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June 14, 2002
CEOG-02-125

NRC Project 692

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001
ATTN: Chief, Information Management Branch

Subject: Request for Review of CE Owners Group Report WCAP-15691 Rev 02,"Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension."

Reference: (1) CEOG letter to NRC, "Request for Review of CE Owners Group Report WCAP-15691, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," CEOG-01-184, dated 7/19/01.

(2) Transmittal of WCAP-15691 Supplement 1 (Proprietary) and WCAP-15715 Supplement 1 (Non-Proprietary), "Application of the Joint Application Report to Calvert Cliffs Nuclear Power Plant Units 1 And 2," CEOG-01-314, dated 12/18/01.

WCAP-15691, submitted for staff review via the reference letters, documented the acceptability and provided plant-specific results for performing a containment integrated leak rate test at Waterford-3 and Calvert Cliffs-1 & 2 on a 15 year interval. One-time plant-specific integrated leak rate test extensions for Waterford and Calvert Cliffs, based on Appendices A and B of WCAP-15691, have been approved by the staff.

The purpose of this letter is to submit additional information for staff review in conjunction with WCAP-15691. This information consists of updates to tables in sections 5 and 6 of the report plus Appendices C and D that provide a risk-informed justification to extend the containment integrated leak rate test interval at St. Lucie-1 & 2. Five (5) copies of WCAP-15691, Rev 02 are enclosed for staff review. An application will be submitted by FPL to modify the relevant containment surveillance technical specifications consistent with this submittal.

Westinghouse has evaluated the information contained in WCAP-15691 Rev 02 and has determined that this material is non-proprietary and may be placed in public records. This determination supersedes all earlier submittals of WCAP-15691, References 1 & 2, that were

Continued

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designated as Westinghouse Proprietary Class 2. For completeness, this submittal contains the topical report and Appendices A through D. Only Appendices C and D and relevant tables in report sections 5 and 6 contain material not previously transmitted for staff review.

The NRC should address any technical questions concerning this report to Mr. Gordon Bischoff, CE Owners Group Project Office. Please do not hesitate to contact me at 623-393-5882 or Gordon Bischoff, CEOG Project Office, at 860-731-6200 if you have any questions.

Sincerely,

Richard A. Bernier

Richard A. Bernier, Chairman
CE Owners Group

Enclosure: WCAP-15691, Rev 02 (Non-Proprietary Class 3)

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CEOG COMBUSTION ENGINEERING OWNERS GROUP

WCAP-15691
Rev. 02

Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension

CEOG Task 2027

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WCAP 15691, Rev. 02

Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension

CEOG Task 2027

June 2002

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LIST OF ACRONYMS

ASME	American Society of Mechanical Engineers
CCNPP	Calvert Cliffs Nuclear Power Plant
CDF	Core Damage Frequency
CE	Combustion Engineering
CEOG	Combustion Engineering Owners Group
CET	Containment Event Tree
CIAS	Containment Isolation Actuation Signal
CILRT	Containment Integrated Leak Rate Test
CIV	Containment Isolation Valve
$F_{Class\ x}$	Frequency of Event Class x
FSAR	Final Safety Analysis Report
ILRT	Integrated Leak Rate Test
IPE	Individual Plant Examination
ISLOCA	Interfacing System Loss of Coolant Accident
ISTS	Improved Standard Technical Specifications
L_a	Containment Allowable Leak Rate
LDBA	Leakage Design Basis Accident
LERF	Large Early Release Frequency
LOCA	Loss of Coolant Accident
MSSV	Main Steam Safety Valve
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
ORNL	Oak Ridge National Laboratory
P_a	Internal Containment Pressure
PSA	Probabilistic Safety Assessment
PWR	Pressurized Water Reactor
RCS	Reactor Coolant System
SG	Steam Generator
SGTR	Steam Generator Tube Rupture
TS	Technical Specification
UCL	Upper Confidence Limit
WSES	Waterford Steam Electric Station

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1.0 INTRODUCTION

The purpose of this report is to provide a risk informed methodology for justifying modification of the plant licensing basis for PWR containment Integrated Leak Rate Test (ILRT) intervals. Specifically, this report provides technical justification for an extension of the Integrated Leak Rate Test (ILRT) interval for the containment from 10 years to 20 years.

This report provides the risk-informed methodology and the results of an evaluation for extending the Integrated Leak Rate Test (ILRT) test interval from 10 years to 20 years. This ILRT extension is sought to provide cost savings and increased plant availability by shortening refueling outages by approximately two critical path days. Justification of this ILRT modification is based on a review and assessment of plant operations, deterministic/design basis factors, and plant risk.

The ILRT extension was found to have a very small impact on the risk of events that may give rise to large early radionuclide releases. Therefore, any decrease in containment reliability due to the ILRT extension for the requested ILRT test interval modifications would result in a very small (negligible) impact on the large early release probability.

PWRs can realize substantial cost savings while continuing to operate with an acceptable level of risk. The results of the evaluation provided herein demonstrate that the risk level associated with the proposed ILRT extension is below the regulatory guidelines set forth in Regulatory Guide 1.174 (Reference 3).

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2.0 SCOPE OF PROPOSED CHANGE

2.1 DEFINITION OF CONTAINMENT INTEGRATED LEAK RATE TEST

Containment structure testing is intended to assure leak-tight integrity of the containment structure under all design basis conditions. Containment leakage test methods include Integrated Leakage Rate Tests (ILRTs or Type A tests) and local leakage rate tests (LLRTs or Type B and Type C tests). The intention of this report is to justify modifying the test interval for Type A ILRT testing.

Type A tests are performed by pressurizing the primary containment to an internal pressure (P_a) derived from the Leakage Design Basis Accident (LDBA) and specified in the unit technical specifications or associated bases. The primary containment system is aligned, as closely as practical, to the configuration that would exist following a LDBA (e.g. systems are vented, drained, flooded, or in operation, as appropriate). At pressure P_a, the actual containment leakage rate (L_a) is derived from measurements. The derived leakage rate is expressed in percent per 24 hours by weight of the containment normal air inventory, with the leakage taking place at P_a. The parameters actually measured are pressure, temperature and humidity. Utilizing the Ideal Gas Law and placing a statistical boundary on the leakage rate calculated at 95% probability or upper confidence limit, a true leakage rate is calculated.

Type A tests measure very small leakage rates and require approximately two days of critical path time to complete.

2.2 PROPOSED EXTENSION OF ILRT INTERVAL

This report provides justifications for an extension in the containment ILRT interval from 10 years to 20 years. This is consistent with the conclusions of NUREG-1493 (Reference 4), Performance-Based Containment Leak-Test Program. NUREG-1493 conclusions are that "Reducing the frequency of Type A tests (ILRTs) from three per 10-year period to one per 20 years was found to lead to an imperceptible increase in risk."

The risk calculations included in this evaluation consider all significant impacts of the ILRT test interval modification, including:

- Change in Large Early Release Frequency
- Total impact in terms of change in person-rem/year.
- Altering the ILRT test interval has no impact on Core Damage Frequency (CDF)

The supporting analytical material contained within this document is considered applicable to PWRs with large dry containments, including all CE NSSS designed units of the CEOG member utilities.

For some of the CEOG plants, implementation of the ILRT interval change will require a change to the plant's Technical Specifications or other Licensing document. For other CE designed plants, the change can be made to administrative documents which define the approved ILRT interval.

3.0 BACKGROUND

This report provides a risk-informed technical basis for extending the containment integrated leak rate test interval. This change is warranted based on the low risk associated with the extended ILRT. This application is being pursued by the CEOG as a risk informed plant modification in accordance with NRC Regulatory Guide 1.174, (Reference 3).

Implementation of the ILRT extension will save utilities approximately two critical path days per outage where an ILRT is performed, with a resulting savings in excess of $300,000 per day. This saving will be realized with negligible public risk impact.

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4.0 SYSTEM DESCRIPTION AND OPERATING EXPERIENCE

4.1 SYSTEM DESCRIPTION

The primary function of containment is to prevent the release of radioactive material from either the containment atmosphere or the reactor coolant system to the outside environment. The appendices to this report contain plant specific descriptions of the containment systems.

4.2 OPERATING EXPERIENCE

NUREG-1493, Performance-Based Containment Leak-Test Program, determined that, "In approximately 180 ILRT reports considered in this study, covering approximately 770 years of operating history, only five ILRT failures were found which local leakage-rate testing could not and did not detect. These results indicate that Type A testing detected failures to meet current leak-tightness requirements in approximately 3 percent of all tests. These findings clearly support earlier indications that Type B and C testing can detect a very large percentage of containment leakages. The percentage of containment leakages that can be detected only by integrated containment leakage testing is very small. Of note, in the ILRT failures observed that were not detected by Type B and C testing, the actual leakage rates were very small, only marginally in excess of the current leak-tightness requirements."

The current surveillance testing requirements, as outlined in NEI 94-01 (Reference 1) for Type A testing, is at least once per 10 years based on an acceptable performance history (define as two consecutive Type A tests at least 24 months apart in which the calculated performance leakage was less than $1.0L_a$). The appendices to this report discuss plant specific operating experience.

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5.0 ASSESSMENT OF RISK

The purpose of this Section is to provide a risk-informed assessment for extending a plant's Integrated Leak Rate Test (ILRT) interval from 10 to 20 years. The risk assessment is consistent with the methodologies set forth in NEI 94-01 (Reference 1), the methodology used in EPRI TR-104285 (Reference 2) and the NRC guidance in NUREG-1493 (Reference 4). In addition, the methodology incorporates Probabilistic Safety Assessment (PSA) findings and risk insights in support of risk informed licensee requests for changes to a plant's licensing basis, Regulatory Guide 1.174 (Reference 3).

Specifically, this approach combines the plant's PSA results and findings with the methodology described in EPRI TR-104285 to estimate public risk associated with extending the containment Type A test interval.

The change in plant risk is evaluated based on the change in the predicted releases in terms of person-rem/year and Large Early Release Frequency (LERF). Changes to Type A testing have no impact on plant CDF.

5.1 OVERVIEW

In October 26, 1995, the NRC revised 10 CFR 50, Appendix J. The revision to Appendix J allowed individual plants to select containment leakage testing under Option A "Prescriptive Requirements" or Option B "Performance-Based Requirements." Individual CEOG members have selected the requirements under Option B as their testing program.

The current surveillance testing requirement, as outlined in NEI 94-01 (Reference 1) for Type A testing, is at least once per 10 years based on an acceptable performance history (define as two consecutive Type A tests at least 24 months apart in which the calculated performance leakage was less than $1.0L_a$). Experience has not shown these tests as being needed for identifying containment leakages, with more than 97% of all containment leakages in excess of L_a being identified by local tests. As a result of the small benefit, the risk impact of extending this test interval from 10 to 20 years will be negligible. This Section provides the risk assessment methodology for assessing the risk significance of this surveillance test interval change. Analysis presented in the following paragraphs is consistent with the NRC methodology used for their initial Appendix J change and considers risk impact in accordance with Regulatory Guide 1.174.

5.2 RISK ASSESSMENT METHODOLOGY

The risk of extending the ILRT interval for Type A tests from its current interval of 10 years to 20 years, is evaluated for potential public exposure impact (as measured in person-rem/year) and for impact on Large Early Release Frequency (LERF) as identified in Regulatory Guide 1.174 (Reference 3). The analysis employs a simplified approach similar to that presented in EPRI TR-104285 (Reference 2) and NUREG-1493 (Reference 4). The methodology explicitly accounts for large releases and specifically computes the LERF metric. The analysis performed examines

each plant's IPE and subsequent PSA upgrades for plant specific accident sequences which may impact containment performance.

In the EPRI/NRC approaches, the core damage events are binned into eight containment classes including two intact containment states; one with containment leakage less than L_a, and one with containment leakage in excess of L_a. It is assumed that extending the ILRT will increase the likelihood of containment states with excess leakage. This Section contains an evaluation of the magnitude of the increase in probability of core damage events with significant containment leakage. This evaluation is performed using the methodology described below. The methodology for the risk calculations is summarized in Sections 5.2.1 through 5.2.4. These sections are divided as follows:

Section 5.2.1 defines the containment failure frequency and associated releases for each of eight accident classes used in this evaluation.

Section 5.2.2 develops the plant specific dose (population dose) per reactor year.

Section 5.2.3 provides an evaluation of the risk impact of extending Type A test interval from 10 years to 15 and 20 years.

Section 5.2.4 evaluates the risk impact of extending the Type A test interval based on the change in risk in terms of Large Early Release Frequency (LERF), in accordance with Regulatory Guide 1.174 (Reference 3)

5.2.1 Methodology for Assessment of Accident Class Frequency and Releases

Extension of the Type A interval does not influence those accident progressions that involve containment isolation failures associated with Type B or Type C testing or containment failure induced by severe accident phenomena. The CET containment isolation models are reviewed for applicable isolation failures and their impacts on the overall plant risk. Specifically, a simplified model to predict the likelihood of having a small or large pre-existing breach in the containment, that is undetected due to the extension of the Type A ILRT test interval, is developed.

For this present work, the EPRI accident Class designations (Reference 2) are used to define the spectrum of plant releases. Following the EPRI approach, the intact containment event was modified to include the probability of a pre-existing containment breach at the time of core damage. Two additional basic events are addressed. These are Event Class 3A (small leak) and Event Class 3B (large leak). (This addresses the 'Class 3' sequence discussed in EPRI TR-104285). Both event Class 3A and 3B are considered in estimating the public exposure impact of the ILRT extension. However, since leaks associated with event Class 3A are small (that is, marginally above normal containment leakage), only event Class 3B frequency change is considered in bounding the LERF impact for the proposed change.

The eight EPRI accidents Classes are discussed in the following paragraphs.

Class 1 Sequences: This sequence class consists of all core damage accident progression bins for which the containment remains intact with negligible leakage. Class 1 sequences arise from those core damage sequences where containment isolation is successful, and long term containment heat removal capability is available via containment sprays or fan coolers. The frequency of an intact containment is established based on the individual plant's PSA. For Class 1 sequences, it is assumed that the intact containment end state is subject to a containment leakage rate less than the containment allowable leakage (L_a). To obtain the Class 1 event frequency, intact containment events are parsed into three classes: Class 3A, Class 3B and Class 1. Class 1 represents containments with expected leakages less than L_a. Class 3A represents intact containments with leakages somewhat larger than L_a, and Class 3B represents intact containment endstates with large leaks.

