failure, personnel errors)	1.56E-7	2.93E+6	4.571E-1
7	Severe Accident Phenomena Induce Failure (Early and Late)	2.22E-6	7.80E+6[4]	1.734E+1
8	Containment Bypass	5.75E-7	3.07E+7[4]	1.766E+1
	Total	1.795E-5		3.5462E+1

1. The PRA frequency of Class 1 has been reduced by the frequency of Class 3a and Class 3b in order to preserve total CDF.
2. From Table 6.
3. ε represents a probabilistically insignificant value.
4. The value presented represents an average of the contributing release categories

Using the same methods as for the baseline, and the data in Table 7 the percent risk contribution due to Type A testing is as follows:

$$\%Risk_{10} = [(Class3a_{10} + Class3b_{10}) / Total_{10}] \times 100 \quad \text{(eq. 13)}$$

Where:

$Class3a_{10}$ = Class 3a person-rem/year = 3.65E-3 person-rem/year

$Class3b_{10}$ = Class 3b person-rem/year = 1.27E-3 person-rem/year

$Total_{10}$ = total person-rem year for current 10-year interval = 35.462 person-rem/year (Table 7)

$$\%Risk_{10} = [(3.65E\text{-}3 + 1.27E\text{-}3) / 35.462] \times 100 = \mathbf{0.014\%} \quad \text{(eq. 14)}$$

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

$$\Delta\%Risk_{10} = [(Total_{10} - Total_{BASE}) / Total_{BASE}] \times 100.0 \qquad \text{(eq. 15)}$$

Where:

$Total_{BASE}$ = total person-rem/year for baseline interval = 35.459 person-rem/year (Table 6)

$Total_{10}$ = total person-rem/year for 10-year interval = 35.462 person-rem/year (Table 7)

$$\Delta\%Risk_{10} = [(35.462 - 35.459) / 35.459] \times 100.0 = \mathbf{0.009\%} \qquad \text{(eq. 16)}$$

Step 4: Calculate the Type A leakage estimate to address extended inspection intervals

If the test interval is extended to 1 per 15 years, the average time that a leak detectable only by an ILRT test goes undetected increases to 90 months (0.5 x 15 x 12). For a 15-yr-test interval, the result is the ratio (90/18) of the exposure times as was the case for the 10 year case. Thus, increasing the ILRT test interval from 3 years to 15 years results in a proportional increase in the overall probability of leakage.

The approach for developing the risk contribution for a 15-year interval is the same as that for the 10-year interval. The increase for a 15-yr ILRT interval is the ratio of the average time for a failure to detect for the increased ILRT test interval (from 18 months to 90 months) multiplied by the existing Class 3a probability as shown in Equation 17.

$$p_{Class3a}(15y) = 0.0275 \times \left(\frac{90}{18}\right) = 0.1375 \qquad \text{(eq. 17)}$$

A similar calculation is performed for the Class 3b probability as presented in Equation 18.

$$p_{Class3b}(15y) = 0.00273 \times \left(\frac{90}{18}\right) = 0.0137 \qquad \text{(eq. 18)}$$

As stated for the 10-year case, the increased probability of not detecting excessive leakage due to Type A tests directly impacts the frequency of the Class 3 sequences.

The increased risk contribution is determined by multiplying the Class 3 accident frequency by the increase in the probability of leakage. Additionally the Class 1 frequency is adjusted to maintain the overall core damage frequency constant. The results of this calculation are presented in Table 8 below.

Table 8
Risk Profile for Once in Fifteen Year Testing

Class	Description	Frequency (/yr)	Person-rem [2]	Person-rem (/yr)
1	No Containment Failure[1]	1.23E-5	2.22E+2	2.73E-3
2	Large Containment Isolation Failures	ε[3]		
3a	Small Isolation Failures (Liner breach)	2.47E-6	2.22E+3	5.47E-3
3b	Large Isolation Failures (Liner breach)	2.45E-7	7.77E+3	1.91E-3
4	Small isolation failures - failure to seal (type B)	ε		
5	Small isolation failures - failure to seal (type C)	ε		
6	Containment Isolation Failures (dependent failure, personnel errors)	1.56E-7	2.93E+6	4.57E-1
7	Severe Accident Phenomena Induce Failure (Early and Late)	2.22E-6	7.80E+6[4]	1.73E+1
8	Containment Bypass	5.75E-7	3.07E+7[4]	1.77E+1
	Total	1.795E-5		3.5465E+1

1. The PRA frequency of Class 1 has been reduced by the frequency of Class 3a and Class 3b in order to preserve total CDF.
2. From Table 6.
3. ε represents a probabilistically insignificant value.
4. The value presented represents an average of the contributing release categories

Using the same methods as for the baseline, and the data in Table 10 the percent risk contribution due to Type A testing is as follows:

$\%Risk_{15} = [(Class3a_{15} + Class3b_{15}) / Total_{15}] \times 100$ (eq. 19)

Where:

$Class3a_{15}$ = Class 3a person-rem/year = 5.47E-3 person-rem/year

$Class3b_{15}$ = Class 3b person-rem/year = 1.91E-3 person-rem/year

$Total_{15}$ = total person-rem year for 15-year interval = 35.465 person-rem/year (Table 8)

$\%Risk_{15} = [(5.47E\text{-}3 + 1.91E\text{-}3) / 35.465] \times 100 =$ **0.021%** (eq. 20)

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

$$\Delta\%Risk_{15} = [(Total_{15} - Total_{BASE}) / Total_{BASE}] \times 100.0 \quad \text{(eq. 21)}$$

Where:

$Total_{BASE}$ = total person-rem/year for baseline interval = 35.459 person-rem/year (Table 6)

$Total_{15}$ = total person-rem/year for 15-year interval = 35.465 person-rem/year (Table 8)

$$\Delta\%Risk_{15} = [(35.465 - 35.459) / 35.459] \times 100.0 = \mathbf{0.015\%} \quad \text{(eq. 22)}$$

Step 5: Calculate increase in risk due to extending Type A inspection intervals

Based on the guidance in Reference 1, the percent increase in the total integrated plant risk for these accident sequences is computed as follows:

$$\%Total_{10\text{-}15} = [(Total_{15} - Total_{10}) / Total_{10}] \times 100 \quad \text{(eq. 23)}$$

Where:

$Total_{10}$ = total person-rem/year for 10-year interval = 35.462 person-rem/year (Table 7)

$Total_{15}$ = total person-rem/year for 15-year interval = 35.465 person-rem/year (Table 8)

$$\%\ Total_{10\text{-}15} = [(35.465 - 35.462) / 35.462] \times 100 = \mathbf{0.006\%} \quad \text{(eq. 24)}$$

Step 6: Calculate the change in Risk in terms of 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 larger release due to failure to detect a pre-existing leak during the relaxation period.

From References 1, 3, 4 and 6, the Class 3a dose is assumed to be 10 times the allowable intact containment leakage, L_a (or 2,220 person-rem) and the Class 3b dose is assumed to be 35 times L_a (or 7,770 person-rem). The dose equivalent for allowable leakage (L_a) is developed in Reference 2. This compares to a historical observed average of twice L_a. Therefore, the estimate is somewhat conservative.

Based on the NEI guidance (Reference 1) and the previously approved methodology (References 3, 4 and 6), 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 $2L_a$). 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. At the same time, sequences in the SONGS PRA (References 13 and 14) that result in large releases, are not impacted because a LERF will occur regardless of the presence of a pre-existing leak.

Therefore, the change in the frequency of Class 3b sequences is used as the increase in LERF for SONGS, and the change in LERF can be determined by the differences. Reference 1 identifies that Class 3b is considered to be the contributor to LERF. Table 9 summarizes the results of the LERF evaluation that Class 3b is indicative of a LERF sequence.

Table 9
Impact on LERF due to Extended Type A Testing Intervals

ILRT Inspection Interval	3 Years (baseline)	10 Years	15 Years
Class 3b (Type A LERF)	4.91E-8/yr	1.64E-7/yr	2.45E-7/yr
ΔLERF (10 year baseline)		1.14E-7/yr	8.18E-8/yr
ΔLERF (3 year baseline)			1.96E-7/yr

Reg. Guide 1.174 (Reference 12) provides guidance for determining the risk impact of plant-specific changes to the licensing basis. The Reg. Guide 1.174 defines very small changes in risk as resulting in increases of core damage frequency (CDF) below 1E-6/yr and increases in LERF below 1E-7/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.

Increasing the ILRT interval from the currently acceptable 10 years to a period of 15 years results in an increase in the LERF contribution of 8.18E-8/yr. This value meets the guidance in Reg. Guide 1.174 defining very small changes in LERF. The LERF increase is measured from the original 3-in-10-year interval to the 15-year interval is 1.96E-7/yr, which slightly exceeds the criterion presented in Regulatory Guide 1.174.

Reference 17 indicates that plants with a CDF in excess of 1.0E-5/yr may have difficulty demonstrating a change in LERF less than 1.0E-7/yr. It further states that the analysis as embodied in the NEI approach is conservative and provides additional guidance with respect to refining the initial analysis.

The change in LERF when extending the current ILRT period from 10 to 15 years is less than the target of 1.0E-7/yr and is acceptable. However, the increase from 3 years to 15 years exceeds the limit and some refinement is necessary. The increase is explicitly tied to the Class 3b contribution which is generated by multiplying the total CDF by the defined split fraction (0.0027).

This is conservative since some sequence frequencies comprising the total CDF already account for other LERF sequences which may occur due to interfacing system LOCA events or steam generator tube ruptures. The first refinement centers on this conservatism. Sequences which result in LERF contributions are not influenced (change in outcome) by the potential for Type A leakage and can be excluded from the calculation of Class 3 leakage.

The second aspect defined in Reference 17 addresses the magnitude of the source term expected to be available for release during the accident sequence. If the debris escapes the reactor vessel but remains essentially covered with water (either due to large pools or continual containment sprays) the source term will be greatly reduced and a large source term would not be expected. Therefore, if the accident sequence involves containment spray operation or coverage of the debris with large pools of water, the source term is not considered sufficient to support a LERF release and these contributions can be excluded.