The frequency for Class 1 events is related to the intact containment core damage frequency (CDF_{Intact}) and the Class 3 categories, as follows.

$$F_{Class\ 1} = CDF_{Intact} - F_{Class\ 3A} - F_{Class\ 3B}$$

Where:
CDF_{Intact} = the Core Damage Frequency for intact containment sequences from the plant specific PSAs.

The calculation of Class 3 frequencies is discussed below. Radiological releases for Class 1 sequences are established assuming a containment leakage rate equal to the design basis allowable leakage (L_a).

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

$$F_{Class\ 2} = PROB_{large\ CI} * CDF_{Total}$$

Where:
$PROB_{large\ CI}$ = random containment large isolation failure probability (i.e. large valves), and
CDF_{Total} = Total plant specific CDF.

This value is obtained from plant specific PSAs.

For this analysis, the associated maximum containment leakage for this group is estimated at approximately 100 wt% per day (See Table 5-1).

Class 3 Sequences: Class 3 endstates are developed specifically for this application. The Class 3 endstates include all core damage accident progression bins with a pre-existing leakage in the containment structure in excess of normal leakage. The containment leakage for these sequences can be grouped into two categories; small leakage, or large.

The respective frequencies per year are determined as follows:

$F_{Class\ 3A} = PROB_{Class\ 3A} * CDF_{Intact}$

$F_{Class\ 3B} = PROB_{Class\ 3B} * CDF_{Intact}$

Where:
$PROB_{Class\ 3A}$ = the probability of small pre-existing containment leakage in excess of design allowable but less than 100 L_a. $PROB_{Class\ 3A}$ is presented as a function of ILRT test interval in Table 5-5, in Section 5.2.3,
$PROB_{Class\ 3B}$ = the probability of large (>100L_a) pre-existing containment leakage. $PROB_{Class\ 3B}$ is a presented as a function of ILRT test interval in Table 5-5, in Section 5.2.3, and
CDF_{Intact} = the Core Damage Frequency for intact containment sequences from the plant specific PSAs.

No ILRT has identified a pre-existing leakage in excess of 21 L_a (See Section 5.2.3). However, a 100 L_a upper limit has been conservatively selected for defining the frequency of Class 3A. Class 3A releases are estimated to be 25 L_a. Class 3B releases are approximated as an absolute leakage of 100 wt% per day. This corresponds to an equivalent containment leakage of about 6 in^2 (See Figure 5-1).

Class 4 Sequences: This group consists of all core damage accident progression bins for which a failure-to-seal containment isolation failure of Type B test components occurs. Because these failures are detected by Type B tests, and their frequency is very low compared with the other classes, this group is not evaluated any further. The frequency for Class 4 sequences is subsumed into Class 7 where it contributes insignificantly.

Class 5 Sequences: This group consists of all core damage accident progression bins for which a failure-to-seal containment isolation failure of Type C test components occurs. Because these failures are detected by Type C tests, and their frequency is very low compared with the other classes, this group is not evaluated any further. The frequency for Class 5 sequences is subsumed into Class 7 where it contributes insignificantly.

Class 6 Sequences: This group is similar to Class 2. These are sequences that involve core damage accident progression bins for which a failure-to-seal containment leakage, due to failure to isolate the containment, occurs. These sequences are dominated by misalignment of containment isolation valves following a test/maintenance evolution typically resulting in a failure to close smaller containment isolation valves. All other failure modes are bounded by the Class 2 assumptions.

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

$$F_{Class\ 6} = PROB_{largeT\&M} * CDF_{Total}$$

Where:
$PROB_{largeT\&M}$ = probability of random failure of containment to isolate due to valve misalignment (failure modes not otherwise include in Class 2).
CDF_{Total} = the Total plant specific CDF.

For this analysis the associated maximum containment leakage for this group is 35 wt%/day.

Class 7 Sequences: This group consists of all core damage accident progression bins in which containment failure induced by severe accident phenomena occurs (i.e. H_2 combustion, direct containment heating, etc.).

$$F_{Class\ 7} = CDF_{CFL} + CDF_{CFE}$$

Where:
CDF_{CFE} = the CDF resulting from accident sequences that lead to early containment failure, and
CDF_{CFL} = the CDF resulting from accident sequences that lead to late containment failure.

$F_{Class\ 7}$ can be determined by subtracting the intact, bypass (See Class 8 discussion) and loss of isolation CDFs from the total CDF.

These endstates include containment failure. For this analysis the associated containment leakage for this group is 280 wt%/day (based on 0.1 ft^2 failure, see NUREG 1493)

Class 8 Sequences: This group consists of all core damage accident progression bins in which containment bypass occurs. Each plant's PSA is used to determine the containment bypass contribution. Contributors to bypass events include ISLOCA events and SGTRs with an unisolated steam generator.

$$F_{Class\ 8} = CDF_{ISLOCA} + CDF_{Unisolated\ SGTR}$$

The magnitude of bypass releases is plant specific and is typically considerably larger (two or more orders of magnitude) than releases expected for leakage events. The containment structure will not impact the release magnitude for this event class.

Table 5-1 summarizes the methodology for determining the event class frequency and associated releases.

Table 5-1
Mean Containment Frequency Measures and Representative Releases - by Accident Class

Class	Description	Frequency Relationships (NOTE 1)	Estimated Leakage
1	No Containment Failure	$F_{Class\ 1} = CDF_{Intact} - F_{Class\ 3A} - F_{Class\ 3B}$	L_a
2	Large Containment Isolation Failures (failure-to-close)	$F_{Class\ 2} = PROB_{large\ CI} * CDF_{Total}$	100 wt%/day
3A	Small Pre-existing Containment Leak	$F_{Class\ 3A} = PROB_{Class\ 3A} * CDF_{Intact}$ (Note 2)	25 L_a
3B	Large Pre-existing Containment Leak	$F_{Class\ 3B} = PROB_{Class\ 3B} * CDF_{Intact}$ (Note 2)	100 wt%/day
4	Small isolation failure - failure-to-seal (Type B test)	Not Analyzed	
5	Small isolation failure - failure-to-seal (Type C test)	Not Analyzed	
6	Containment Isolation Failures (dependent failures, personnel errors)	$F_{Class\ 6} = PROB_{largeT\&M} * CDF_{Total}$	35 wt%/day
7	Severe Accident Phenomena Induced Failure (early and late failures)	$F_{Class\ 7} = CDF_{CFL} + CDF_{CFE}$	280 wt%/day
8	Containment Bypassed (ISLOCA, SGTR with stuck open MSSVs)	$F_{Class\ 8}$ = [Plant Specific]/year	PSA defined large release
Total	All CET Endstates	From PSA (Sum of Classes 1 through 8)	

Note 1 - Plant specific parameters are summarized in Table 5-2.
Note 2 - $PROB_{Class\ 3A}$ and $PROB_{Class\ 3B}$ are ILRT interval specific and are summarized in Table 5-5.

The appendices to this report include determination of the plant specific frequencies for each event class. Table 5-2 summarizes the plant specific frequencies for each event class for participating PWRs (See for example Appendix A).

Table 5-2
Plant Specific Event Class Frequencies (per year)– Baseline ILRT Interval

Class	Description	WSES[1]	Calvert Cliffs[1]	Saint Lucie 1	Saint Lucie 2
1	No Containment Failure	1.27E-5	4.67E-5	2.20E-05	1.58E-05
2	Large Containment Isolation Failures (failure-to-close)	2.54E-8	4.97E-8	2.26E-08	1.63E-08
3A	Small Pre-existing Containment Leak	3.67E-7	1.35E-6	6.33E-07	4.56E-07
3B	Large Pre-existing Containment Leak	2.20E-9	8.08E-9	3.80E-09	2.74E-09
4	Small isolation failure – failure-to-seal (Type B test)	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
5	Small isolation failure – failure-to-seal (Type C test)	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
6	Containment Isolation Failures (dependent failures, personnel errors)	4.78E-10	1.41E-6	0.00E+00	0.00E+00
7	Severe Accident Phenomena Induced Failure (early and late failures)	1.08E-5	5.43E-5	3.15E-06	2.17E-06
8	Containment Bypassed (ISLOCA, SGTR with stuck open MSSVs)	1.47E-6	6.47E-6	4.09E-06	5.88E-06
Total	All CET Endstates	2.54E-5	1.10E-4	2.99E-05	2.44E-05

Note 1 – Values for WSES and Calvert Cliffs obtained from Appendix A and Appendix B respectively.
Note 2 – Relevant data for each plant is provided at the time of each plant's submittal.

5.2.2 Methodology for the Calculation of Plant Specific Population Dose (per reactor year)

Plant-specific release analyses are performed to evaluate the whole body dose to the population, within a 50-mile radius from the plant. The releases are based on the large Loss-Of-Coolant Accident (LOCA) associated with the maximum hypothetical accident.

The population dose is estimated assuming leakages for accident Classes are as defined in Table 5-1.

Since the containment release pathways are generally the same for containment Classes 1 through 7, doses are directly proportional to the ratio of the leakage rate to the nominal leakage value. Therefore, the Class 2 through 7 leakage related doses are ratioed upwards to account for the particular increased leakages associated with event Classes 2 through 7. In this methodology, the Class 1 leakage is represented by REL_{Intact}. Table 5-3 presents the releases for each class as a function of REL_{Intact} and L_a. Class 8 events are represented by bypass releases based on iodine and noble gas releases identified in the PSA for the dominant sequence. The population estimate can be based on FSAR siting projections.

The assessment of containment leakages for Classes 1 through 8 and associated releases are defined in Table 5-3. Intact containment release (REL_{Intact}) for Class 1 events and bypass

releases for Class 8 events are obtained from plant specific assessments. Plant specific containment releases are summarized in Table 5-4.

Table 5-3
Containment Leakage Rates and Doses – for Accident Classes

Class	Description	Leakage (wt%/day)	Release (50 miles) (person-rem)	Basis
1	No Containment Failure	L_a*	REL_{Intact}	See Section [5.2.1]
2	Large Containment Isolation Failures (failure-to-close)	100	$(100/L_a)$* REL_{Intact}	Ratio from Class 1 baseline
3A	Small Pre-existing Containment Leak	25 L_a	25* REL_{Intact}	Ratio from Class 1 baseline
3B	Large Pre-existing Containment Leak	100	$(100/L_a)$* REL_{Intact}	Ratio from Class 1 baseline
4	Small isolation failure - failure-to-seal (Type B test)	Not analyzed	N/A	Ratio from Class 1 baseline
5	Small isolation failure - failure-to-seal (Type C test)	Not analyzed	N/A	Ratio from Class 1 baseline
6	Containment Isolation Failures (dependent failures, personnel errors)	35	$(35/L_a)$* REL_{Intact}	Ratio from Class 1 baseline
7	Severe Accident Phenomena Induced Failure (early and late failures)	280	$(280/L_a)$* REL_{Intact}	Ratio from Class 1 baseline
8	Containment Bypassed (ISLOCA, SGTR with stuck open MSSVs)	-	[Plant Specific]	No credit for containment

* Plant Specific parameter, typically 0.1 or 0.5 wt%/day.

Table 5-4, below, provides a summary of the plant specific releases for each of the eight event classes.

Table 5-4
Plant Specific Event Class Releases (person-rem - within 50 miles)

Class	Description	WSES[1]	Calvert Cliffs[1]	Saint Lucie 1	Saint Lucie 2
1	No Containment Failure	6.73E+4	9.79E+05	1.84E+05	1.84E+05
2	Large Containment Isolation Failures (failure-to-close)	1.35E+7	4.90E+08	3.68E+07	3.68E+07
3A	Small Pre-existing Containment Leak	1.68E+6	2.45E+07	4.60E+06	4.60E+06
3B	Large Pre-existing Containment Leak	1.35E+7	4.90E+08	3.68E+07	3.68E+07
4	Small isolation failure – failure-to-seal (Type B test)	N/A	N/A	NA	NA
5	Small isolation failure – failure-to-seal (Type C test)	N/A	N/A	NA	NA
6	Containment Isolation Failures (dependent failures, personnel errors)	4.71E+6	1.71E+08	1.29E+07	1.29E+07
7	Severe Accident Phenomena Induced Failure (early and late failures)	3.77E+7	1.37E+09	1.03E+08	1.03E+08
8	Containment Bypassed (ISLOCA, SGTR with stuck open MSSVs)	1.08E+8	5.47E+08	1.39E+08	1.39E+08

Note 1 – Values for WSES and Calvert Cliffs obtained from Appendix A and Appendix B respectively.
Note 2 – Relevant data for each plant is provided at the time of each plant's submittal.

The above results can be combined with the class frequency results presented in Table 5-1 to yield the plant specific baseline mean risk measure for each accident class (calculated as the product of the frequencies in Table 5-1 and the releases in Table 5-3). The resulting doses for the ith Class are represented by the parameter $Risk_{Class\ i}$.

Risk Contribution of Classes 1 and 3

In order to evaluate the impact of an ILRT extension on incremental doses, it is necessary to investigate the change in the expected doses on the "intact" containment classes. While other sequences contribute more significantly to risk, the other sequences are insensitive to changes in ILRT intervals.

Based on the parameters defined above, the percent risk contribution associated with the "intact" containment sequences for Class 1 and Class 3 (%Risk) is as follows:

$$\%Risk = [(Risk_{Class\ 1} + Risk_{Class\ 3A} + Risk_{Class\ 3B}) / Total] \times 100$$

Where:
$Risk_{Class\ 1}$ = Class 1 person-rem/year
$Risk_{Class\ 3A}$ = Class 3A person-rem/year
$Risk_{Class\ 3B}$ = Class 3B person-rem/year

Total = total person-rem/year

Thus, the total risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios can be determined for the baseline ILRT interval (the 3 per 10 year ILRT interval that is represented in the PSA), the current 10 year ILRT interval, and for 15 and 20 year ILRT intervals. All of the parameters in the above equation are dependent on the ILRT interval.

5.2.3 Methodology for Evaluation of Risk Impact of Extending Type A Test Interval From 10 To 15 and 20 Years

In order to calculate the impact of the change in the ILRT interval, it is first necessary to define the probability that a Type A leakage test is required to detect a containment leak. This probability is then adjusted to account for the proposed change in testing interval.

Probability of ILRT Leak Detection

NUREG-1493 (Reference 4) states that a review of experience data finds that a review of approximately 180 ILRT Type A tests identified 5 leaks that would not otherwise be identified by the more frequent local leak tests (Types B and C). That is, approximately 3% (0.028) of containment leakage events would not be identified without a Type A ILRT. In all instances, the detected leaks exhibited leak rates marginally in excess of the design basis allowable leakage. Therefore the probability of finding a small Type A leak (Class 3A) at a given Type A ILRT test is 0.028.

This probability is based on a testing frequency of three tests over a ten-year period and is used to define the baseline for the analysis. A once per ten-year frequency is currently employed at CEOG plants. Therefore, it is necessary to adjust the baseline probability (0.028) to reflect the current testing interval, and alternative testing intervals.

Probability of ILRT Identifying a Large Leak

The data in Reference 4 indicates that in the conduct of the ILRTs discussed above, 23 leaks were detected; the largest leak was 21 L_a, the second largest was 10 L_a, and the third largest was less than 3 L_a. The leak data from Reference 4 was used to estimate the probability that, given a leak, that it is a large leak. For estimation purposes a large leak is to be defined as 100 L_a. As the allowable leakage (L_a) will range from 0.1 wt% to 0.5 wt%, the risk impact of this leakage will vary. It is estimated that leaks in this range (10 to 50 L_a) would have a 1% to 6% impact on plant risk (See Figure 5-2).

The NUREG-1493 data was evaluated to estimate the probability of a given leak exceeding 100 L_a. From the data, it can be seen that the best estimate is that the probability of exceeding 21 L_a is less than 5% (<1 out of 23). The data is very skewed toward the small leak sizes. By inspecting the data our judgement is that the probability of exceeding 100 L_a is probably less than 1%. Several functions were fit to the data to extrapolate a probability value for exceeding 100 L_a. These include Exponential, Weibull and Lognormal distributions, all of which yielded probability estimates under 1%. Of these, the use of the Lognormal distribution yielded the most adverse (conservative) results, and is discussed below.

The probability of a large leak was established by fitting the observed Type A leak detection data with a lognormal distribution and extrapolating the probability to the "large" leak range. The raw data was ranked from the lowest leak rate to the highest leak rate (in terms of multiples of L_a) and was used to fit the data to an assumed log normal distribution defined by the distribution mean and standard deviation. The median is defined as the point at which 50 percent of the data is below and 50 percent of the data is above. Since 12 of the 23 raw data points are less than or equal to 1, the median was set to 1.0. The 95th percentile of the raw data was estimated by multiplying the number of leaks by 95 percent, which gives a value of 21.85. Then by looking at the 21st and 22nd ranked leak rate data elements, it was determined that the ninety-fifth percentile leak rate multiple for the raw data must be greater than 3 L_a, but less than 10 L_a, so an estimate of 6.0 was used. The error factor (erf) was calculated to be 6 using the following equation:

erf = (95th percentile) / (median)

Where: 95th percentile data leak rate multiple = 6, and

median leak rate multiple = 50th percentile of the data = 1.

Substitution yields:

erf = 6

The log normal parameter, σ, was then derived to be 1.0893, using the following equation;

$\sigma = \ln(\text{erf}) / 1.645$

Where: σ = standard deviation,
erf = error factor.

The log normal parameter μ, was derived using the following equation:

$\mu = \ln(\text{median})$

Where: median = the 50th percentile of the data.

Since the median value is one, the value for μ is equal to zero. The mean was then derived to be 1.8098, using the following equation:

$\text{mean} = \exp[\mu + \sigma^2/2]$

Using the log normal distribution parameter values derived above, points of the cumulative distribution function were calculated for the data values observed and for the predictive value for 100 L_a, using the Microsoft Excel function "LogNormDist."

The conditional probability for a large leak greater than 100 L_a is thus estimated to be 0.006. The log normal model that was used is conservative in the tail of the distribution. Whereas the raw data distribution is skewed left and shows that small leaks, are the most likely to occur. The log normal distribution that was fitted to the data is conservatively skewed towards larger leak rates. Thus, the probabilities predicted using the tail of this distribution are somewhat larger than those that would be predicted using a more left skewed distribution.

The probability of a Type A failure sufficient to contribute to Class 3B is found by multiplying the probability of a Type A leak (0.028) by the conditional probability that the leak is large (0.006). Thus the probability of a large Type A leak is 1.68E-4 for the case involving three tests per 10 years (baseline). It is conservatively assumed that releases of this magnitude may be considered to be LERFs.

Impact of Test Interval Extension on Leak Probabilities

The same process as described above for the three tests per ten-year case is applied for the current interval of once per 10 years, and for 15 and 20-year intervals.

The impact of relaxing the Type A test interval will increase the average time that a leak, that could only be detected by the Type A test, could possibly be present. The increase is proportional to the increase in duration between containment tests. The historical data is based on testing three times per ten years. This equates to a mean time between tests of 3.3 years or 40 months. The current test interval is 10 years (120 months). The increase in exposure time will influence the probability of leakage. To calculate this impact, two assumptions are made: a constant rate for Type A leakage events, and the potential for leakage is equally distributed across the period of interest such that the average exposure time is one-half the test interval.

The increased probability can be determined as the ratio of the proposed to the prior exposure times multiplied by the known rate for the prior probability of failure. For the current ten year ILRT interval, the equation is:

$$P_{10} = P_{10/3}[(0.5Exp_{10}/0.5Exp_{10/3})]$$

Substituting for $P_{10/3}$ (0.028) and for the exposure times, Exp_{10} =120, and $Exp_{10/3}$ = 40, yields a value for the probability of leakage of 0.084. This value represents the likelihood of Type A leakage given a 10-year testing interval.

The proposed ILRT interval extensions would increase the duration between tests by increasing the time between tests from 10 years to 15 or 20 years. Therefore the total time between Type A testing will increase from 10 years (120 months) to 15 years (180 months) or 20 years (240 months). The above equation is used with these new values:

$$P_{15} = P_{10}\ [(0.5Exp_{15}/0.5Exp_{10})]$$

$$P_{20} = P_{10}\ [(0.5Exp_{20}/0.5Exp_{10})]$$

The same method was used to determine the probability of a small leak and of a large leak, as a function of ILRT test interval. Substituting yields the values shown in Table 5-5.

Table 5-5
Probability of Type A Leakage for a Given Test Interval

Test Interval	Probability	
	Small Leak (Class 3A) ($PROB_{Class\ 3A}$)	Large Leak (Class 3B) ($PROB_{Class\ 3B}$)
3 per 10 Years	0.028	1.68E-4
10 Years	0.084	5.04E-4
15 Years	0.126	7.56E-4
20 Years	0.168	1.01E-3

Definition of Large Leak

No large leaks have occurred. The largest reported leak rate out of the 23 'failures' identified in the NUMARC list in NUREG-1493 (Reference 4), was 21 times the allowable leakage rate (L_a). Since 21 L_a (or from 2.1 to 10.5 wt% per day) does not constitute a large release, the conditional probability that a given leak is large may be inferred from the observation that of 23 'failures' observed in all ILRT testing, none were in excess of 21 L_a (which is classified as small).

For the purpose of this calculation, the probability of occurrence of a large leak, a large leak is assumed to result in a containment failure with a leak rate of >100 L_a per day.

Risk Impacts due to Test Interval Extensions

Contribution of Class 1 and 3 to Risk -Type A tests impact only Class 1 and Class 3 sequences. The increased probability of not detecting excessive leakage does not increase the frequency of occurrence for Class 1 sequences. In fact, the frequency of occurrence decreases by the same amount that Class 3 frequency of occurrence increases. For Class 3 sequences, the frequency increases in proportion to the 'Large Leak' probabilities shown in Table 5-5.

Note that the release magnitude of a class is not impacted by the change in test interval. That is, the magnitude of a small leak remains the same, even thought the probability of not detecting the leak increases.

Thus, the only parameters that change for calculating the risk impacts of an [N] year interval versus the baseline interval (3 per 10 year testing interval), are the frequencies for Class 1 and Class 3 events.

The impact of the interval extensions on the frequencies of Class 1, 3A and 3B events are presented in Table 5-6. Frequency values are shown for the initial baseline of 3 inspections in 10

years (3/10), the current once per ten years (1/10) and for once in 15 years (1/15) and once in 20 years (1/20).

Table 5-6
Mean Event Class Frequencies for Various ILRT Intervals
(Intact Sequences – events/yr)

Plant	ILRT Interval	$F_{Class\ 1}$	$F_{Class\ 3A}$	$F_{Class\ 3B}$	Total(1 and 3)
Waterford	3/10	1.27E-5	3.67E-7	2.20E-9	1.31E-5
Waterford	1/10	1.20E-5	1.10E-6	6.60E-9	1.31E-5
Waterford	1/15	1.14E-5	1.65E-6	9.90E-9	1.31E-5
Waterford	1/20	1.09E-5	2.20E-6	1.32E-8	1.31E-5
Calvert Cliffs	3/10	4.67E-5	1.35E-6	8.08E-9	4.81E-5
Calvert Cliffs	1/10	4.40E-5	4.04E-6	2.42E-8	4.81E-5
Calvert Cliffs	1/15	4.20E-5	6.06E-6	3.64E-8	4.81E-5
Calvert Cliffs	1/20	4.00E-5	8.08E-6	4.85E-8	4.81E-5
Saint Lucie 1	3/10	2.20E-5	6.33E-7	3.80E-9	2.26E-5
Saint Lucie 1	1/10	2.07E-5	1.90E-6	1.14E-8	2.26E-5
Saint Lucie 1	1/15	1.97E-5	2.85E-6	1.71E-8	2.26E-5
Saint Lucie 1	1/20	1.88E-5	3.80E-6	2.28E-8	2.26E-5
Saint Lucie 2	3/10	1.58E-5	4.56E-7	2.74E-9	1.63E-5
Saint Lucie 2	1/10	1.49E-5	1.37E-6	8.22E-9	1.63E-5
Saint Lucie 2	1/15	1.42E-5	2.05E-6	1.23E-8	1.63E-5
Saint Lucie 2	1/20	1.35E-5	2.74E-6	1.64E-8	1.63E-5

Note 1 – Relevant data for each plant is provided at the time of each plant's submittal.

The impact of the interval extensions on Class 1, 3A and 3B doses, and the % risk impact of the intact sequences is presented in Table 5-7. The appendices to this report include determination of the plant specific risk measures for each event class. Table 5-7 summarizes the plant specific risk measures for each event class. Table 5-7 shows how risk contribution of Class 1 and Class 3 events changes as a function of ILRT interval for various plants. Risk and %Risk values are shown for the initial baseline of 3 inspections in 10 years (3/10), the current once per ten years (1/10) and for once in 15 years (1/15) and once in 20 years (1/20).

Table 5-7
Mean Event Class Risk Measures for various ILRT Intervals
(Intact Sequences, person-rem/year)

Plant	ILRT Interval	$Risk_{Class\ 1}$	$Risk_{Class\ 3A}$	$Risk_{Class\ 3B}$	Total	% Risk
Waterford	3/10	0.857	0.617	0.030	568	0.26
Waterford	1/10	0.807	1.85	0.089	569	0.48
Waterford	1/15	0.770	2.78	0.133	570	0.65
Waterford	1/20	0.730	3.70	0.178	571	0.81
Calvert Cliffs	3/10	45.8	33.0	3.96	78270	0.11
Calvert Cliffs	1/10	43.1	98.9	11.9	78341	0.20
Calvert Cliffs	1/15	41.1	148	17.8	78395	0.26
Calvert Cliffs	1/20	39.1	198	23.7	78448	0.33
Saint Lucie 1	3/10	4.04	2.91	0.14	901	0.79
Saint Lucie 1	1/10	3.81	8.73	0.419	907	1.43
Saint Lucie 1	1/15	3.63	13.1	0.629	911	1.90
Saint Lucie 1	1/20	3.64	17.5	0.838	916	2.38
Saint Lucie 2	3/10	2.91	2.10	0.101	1046	0.49
Saint Lucie 2	1/10	2.75	6.30	0.302	1050	0.89
Saint Lucie 2	1/15	2.62	9.45	0.453	1054	1.19
Saint Lucie 2	1/20	2.49	12.6	0.605	1057	1.49

Note 1 – Relevant data for each plant is provided at the time of each plant's submittal.
Note that the methodology for computing %Risk is defined in Section 5.2.2.

Increase in Total Risk vs Baseline Interval - The percent risk increase ($\%\Delta Risk_N$) due to an N-year ILRT over the baseline case is as follows:

$$\%\Delta Risk_N = [(Total_N - Total_{BASE}) / Total_{BASE}] \times 100.0$$

Where:
$Total_{BASE}$ = total person-rem/yr for baseline test interval
$Total_N$ = total person-rem/yr for N-year test interval

Thus, we can determine the total increase in risk contribution associated with relaxing the ILRT test frequency.

Table 5-8 shows $\%\Delta Risk_N$ as a function of ILRT interval for various plants. $\%\Delta Risk$ values are shown for the initial baseline of 3 inspections in 10 years (3/10), the current once per ten years (1/10) and for once in 15 years (1/15) and once in 20 years (1/20).

Table 5-8
Percent Change in Total Risk for ILRT Interval Extensions

Plant	ILRT Interval	%ΔRisk
Waterford	from 3/10 to 1/10	0.22 %
Waterford	from 1/10 to 1/15	0.17 %
Waterford	from 1/10 to 1/20	0.33 %
Calvert Cliffs	from 3/10 to 1/10	0.09 %
Calvert Cliffs	from 1/10 to 1/15	0.07 %
Calvert Cliffs	from 1/10 to 1/20	0.14 %
Saint Lucie 1	from 3/10 to 1/10	0.65 %
Saint Lucie 1	from 1/10 to 1/15	0.49 %
Saint Lucie 1	from 1/10 to 1/20	0.97%
Saint Lucie 2	from 3/10 to 1/10	0.40 %
Saint Lucie 2	from 1/10 to 1/15	0.30 %
Saint Lucie 2	from 1/10 to 1/20	0.60 %

Note 1 – Relevant data for each plant is provided at the time of each plant's submittal. Note that the methodology for computing %ΔRisk is described above.