The SONGS Level 2 containment event tree model was utilized to identify the characteristics necessary for determining the status of these aspects of the analysis. The existing containment event tree model provided clear branch points for LERF, debris flooded and containment spray status in recirculation such that a set of logical rules could be applied to the model to obtain the necessary results in terms of CDF. The analysis is summarized in Reference 18 and the results illustrated graphically in Figure 1.

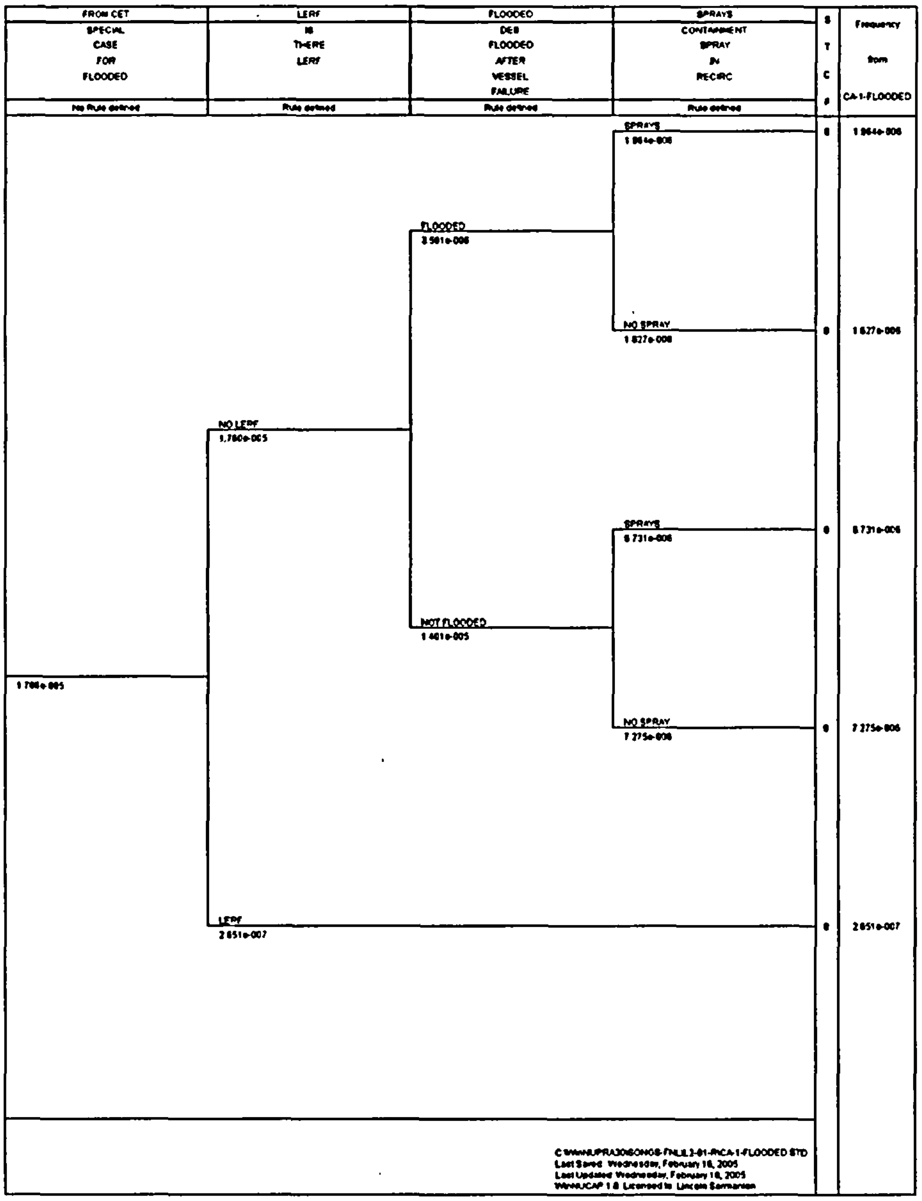

Figure 1. Quantified Source Term Category Diagram for SONGS Case 1 (from Reference 18)

The figure illustrates how the total CDF frequency is subdivided based on the three identified criterion. From the solution presented in the figure a table of results is obtained and reproduced in Table 10.

Table 10
Source Term Outcomes

Source Term Outcome	Frequency (/yr)	Description
STC Refinement Outcome 1	1.964E-6	Non-LERF sequence with the debris flooded and containment sprays functioning
STC Refinement Outcome 2	1.627E-6	Non-LERF sequence with the debris flooded and the containment sprays do not function after recirculation
STC Refinement Outcome 3	8.731E-6	Non-LERF sequence without water pools covering the debris and containment sprays functioning
STC Refinement Outcome 4	7.275E-6	Non-LERF sequence without water pools covering the debris and containment sprays do not function
STC Refinement Outcome 5	2.651E-7	LERF sequence

Only outcome 4 contributes to the potential for a Type A LERF. This value is then utilized to calculate the LERF contribution from Class 3b frequency by the following equation:

$FREQ_{class3b} = PROB_{class3b}$ x Adjusted CDF = 0.00273 x 7.275E-6/yr = 1.986E-8/yr (eq. 27)

This can then be extrapolated using the methods presented earlier to determine the 10-year and 15-year contributions and to generate adjusted LERF values as presented in Table 11.

Table 11
Class 3b Contributions Using Adjusted CDF

Test Interval	Frequency (/yr)	Delta Frequency from Prior Period (/yr)
Baseline	1.99E-8	
10-year (current)	6.62E-8	4.63E-8
15-year	9.93E-8	3.31E-8

Summing the last column provides the total increase from the baseline (3 year) to the proposed (15 year) interval (7.94E-8/yr). This increase is sufficiently small to meet the guidance for a small change in risk.

Since only a single branch point contributes to the LERF estimation, an additional evaluation of the contributors associated with this LERF contribution was performed. From this effort, it was identified that the major initiating event contributing sequence was small LOCA. A significant portion of this contribution dealt with a failure of the sump suction due to debris clogging. A somewhat conservative assumption is made for this sequence that if debris is released complete clogging will occur. In the case of a large LOCA where significant pressure and steam flows are present it may be somewhat reasonable to assume clogging if materials are found to be present in the containment that could be swept to the sumps due to forces present during the initial blowdown.

For a small LOCA, however, this is believed to be overly conservative since the effects would be more localized and if debris were to be dislodged it would be of lesser quantity and therefore less likely to plug the sump. A more realistic estimation of the probability of clogging given a small LOCA is provided in Reference 18. The investigation also identified a conservative error factor estimate associated with the human error probability (HEP) to close the containment sump access hatch prior to closure of the containment for planned startup.

This information was used to refine the LERF estimate. The STC Outcome 4 is divided into two parts, not small LOCA (5.005E-6/yr) and small LOCA (2.27E-6/yr). Then the small LOCA contribution was examined and the identified conservatisms addressed. The intermediate and final adjustments are presented in Table 12.

Table 12
Adjustment to Small LOCA Contribution to STC Refinement Outcome 4 (from Reference 18)

Attribute	Frequency (/yr)	Total Frequency Reduction (/yr)
Initial small LOCA contribution	2.27E-6	
Initial contribution from small LOCA with sump clogging	2.27E-7	2.04E-6
Adjusted Human Error Factor	1.09E-7	2.16E-6

The inclusion of these refinements reduces the small LOCA contribution for STC Outcome 4 from 2.27E-6/yr to 1.09E-7/yr. This is then combined with the unadjusted contribution to STC Outcome 4 (5.005E-6/yr) to arrive at the new LERF contribution of 5.11E-6/yr. Substitution into the LERF calculation equations defined earlier yields the final results presented in Table 13.

Table 13
Class 3b Contributions Using Adjusted CDF

Test Interval	Frequency (/yr)	Delta Frequency from Prior Period (/yr)
Adjusted STC Outcome 4	5.11E-6	
Baseline LERF	1.40E-8	
10-year (current)	4.65E-8	3.26E-8
15-year	6.98E-8	2.33E-8

Again, summing the last column provides the total increase from the baseline (3 year) to the proposed (15 year) interval (5.58E-8/yr). This increase is sufficiently small to meet the guidance for a small change in risk. This value meets the required criterion with margin.

Step 7: Calculate the change in Conditional Containment Failure Probability (CCFP)

The conditional containment failure probability (CCFP) is defined as the probability of containment failure given the occurrence of an accident. This probability can be expressed using the following equation:

$$CCFP = 1 - \left[\frac{f(ncf)}{CDF} \right] \qquad \text{(eq. 25)}$$

Where *f(ncf)* is the frequency of those sequences which result in no containment failure. This frequency is determined by summing the Class 1 and Class 3a results, and CDF is the total frequency of all core damage sequences.

Therefore the change in CCFP for this analysis is the CCFP using the results for 15 years ($CCFP_{15}$) minus the CCFP using the results for 10 years ($CCFP_{10}$). This can be expressed by the following:

$$\Delta CCFP_{10\text{-}15} = CCFP_{15} - CCFP_{10} \qquad \text{(eq. 26)}$$

Using the data previously developed the change in CCFP from the current testing interval is calculated and presented in Table 14.

Table 14
Impact on Conditional Containment Failure Probability due to Extended Type A Testing Intervals

ILRT Inspection Interval	3 Years (baseline)	10 Years	15 Years
f(ncf) (/yr)	1.495E-5	1.484E-5	1.475E-5
f(ncf)/CDF	0.833	0.826	0.822
CCFP	0.167	0.174	0.178
ΔCCFP (3 year baseline)		0.638%	1.093%
ΔCCFP (10 year baseline)			0.455%

Appendix A:
External Events Sensitivity Study

A.0 EXTERNAL EVENTS SENSITIVITY STUDY

NEI guidance (Reference 17) suggests the need to address external initiating events when estimating the impact of the proposed ILRT extension in cases where additional refinements are made to the analysis. A sensitivity study using data for the plant damage state frequencies including seismic and fire contribution to release frequency is used to address this requirement.

A.1 SUMMARY OF THE ANALYSIS

This section is completed in the same manner as NEI baseline analysis. Information from References 1 through 16 are used in the same manner as NEI baseline analysis presented in the prior sections and the methodology steps outlined in Section 4.1. The section only addresses areas of deviation from the earlier results and includes a summary of the results.

A.2 SUMMARY OF RESULTS/CONCLUSIONS

The specific results are summarized in Table A.1 below. The Type A contribution to LERF is defined as the contribution from Class 3b.

Table A.1
Summary of Risk Impact on Extending Type A ILRT Test Frequency

	Risk Impact for 3-years (baseline)	Risk Impact for 10-years (current requirement)	Risk Impact for 15-years
Total integrated risk (person-rem/yr)	72.945	72.951	72.955
Type A testing risk (person-rem/yr)	0.003	0.009	0.014
% total risk (Type A / total)	0.004%	0.013%	0.020%
Type A LERF (Class 3b) (per year)	2.00E-8	6.67E-8	1.00E-7
Changes due to extension from 10 years (current)			
Δ risk from current (person-rem/yr)			4.36E-3
% increase from current (Δ risk / total risk)			0.008%
Δ LERF from current (per year)			3.34E-8
Δ CCFP from current			0.455%
Changes due to extension from 3 years (baseline)			
Δ risk from baseline (person-rem/yr)			1.05E-2
% increase from baseline (Δ risk / total risk)			0.014%
Δ LERF from baseline (per year)			8.01E-8
Δ CCFP from baseline			1.093%

Based on the analysis and available data the following is stated:

- The person-rem/year increase in risk contribution from extending the ILRT test frequency from the current once-per-ten-year interval to once-per-fifteen years is 0.004 person-rem/year.

- The risk increase in LERF from extending the ILRT test frequency from the current once-per-10-year interval to once-per-15 years is 3.34E-8/yr.

- The change in conditional containment failure probability (CCFP) from the current once-per-10-year interval to once-per-15 years is 0.455%.

- The change in Type A test frequency from once-per-ten-years to once-per-fifteen-years increases the risk impact on the total integrated plant risk by only 0.008%. Also, the change in Type A test frequency from the original three-per-ten-years to once-per-fifteen-years increases the risk only 0.014%. Therefore, the risk impact when compared to other severe accident risks is negligible.

- 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 CDF below 10^{-6}/yr and increases in LERF below 10^{-7}/yr. 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 a once-per-ten-years to a once per-fifteen-years is 3.34E-8. Guidance in Reg. Guide 1.174 defines very small changes in LERF as below 10^{-7}/yr, increasing the ILRT interval from 10 to 15 years is therefore considered non-risk significant. The value is below this guidance indicating that the change is not risk significant. In addition, the change in LERF resulting from a change in the Type A ILRT test interval from a three-per-ten-years to a once per-fifteen-years is 8.01E-8/yr, and is also below the guidance.

- R.G. 1.174 also encourages the use of risk analysis techniques to help ensure and show that the proposed change is consistent with the defense-in-depth philosophy. Consistency with defense-in-depth philosophy is maintained by demonstrating that the balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation. The change in conditional containment failure probability was estimated to be 0.455% for the proposed change and 1.093% for the cumulative change of going from a test interval of 3 in 10 years to 1 in 15 years. These changes are small and demonstrate that the defense-in-depth philosophy is maintained.

A.3 DESIGN INPUTS

The inputs for this calculation are similar to the information in the baseline analysis. The only change is that the input information includes not only internal event initiators but fire and seismic. The inclusion of these initiating events comprises the SONGS Case 2 results. The plant damage states are summarized in Table A.2.

Table A.2
SONGS Plant Damage States Including Fire and Seismic

Plant Damage State	Representative Sequence	Frequency (/yr)
PDS 1	Transient with loss of secondary heat removal	2.09E-5
PDS 2	Transient with loss of secondary heat removal, and loss of containment spray recirculation	2.82E-7
PDS 3	Transient with loss of secondary heat removal, and loss of containment heat removal	3.06E-7
PDS 4	Transient/SSL with loss of HPSI in recirculation	1.51E-9
PDS 5	Transient/SSL with loss of HPSI in recirculation, and loss of containment heat removal	0.00E+0
PSD 6	Transient/SSL with loss of HPSI in recirculation, loss of secondary heat removal, and loss of containment spray recirculation	3.00E-7
PDS 7	Transient with loss of HPSI/LPSI injection and loss of containment heat removal	1.45E-6
PDS 8	Transient with loss of HPSI/LPSI injection, loss of secondary heat removal and loss of containment heat removal	1.61E-6
PDS 9	Small LOCA with loss of containment spray recirculation	3.76E-10
PDS 10	Small LOCA with loss of containment heat removal	8.52E-7
PDS 11	Small LOCA with loss of secondary heat removal	2.22E-7
PDS 12	Small LOCA with loss of HPSI recirculation	2.47E-7

Table A.2 (Continued)
SONGS Plant Damage States Including Fire and Seismic

Plant Damage State	Representative Sequence	Frequency (/yr)
PDS 13	Small LOCA with loss of HPSI recirculation, and loss of containment spray recirculation	5.62E-6
PDS 14	Small LOCA with loss of HPSI recirculation, and loss of containment heat removal	9.07E-8
PDS 15	Small LOCA with loss of HPSI recirculation and loss of secondary heat removal	2.72E-8
PDS 16	Small LOCA with loss of HPSI recirculation, loss of secondary heat removal, and loss of containment spray recirculation	3.08E-8
PDS 17	Small LOCA with loss of HPSI recirculation, loss of secondary heat removal, and loss of containment heat removal	6.22E-7
PDS 18	Small LOCA with loss of HPSI/LPSI injection	4.11E-7
PDS 19	Large/medium LOCA with loss of core heat removal	1.39E-6
PDS 20	Large/medium LOCA with loss of core heat removal, and loss of containment spray recirculation	1.09E-9
PDS 21	Large/medium LOCA with loss of core and containment heat removal	4.07E-9
PDS 22	Large/medium LOCA with loss of HPSI recirculation	2.01E-7
PDS 23	Large/medium LOCA with loss of HPSI recirculation, and loss of containment spray recirculation	1.59E-9
PDS 24	Large/medium LOCA with loss of HPSI recirculation, and loss of containment heat removal	8.40E-9
PDS 25	Large/medium LOCA with loss of HPSI/LPSI injection	2.01E-9
PDS 26	Transient/LOCA with loss of containment isolation and heat removal	3.00E-8
PDS 27	Interfacing system LOCA (ISLOCA) initiating event	5.61E-8
PDS 28	Steam generator tube rupture (SGTR) initiating event, no stuck open relief valve (SORV)	1.48E-8
PDS 29	Steam generator tube rupture (SGTR) initiating event, with stuck open relief valve (SORV)	1.25E-8

Table A.2 (Continued)
SONGS Plant Damage States Including Fire and Seismic

Plant Damage State	Representative Sequence	Frequency (/yr)
TOTAL		3.461E-5

The release category dose information is presented in Table A.3.

Table A.3
Release Category Radionuclide Fraction

Release Category	Frequency (/yr)	Noble Gas[1]	Iodine[1]	Cesium[1]	Tellurium[1]	Strontium[1]	Total Dose
IC-1 (S)	2.94E-5	NA[2]	NA	NA	NA	NA	2.22E+2[3]
B[4]	1.40E-6	6.50E-2	1.00E-3	1.00E-3	6.00E-9	3.00E-7	1.98E+5
D[5]	1.25E-8	9.74E-1	5.50E-2	3.30E-2	7.00E-3	2.00E-6	5.90E+6
G[6]	2.79E-7	5.48E-1	2.00E-2	2.00E-2	2.10E-2	6.00E-4	2.93E+6
L[7]	2.08E-6	1.00E+0	4.00E-3	7.00E-3	2.00E-4	2.00E-6	2.05E+6
T[8]	5.61E-8	9.98E-1	8.42E-1	8.42E-1	7.70E-2	2.00E-3	8.61E+7
W[9]	1.38E-6	1.00E+0	1.20E-1	1.21E-1	4.00E-5	3.00E-7	1.36E+7

1. Contributing fission product groups are discussed in Reference 2.
2. Release fractions not necessary for this calculation.
3. Intact containment representing design basis leakage (developed in Reference 2).
4. Release category B is defined by containment bypassed with less than 0.1% of volatiles released.
5. Release category D is defined by containment bypassed with up to 10% of volatiles released.
6. Release category G is defined by early or isolation failure, containment failure prior to or at vessel failure with up to 10% of volatiles released.
7. Release category L is defined by late containment failure with up to 1% of volatiles released.
8. Release category T is defined by containment bypassed with greater than 10% of volatiles released.
9. Release category W is defined by late containment failure with more than 10% of volatiles released.

A.4 CALCULATIONS

Following the methodology presented in Section 4.1, the following calculation steps were performed:

1. Map the Level 3 release categories into the 8 release classes defined by the EPRI Report (Reference 10).
2. Calculate the Type A leakage estimate to define the analysis baseline.
3. Calculate the Type A leakage estimate to address the current inspection frequency.
4. Modify the Type A leakage estimates to address extension of the Type A test interval.
5. Calculate increase in risk due to extending Type A inspection intervals.
6. Estimate the change in LERF due to the Type A testing.
7. Estimate the change in conditional containment failure probability due to the Type A testing.

A.5 SUPPORTING CALCULATIONS

Step 1: Map the Level 3 release categories into the 8 release classes defined by the EPRI Report

EPRI Report TR-104285 defines eight (8) release classes as presented in Table A.4.