5.2.4 Methodology for Evaluating Change in Risk in Terms of Large Early Release Frequency (LERF)

Regulatory Guide 1.174 (Reference 3) provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Regulatory Guide 1.174 defines very small changes in risk as those resulting in increases of Core Damage Frequency (CDF) of less than 1.0E-6/yr and increases in LERF of less than 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 test interval on the large leakage probability.

Quantification of LERF

Justifying the extension of the Type A test interval requires establishing the success criteria for a large release. This criteria is based on:

1) The containment leak rate versus breach size, and
2) The impact of leak rate on risk.

Type A tests have typically been used in the past to identify containment leaks that are on the order of the diameter of a quarter inch or less. An approximate assessment of the effect of containment leak size on the containment leak rate is presented in Figure 5-1. The assessment assumes that leakage occurs as a result of critical flow of a steam-air mixture from the

containment through variously sized leak areas. The actual leak rate for a given containment failure is dependent on containment volume and assumptions regarding the specific constituents in the containment atmosphere. In addition, Oak Ridge National Laboratory (ORNL) (Reference 5) completed a study evaluating the impact of leak rates on public risk using information from WASH-1400 (Reference 6) as the basis for its risk sensitivity calculations (See Figure 5-2).

It is judged that small leaks resulting from a severe accident (those that are deemed not to dominate public risk) can be defined as those leaks that have a weighted impact of less than 5%. In general, this suggests that containment leaks of about 35 wt% per day are not dominant contributors to public risk. For this assessment, large releases are assumed to occur when the leakage rate exceeds 100 L_a (or 10 to 50 wt%/day depending on the plant L_a).

The actual 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 (intact containment with a leakage of $< L_a$) could in fact result in a large release due to failure to detect a pre-existing leak during the relaxation period. Experience indicates that leaks not detected by Type B or C (LLRT tests) are both infrequent and of low magnitude. Therefore, for this evaluation, only Class 3 sequences will have the potential to impact risk as a result of the inability to detect a containment leak. Class 3A events would increase the leakage a marginal amount. Class 3B events are those for which the containment release may be conservatively considered to be large. Class 1 sequences are not large release pathways because the containment leak rate is expected to be small (on the order of L_a). It should be noted that, in estimating the ΔLERF, only changes to Class 3B events will effect a change in the LERF metric. However, for the purpose of this evaluation, the baseline LERF consists of contributions due to Classes 2, 3B and 6, 7 (early release portion, assumed to be half the total), and 8.

Figure 5-1
Evaluated Impact of Containment Leak Size on Containment Leak Rate

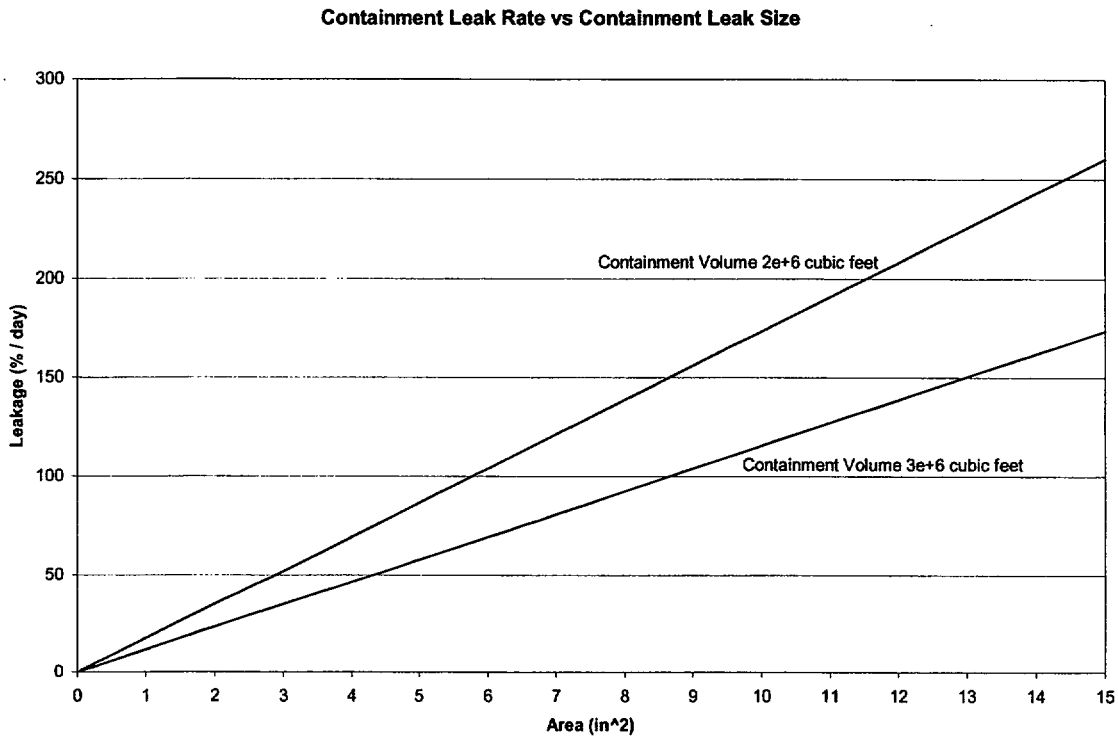
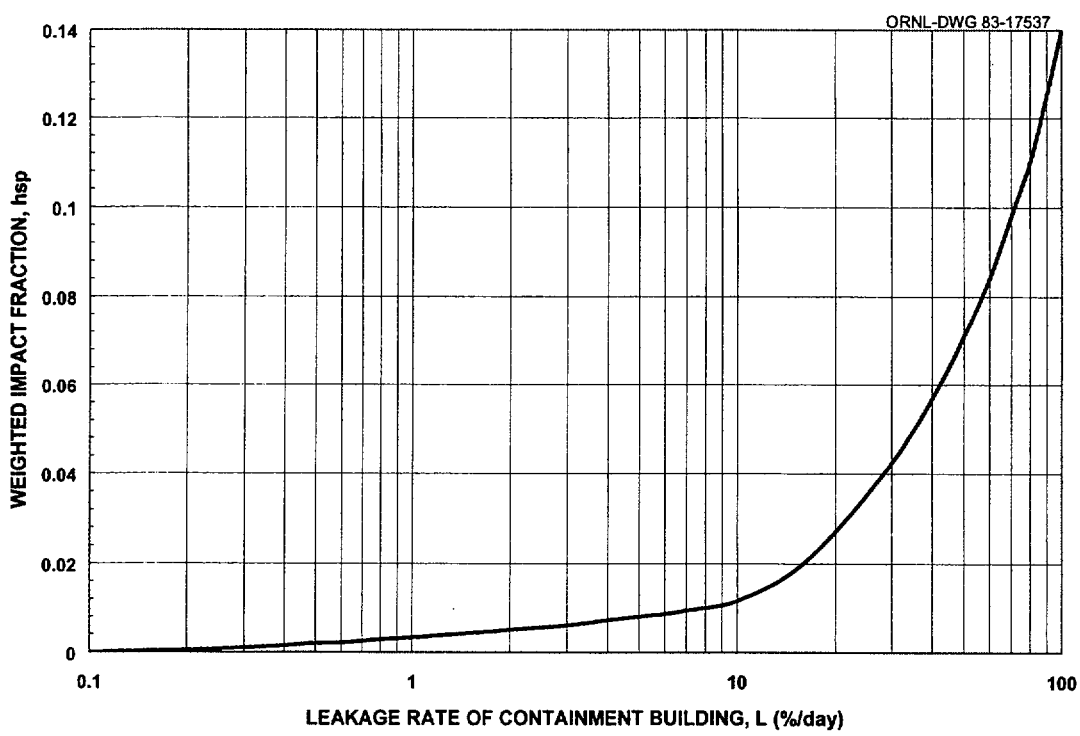


Figure 5-2
Fractional Impact on Risk Associated with Containment Leak Rates



Plant specific LERF frequency values are listed in Table 5-9a thru 5-9d for the baseline, 10 year, 15 year and 20 year ILRT test intervals, respectively.

For the purpose of discussion, a generic estimate of the LERF increment may be readily estimated for a bounding PWR. As previously discussed in this Section, the only large release event class impacted by the increase in ILRT interval is that of Class 3B.

The relationship between the event Class 3B and ILRT test interval (INT_{ILRT}) is as follows:

$F_{Class\ 3B}$ (INT_{ILRT}) = [Probability of a Class 3B failure for a given inspection interval]x[CDF_{Intact}]

(See Table 5-5 for the Probability of a Class 3B failure for a given inspection interval)

$F_{Class\ 3B}$ (INT_{ILRT}) = [1.68E-4] x [INT_{ILRT}/3.33]x[CDF_{Intact}] = 5.05E-5 x INT_{ILRT} x CDF_{Intact}

Where:
INT_{ILRT} is the inspection interval in years.

ΔLERF is defined as the increment in the large early release frequency. The ΔLERF is the difference between the Class 3B frequency established using the new inspection interval and the current Class 3B frequency.

For the bounding case of a PWR with a total CDF of 1.0E-4/year, and a 75% probability of an intact containment, the ΔLERF for a 20 year interval extension, compared with the current 10 year interval, is:

ΔLERF = (5.05E-5/year) x (20 yrs - 10 yrs) x 0.75 x 1.0E-4/year = 3.8E-8/year

LERF increments of this magnitude are considered to be very small (negligible). Plant specific LERF results are presented in Tables 5-9a through 5-9d.

Table 5-9a
Plant Specific LERF Frequencies - Baseline ILRT Interval

Class	Description	LERF (per year)			
		WSES	Calvert Cliffs	Saint Lucie 1	Saint Lucie 2
2	Large Isolation Failures (failure to close)	2.54E-8	4.97E-8	2.26E-08	1.63E-08
3B	Large Pre-existing Containment Leak	2.20E-9	8.08E-9	3.80E-09	2.74E-09
6	Other Isolation Failures (e.g., dependent failures)	4.78E-10	1.41E-6	0.00E+00	0.00E+00
7 (Early)	Failure Induced by Phenomena (early failures)	5.40E-6	7.39E-6	4.21E-08	2.91E-08
8	Bypass (SGTR. ISLOCA)	1.47E-6	6.47E-6	4.09E-06	5.88E-06
LERF	Total	6.898E-6	1.533E-5	4.158E-06	5.925E-06

Note 1 – Relevant data for each plant is provided at the time of each plant's submittal.

Table 5-9b
Plant Specific LERF Frequencies - 10 Year ILRT Interval

Class	Description	LERF (per year)			
		WSES	Calvert Cliffs	Saint Lucie 1	Saint Lucie 2
2	Large Isolation Failures (failure to close)	2.54E-8	4.97E-8	2.26E-08	1.63E-08
3B	Large Pre-existing Containment Leak	6.60E-9	2.42E-8	1.14E-08	8.22E-09
6	Other Isolation Failures (e.g., dependent failures)	4.78E-10	1.41E-6	0.00E+00	0.00E+00
7 (Early)	Failure Induced by Phenomena (early failures)	5.40E-6	7.39E-6	4.21E-08	2.91E-08
8	Bypass (SGTR. ISLOCA)	1.47E-6	6.47E-6	4.09E-06	5.88E-06
LERF	Total	6.903E-6	1.534E-5	4.166E-06	5.931E-06
ΔLERF	Increase from Baseline LERF	4.40E-9	1.616E-8	7.59E-9	5.48E-9
% ΔLERF	% Increase from Baseline LERF	0.06%	0.11%	0.18%	0.09%

Note 1 – Relevant data for each plant is provided at the time of each plant's submittal.

Table 5-9c
Plant Specific LERF Frequencies - 15 Year ILRT Interval

Class	Description	LERF (per year)			
		WSES	Calvert Cliffs	Saint Lucie 1	Saint Lucie 2
2	Large Isolation Failures (failure to close)	2.54E-8	4.97E-8	2.26E-08	1.63E-08
3B	Large Pre-existing Containment Leak	9.90E-9	3.64E-8	1.71E-08	1.23E-08
6	Other Isolation Failures (e.g., dependent failures)	4.78E-10	1.41E-6	0.00E+00	0.00E+00
7 (Early)	Failure Induced by Phenomena (early failures)	5.40E-6	7.39E-6	4.21E-08	2.91E-08
8	Bypass (SGTR. ISLOCA)	1.47E-6	6.47E-6	4.09E-06	5.88E-06
LERF	Total	6.906E-6	1.536E-5	4.172E-06	5.935E-06
ΔLERF	Increase from Current LERF	3.30E-9	1.212E-8	5.695E-09	4.108E-9
% ΔLERF	% Increase from Current LERF	0.05%	0.08%	0.14%	0.07%

Note 1 – Relevant data for each plant is provided at the time of each plant's submittal.

Table 5-9d
Plant Specific LERF Frequencies - 20 Year ILRT Interval

Class	Description	LERF (per year)			
		WSES	Calvert Cliffs	Saint Lucie 1	Saint Lucie 2
2	Large Isolation Failures (failure to close)	2.54E-8	4.97E-8	2.26E-08	1.63E-08
3B	Large Pre-existing Containment Leak	1.32E-8	4.85E-8	2.28E-08	1.64E-08
6	Other Isolation Failures (e.g., dependent failures)	4.78E-10	1.41E-6	0.00E+00	0.00E+00
7 (Early)	Failure Induced by Phenomena (early failures)	5.40E-6	7.39E-6	4.21E-08	2.91E-08
8	Bypass (SGTR. ISLOCA)	1.47E-6	6.47E-6	4.09E-06	5.88E-06
LERF	Total	6.909E-6	1.537E-5	4.177E-06	5.939E-06
ΔLERF	Increase from Current LERF	6.60E-9	2.424E-8	1.139E-08	8.215E-9
% ΔLERF	% Increase from Current LERF	0.10%	0.16%	0.27%	0.14%

Note 1 – Relevant data for each plant is provided at the time of each plant's submittal.

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6.0 RESULTS AND CONCLUSIONS

6.1 Summary of Results

The results of the plant specific evaluations of risk impacts of ILRT test interval extension are summarized in Table 6-1.