Table A.4
Containment Failure Classifications (from Reference 10)

Failure Classification	Description	Interpretation for Assigning SONGS Release Category
1	Containment remains intact with containment initially isolated	Intact containment bins
2	Dependent failure modes or common cause failures	Isolation faults that are related to a loss of power or other isolation failure mode that is not a direct failure of an isolation component
3	Independent containment isolation failures due to Type A related failures	Isolation failures identified by Type A testing
4	Independent containment isolation failures due to Type B related failures	Isolation failures identified by Type B testing
5	Independent containment isolation failures due to Type C related failures	Isolation failures identified by Type C testing
6	Other penetration failures	Other faults not previously identified
7	Induced by severe accident phenomena	Early containment failure sequences as a result of hydrogen burn or other early phenomena
8	Bypass	Bypass sequence or SGTR

Table A.5 presents the SONGS release category mapping for these eight accident classes. Person-rem per year is the product of the frequency and the person-rem.

Table A.5
SONGS PRA Release Category Grouping to EPRI Classes (as described in Reference 7)

Class	Description	Release Category	Frequency	Person-Rem	Person-Rem/yr
1	No containment failure	IC-1 (S)	2.94E-5	2.22E+2	6.53E-3
2	Large containment isolation failures	None	ε[1]		
3a	Small isolation failures (liner breach)	None	Not addressed		0.00E+0
3b	Large isolation failures (liner breach)	None	Not addressed		0.00E+0
4	Small isolation failures - failure to seal (type B)	None	ε		
5	Small isolation failures - failure to seal (type C)	None	ε		
6	Containment isolation failures (dependent failure, personnel errors)	G	2.79E-7	2.93E+6	8.17E-1
7	Severe accident phenomena induced failure (early and late)	L, W	3.46E-6	7.80E+6	2.70E+1
8	Containment bypass	B, D, T	1.47E-6	3.07E+7	4.51E+1
		Total	3.461E-5		7.2942E+1

1. ε represents a probabilistically insignificant value.

Step 2: Calculate the Type A leakage estimate to define the analysis baseline (3 year test interval)

As displayed in Table 17 the SONGS PRA did not identify any release categories specifically associated with EPRI Classes 3, 4, or 5. Therefore each of these classes must be evaluated for applicability to this study.

Class 3:

Containment failures in this class are due to leaks such as liner breaches that could only be detected by performing a Type A ILRT. In order to determine the impact of the extended testing interval, the probability of Type A leakage must be calculated.

In order to better assess the range of possible leakage rates, the Class 3 calculation is divided into two classes. Class 3a is defined as a small liner breach and Class 3b is defined as a large liner breach. This division is consistent with the NEI guidance (Reference 1) and the previously approved methodology (References 3, 4 and 6). The calculation of Class 3a and Class 3b probabilities is presented below.

Calculation of Class 3a Probability

The data presented earlier from NUREG-1493 (Reference 11) and data presented in Reference 1 is used to calculate the probability that a liner leak will be small (Class 3a) as done earlier. Using the data a mean estimate for the probability of leakage is determined for Class 3a as shown in Equation 1.

$$p_{Class3a} = \frac{5}{182} = 0.0275 \qquad \text{(eq. 1)}$$

This probability, however, is based on three tests over a 10-year period and not the one per ten-year frequency currently employed at SONGS (References 7 and 8). The probability (0.0275) must be adjusted to reflect this difference and is adjusted in step 3 of this calculation.

Multiplying the CDF times the probability of a Class 3a leak develops the Class 3a frequency contribution in accordance with guidance provided in Reference 2. This is conservative since part of the CDF already includes LERF sequences. The CDF for SONGS is 3.461E-5/yr as presented in Table A.5.

Therefore the frequency of a Class 3a failure is calculated as:

$$FREQ_{class3a} = PROB_{class3a} \times CDF = 0.0275 \times 3.461E\text{-}5/yr = 9.51E\text{-}7/yr \qquad \text{(eq. 2)}$$

Calculation of Class 3b Probability

To calculate the probability that a liner leak will be large (Class 3b) use was made of the data presented in the calculation of Class 3a. Of the events identified in NUREG-1493 (Reference 11), the largest reported leak rate from those 144 tests was 21 times the allowable leakage rate (L_a). Since 21 L_a does not constitute a large release, no large releases have occurred based on the 144 ILRTs reported in NUREG-1493. The additional data point was also not considered to constitute a large release.

To estimate the failure probability given that no failures have occurred, the guidance provided in Reference 2 suggests the use of a non-informative prior. This approach essentially updates a uniform distribution (no bias) with the available evidence (data) to provide a better estimation of an event. A beta distribution is typically used for the uniform prior with the parameters α=0.5

and β=1. This is then combined with the existing data (no Class 3b events, 182 tests) using Equation 3.

$$p_{Class3b} = \frac{n+\alpha}{N+\beta} = \frac{0+0.5}{182+1} = \frac{0.5}{183} = 0.00273 \qquad \text{(eq. 3)}$$

where: N is the number of tests, n is the number of events (faults) of interest, α, β are the parameters of the non-informative prior distribution. From this solution, the frequency for Class 3b is generated using Equation 4 and is adjusted appropriately in step 3.

$$FREQ_{class3b} = PROB_{class3b} \times CDF = 0.00273 \times 3.461E\text{-}5/yr = 9.46E\text{-}8/yr \qquad \text{(eq. 4)}$$

Class 4:

This group consists of all core damage accident accidents for which a failure-to-seal containment isolation failure of Type B test components occurs. By definition, these failures are dependent on Type B testing, and Type A testing will not impact the probability. Therefore this group is not evaluated any further, consistent with the approved methodology.

Class 5:

This group consists of all core damage accident accidents for which a failure-to-seal containment isolation failure of Type C test components occurs. By definition, these failures are dependent on Type C testing, and Type A testing will not impact the probability. Therefore this group is not evaluated any further, consistent with the approved methodology.

Class 6:

The Class 6 group is comprised of isolation faults that occur as a result of the accident sequence progression. The leakage rate is not considered large by the PRA definition and therefore it is placed into Class 6 to represent a small isolation failure and identified in Table A.5 as Class 6.

$$FREQ_{class6} = 2.79E\text{-}7/yr \qquad \text{(eq. 5)}$$

Class 1:

Although the frequency of this class is not directly impacted by Type A testing, the PRA did not model Class 3 failures, and the frequency for Class 1 should be reduced by the estimated frequencies in the new Class 3a and Class 3b in order to preserve the total CDF. The revised Class 1 frequency is therefore:

$$FREQ_{class1} = FREQ_{class1} - (FREQ_{class3a} + FREQ_{class3b}) \qquad \text{(eq. 6)}$$

$$FREQ_{class1} = 2.94E\text{-}5/yr - (9.51E\text{-}7/yr + 9.46E\text{-}8/yr) = 2.84E\text{-}5/yr \qquad \text{(eq. 7)}$$

Class 2:

The SONGS PRA did not identify any contribution to this group above the quantification truncation.

Class 7:

The frequency of Class 7 is the sum of those release categories identified in Table A.5 as Class 7.

$FREQ_{class7} = 3.46E\text{-}6/yr$ (eq. 8)

Class 8:

The frequency of Class 8 is the sum of those release categories identified in Table A.5 as Class 8.

$FREQ_{class8} = 1.47E\text{-}6/yr$ (eq. 9)

Table A.6 summarizes the above information by the EPRI defined classes. This table also presents dose exposures calculated using the methodology described in Reference 2. For Class 1, 3a and 3b, the person-rem is developed based on the design basis assessment of the intact containment. The Class 3a and 3b doses are represented as $10L_a$ and $35L_a$ respectively.

Table A.6 also presents the person-rem frequency data determined by multiplying the failure class frequency by the corresponding exposure.

Table A.6
Baseline Risk Profile

Class	Description	Frequency (/yr)	Person-rem (calculated)[1]	Person-rem (from L_a factors)	Person-rem (/yr)
1	No containment failure	2.84E-5		2.22E+2[2]	6.29E-3
2	Large containment isolation failures	ε[3]			
3a	Small isolation failures (liner breach)	9.51E-7		2.22E+3[4]	2.11E-3
3b	Large isolation failures (liner breach)	9.46E-8		7.77E+3[5]	7.35E-4
4	Small isolation failures - failure to seal (type B)	ε			
5	Small isolation failures - failure to seal (type C)	ε			
6	Containment isolation failures (dependent failure, personnel errors)	2.79E-7	2.93E+6		8.17E-1
7	Severe accident phenomena induced failure (early and late)	3.46E-6	7.80E+6[6]		2.70E+1
8	Containment bypass	1.47E-6	3.07E+7[6]		4.51E+1
	Total	3.461E-5			7.29446E+1

1. From Table 17 using the method presented in Reference 2.
2. 1 times L_a dose value calculated in Reference 2.
3. ε represents a probabilistically insignificant value.
4. 10 times L_a.
5. 35 times L_a.
6. The value presented represents an average of the contributing release categories..

The percent risk contribution due to Type A testing is as follows:

$\%Risk_{BASE} = [(Class3a_{BASE} + Class3b_{BASE}) / Total_{BASE}] \times 100$ (Eq. 10)

Where:

$Class3a_{BASE}$ = Class 3a person-rem/year = 2.11E-3 person-rem/year

$Class3b_{BASE}$ = Class 3b person-rem/year = 7.35E-4 person-rem/year

$Total_{BASE}$ = total person-rem year for baseline interval = 7.29446E+1 person-rem/year (Table A.6)

$\%Risk_{BASE}$ = [(2.11E-3 + 7.35E-4) / 7.29446E+1] x 100 = **0.004%** (Eq. 11)

Step 3: Calculate the Type A leakage estimate to address the current inspection interval

The current surveillance testing requirements as proposed in NEI 94-01 (Reference 9) for Type A testing and allowed by 10 CFR 50, Appendix J is at least once per 10 years 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 $1.0L_a$).

According to References 1 and 11, extending 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. Multiplying the testing interval by 0.5 and multiplying by 12 to convert from "years" to "months" calculates the average time for an undetected condition to exist.

The increase for a 10-yr ILRT interval is the ratio of the average time for a failure to detect for the increased ILRT test interval (from 18 months to 60 months) multiplied by the existing Class 3a probability as shown in Equation 12.

$$p_{Class3a}(10y) = 0.0275 \times \left(\frac{60}{18}\right) = 0.0916 \qquad \text{(eq. 12)}$$

A similar calculation is performed for the Class 3b probability as presented in Equation 13.

$$p_{Class3b}(10y) = 0.00273 \times \left(\frac{60}{18}\right) = 0.0091 \qquad \text{(eq. 13)}$$

<u>Risk Impact due to 10-year test interval</u>

Based on the previously approved methodology (References 3, 4 and 6) and the NEI guidance (Reference 1), the increased probability of not detecting excessive leakage due to Type A tests directly impacts the frequency of the Class 3 sequences.

Consistent with Reference 1 the risk contribution is determined by multiplying the Class 3 accident frequency by the increase in the probability of leakage. Additionally the Class 1 frequency is adjusted to maintain the overall core damage frequency constant. The results of this calculation are presented in Table A.7 below.

Table A.7
Risk Profile for Once in Ten Year Testing

Class	Description	Frequency (/yr)	Person-rem[2]	Person-rem (/yr)
1	No containment failure[1]	2.59E-5	2.22E+2	5.75E-3
2	Large containment isolation failures	ε[3]		
3a	Small isolation failures (liner breach)	3.17E-6	2.22E+3	7.04E-3
3b	Large isolation failures (liner breach)	3.15E-7	7.77E+3	2.45E-3
4	Small isolation failures - failure to seal (type B)	ε		
5	Small isolation failures - failure to seal (type C)	ε		
6	Containment isolation failures (dependent failure, personnel errors)	2.79E-7	2.93E+6	8.17E-1
7	Severe accident phenomena induced failure (early and late)	3.46E-6	7.80E+6[4]	2.70E+1
8	Containment bypass	1.47E-6	3.07E+7[4]	4.51E+1
	Total	3.461E-5		7.29507E+1

1. The IPE frequency of Class 1 has been reduced by the frequency of Class 3a and Class 3b in order to preserve total CDF.
2. From Table 20.
3. ε represents a probabilistically insignificant value.
4. The value presented represents an average of the contributing release categories.

Using the same methods as for the baseline, and the data in Table A.7 the percent risk contribution due to Type A testing is as follows:

$$\%Risk_{10} = [(Class3a_{10} + Class3b_{10}) / Total_{10}] \times 100 \qquad \text{(eq. 14)}$$

Where:

$Class3a_{10}$ = Class 3a person-rem/year = 7.04E-3 person-rem/year

$Class3b_{10}$ = Class 3b person-rem/year = 2.45E-3 person-rem/year

$Total_{10}$ = total person-rem year for current 10-year interval = 7.29507E+1 person-rem/year (Table A.7)

$\%Risk_{10}$ = [(7.04E-3 + 2.45E-3) / 7.29507E+1] x 100 = **0.012%** (eq. 15)

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

$\Delta\%Risk_{10}$ = [($Total_{10}$ - $Total_{BASE}$) / $Total_{BASE}$] x 100.0 (eq. 16)

Where:

$Total_{BASE}$ = total person-rem/year for baseline interval = 7.29446E+1 person-rem/year (Table A.6)

$Total_{10}$ = total person-rem/year for 10-year interval = 7.29507E+1 person-rem/year (Table A.7)

$\Delta\%Risk_{10}$ = [(7.29507E+1 – 7.29446E+1) / 7.29446E+1] x 100.0 = **0.008%** (eq. 17)

Step 4: Calculate the Type A leakage estimate to address extended inspection intervals

If the test interval is extended to 1 per 15 years, the average time that a leak detectable only by an ILRT test goes undetected increases to 90 months (0.5 x 15 x 12). For a 15-yr-test interval, the result is the ratio (90/18) of the exposure times as was the case for the 10 year case. Thus, increasing the ILRT test interval from 3 years to 15 years results in a proportional increase in the overall probability of leakage.

The approach for developing the risk contribution for a 15-year interval is the same as that for the 10-year interval. The increase for a 15-yr ILRT interval is the ratio of the average time for a failure to detect for the increased ILRT test interval (from 18 months to 90 months) multiplied by the existing Class 3a probability as shown in Equation 18.

$$p_{Class3a}(15y) = 0.0275 \times \left(\frac{90}{18}\right) = 0.1375 \quad \text{(eq. 18)}$$

A similar calculation is performed for the Class 3b probability as presented in Equation 19.

$$p_{Class3b}(15y) = 0.00273 \times \left(\frac{90}{18}\right) = 0.0137 \quad \text{(eq. 19)}$$

As stated for the 10-year case, the increased probability of not detecting excessive leakage due to Type A tests directly impacts the frequency of the Class 3 sequences.

The increased risk contribution is determined by multiplying the Class 3 accident frequency by the increase in the probability of leakage. Additionally the Class 1 frequency is adjusted to maintain the overall core damage frequency constant. The results of this calculation are presented in Table A.8 below.

Table A.8
Risk Profile for Once in Fifteen Year Testing

Class	Description	Frequency (/yr)	Person-rem[2]	Person-rem (/yr)
1	No containment failure[1]	2.42E-5	2.22E+2	5.37E-3
2	Large containment isolation failures	ε[3]		
3a	Small isolation failures (liner breach)	4.75E-6	2.22E+3	1.06E-2
3b	Large isolation failures (liner breach)	4.73E-7	7.77E+3	3.67E-3
4	Small isolation failures - failure to seal (type B)	ε		
5	Small isolation failures - failure to seal (type C)	ε		
6	Containment isolation failures (dependent failure, personnel errors)	2.79E-7	2.93E+6	8.17E-1
7	Severe accident phenomena induced failure (early and late)	3.46E-6	7.80E+6[4]	2.70E+1
8	Containment bypass	1.47E-6	3.07E+7[4]	4.51E+1
	Total	3.461E-5		7.29550E+1

1. The IPE frequency of Class 1 has been reduced by the frequency of Class 3a and Class 3b in order to preserve total CDF.
2. From Table 20.
3. ε represents a probabilistically insignificant value.
4. The value presented represents an average of the contributing release categories

Using the same methods as was described earlier, and the data in Table A.8, the percent risk contribution due to Type A testing is as follows:

$\%Risk_{15} = [(Class3a_{15} + Class3b_{15}) / Total_{15}] \times 100$ (eq. 20)

Where:

$Class3a_{15}$ = Class 3a person-rem/year = 1.06E-2 person-rem/year

$Class3b_{15}$ = Class 3b person-rem/year = 3.67E-3 person-rem/year

$Total_{15}$ = total person-rem year for 15-year interval = 7.29550E+1 person-rem/year (Table A.8)

$\%Risk_{15} = [(1.06E-2 + 3.67E-3) / 7.29550E+1] \times 100 = 0.02\%$ (eq. 21)

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

$\Delta\%Risk_{15} = [(Total_{15} - Total_{BASE}) / Total_{BASE}] \times 100.0$ (eq. 22)

Where:

$Total_{BASE}$ = total person-rem/year for baseline (3 per 10 years) interval = 7.29446E+1 person-rem/year (Table A.6)

$Total_{15}$ = total person-rem/year for 15-year interval = 7.29550E+1 person-rem/year (Table A.8)

$\Delta\%Risk_{15} = [(7.29550E+1 - 7.29446E+1) / 7.29446E+1] \times 100.0 =$ **0.014%** (eq. 23)

Step 5: Calculate increase in risk due to extending Type A inspection intervals

Based on the guidance in Reference 1, the percent increase in the total integrated plant risk for these accident sequences is computed as follows:

$\%Total_{10\text{-}15} = [(Total_{15} - Total_{10}) / Total_{10}] \times 100$ (eq. 24)

Where:

$Total_{10}$ = total person-rem/year for 10-year interval = 7.29507E+1 person-rem/year (Table A.7)

$Total_{15}$ = total person-rem/year for 15-year interval = 7.29550E+1 person-rem/year (Table A.8)

$\% Total_{10\text{-}15} = [(7.29550E+1 - 7.29507E+1) / 7.29507E+1] \times 100 =$ **0.0059%** (eq. 25)

Step 6: Calculate the change in risk in terms of 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 larger release due to failure to detect a pre-existing leak during the relaxation period.

From References 1, 3, 4 and 6, the Class 3a dose is assumed to be 10 times the allowable intact containment leakage, L_a (or 2,220 person-rem) and the Class 3b dose is assumed to be 35 times L_a (or 7,770 person-rem). The dose equivalent for allowable leakage (L_a) is developed in Reference 2. This compares to a historical observed average of twice L_a. Therefore, the estimate is somewhat conservative.

Based on the NEI guidance (Reference 1) and the previously approved methodology (References 3, 4 and 6), 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 $2L_a$). 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. At the same time, sequences in the SONGS PRA (Reference 13 and 14) that result in large early releases, are not impacted because a LERF will occur regardless of the presence of a pre-existing leak.

Therefore, the change in the frequency of Class 3b sequences is used as the increase in LERF for SONGS, and the change in LERF can be determined by the calculated differences. Reference 1 also identifies that Class 3b is considered to be the contributor to LERF. Table A.9 summarizes the results of the LERF evaluation assuming that Type 3b is indicative of a LERF sequence.

Table A.9
Impact on LERF due to Extended Type A Testing Intervals

ILRT Inspection Interval	3 Years (baseline)	10 Years	15 Years
Class 3b (Type A LERF)	9.46E-8	3.15E-7	4.73E-7
ΔLERF (3 year baseline)		2.21E-7	3.78E-7
ΔLERF (10 year baseline)			1.57E-7

Reg. Guide 1.174 (Reference 12) 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 CDF below 1.0E-6/yr and increases in LERF below 1.0E-7/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.

Since guidance in Reg. Guide 1.174 defines very small changes in LERF as below 1.0E-7/yr, increasing the ILRT interval to 15 years (1.57E-7/yr) is above this criterion. The LERF increase when measured from the original 3-in-10-year is 3.78E-7/yr, which is also above the 1.0E-7/yr screening criterion in Reg. Guide 1.174.

Reference 17 indicates that plants with a CDF in excess of 1.0E-5/yr may have difficulty demonstrating a change in LERF less than 1.0E-7/yr. It further states that the analysis as embodied in the NEI approach is conservative and provides additional guidance with respect to refining the initial analysis.