Table 6-1
Summary of Risk Impact of Extending Type A ILRT Test Interval

	WSES	Calvert Cliffs	Saint Lucie 1	Saint Lucie 2
BASELINE ILRT INTERVAL				
Baseline Risk Contribution of Class 1 and 3	0.26%	0.11%	0.79%	0.49%
Baseline LERF (per year)	6.898E-6	1.533E-5	4.158E-6	5.925E-6
10 YEAR ILRT INTERVAL				
10 Year Interval Risk Contribution of Class 1 and 3	0.48%	0.20%	1.43%	0.89%
Increase in Total Risk from increasing from Baseline to 10 years	0.22%	0.09%	0.65%	0.40%
10 Year Interval LERF (per year)	6.903E-6	1.534E-5	4.166E-6	5.931E-6
Increase in LERF – Baseline to 10 years (per year)	4.40E-9	1.62E-8	7.59E-9	5.477E-9
15 YEAR ILRT INTERVAL				
15 Year Interval Risk Contribution of Class 1 and 3	0.65%	0.26%	1.90%	1.19%
Increase in Total Risk from increasing from 10 to 15 years	0.17%	0.07%	0.49%	0.30%
15 Year Interval LERF (per year)	6.906E-6	1.536E-5	4.172E-6	5.935E-6
Increase in LERF – 10 Years to 15 years (per year)	3.30E-9	1.212E-8	5.695E-9	4.108E-9
% Increase in LERF – 10 Years to 15 years	0.05%	0.08%	0.14%	0.07%
20 YEAR ILRT INTERVAL				
20 Year Interval Risk Contribution of Class 1 and 3	0.81%	0.33%	2.38%	1.49%
Increase in Total Risk from increasing from 10 to 20 years	0.33%	0.14%	0.97%	0.60%
20 Year Interval LERF (per year)	6.909E-6	1.537E-5	4.177E-6	5.939E-6
Increase in LERF – 10 Years to 20 years (per year)	6.60E-9	2.424E-8	1.139E-8	8.215E-9
% Increase in LERF – 10 Years to 20 years	0.10%	0.16%	0.27%	0.14%

Note 1 – Relevant data for each plant will be provided at the time of each plant's submittal.

6.2 Conclusions from Risk Evaluation

Results are in agreement with the initial NRC/EPRI conclusions that there is a very small (negligible) increase in risk (in terms of person-rem per year) and that there is a very small (negligible) impact on LERF. The change in Type A test interval from 10 years to 20 years increases the risk of those associated specific accident sequences by a small percentage.

However, the risk impact on the total integrated plant risk for those accident sequences influenced by Type A testing is a very small percentage (See Table 5-8 for plant specific values). Therefore, the risk impact when compared to other severe accident risks is very small (negligible).

Regulatory Guide 1.174 provides guidance for determining the risk impact of plant-specific changes to the licensing basis. Regulatory Guide 1.174 defines very small changes in risk as resulting in increases of CDF below 1.0E-6 per year, and increases in LERF below 1.0E-7 per year. Since the ILRT does not impact CDF, the relevant criterion is LERF. The increase in LERF resulting from a change in the Type A ILRT test interval from an 10 years to an 20 years is <1.0E-7 /yr. Therefore, the risk for increasing the ILRT interval from 10 to 20 years is considered to be very small.

7.0 REFERENCES

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

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

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

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

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

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

7. Waterford Steam Electric Station Individual Plant Examination, August 1992.

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APPENDIX A

APPLICATION OF THE JOINT APPLICATION REPORT TO WATERFORD STEAM ELECTRIC STATION (WSES), Unit 3

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A1.0 SYSTEM DESCRIPTION AND OPERATING EXPERIENCE

A1.1 System Description

The primary function of containment is to prevent the release of radioactive material from either the containment atmosphere or the reactor coolant system to the outside environment.

The Waterford 3 containment vessel completely encloses the reactor coolant system to ensure that there is no leakage of radioactive materials to the environment in the unlikely event of a loss of coolant accident. The containment system incorporates a free-standing containment vessel surrounded by a low leakage reinforced concrete shield building. A four foot annular air space is provided between the outer wall of the containment vessel and the inner wall of the shield building to allow filtration of any containment vessel leakage during accident conditions, to minimize offsite doses.

The free-standing containment vessel is a 2 inch thick circular cylinder, with a one inch thick hemispherical dome and a two inch thick ellipsoidal bottom. The overall vessel dimensions are: 140 foot diameter by 240.5 foot high. The vessel wall thickness is increased to a minimum of 4 inches adjacent to all penetrations and openings. The vessel is fabricated of ASME-SA 516 Grade 70 pressure vessel quality steel plate. The net free volume of the containment is approximately 2,680,000 cubic feet.

The containment vessel structure includes one personnel airlock, one emergency escape airlock, one fuel transfer tube, one equipment maintenance hatch, and one seal-welded construction hatch. All process piping and electrical penetrations are welded directly to the containment vessel nozzles, with the exception of the main steam, main feedwater, and fuel transfer tube penetrations. These penetrations are provided with testable expansion bellows to allow for thermal growth or building differential motion.

The containment vessel is designed and constructed in accordance with the requirements for class MC vessels contained in Section III Subsection NE of the ASME Code, 1971 Edition including Summer 1971 Addenda and Code Cases 1431, 1454-1 and 1517, as approved by the USNRC Regulatory Guides 1.84 and 1.85. The containment vessel is code stamped in accordance with Paragraph NE-8000 of Section III of the ASME Boiler and Pressure Vessel Code. The containment vessel and all penetrations are designed to limit total leakage to less than 0.5 percent by weight of the containment air mass per day at a design pressure of 44 psig. The calculated peak accident pressure for the design basis accident at Waterford SES Unit 3 is less than 44 psig.

A1.2 WSES Operating Experience

Type A Testing History

The Waterford 3 Type A test history provides substantial justification for the proposed ILRT test interval modification. Three Type A tests were performed over an eight year period with successful results. The tests indicate that Waterford 3 has a low leakage containment and that the leakage has never exceeded 24.6% of the allowable leakage rate, L_a.

Three Type A full pressure, 44 psig, containment integrated leak rate tests have been conducted; preoperational Type A test (4/30/83), first periodic Type A test [Refuel 2, (5/23/88)], and second periodic Type A test [Refuel 4, (5/12/91)]. Two different testing methods were employed in the performance of these tests. The first method, calculated Mass Point Leakage Rate, was the only method employed for the preoperational Type A test. The first and second periodic Type A tests employed both the calculated Mass Point Leakage Rate method and the BN-TOP-1 Total Time Leakage Rate method.

Preoperational Type A Test (4/30/83)

The preoperational Type A containment Integrated Leakage Rate Test was successfully performed on April 30, 1983 with a calculated Mass Point Leakage Rate of 0.066% wt per day and a 95% upper confidence limit (UCL) of 0.068% wt per day. The Type A test report was provided to the NRC, via letter W3P83-2399.

First Periodic Type A Test [Refuel 2. (5/23/88)]

The first periodic Type A Containment Integrated Leakage Rate Test was successfully performed on May 23, 1988 with the following results: 1. A calculated Mass Point Leakage Rate of 0.061% wt per day and a 95% UCL of 0.070% wt per day, 2. A 95% UCL Total Time Leakage Rate (including additions) of 0.116% wt per day, and 0.123% wt per day including minimum pathway improvements. Results from the Total Time Leakage Rate calculations were submitted as the final test results, but the calculated Mass Point Leakage Rates were also included in the report to the NRC. The periodic Type A test report was provided to the NRC on August 23, 1988, via letter W3P88-1283.

Second Periodic Type A Test [Refuel 4. (5/12/91)]

The second periodic Type A Containment Integrated Leakage Rate Test (CILRT) was successfully performed on May 12, 1991 with the following results: 1. A calculated Mass Point Leakage Rate of 0.0669% wt per day and a 95% UCL of 0.0679% wt per day, 2. A 95% UCL Total Time Leakage Rate (including additions) of 0.073% wt per day, and 0.0858% wt per day including minimum pathway improvements. Results from the Total Time Leakage Rate calculations were submitted as the final test results, but the calculated Mass Point Leakage Rates were also included in the report to the NRC. The periodic Type A test report was provided to the NRC on August 12, 1991, via letter W3F1-91-0447.

During the stabilization period for the second periodic CILRT, preliminary leakage rate calculations indicated excessive leakage of approximately 2.9% wt per day. The major portion of the leakage was observed at the refueling water storage pool access hatch. Air was leaking through the Safety Injection Sump Recirculation line valves SI-602A and B. These valves are not classified as containment isolation valves and are not required to be vented for the CILRT per FSAR Table 6.2-32. Initial hand tightening of the valves reduced the leakage to approximately 0.60% wt per day. No other significant leakage paths were identified. Additional hand tightening of the valves reduced the leakage to approximately 0.06% wt per day. During the evolution of stopping the leakage, instead of a 4 hour stabilization period, the plant actually experienced a 22 hour 24 minute stabilization. This longer stabilization period resulted in the Mass Point Leakage Rate (0.068% wt per day) being close to the Total Time Leakage Rate (0.0858% wt per day) for Refuel 4 CILRT and the Total Time Leakage Rate (0.0858% wt per day) being less than the Refuel 2 CILRT Total Time Leakage Rate (0.123% wt per day).

Summary Type A Testing History

CILRT Test Results using the Calculated Mass Point Leakage Rate Method, demonstrates that the Waterford 3 SES Unit No. 3 has a significantly low leakage containment and did not exceed 13.8% of L_a (0.5% wt per day) or 18.4% of the Acceptance Criteria 0.75 L_a (0.375% wt per day)

CILRT Test Results using the BN-TOP-1 Method, demonstrates that the results of the Waterford 3 SES Unit No. 3 first and second periodic CILRTs, as reported to the NRC, also strongly indicate that the Waterford 3 SES Unit No. 3 is a low leakage containment and did not exceed 24.6% of L_a (0.5% wt per day) or 32.8% of 0.75 L_a (0.375% wt per day).

The first periodic CILRT, which for the first time utilized BN-TOP-1, was performed in a shorter duration than the first preoperational test. The results for the Total Time Leakage was higher than the Calculated Mass Point Leakage. This result can be attributed to the shorter stabilization and test duration. Initially, there is a wider band of data scatter and as the test progresses in time, the data scatter stabilizes. Therefore, the total time test results are very conservative compared to the Mass Point Leakage calculation.

The Type A tests over an eight year period substantiate that the Waterford 3 containment is a low leakage containment, there is no increasing trend in leakage, and the leakage from the containment is significantly below the maximum acceptable leakage rate of 0.75 L_a.

A2.0 ASSESSMENT OF RISK FOR WSES

The purpose of this section is to provide a risk informed assessment for extending the WSES Integrated Leak Rate Test (ILRT) interval from ten to twenty years. The risk assessment is performed as described in the main body of this report.

In addition, the results and findings from the WSES Individual Plant Examination (IPE) (Reference 7) are used for this risk assessment. Specifically the approach combines the use of the WSES Individual Plant Examination (IPE) results and findings with the methodology described in EPRI TR-104285 to estimate public risk associated with extending the containment Type A testing.

The change in plant risk is evaluated based on the change in the predicted releases in terms of person-rem/year and Large Early Release Frequency (LERF). Changes to Type A testing have no impact on CDF.

A2.1 Overview

In October 26, 1995, the NRC revised 10 CFR 50, Appendix J. The revision to Appendix J allowed individual plants to select containment leakage testing under Option A "Prescriptive Requirements" or Option B "Performance-Based Requirements." The Waterford Unit 3 Steam Electric Station Nuclear Power Plant (WSES) selected the requirements under Option B as its testing program.

The current surveillance testing requirement, as outlined in NEI 94-01 (Reference 1) for Type A testing, is at least once per 10 years based on an acceptable performance history (define as two consecutive periodic Type A tests at least 24 months apart in which the calculated performance leakage was less than $1.0L_a$). However, WSES seeks to extend the test interval for Type A testing from ten years to fifteen years based on the substantial cost savings from extending the test interval for the next Type A test.

A2.2 Assessment of Risk

The risk impact of extending the ILRT (Type A) interval from its current interval of 10 years to 15 years, is evaluated from a potential public exposure impact (as measured in person-rem/year) and from a Large Early Release (LERF) perspective as identified in Regulatory Guide 1.174. The methodology used accounts for large releases and computes the LERF metric. The analysis examined the WSES IPE and subsequent PSA upgrades for plant specific accident sequences which may impact containment performance. Specifically, as discussed in the main body of this report, core damage sequences were considered with respect to which EPRI event class they are in (EPRI TR-104285 Class 1, 2, 3, 4, 5, 6, 7 or 8 events in terms of containment integrity).

Table A2-2 presents the WSES PSA frequencies for these eight accident classes.

A2.2.1 Quantification Of Base-Line Frequency For Accident Classes

The eight EPRI accident class frequencies were determined, using the methodology described in the main body of this report, as described in the following paragraphs:

Class 1 Sequences: This group consists of all core damage accident progression bins for which the containment remains intact. Class 1 sequences arise from those core damage sequences that have long term heat removal capability available via containment sprays or fan coolers. For the WSES IPE, the frequency of an intact containment was established as 7.6E-6 per year. PSA upgrades performed over the past five years have resulted in an increase in the overall plant CDF from an IPE value of 1.68E-5/year to the current value of 2.54E-5/year.

Based on a review of the resultant core damage sequences, the intact containment frequency was revised to 1.31E-5 per year. For this analysis, it is assumed that the associated maximum containment leakage for this group is L_a (or 0.5 wt/% per day). For this analysis, the events that the PSA categorizes as intact containment events are parsed into three categories, Class 3A, Class 3B and Class 1. As discussed in the text of the main report, as Class 1 and Class 3 events are related, the frequency for Class 1 events is calculated as:

$$F_{Class\ 1} = CDF_{Intact} - F_{Class\ 3A} - F_{Class\ 3B}$$

Class 1 event frequencies are presented in the discussion of Class 3 events, below.

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

$$F_{Class\ 2} = PROB_{large\ CI} * CDF_{Total}$$

Where:

$PROB_{large\ CI}$ = random large containment isolation failure probability (i.e. large valves). This value is obtained from the WSES PSA = 1.0E-3. (This value was selected as an upper bound estimate for this parameter.)
CDF_{Total} = the total plant specific CDF = 2.54E-5 /year (from WSES PSA Revision 2)

$$F_{Class\ 2} = 1.0E\text{-}3 * 2.54E\text{-}5\ /year$$

$$\mathbf{F_{Class\ 2} = 2.54E\text{-}8\ /year}$$

For this analysis the associated maximum containment leakage for this group is assumed to be 100 wt % per day (See Table A2-2).