The change in LERF when extending the current ILRT period from 10 to 15 years is greater than the target of 1.0E-7/yr. The increase from 3 years to 15 years also exceeds the limit and some refinement is necessary. The increase is explicitly tied to the Class 3b contribution which is generated by multiplying the total CDF by the defined split fraction (0.00273).

This is conservative since some sequence frequency comprising the total CDF already accounts for other LERF sequences which may occur due to interfacing system LOCA events or steam generator tube ruptures. The first refinement centers on this conservatism. Sequences which result in LERF contributions are not influenced (change in outcome) by the potential for Type A leakage and can be excluded from the calculation of Class 3 leakage.

The second aspect defined in Reference 17 addresses the magnitude of the source term expected to be available for release during the accident sequence. If the debris escapes the reactor vessel but remains essentially covered with water (either due to large pools or continual containment sprays) the source term will be greatly reduced and a large source term would not be expected. Therefore, if the accident sequence involves containment spray operation or coverage of the debris with large pools of water, the source term is not considered sufficient to support a LERF release and these contributions can be excluded.

The SONGS Level 2 containment event tree model was utilized to identify the characteristics necessary for determining the status of these aspects of the analysis. The existing containment event tree model provided clear branch points for LERF, debris flooded and containment spray status in recirculation such that a set of logical rules could be applied to the model to obtain the necessary results in terms of CDF. The analysis is summarized in Reference 18 and the results illustrated graphically in Figure A.1.

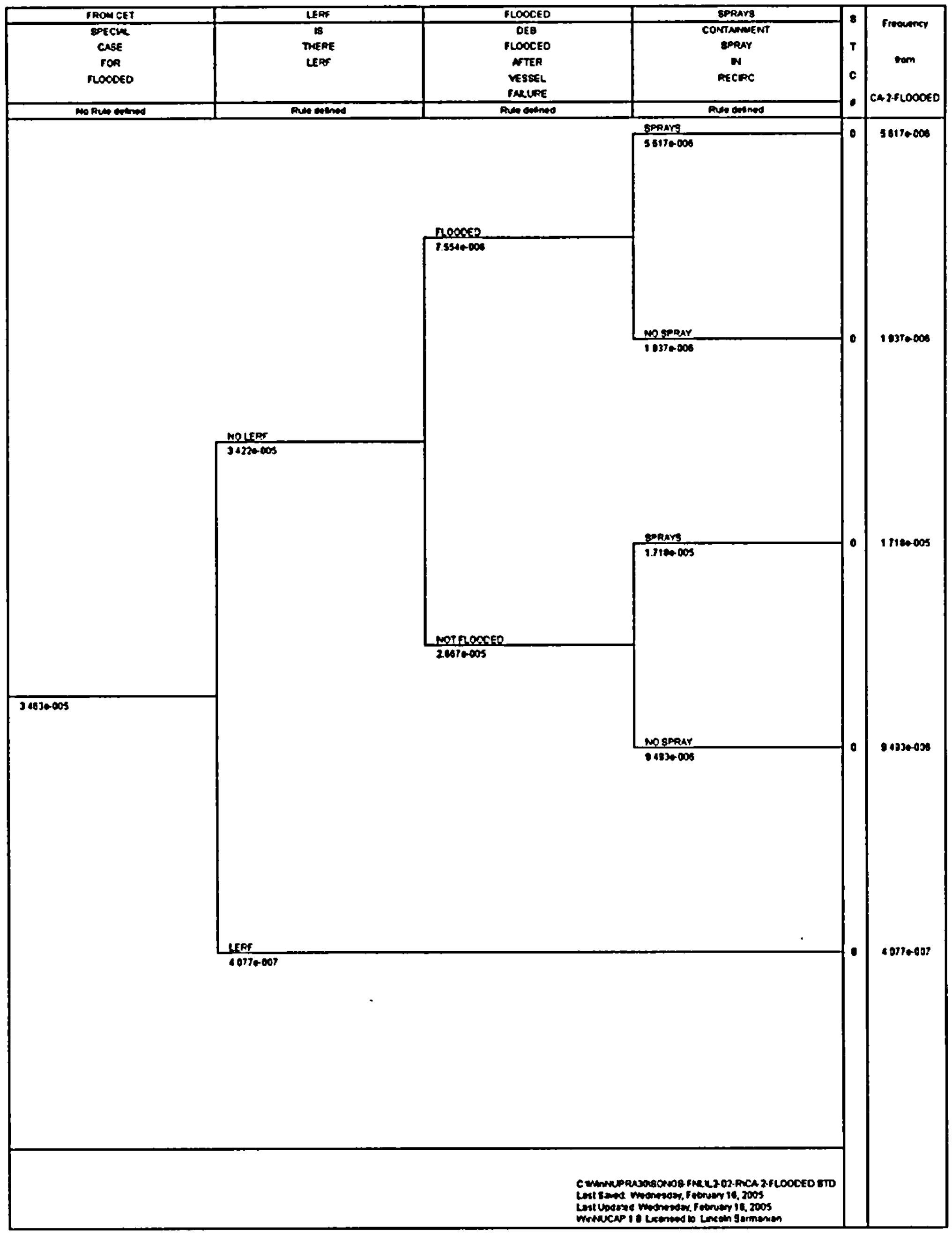

Figure A.1. Quantified Source Term Category Diagram for SONGS Case 2 (from Reference 18)

The figure illustrates how the total CDF frequency is subdivided based on the three identified criterion. From the solution presented in the figure a table of results is obtained and reproduced in Table A.10.

Table A.10
Source Term Outcomes

Source Term Outcome	Frequency (/yr)	Description
STC Refinement Outcome 1	5.617E-6	Non-LERF sequence with the debris flooded and containment sprays functioning
STC Refinement Outcome 2	1.937E-6	Non-LERF sequence with the debris flooded and the containment sprays do not function after recirculation
STC Refinement Outcome 3	1.718E-5	Non-LERF sequence without water pools covering the debris and containment sprays functioning
STC Refinement Outcome 4	9.493E-6	Non-LERF sequence without water pools covering the debris and containment sprays do not function
STC Refinement Outcome 5	4.077E-7	LERF sequence

Only outcome 4 contributes to the potential for a Type A LERF. This value is then utilized to calculate the LERF contribution from Class 3b frequency by the following equation:

$FREQ_{class3b} = PROB_{class3b}$ x Adjusted CDF = 0.00273 x 9.493E-6/yr = 2.59E-8/yr (eq. 26)

This can then be extrapolated using the methods presented earlier to determine the 10-year and 15-year contributions and to generate adjusted LERF values as presented in Table A.11.

Table A.11
Class 3b Contributions Using Adjusted CDF

Test Interval	Frequency (/yr)	Delta Frequency from Prior Period (/yr)
Baseline	2.59E-8	
10-year (current)	8.64E-8	6.05E-8
15-year	1.30E-7	4.32E-8

Summing the last column provides the total increase from the baseline (3 years) to the proposed (15 year) interval (1.04E-7/yr). This increase is only slightly above the guidance for a small change in risk and does not address the identified conservatism in the small LOCA contribution.

A more realistic estimation of the probability of clogging given a small LOCA is provided in Reference 18 and the resulting impact is found in Table 13. The reduction in the small LOCA contribution reduces the STC Outcome 4 to 7.33E-6/yr, 9.493E-6/yr – 2.16E-6/yr (value taken from Table 12 of main report). Substitution into the LERF calculation equations defined earlier yields the final results presented in Table A.12.

Table A.12
Class 3b Contributions Using Adjusted CDF

Test Interval	Frequency (/yr)	Delta Frequency from Prior Period (/yr)
Adjusted STC Outcome 4	7.33E-6	
Baseline LERF	2.00E-8	
10-year (current)	6.67E-8	4.67E-8
15-year	1.00E-7	3.34E-8

Again, summing the last column provides the total increase from the baseline (3 years) to the proposed (15 year) interval (8.01E-8/yr). This increase is sufficiently small to meet the guidance for a small change in risk with margin.

Step 7: Calculate the change in conditional containment failure probability (CCFP)

The CCFP is defined as the probability of containment failure given the occurrence of an accident. This probability can be expressed using the following equation:

$$CCFP = 1 - \left[\frac{f(ncf)}{CDF}\right] \qquad \text{(Eq. 27)}$$

Where *f(ncf)* is the frequency of those sequences which result in no containment failure. This frequency is determined by summing the Class 1 and Class 3a results, and CDF is the total frequency of all core damage sequences.

Therefore the change in CCFP for this analysis is the CCFP using the results for 15 years ($CCFP_{15}$) minus the CCFP using the results for 10 years ($CCFP_{10}$). This can be expressed by the following:

$$\Delta CCFP_{10-15} = CCFP_{15} - CCFP_{10} \qquad \text{(Eq. 28)}$$

Using the data previously developed the change in CCFP from the current testing interval is calculated and presented in Table A.13.

Table A.13
Impact on Conditional Containment Failure Probability due to Extended Type A Testing Intervals

ILRT Inspection Interval	3 Years (baseline)	10 Years	15 Years
f(ncf)	2.931E-5	2.908E-5	2.893E-5
f(ncf)/CDF	0.847	0.840	0.836
CCFP	0.153	0.160	0.164
ΔCCFP (3 year baseline)		0.638%	1.093%
ΔCCFP (10 year baseline)			0.455%

Appendix B:
Exposure and Dose Sensitivity Studies

B.0 EXPOSURE AND DOSE SENSITIVITY STUDIES

Sensitivity studies were performed to address questions related to the development of the overall person-rem estimates utilized to calculate certain metrics presented in the ILRT submittal. The specific areas of examination are the use of a 95% evacuation assumption when estimating the intact containment dose and the person-rem estimates estimated for accident sequence associated with Classes 6, 7 and particularly 8.

The underlying issue is centered on the estimation of the change in risk parameters. Since this typically is calculated by a ratio calculation there is the potential to understate the increase if the numerator is uncharacteristically small or the denominator is uncharacteristically large. It is this aspect of the selection process that was the focus of the comments received and that is addressed by the sensitivity analysis.