Class 3 Sequences: Class 3 endstates are developed specifically for this application. The Class 3 endstates include all core damage accident progression bins for which a pre-existing leakage in the containment structure exists. The containment leakage for these sequences can be grouped into two categories, small leaks or large.

The respective frequencies per year are determined as follows:

$$F_{Class\ 3A} = PROB_{Class\ 3A} * CDF_{Intact}$$

$$F_{Class\ 3B} = PROB_{Class\ 3B} * CDF_{Intact}$$

Where:
CDF_{Intact} = the Core Damage Frequency for intact containment sequences, and is 1.31E-5/year.
$PROB_{Class\ 3A}$ = the probability of small pre-existing containment leakage in excess of design allowable.
$PROB_{Class\ 3B}$ = the probability of large pre-existing containment leakage.

$PROB_{Class\ 3A}$ and $F_{Class\ 3B}$ are a function of inspection interval and are obtained from Section 5.2.3, using Table 5-5 (reproduced here for convenience) as follows.

Probability of Type A Leakage for a Given Test Interval

Test Interval	Probability	
	Small Leak (Class 3A) ($PROB_{Class\ 3A}$)	Large Leak (Class 3B) ($PROB_{Class\ 3B}$)
3 per 10 Years	0.028	1.68E-4
10 Years	0.084	5.04E-4
15 Years	0.126	7.56E-4
20 Years	0.168	1.01E-3

The resulting values for $F_{Class\ 1}$, $F_{Class\ 3A}$, and $F_{Class\ 3B}$ as a function of ILRT interval are presented in Table A2-1.

Table A2-1
Frequency of Type A Leakage for a Given Test Interval

Test Interval	Release Class Frequency (per year)		
	$F_{Class\ 1}$	$F_{Class\ 3A}$	$F_{Class\ 3B}$
3 per 10 Years	1.27E-5	3.67E-7	2.20E-9
10 Years	1.20E-5	1.10E-6	6.60E-9
15 Years	1.14E-5	1.65E-6	9.90E-9
20 Years	1.09E-5	2.20E-6	1.32E-8

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

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

Class 6 Sequences: This group is similar to Class 2. These are sequences that involve core damage accident progression bins for which a failure-to-seal containment leakage due to failure to isolate the containment occurs. These sequences are dominated by misalignment of containment isolation valves following a test/maintenance evolution, typically resulting in a failure to close smaller containment isolation valves. All other failure modes are bounded by the Class 2 assumptions.

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

$$F_{Class\ 6} = PROB_{largeT\&M} * CDF_{Total}$$

Where:
$PROB_{largeT\&M}$ = probability of random failure of containment to isolate due to valve misalignment (failure modes not otherwise include in Class 2) = 1.88E-5
CDF_{Total} = the total plant specific CDF = 2.54E-5 /year (from WSES PSA Revision 2)

$$F_{Class\ 6} = 1.88E\text{-}5 * 2.54E\text{-}5\ /year$$

$$\mathbf{F_{Class\ 6} = 4.78E\text{-}10\ /year}$$

For this analysis the associated maximum containment leakage for this group is 35 wt%/day.

Class 7 Sequences: This group consists of all core damage accident progression bins in which containment failure induced by severe accident phenomena occurs (i.e. H_2 combustion).

$$F_{Class\ 7} = CDF_{CFL} + CDF_{CFE}$$

Where:
CDF_{CFE} = the CDF resulting from phenomena that lead to early containment failure.
CDF_{CFL} = the CDF resulting from phenomena that lead to late containment failure.

This frequency was determined by subtracting the intact, bypass (See Class 8 discussion) and loss of isolation CDFs from the total CDF. This results in the following Class 7 frequency:

$$\mathbf{F_{Class\ 7} = 1.08E\text{-}5\ /\ year}$$

These endstates include containment failure. For this analysis the associated containment leakage for this group is 280 wt%/day (this value is typical of a 0.1 ft^2 failure, see for example NUREG 1493). It is assumed that half of Class 7 sequences are early, and half are late.

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

The IPE indicates a containment bypass contribution of 1.3E-6 per year. Using the results of the most recent WSES PSA and re-binning ISLOCA and SGTR sequences resulted in an updated failure frequency for this class of 1.47E-6 / year.

$$\mathbf{F_{Class\ 8} = 1.47E\text{-}6\ /\ year}$$

For WSES, the bypass leakages are based on an unmitigated bypass release of 100% of the core inventory of Noble Gases and 39% of the Iodine.

Table A2-2 provides a summary of the WSES Release Class frequencies and the assumed leakage for each Class.

Table A2-2
WSES Mean Containment Frequencies (from the PSA) and Representative Releases

Class	Description	Frequency (per Rx-year)	Estimated Leakage
1	No Containment Failure	1.27E-5	L_a
2	Large Containment Isolation Failures (failure-to-close)	2.54E-8	100 wt %/day
3A	Small Pre-existing Containment Leak	3.67E-7	25 L_a
3B	Large Pre-existing Containment Leak	2.20E-9	100 wt%/day
4	Small isolation failure - failure-to-seal (Type B test)	Not Analyzed	N/A
5	Small isolation failure - failure-to-seal (Type C test)	Not Analyzed	N/A
6	Containment Isolation Failures (dependent failures, personnel errors)	4.78E-10	35 wt%/day
7	Severe Accident Phenomena Induced Failure (early and late failures)	1.08E-5	280 wt%/day
8	Containment Bypassed (SGTR / ISLOCA)	1.47E-6	See Class 8 description, above
Total	All CET Endstates	2.54E-5	

A2.2.2 WSES population dose per reactor year

Plant-specific release analysis was performed for WSES to evaluate the doses to the population, within a 50-mile radius from the plant. The releases for Classes 1 through 7 are based on post large Loss-Of-Coolant Accident (LOCA) as shown in Table A2-3 and the releases for Class 8 events are based on Bypass events as shown in Table A2-4. These tables tabulate the whole body population dose within 50 miles. Calculations were performed using RADCON Version 2 assuming a containment source term equivalent to TID-14844. Intact containment release computations were validated via comparisons with WSES FSAR results.

LBLOCA dose models with defined leakages are assumed to be representative for all containment leakage release classes. Bypass releases based on iodine and noble gas releases are identified in the IPE study for the dominant sequence. Population estimates are based on WSES FSAR projections to year 2030. Atmospheric dispersions are based on mean weather data obtained at the plant site and reported in the plant FSAR.

Table A2-3
WSES Population Dose – LOCA

Waterford Unit 3 Doses and Population Doses due to LOCA			
		Doses (rem)	Doses (person - rem)
Zone (miles)	Population	Containment Leakage Events (based on leakage of 1 La)	Containment Leakage Events (based on leakage of 1 La)
0-1	453	8.87E-01	4.02E+02
1-2	1864	2.21E-01	4.13E+02
2-3	3362	4.92E-02	1.65E+02
3-4	16599	2.31E-02	3.83E+02
4-5	16423	1.40E-02	2.30E+02
5-10	70695	2.95E-02	2.08E+03
10-20	735167	2.95E-02	2.17E+04
20-30	1046794	2.60E-02	2.72E+04
30-40	554306	2.60E-02	1.44E+04
40-50	473566	6.44E-04	3.05E+02
Total	2919229		6.73E+04

Table A2-4
WSES Population Dose – Bypass Events

Waterford Unit 3 Doses and Population Doses due to Bypass Events			
		Doses (rem)	Doses (person - rem)
Zone (miles)	Population	Bypass Events	Bypass Events
0-1	453	1.42E+03	6.45E+05
1-2	1864	3.55E+02	6.62E+05
2-3	3362	7.89E+01	2.65E+05
3-4	16599	3.71E+01	6.15E+05
4-5	16423	2.24E+01	3.68E+05
5-10	70695	4.73E+01	3.34E+06
10-20	735167	4.73E+01	3.48E+07
20-30	1046794	4.17E+01	4.37E+07
30-40	554306	4.17E+01	2.31E+07
40-50	473566	1.03E+00	4.90E+05
Total	2919229		1.08E+08

The population dose out to 50 miles is determined based on the design-basis normal containment leak rate of 0.5% /day and is 6.73E+04 person-rem per event. Since the containment release pathways are generally the same for containment Classes 1 through 7, the population doses are directly proportional to the ratio of the leakage rate to that of the intact nominal leakage case (Class 1). Therefore, the Class 2 through 7 leakage related doses are ratioed upwards to account for the increased leakages associated with event Classes 2 through 7. Classes 1 through 8 leakages and doses are summarized in Table A2-5.

Table A2-5
WSES Containment Leakage Rate and Dose – for Accident Classes

Class	Description	Leakage (wt%/day)	Release (50 miles) (person-rem)	Basis
1	No Containment Failure	0.5 (L_a)	6.73E+4	See Table A2-2
2	Large Containment Isolation Failures (failure-to-close)	100	1.35E+7	Ratio from class 1 baseline
3A	Small Isolation Failures (containment leak)	12.5 (25 L_a)	1.68E+6	Ratio from class 1 baseline
3B	Large Isolation Failures (containment leak)	100	1.35E+7	Ratio from class 1 baseline
4	Small isolation failure - failure-to-seal (Type B test)	Not analyzed	N/A	Ratio from class 1 baseline
5	Small isolation failure - failure-to-seal (Type C test)	Not analyzed	N/A	Ratio from class 1 baseline
6	Containment Isolation Failures (dependent failures, personnel errors)	35	4.71E+6	Ratio from class 1 baseline
7	Severe Accident Phenomena Induced Failure (early and late failures)	280	3.77E+7	Ratio from class 1 baseline
8	Containment Bypassed (SGTR / ISLOCA)	-	1.08E+8	No credit for containment. (See Class 8 description)

The above results when combined with the frequencies presented in Table A2-2 yields the WSES baseline mean consequence measures (risks, in terms of person-rem/yr) for each accident class. The resulting risks (in terms of person-rem/yr), for each accident class, are presented in Table A2-6 below.

Table A2-6
WSES Mean Baseline Risk - for Accident Classes

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr (50-Miles)
1	No Containment Failure	1.27E-5	6.73E+4	8.57E-1
2	Large Isolation Failures (failure to close)	2.54E-8	1.35E+7	3.42E-1
3A	Small Pre-existing Containment Leak	3.67E-7	1.68E+6	6.17E-1
3B	Large Pre-existing Containment Leak	2.20E-9	1.35E+7	2.96E-2
4	Small Isolation Failure to Seal (Type B Test)	Not Analyzed	N/A	N/A
5	Small Isolation Failure to Seal (Type C Test)	Not Analyzed	N/A	N/A
6	Other Isolation Failures (e.g., dependent failures)	4.78E-10	4.71E+6	2.25E-3
7	Failure Induced by Phenomena (early and late failures)	1.08E-5	3.77E+7	4.07E+2
8	Bypass (SGTR / ISLOCA)	1.47E-6	1.08E+8	1.59E+2
Total	All CET End States	2.54E-5	N/A	568

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

$$\%Risk_{BASE} = [(Risk_{Class\ 1\ BASE} + Risk_{Class\ 3A\ BASE} + Risk_{Class\ 3B\ BASE}) / Total_{BASE}] \times 100$$

Where:

$Risk_{Class\ 1\ BASE}$ = Class 1 person-rem/yr = 8.57E-1 person-rem/yr [Table A2-6]

$Risk_{Class\ 3A\ BASE}$ = Class 3A person-rem/yr = 6.17E-1 person-rem/yr [Table A2-6]

$Risk_{Class\ 3B\ BASE}$ = Class 3B person-rem/yr = 2.96E-2 person-rem/yr [Table A2-6]

$Total_{BASE}$ = total dose/year for baseline interval = 568 person-rem/year [Table A2-6]

$$\%Risk_{BASE} = [(8.57E\text{-}1 + 6.17E\text{-}1 + 2.96E\text{-}2) / 568] \times 100$$

$$\mathbf{\%Risk_{BASE} = 0.26\ \%}$$

Therefore, the total baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.26 %.

A2.2.3 Risk Impact of Extending Type A Test Interval From 10 To 15 And 20 Years

Using the methodology described in the main report that was used above to determine baseline risk values (see Table A2-6), the risk values were determined for the Current 10 year ILRT test interval, a 15 year ILRT test interval, and a 20 year ILRT test interval. These risk values are presented below in Table A2-7.

Table A2-7
WSES Risk Values vs ILRT Interval (Person-Rem/yr to 50-Miles)

Class	Description	Current 10 year ILRT interval	15 year ILRT interval	20 year ILRT interval
1	No Containment Failure	8.07E-1	7.70E-1	7.33E-1
2	Large Isolation Failures (failure to close)	3.42E-1	3.42E-1	3.42E-1
3A	Small Pre-existing Containment Leak	1.85E+0	2.78E+0	3.70E+0
3B	Large Pre-existing Containment Leak	8.89E-2	1.33E-1	1.78E-1
4	Small Isolation Failure to Seal (Type B Test)	N/A	N/A	N/A
5	Small Isolation Failure to Seal (Type C Test)	N/A	N/A	N/A
6	Other Isolation Failures (e.g., dependent failures)	2.25E-3	2.25E-3	2.25E-3
7	Failure Induced by Phenomena (early and late failures)	4.07E+2	4.07E+2	4.07E+2
8	Bypass (SGTR/ISLOCA)	1.59E+2	1.59E+2	1.59E+2
Total	All CET End States	569	570	571

Based on the above values, and using the methodology described in the main report, the percent risk contribution ($\%Risk_{10}$) for Class 1 and Class 3 is determined and yields the results summarized in Table A2-8, below. Also, the percent change in risk due to ILRT interval extensions is determined and presented in Table A2-8.

Table A2-8
WSES Percent Risk Increases from ILRT Interval Extensions

	Description	Current 10 year ILRT interval	15 year ILRT interval	20 year ILRT interval
$\%Risk_N$	Percent risk contribution for Class 1 and Class 3	0.48%	0.65%	0.81%
$\Delta\%Risk_{Base\ to\ N}$	Percent increase in total risk due to an N-year ILRT over the baseline case	0.22%	N/A	N/A
$\Delta\%Risk_{10\text{-}N}$	Percent increase in risk due to an N-year ILRT over the 10 year case	N/A	0.17%	0.33%

A2.2.4 Change In Risk In Terms Of Large Early Release Frequency (LERF)

Section 5.2.4 of the main body of this report discusses the quantification of LERF. This analysis assumes that Class 2, 3B, 6, 7 and 8 lead to large leak rates. The baseline LERF frequency, for the three in 10 year inspection interval, is determined as shown in Table A2-9. The estimate for Class 7 is based on the assumption that half of the phenomena induced containment failures are early failures.

Table A2-9
WSES Baseline LERF Frequency Calculation

Class	Description	LERF
2	Large Isolation Failures (failure to close)	2.54E-8
3B	Large Pre-existing Containment Leak	2.20E-9
6	Other Isolation Failures (e.g., dependent failures)	4.78E-10
7 (Early)	Failure Induced by Phenomena (early failures)	5.40E-6
8	Bypass (SGTR / ISLOCA)	1.47E-6
LERF	(total)	6.90E-6

Impact of ILRT Test Interval Extensions on Large Early Release Frequency (LERF)

Table A2-10 presents the frequencies for each large release class, for each of four ILRT intervals. The total LERFs are also listed, along with the increase in LERF from the current LERF, and the percent increase from the current LERF.

As the only class contributor to the change in large early release is due to Class 3B events, the $\Delta LERF = F_{Class\ 3B}$ (evaluated at the new inspection interval) – $F_{Class\ 3B}$ (of the baseline interval or the current interval, as appropriate).

The percent change in LERF is calculated as:

$$\%\Delta LERF = [\Delta LERF/LERF_{Total}] \times 100$$

Where:
$LERF_{Total}$ = The sum of the Frequencies of Sequences 2, 3B, 6,8, and 50% of Class 7. (50% of the Class 7 frequency is assumed to be containment failures due to severe accident phenomena that are early).

Table A2-10
WSES LERF Variation as a Function of Change in Inspection Interval

Class	Description	3 per 10 Years	10 Years	15 Years	20 Years
2	Large Isolation Failures (failure to close)	2.54E-8	2.54E-8	2.54E-8	2.54E-8
3B	Large Pre-existing Containment Leak	2.20E-9	6.60E-9	9.90E-9	1.32E-8
6	Other Isolation Failures (e.g., dependent failures)	4.78E-10	4.78E-10	4.78E-10	4.78E-10
7 (Early)	Failure Induced by Phenomena (early failures)	5.40E-6	5.40E-6	5.40E-6	5.40E-6
8	Bypass (SGTR)	1.47E-6	1.47E-6	1.47E-6	1.47E-6
LERF	Total	6.898E-6	6.903E-6	6.906E-6	6.909E-6
ΔLERF	Increase from Current LERF	N/A	0.0	3.30E-9	6.60E-9
%ΔLERF	% Increase from Current LERF	N/A	0.0%	0.05%	0.10%

A3.0 SUMMARY OF RESULTS

Baseline ILRT Interval Results (For this evaluation, the baseline risk contribution is taken as the original inspection interval at the time that the IPE was done; that is, three inspections per 10 year interval)

1. The baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.26 % of total risk.

2. The baseline LERF is 6.898E-6 per year.

Ten Year ILRT Interval Results

1. The current Type A 10-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.48 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the baseline interval to current 10 year interval is 0.22 %.

3. The LERF with a 10 year ILRT interval is 6.903E-6 per year.

4. The increase in LERF from extending the ILRT test interval from the baseline interval to the current 10 year interval is 4.40E-9 per year.

5. The % increase in LERF from extending the ILRT test interval from the baseline interval to 10 years is 0.06 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.06%) in conditional containment unreliability.

Fifteen Year ILRT Interval Results

1. Type A 15-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.65 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the current 10 year interval to 15 years is 0.17 %.

3. The LERF for the 15 year interval is 6.906E-6 per year.

4. The increase in LERF from extending the ILRT test interval from the 10 year interval to 15 years is 3.30E-9 per year.

5. The % increase in LERF from extending the ILRT test interval from the 10 year interval to 15 years is 0.05 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.05%) in conditional containment unreliability.

Twenty Year ILRT Interval Results

1. Type A 20-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.81 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the current 10 year interval to 20 years is 0.33 %.

3. The LERF for the 20 year interval is 6.909E-6 per year.

4. The increase in LERF from extending the ILRT test interval from the 10 year interval to 20 years is 6.60E-9 per year.

5. The % increase in LERF from extending the ILRT test interval from the 10 year interval to 20 years is 0.10 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.10%) in conditional containment unreliability.

APPENDIX B

APPLICATION OF THE JOINT APPLICATION REPORT TO CALVERT CLIFFS NUCLEAR POWER PLANT (CCNPP), Units 1 and 2

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B1.0 System Description and Operating Experience

B1.1 System Description

The primary function of containment is to prevent the release of radioactive material from either the containment atmosphere or the reactor coolant system to the outside environment.

The Calvert Cliffs containment vessel structures consist of a post-tensioned, reinforced concrete cylinder and dome connected to and supported by a massive reinforced concrete foundation slab. The cylinder wall thickness is increased at six equally spaced locations to form vertical buttresses for pre-stressing tendon end anchorage. Reinforced openings in the cylinder wall are provided for equipment and personnel access as well as for electrical and mechanical feed through. The entire interior surface of the structure is lined with a ¼ inch thick welded ASTM A36 steel plate that serves as a leak tight membrane. The net free volume of containment is 2,000,000 ft^3.

The principal dimensions of the containment are:

Inside Diameter	130 ft.
Inside Height	181 ft. 8 in.
Vertical Wall Thickness	3 ft. 9 in.
Dome Thickness	3 ft. 3 in.
Foundation Slab Thickness	10 ft.

The containment vessel structure includes one personnel air lock; one personnel escape airlock, one equipment hatch, and one fuel transfer tube penetration.

All containment penetrations are leak tight assemblies welded to the containment liner. Piping penetrations in the containment have isolation valves to allow isolation of the containment structure from the surrounding environment. Portions of the liner that must resist full design pressure, such as penetrations, are made of ASTM A-300 steel. At all penetrations, the liner is thickened to reduce stress.

The containment vessel design leak rate is 0.2 percent /day leakage by weight of the original content of air, at design pressure of 50 psig and design temperature of 276 F. The calculated peak accident pressure for the design basis accident at CCNPP Unit 1 and Unit 2 does not exceed 50 psig.

B1.2 CCNPP Operating Experience

Type A Testing History

The Calvert Cliffs Unit 1 and Unit 2 Type A Test history provides substantial justification for the proposed ILRT test interval modification. Six Type A Tests were performed over an eighteen-year history on Unit 1 and five Type A Tests were performed on Unit 2 over a fifteen-year history with successful results.

Calvert Cliffs Unit 1 has performed six Type A full-pressure, 50 psig, containment leak rate tests; a pre-operational Type A test (12/1/73) and periodic Type A tests on 3/6/78, 6/22/82, 5/20/85, 5/27/88, and 7/5/92. Calvert Cliffs Unit 2 has performed five Type A full-pressure, 50 psig, containment leak rate tests; a pre-operational Type A test (4/14/76) and periodic Type A tests on 10/15/79, 12/18/82, 10/24/85, and 12/16/91. Pre-operational Type A tests employed a full pressure (50 psig) and a reduced pressure (25 psig) test. Periodic Type A tests employed both the calculated Mass Point Leakage Rate method and the Total Time Leakage Rate method.

Unit 1

Unit 1 Pre-operational Type A Test (December 1, 1973)

The Unit 1 Pre-operational Type A containment Integrated Leakage Rate Test was successfully completed on December 1, 1973 with the following results. The measured leak rate at peak test pressure of 50 psig was 0.0466%/Day. The measured leak rate at reduced test pressure of 25 psig was 0.0134 %/Day. The Type A test report was provided to the NRC dated March 1, 1974.

First Periodic Type A Test of Unit 1

The first Unit 1 periodic Type A Integrated Leak Rate Test was successfully completed on March 6, 1978 with the following results. The calculated Mass Point Leakage Rate was 0.097 %/Day with a 95% UCL of 0.108 %/Day. The 95% UCL Total Time Leakage Rate was 0.176 %/Day. The Periodic Type A Test report was provided to the NRC on 7/13/1978.

Second Periodic Type A Test of Unit 1

The second Unit 1 periodic Type A Integrated Leak Rate Test was successfully completed on June 22, 1982 with the following results. The calculated Mass Point Leakage Rate was 0.021 %/Day with a 95% UCL of 0.026 %/Day. The 95% UCL Total Time Leakage Rate was 0.086 %/Day. The Periodic Type A Test report was provided to the NRC on 11/30/1982.

Third Periodic Type A Test of Unit 1

The third Unit 1 periodic Type A Integrated Leak Rate Test was successfully completed on May 20, 1985 with the following results. The calculated Mass Point Leakage Rate was 0.032 %/Day with a 95% UCL of 0.035 %/Day. The 95% UCL Total Time Leakage Rate was 0.069 %/Day. The Periodic Type A Test report was provided to the NRC on 8/5/1985.

Fourth Periodic Type A Test of Unit 1

The fourth Unit 1 periodic Type A Integrated Leak Rate Test was successfully completed on May 27, 1988 with the following results. The calculated Mass Point Leakage Rate was 0.022 %/Day with a 95% UCL of 0.026 %/Day. The 95% UCL Total Time Leakage Rate was 0.080 %/Day. The Periodic Type A Test report was provided to the NRC in May 1988.

Fifth Periodic Type A Test of Unit 1

The fifth Unit 1 periodic Type A Integrated Leak Rate Test was successfully completed on July 5, 1992 with the following results. The calculated Mass Point Leakage Rate was 0.0771 %/Day with a 95% UCL of 0.0824 %/Day. The 95% UCL Total Time Leakage Rate was 0.0703 %/Day. The Periodic Type A Test report was provided to the NRC in July 1992.

Unit 2

Unit 2 Pre-operational Type A Test (April 14, 1976)

The Unit 2 Pre-operational Type A containment Integrated Leakage Rate Test was successfully completed on April 14, 1976 with the following results. The measured leak rate at peak test pressure of 50 psig was 0.019 %/Day. The measured leak rate at reduced test pressure of 25 psig was 0.004 %/Day.

First Periodic Type A Test of Unit 2

The first Unit 2 periodic Type A Integrated Leak Rate Test was successfully completed on November 15, 1979 with the following results. The calculated Mass Point Leakage Rate was 0.052 %/Day with a 95% UCL of 0.064 %/Day. The 95% UCL Total Time Leakage Rate was 0.128 %/Day. The Periodic Type A Test report was provided to the NRC on 2/15/1980.

Second Periodic Type A Test of Unit 2

The second Unit 2 periodic Type A Integrated Leak Rate Test was successfully completed on December 18, 1982 with the following results. The calculated Mass Point Leakage Rate was 0.013 %/Day with a 95% UCL of 0.023 %/Day. The 95% UCL Total Time Leakage Rate was 0.071 %/Day. The Periodic Type A Test report was provided to the NRC on 7/1/1983.

Third Periodic Type A Test of Unit 2

The third Unit 2 periodic Type A Integrated Leak Rate Test was successfully completed on November 24, 1985 with the following results. The calculated Mass Point Leakage Rate was 0.052 %/Day with a 95% UCL of 0.060 %/Day. The 95% UCL Total Time Leakage Rate was 0.104 %/Day. The Periodic Type A Test report was provided to the NRC on 2/27/1986.

Fourth Periodic Type A Test of Unit 2

The fourth Unit 2 periodic Type A Integrated Leak Rate Test was successfully completed on January 16, 1991 with the following results. The calculated Mass Point Leakage Rate was 0.055 %/Day with a 95% UCL of 0.061 %/Day. The 95% UCL Total Time Leakage Rate was 0.118 %/Day. The Periodic Type A Test report was provided to the NRC on 5/29/1991.

Summary Type A Testing History

Containment Integrated Leak Rate results using the Calculated Mass Point Leakage Rate Method and Total Time Leak Rate method both demonstrate that Calvert Cliffs Unit 1 and Unit 2 are very low leakage containments. The average value of the Calculated Mass Point Leakage values is less than 25% of the Acceptance Criteria value.

B2.0 ASSESSMENT OF RISK FOR CCNPP

The purpose of this section is to provide a risk informed assessment for extending the CCNPP Integrated Leak Rate Test (ILRT) interval from ten to twenty years. The risk assessment is performed as described in the main body of this report.

In addition, the results and findings from the CCNPP Individual Plant Examination (IPE) (Reference B-1) are used for this risk assessment. Specifically the approach combines the use of the CCNPP Individual Plant Examination (IPE) results and findings with the methodology described in EPRI TR-104285 (Reference B-3) to estimate public risk associated with extending the containment Type A testing.

The change in plant risk is evaluated based on the change in the predicted releases in terms of person-rem/year and Large Early Release Frequency (LERF). Changes to Type A testing have no impact on CDF.

B2.1 Overview

In October 26, 1995, the NRC revised 10 CFR 50, Appendix J. The revision to Appendix J allowed individual plants to select containment leakage testing under Option A "Prescriptive Requirements" or Option B "Performance-Based Requirements." Calvert Cliffs Nuclear Power Plant (CCNPP) selected the requirements under Option B as its testing program.

The current surveillance testing requirement, as outlined in NEI 94-01 (Reference B-2) for Type A testing, is at least once per 10 years based on an acceptable performance history (define as two consecutive periodic Type A tests at least 24 months apart in which the calculated performance leakage was less than $1.0L_a$). However, CCNPP seeks to extend the test interval for Type A testing from ten years to fifteen years based on the substantial cost savings from extending this test interval and the low risk impact.

B2.2 Assessment of Risk

The risk impact of extending the ILRT (Type A) interval from its current interval of 10 years to 15 years, is evaluated from a potential public exposure impact (as measured in person-rem/year) and from a Large Early Release (LERF) perspective as identified in Regulatory Guide 1.174. The methodology used accounts for large releases and computes the LERF metric. The analysis examined the CCNPP IPE and subsequent PSA upgrades for plant specific accident sequences which may impact containment performance. Specifically, as discussed in the main body of this report, core damage sequences were considered with respect to which EPRI event class they are in (EPRI TR-104285 Class 1, 2, 3, 4, 5, 6, 7 or 8 events in terms of containment integrity – Reference B-3).

Table B2-2 presents the CCNPP PSA frequencies for these eight accident classes.