B.1 SUMMARY OF RESULTS/CONCLUSIONS

The specific results for the sensitivity studies are summarized in Table B.1. The risk increase is provided for the increment from the current 10 year interval to the proposed 15 year interval and for the baseline 3 in 10 year interval to the 15 year interval. Additional detail is provided in the sections that follow.

Table B.1
Summary of Risk Impacts for Sensitivity Analyses

Case	Percent Increase from current (10yr)	Percent Increase from baseline (3 per 10 yr)	Evacuation Assumption	Class 6, 7, 8 Dose Assumption	Detailed Data Table
Baseline (main report)	0.006%	0.015%	95% evacuation	SONGS-specific	Table 1
Sensitivity Case 1	0.127%	0.305%	No evacuation	SONGS-specific	Table B.3
Sensitivity Case 2	0.044%	0.105%	95% evacuation	Generic[1]	Table B.11
Sensitivity Case 3 (upper bound)	0.851%	2.075%	No evacuation	Generic	Table B.12

1. Exposure for these classes based on NUREG-1150 results (Reference 19).

The baseline evaluation is considered the most representative of the risk impact since it utilizes plant-specific information and evacuation assumptions similar to those presented in Reference 19 which were adopted for the NUREG-1150 risk study.

B.2 INTACT CONTAINMENT DOSE ESTIMATION

The intact dose estimation for the baseline analysis is documented in Reference 2. A parametric sensitivity analysis is performed in this report to determine how a change in the evacuation assumption would impact the person-rem estimates used as a risk measure.

The use of evacuation is typical for most offsite dose analyses and a value of 95% evacuation is typically assumed in many cases (Reference 19 for example assumed 99.5%). However, as the evacuation increases, the person-rem dose decreases. Most of the calculated parameters utilize the intact dose indirectly in the numerator. This is because the estimated doses for Class 1, Class 3a and Class 3b are the only dynamic estimates in the risk calculation and are the only values that can be used for the change in risk.

Expanding this discussion, since Class 1 represents an intact containment and Classes 3a and 3b are multiples of Class 1 the predicted values are linked. Also, since the results are typically utilized in the numerator, the smaller the value obtained, the lower the change in risk.

To reflect the most conservative case and maximize the numerator in the risk calculations the assumption of no evacuation can be made and the estimate for intact dose updated. The dose is proportional to the available persons and since no evacuation is assumed the value is increased by a factor of 20 (0.05/1). This increases the intact dose for Class 1 from 222 to a value of 4,440 person-rem.

A sensitivity study is performed on the baseline analysis to determine how the increased Class 1 exposure would impact the conclusions of the analysis. The change in the baseline exposure has no impact on the LERF value or the conditional probability of containment failure since both are based on frequency values and they are not impacted by any exposure assumptions.

Only those metrics based on exposure are impacted. In those cases the increase in risk for the impacted classes (Classes 1, 3a and 3b) will tend to annunciate the impact of any change by increasing the baseline value that is present in the numerator of the equation. It will also tend to increase proportionally the net change between the different time periods.

The total integrated risk and Type A risk are developed using the approach defined in the main report. Specifically, the baseline intact dose (222 person-rem) is increased to the value associated with no evacuation (4,444 person-rem). Then the person-rem values for Classes 1, 3a and 3b are revised and the analysis requantified. Table B.2 presents a comparison of the Class 1, 3a and 3b contributions for the main report and the sensitivity case.

Table B.2
Comparison of Class 1, 3a and 3b Person-Rem for Baseline and No Evacuation Sensitivity Study

Parameter	Main Report Assessment[1]			No Evacuation Assessment[2]		
Testing Interval	3 in 10	10 year	15 year	3 in 10	10 year	15 year
Class 1	3.21E-3	2.93E-3	2.73E-3	6.42E-2	5.86E-2	5.46E-2
Class 3a	1.09E-3	3.65E-3	5.47E-3	2.19E-2	7.30E-2	1.10E-1
Class 3b	3.81E-4	1.27E-3	1.91E-3	7.62E-3	2.54E-2	3.81E-2
Total for All Classes	35.459	35.462	35.465	35.584	35.611	35.657

1. Values taken from Tables 6, 7 and 8.
2. All values except for total represent a factor of 20 increase from the baseline.

The revised total integrated risk values and the key parameters impacted by this value are summarized in Table B.3. The values for total integrated risk are slightly higher than those found in Table 1 of the main report due to the increased doses for Classes 1, 3a and 3b due to the assumption of no evacuation. These increases propagate throughout the remaining values. The overall results, however, indicate that increasing the person-rem by a factor of 20 will result in less than a 0.5% increase in risk.

Table B.3
Summary of Risk Impact on Extending Type A ILRT Test Frequency Without Evacuation

	Risk Impact for 3-years (baseline)	Risk Impact for 10-years (current requirement)	Risk Impact for 15-years
Total Integrated Risk (Person-Rem/yr)	35.548	35.611	35.657
% Total Risk (Type A / Total)	0.08%	0.275%	0.41%
Changes due to extension from 10 years (current)			
Δ Risk from current (Person-rem/yr)			4.52E-2
% Increase from current (Δ Risk / Total Risk)			0.127%
Changes due to extension from 3 years (baseline)			
Δ Risk from baseline (Person-rem/yr)			1.08E-1
% Increase from baseline (Δ Risk / Total Risk)			0.305%

B.3 ACCIDENT SEQUENCE DOSE ESTIMATION

For existing accident sequences, such as interfacing system LOCA or early containment failure, the dose is essentially constant for this assessment since the dose is substantially higher than is predicted for the Type A leakage. Therefore, the contributions from Classes 6, 7 and 8 form a baseline risk value that is constant for the analysis. As the intact dose impacted the numerator, the doses predicted from these classes impact the denominator.

In contrast, the larger the person-rem estimate for these classes, the smaller the increase in risk attributed to the Type A leakage because it reflects a relatively smaller increase in risk. Therefore a lower estimate for Class 6, 7 and 8 would tend to increase the estimates for risk increase due to the extension of interval for the ILRT.

Reference 2 provides plant-specific estimates for person-rem and these values form the basis for the baseline estimate. For the sensitivity study, the results presented in the NUREG 1150 study are utilized as a surrogate estimate for person-rem for Classes 6, 7 and 8.

NUREG 1150 examined both pressurized water reactors (PWRs) and boiling water reactors (BWRs). The results presented for boiling water reactors (i.e, Peach Bottom, Grand Gulf) are not considered appropriate for this analysis since the core melt mechanics and design are substantially different between SONGS and the BWRs. Therefore, their results are excluded from consideration.

NUREG 1150 also analyzed Zion, Sequoyah and Surry PWR designs. Sequoyah utilizes an ice condenser design and the presence of ice and restricted flow paths can lead to sequences and conditions that are not found in a large dry design such as SONGS. Therefore, Sequoyah is not considered a good PWR design for comparison. Zion is a 4 loop Westinghouse design and may be somewhat closer to the SONGS design. However the 4 loop design and the potential for seal LOCA cases associated most often with Westinghouse designs could influence the analysis. Therefore, it is not selected as a surrogate.

Surry is a Westinghouse 3 loop design and is considered the best surrogate after examination of the NUREG 1150 analyzed plants.

Reference 19 provides the Level 2 analysis and offsite consequence assessment for Surry. Table 4.3-1 of Reference 19 provides a summary of consequence results that includes population dose (exposure) within 50 miles for internal events. A range of outcomes exists for each source term group based on the consequence measures. A matrix is formed and values provided for figures of merit.

The exposure estimates for a range of 50 miles around the site are provided in Table B.4 for each reported source term group.

Table B.4
Reported Person Rem Estimates for Surry Source Term Groups (summarized from Reference 19)

Source Term Grouping	Outcome 1 (Sv[1])	Outcome 2 (Sv)	Outcome 3 (Sv)
SUR-01	NA	2.33E+3	1.25E+3
SUR-02	5.33E+3	1.13E+4	5.82E+3
SUR-03	1.15E+4	2.26E+4	1.13E+4
SUR-04	1.04E+4	1.45E+4	NA
SUR-05	NA	5.15E+4	2.62E+4
SUR-06	NA	2.42E+4	2.15E+4
SUR-07	2.76E+4	3.43E+4	1.46E+4
SUR-08	1.68E+4	2.14E+4	1.61E+4
SUR-09	1.36E+4	1.74E+4	NA
SUR-10	4.73E+4	4.66E+4	3.34E+4
SUR-11	4.56E+4	2.77E+4	2.78E+4
SUR-12	2.69E+4	3.01E+4	2.67E+4
SUR-13	2.15E+4	2.68E+4	NA
SUR-14	1.88E+4	2.23E+4	NA
SUR-15	4.28E-1	3.10E+0	NA
SUR-16	4.28E+0	3.75E+1	NA
SUR-17	2.66E+3	6.71E+3	NA
SUR-18	0.00E+0	NA	NA

1. Values provided in Sieverts (Sv). Conversion factor 1 Sv = 100 rem.

In order to utilize this information it is necessary to convert it to the form needed in the ILRT analysis. This involves classification into one of the three EPRI classes and then determining the representative person-rem estimates.

Reference 19 provides some guidance with respect to the composition of the source term grouping. For example SUR-01 is dominated by bypass sequences. Using this information the Surry results are grouped to the EPRI classes. The grouping is presented in Table B.5.

Table B.5
Assignment of Surry Source Term Groups to EPRI Classes

EPRI Class	Surry Source Term Groups Applied[1]
Class 6	SUR-14
Class 7	SUR-04, SUR-07, SUR-08, SUR-09, SUR-11, SUR-12, SUR-13, SUR-15, SUR-16, SUR-17
Class 8	SUR-01, SUR-02, SUR-03, SUR-05, SUR-06, SUR-10

1. Group SUR-18 is not applied to an EPRI class since the listed outcomes in Table B.4 are either 0.0 or NA.

The source term exposure estimates for each source term group are first averaged to obtain a value for the source term group and then the individual groups are averaged to obtain a class estimate. An example calculation is provided below.

Source term group (STG) SUR-01 has two estimates for exposure (see Table B.4). These values are first averaged to obtain a STG average for SUR-1.

$$Sv_{avg} = (2.33E+3 + 1.25E+3)\ Sv / 2 = 1.79E+3\ Sv \qquad \text{(eq. 1)}$$

Repeating this process arrives at the data provided in Table B.6.

It is noted that for Class 7 and Class 8 there are multiple source term groups included. In these cases the individual results using Equation 1 for each contributing Surry STG were summed and then averaged to obtain an estimate for the EPRI class.

Table B.6
Average Person-Rem for Surry Source Term Groups

Source Term Group	Exposure (Sv)
SUR-01	1.79E+3
SUR-02	7.48E+3
SUR-03	1.51E+4
SUR-04	1.25E+4
SUR-05	3.89E+4
SUR-06	2.29E+4
SUR-07	2.55E+4
SUR-08	1.81E+4
SUR-09	1.55E+4
SUR-10	4.24E+4
SUR-11	3.37E+4
SUR-12	2.79E+4
SUR-13	2.42E+4
SUR-14	2.06E+4
SUR-15	1.76E+0
SUR-16	2.09E+1
SUR-17	4.69E+3
SUR-18	NA

These results are then grouped into the EPRI Classes using Table B.5 and the average, minimum and maximum exposures are defined. The results are presented in Table B.7 in units of person-rem.

Table B.7
Average Person-Rem for EPRI Classes Based on Surry Source Term Groups

EPRI Class	Weighted Average Exposure (person-rem)	Max Exposure in Class (person-rem)	Min Exposure in Class (person-rem)
Class 6	2.06E+6	NA[1]	NA
Class 7	1.62E+6	3.37E+6	1.76E+2
Class 8	2.14E+6	4.24E+6	1.79E+5

1. Only one source term group applied.

The average values for the EPRI Classes generated using the Surry data are compared to the baseline values in Table B.8.

Table B.8
Comparison of Surry Based Exposure and SONGS Specific Exposure

EPRI Class	Weighted Surry Based Exposure (person-rem)	SONGS-Specific Exposure (person-rem)	Exposure Ratio
Class 6	2.06E+6	2.93E+6	1.42
Class 7	1.62E+6	7.80E+6	4.81
Class 8	2.14E+6	3.07E+7	14.35

The calculated values based on the Surry results are somewhat lower than those predicted for SONGS. Part of the difference may be due to the increased evacuation allowed by Surry which would reduce the effected population. Also, the relative populations should be considered.

The 50 mile radius population for SONGS is estimated to be 8.32E+6 people (Reference 2). This compares to a range for Surry of 5.94E+5 people at a 30 mile radius and 2.83E+6 people at a 100 mile radius. Examination of the results for Surry (Reference 19) indicates that when the 100 mile radius is considered, larger population doses occur.

For example, the STG SUR-10 (Class 8 contributor) population dose for the entire region has a value on the order of 2.5E+7 person-rem (2.5E+5 Sv). This value is very close to the SONGS estimate. If the Surry population is extended to that of the SONGS value the population dose may even exceed what is currently predicted based on SONGS-specific analysis. Therefore, the conclusions are drawn that the SONGS estimates are within the expected range for exposure and that the Surry calculated results are somewhat conservative with regard to estimating the change in risk, i.e., they are smaller than could be predicted. However, the value unadjusted for population is utilized in the sensitivity study to predict a more conservative estimate.

Substitution of these values into the prior tables for 3-year, 10-year and 15-year intervals derives the necessary metrics for the sensitivity study.

It is important to note that only a few metrics are impacted by changes in the baseline. Class 1, 3a and 3b are not impacted since the exposure is based on a different approach (design basis analysis). Absolute difference equations are also unaffected since the Class 6, 7 and 8 values are essentially constants that appear on both sides of the equation.

The change in exposure has no impact on the LERF value or on the incremental changes in risk since both are based on values not impacted by any exposure assumptions. Only those metrics based on percent exposure are impacted. In those cases the reduction in the total integrated risk will tend to increase the impact of any change by lowering the baseline value that is present in the denominator of the equation.

The Class 6, 7 and 8 risk contributions are developed using the approach defined in the main report. Specifically, the baseline doses are replaced with the doses calculated in Table B.8 and the risk contribution recalculated. The analysis is then performed to determine the total risk and the percent contributions as defined in the main report. Table B.9 presents a comparison of the Class 6, 7 and 8 contributions for the main report and the sensitivity case.

Table B.9
Comparison of Class 1, 3a and 3b Person-Rem for SONGS-Specific and Surry Surrogate Dose Estimate Sensitivity Study

Parameter	Main Report Assessment[1]			No Evacuation Assessment[2]		
Testing Interval	3 in 10	10 year	15 year	3 in 10	10 year	15 year
Class 6	4.57E-01	4.57E-01	4.57E-01	3.21E-01	3.21E-01	3.21E-01
Class 7	1.73E+01	1.73E+01	1.73E+01	3.60E+00	3.60E+00	3.60E+00
Class 8	1.77E+01	1.77E+01	1.77E+01	1.23E+00	1.23E+00	1.23E+00
Total for All Classes[3]	35.459	35.462	35.465	5.157	5.160	5.163

1. Values taken from Tables 6, 7 and 8.
2. All values except for total represent a change equal to the main report values divided by the ratios presented in Table B.8.
3. Change in value due to changes associated with Classes 1, 3a and 3b are consistent between the testing intervals.

The revised total integrated risk values and the key parameters impacted by this value are summarized in Table B.10.

Table B.10
Summary of Risk Impact on Extending Type A ILRT Test Frequency Using Surry Surrogate Exposure Values

	Risk Impact for 3-years (baseline)	Risk Impact for 10-years (current requirement)	Risk Impact for 15-years
Total Integrated Risk (Person-Rem/yr)	5.157	5.160	5.163
% Total Risk (Type A / Total)	0.029%	0.095%	0.143%
Changes due to extension from 10 years (current)			
% Increase from current (Δ Risk / Total Risk)			0.044%
Changes due to extension from 3 years (baseline)			
% Increase from baseline (Δ Risk / Total Risk)			0.105%

Table B.11 provides a comparison of these results to those obtained using the SONGS-specific values.

Table B.11
Comparison of Results for SONGS-Specific and Surry Surrogate Values

	Risk Impact for 3-years (baseline)		Risk Impact for 10-years (current requirement)		Risk Impact for 15-years	
	SONGS[1]	Surry[2]	SONGS[1]	Surry[2]	SONGS[1]	Surry[2]
Total Integrated Risk (Person-Rem/yr)	35.459	5.157	35.462	5.160	35.465	5.163
% Total Risk (Type A / Total)	0.004%	0.029%	0.014%	0.095%	0.021%	0.143%
Changes due to extension from 10 years (current)						
% Increase from current (Δ Risk / Total Risk)					0.006%	0.044%
Changes due to extension from 3 years (baseline)						
% Increase from baseline (Δ Risk / Total Risk)					0.015%	0.105%

1. From Table 1 of the main report and assumes 95% evacuation.
2. From Table B.10.

A comparison of the values indicates that the sensitivity results do indicate a slightly higher percent increase in risk. However, the value for the maximum change is still much less than a 1% increase and the change is still small even assuming what is believed to be a conservative estimate for the total integrated risk.

If the Surry surrogate values were adjusted for the difference in population the conclusions of the sensitivity study may be reversed and indicate that the SONGS-specific values indicate a higher impact to risk due to the inclusion of a higher population density within the 50 mile area of interest.

B.4 BOUNDING SENSITIVITY ANALYSIS

The prior sections addressed individual impacts related to the risk measures. To estimate a bounding maximum impact, the two parameters are combined to provide a somewhat theoretical upper bound for the risk impact. It is clear that this approach is very conservative and does not represent a best-estimate approach as is typically utilized for risk-based applications since a conservative result could bias any prioritization of risk mitigation actions.

The analysis is performed in a manner similar to that previously defined using the sensitivity estimates for intact containment and Classes 6, 7 and 8 exposures. Table B.12 provides a comparison of this upper bound to the best estimate analysis utilizing SONGS-specific values.

Table B.12
Comparison of Results for SONGS-Specific and Upper Bound Estimate Values

	Risk Impact for 3-years (baseline)		Risk Impact for 10-years (current requirement)		Risk Impact for 15-years	
	SONGS[1]	Upper Bound[2]	SONGS[1]	Upper Bound[2]	SONGS[1]	Upper Bound[2]
Total Integrated Risk (Person-Rem/yr)	35.459	5.246	35.462	5.309	35.465	5.354
% Total Risk (Type A / Total)	0.004%	0.562%	0.014%	1.85%	0.021%	2.76%
Changes due to extension from 10 years (current)						
% Increase from current (Δ Risk / Total Risk)					0.006%	0.851%
Changes due to extension from 3 years (baseline)						
% Increase from baseline (Δ Risk / Total Risk)					0.015%	2.075%

1. From Table 1 of the main report and assumes 95% evacuation.
2. Assumes no evacuation and Surry dose estimates for Classes 6, 7 and 8.

Even if the values are chosen such that a maximum impact is predicted the overall risk is still small. There is a less than 1% increase from the current risk exposure and an approximately 2% increase when the baseline contribution is considered.

Another consideration is the increase related to just LERF sequences. Class 8 and Class 6 sequences can be classified as LERF since they involve containment isolation faults and bypass sequences. The total risk contribution expected from these classes upon implementation of the ILRT extension (15-year case) is 1.551 person-rem per year (0.321+ 1.230, from Table B.9).

This compares to a predicted maximum value of 3.811E-2 (from Table B.2) person-rem per year for Class 3b (2.45E-07/yr x 1.55E+05 person-rem). Therefore, the ILRT extension would represent only 2.4% (3.811E-2/(3.811E-2+1.551)) of the LERF contribution. This indicates that the ILRT extension is at maximum only a small contributor to LERF risk and again is supportive of the extension request.

Appendix C:
References

C.0 REFERENCES

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