B2.2.1 Quantification Of Base-Line Frequency For Accident Classes

The eight EPRI accident class frequencies were determined, using the methodology described in the main body of this report, as described in the following paragraphs:

Class 1 Sequences: This group consists of all core damage accident progression bins for which the containment remains intact. Class 1 sequences arise from those core damage sequences that have long term heat removal capability available via containment sprays or fan coolers. PSA upgrades performed over the past several years have resulted in an overall plant CDF estimate of 1.10E-4/year.

Based on a review of the core damage sequences, the intact containment frequency is estimated to be 4.81E-5 per year. For this analysis, it is assumed that the associated maximum containment leakage for this group is L_a (or 0.2 wt/% per day) (Reference B-4, Section 14.24). For this analysis, the events that the PSA categorizes as intact containment events are parsed into three categories, Class 3A, Class 3B and Class 1. As discussed in the text of the main report, as Class 1 and Class 3 events are related, the frequency for Class 1 events is calculated as:

$$F_{Class\ 1} = CDF_{Intact} - F_{Class\ 3A} - F_{Class\ 3B}$$

Class 1 event frequencies are presented in the discussion of Class 3 events, below.

Releases from Class 1 events are calculated based on the design basis L_a. This is consistent with the assumption that the containment is intact.

Class 2 Sequences: This group consists of all core damage accident progression bins for which a pre-existing leakage due to failure to isolate the containment occurs. These sequences are dominated by failure-to-close large (>2-inch diameter) containment isolation valves. Such sequences contribute to the plant LERF. The frequency per year for these sequences is determined from the CCNPP PSA as the sum of those release classes that indicate core damage in the presence of an unisolated containment.

$$\mathbf{F_{Class\ 2} = 4.97E\text{-}8\ /year}$$

For this analysis the associated containment leakage for this group is assumed to be 100 wt% per day (See Table B2-2).

Class 2 releases for CCNPP analyses are associated with loss of isolation failures resulting in a through containment equivalent leakage from a pipe greater than 2 inches in diameter. In this study the Class 2 containment leakage is estimated by a 100 wt% /day containment leakage. A 100 wt% per day release is equivalent to a release from a pipe diameter of about 2.5 inches and containment operation at design pressure.

Class 3 Sequences: Class 3 endstates are developed specifically for this application. The Class 3 endstates include all core damage accident progression bins for which a pre-existing leakage in the containment structure exists. The containment leakage for these sequences can be grouped into two categories, small leaks or large.

The respective frequencies per year are determined as follows:

$F_{Class\ 3A} = PROB_{Class\ 3A} * CDF_{Intact}$

$F_{Class\ 3B} = PROB_{Class\ 3B} * CDF_{Intact}$

Where:

CDF_{Intact} = the Core Damage Frequency for the intact containment sequences, and is 4.81E-5/year.
$PROB_{Class\ 3A}$ = the probability of small pre-existing containment leakage in excess of design allowable.
$PROB_{Class\ 3B}$ = the probability of large pre-existing containment leakage.

$PROB_{Class\ 3A}$ and $F_{Class\ 3B}$ are a function of the inspection interval and are obtained from Section 5.2.3, using Table 5-5 (reproduced here for convenience) as follows.

Probability of Type A Leakage for a Given Test Interval

Test Interval	Probability	
	Small Leak (Class 3A) ($PROB_{Class\ 3A}$)	Large Leak (Class 3B) ($PROB_{Class\ 3B}$)
3 per 10 Years	0.028	1.68E-4
10 Years	0.084	5.04E-4
15 Years	0.126	7.56E-4
20 Years	0.168	1.01E-3

The resulting values for $F_{Class\ 1}$, $F_{Class\ 3A}$, and $F_{Class\ 3B}$ as a function of ILRT interval are presented in Table B2-1.

Table B2-1
Frequency of Type A Leakage for a Given Test Interval

Test Interval	Release Class Frequency (per year)		
	$F_{Class\ 1}$	$F_{Class\ 3A}$	$F_{Class\ 3B}$
3 per 10 Years	4.67E-5	1.35E-6	8.08E-9
10 Years	4.40E-5	4.04E-6	2.42E-8
15 Years	4.20E-5	6.06E-6	3.64E-8
20 Years	4.00E-5	8.08E-6	4.85E-8

As Class 3A represents a small pre-existing containment leak, its value was set to bound the maximum quantified release identified in Table 4-2 of NUREG-1493. The largest identified release multiple was $21L_a$. Class 3A releases were therefore quantified as $25L_a$. For CCNPP units this results in a containment leakage rate of 5 wt% per day.

Class 3B releases are assumed to be greater than $100L_a$ (or 20 wt% per day). Releases in this category were represented by a 100 wt% per day release which is roughly equivalent to a release from a 2.5 inch orifice. This leakage is essentially equivalent to $500L_a$ (for CCNPP) and is considered a very conservative estimate of potential containment releases that may result from extension of Type A containment Testing.

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

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

Class 6 Sequences: This group is similar to Class 2. These are sequences that involve core damage accident progression bins for which a failure-to-seal containment leakage due to failure to isolate the containment occurs. These sequences are dominated by misalignment of containment isolation valves following a test/maintenance evolution, typically resulting in a failure to close smaller containment isolation valves. All other failure modes are bounded by the Class 2 assumptions.

The frequency per year for these sequences is determined from the CCNPP PSA as the sum of core damage events which proceed in the presence of a loss of containment isolation resulting in a small containment failure. Based on the CCNPP PSA, the frequency of Class 6 events was established as:

$$\mathbf{F_{Class\ 6} = 1.41E\text{-}6\ /year}$$

For this analysis the associated maximum containment leakage for this group is 35 wt%/day.

Releases for Class 6 events were established based on a release from a 1.5 inch orifice or roughly a release area of 1.8 square inches. The value is equivalent to a $175L_a$..

Class 7 Sequences: This group consists of all core damage accident progression bins in which containment failure induced by severe accident phenomena occurs (i.e. H_2 combustion).

$$F_{Class\ 7} = CDF_{CFL} + CDF_{CFE}$$

Where:
CDF_{CFE} = the CDF resulting from phenomena that lead to early containment failure.
CDF_{CFL} = the CDF resulting from phenomena that lead to late containment failure.

These frequencies were determined from the CCNPP PSA. CDF_{CFL} is 4.54E-06. CDF_{CFE} is 8.74E-06 (of which 7.39E-06 are large early containment failures)

$$\mathbf{F_{Class\ 7} = 5.427E\text{-}5\ /\ year}$$

These endstates include containment failure. For this analysis the associated containment leakage for this group is 280 wt%/day (this value is typical of a 0.1 ft^2 failure, see for example NUREG 1493).

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

Using the results of the most recent CCNPP PSA and including ISLOCA and SGTR sequences, the failure frequency for this class is 6.47E-6 / year.

$$\mathbf{F_{Class\ 8} = 6.47E\text{-}6\ /\ year}$$

For CCNPP, the bypass leakages are based on an unmitigated bypass release of 100% of the core inventory of Noble Gases and 40% of the Iodine. [Note that the CCNPP IPE (Reference B-1, Section 4.7) indicates that iodine bypass releases increase to 69% of the initial inventory. However, a lower estimate was used in the calculation. Use of the lesser value was selected since the bypass releases were used only for comparative evaluation and, for the metrics used, the lower assumed bypass dose would provide the more conservative metric. This assumption has a small conservative effect on dose ratios presented in Section B2.2.2 and B2.2.3.]

Table B2-2 provides a summary of the CCNPP Release Class frequencies and the assumed leakage for each Class.

Table B2-2
CCNPP Mean Containment Frequencies (from the PSA) and Representative Releases

Class	Description	Frequency (per Rx-year)	Estimated Leakage
1	No Containment Failure	4.67E-5	L_a
2	Large Containment Isolation Failures (failure-to-close)	4.97E-8	100 wt%/day
3A	Small Pre-existing Containment Leak	1.35E-6	25 L_a
3B	Large Pre-existing Containment Leak	8.08E-9	100 wt%/day
4	Small isolation failure - failure-to-seal (Type B test)	Not Analyzed	N/A
5	Small isolation failure - failure-to-seal (Type C test)	Not Analyzed	N/A
6	Containment Isolation Failures (dependent failures, personnel errors)	1.41E-6	35 wt%/day
7	Severe Accident Phenomena Induced Failure (early and late failures)	5.43E-5	280 wt%/day
8	Containment Bypassed (SGTR / ISLOCA)	6.47E-6	See Class 8 description, above
Total	All CET Endstates	1.10E-4	

B2.2.2 CCNPP population dose per reactor year

Plant-specific release analysis was performed for CCNPP to evaluate the doses to the population, within a 50-mile radius from the plant. The releases for Classes 1 through 7 are based on post large Loss-Of-Coolant Accident (LOCA) as shown in Table B2-3 and the releases for Class 8 events are based on Bypass events as shown in Table B2-4. These tables tabulate the whole body population dose within 50 miles. Calculations were performed using RADTRAD Version 3 (Reference B-6) assuming a containment source term equivalent to TID-14844. Intact containment release computations were validated via comparisons with CCNPP FSAR results (Reference B-1, Section 14.24).

LBLOCA dose models with defined leakages are assumed to be representative for all containment leakage release classes. Bypass releases based on iodine and noble gas releases are identified in the IPE study for the dominant sequence. Population estimates are based on CCNPP SAMA projections to 2030 (Reference B-5, Table 2-19). Atmospheric dispersions are based on mean weather data obtained at the plant site and reported in the plant updated FSAR (Reference B-4, Figure 2.3).

Table B2-3
CCNPP Population Dose – LOCA

Calvert Cliffs Doses and Population Doses due to LOCA			
		Doses (rem)	Doses (person - rem)
Zone (miles)	Population	Containment Leakage Events (based on leakage of 1 L_a)	Containment Leakage Events (based on leakage of 1 L_a)
0-1	1631	4.73E+00	7.72E+03
1-2	5309	1.16E+00	6.15E+03
2-3	7932	8.74E-01	6.93E+03
3-4	9425	5.93E-01	5.59E+03
4-5	10705	4.15E-01	4.45E+03
5-10	88971	3.52E-01	3.13E+04
10-20	217646	3.08E-01	6.70E+04
20-30	386945	2.64E-01	1.02E+05
30-40	999293	2.20E-01	2.20E+05
40-50	2991492	1.76E-01	5.27E+05
Total	4719349		9.79E+05

Table B2-4
CCNPP Population Dose – Bypass Events

Calvert Cliffs Doses and Population Doses due to Bypass Events			
		Doses (rem)	Doses (person - rem)
Zone (miles)	Population	Bypass Events	Bypass Events
0-1	1631	2.64E+03	4.30E+06
1-2	5309	6.53E+02	3.47E+06
2-3	7932	4.87E+02	3.87E+06
3-4	9425	3.31E+02	3.12E+06
4-5	10705	2.32E+02	2.48E+06
5-10	88971	1.96E+02	1.75E+07
10-20	217646	1.72E+02	3.74E+07
20-30	386945	1.47E+02	5.71E+07
30-40	999293	1.23E+02	1.23E+08
40-50	2991492	9.85E+01	2.95E+08
Total	4719349		5.47E+08

The population dose, out to 50 miles is determined based on the design-basis normal containment leak rate of 0.2% /day, and is 9.79E+05 person-rem per event. Since the containment release pathways are generally the same for containment Classes 1 through 7, the population doses are directly proportional to the ratio of the leakage rate to that of the intact nominal leakage case (Class 1). Therefore, the Class 2 through 7 leakage related doses are ratioed upwards to account for the increased leakages associated with event Classes 2 through 7. Classes 1 through 8 leakages and doses are summarized in Table B2-5.

Table B2-5
CCNPP Containment Leakage Rate and Dose – for Accident Classes

Class	Description	Leakage (wt%/day)	Release (50 miles) (person-rem)	Basis
1	No Containment Failure	0.2 (L_a)	9.79E+5	See Table B2-2
2	Large Containment Isolation Failures (failure-to-close)	100	4.90E+8	Ratio from class 1 baseline
3A	Small Isolation Failures (containment leak)	5 (25 L_a)	2.45E+7	Ratio from class 1 baseline
3B	Large Isolation Failures (containment leak)	100	4.90E+8	Ratio from class 1 baseline
4	Small isolation failure - failure-to-seal (Type B test)	Not analyzed	NA	Ratio from class 1 baseline
5	Small isolation failure - failure-to-seal (Type C test)	Not analyzed	NA	Ratio from class 1 baseline
6	Containment Isolation Failures (dependent failures, personnel errors)	35	1.71E+8	Ratio from class 1 baseline
7	Severe Accident Phenomena Induced Failure (early and late failures)	280	1.37E+9	Ratio from class 1 baseline
8	Containment Bypassed (SGTR / ISLOCA)	-	5.47E+8	No credit for containment. (See Class 8 description)

The above results when combined with the frequencies presented in Table B2-2 yields the CCNPP baseline mean consequence measures (risks, in terms of person-rem/yr) for each accident class. The resulting risks (in terms of person-rem/yr), for each accident class, are presented in Table B2-6 below.

Table B2-6
CCNPP Mean Baseline Risk - for Accident Classes

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr (50-Miles)
1	No Containment Failure	4.67E-5	9.79E+5	4.58E+1
2	Large Isolation Failures (failure to close)	4.97E-8	4.90E+8	2.43E+1
3A	Small Pre-existing Containment Leak	1.35E-6	2.45E+7	3.30E+1
3B	Large Pre-existing Containment Leak	8.08E-9	4.90E+8	3.96E+0
4	Small Isolation Failure to Seal (Type B Test)	Not Analyzed	NA	N/A
5	Small Isolation Failure to Seal (Type C Test)	Not Analyzed	NA	N/A
6	Other Isolation Failures (e.g., dependent failures)	1.41E-6	1.71E+8	2.42E+2
7	Failure Induced by Phenomena (early and late failures)	5.43E-5	1.37E+9	7.44E+4
8	Bypass (SGTR / ISLOCA)	6.47E-6	5.47E+8	3.54E+3
Total	All CET End States	1.10E-4	N/A	78270

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

$$\%Risk_{BASE} = [(Risk_{Class\ 1\ BASE} + Risk_{Class\ 3A\ BASE} + Risk_{Class\ 3B\ BASE}) / Total_{BASE}] \times 100$$

Where:

$Risk_{Class\ 1\ BASE}$ = Class 1 person-rem/yr = 4.58E+1 person-rem/yr [Table B2-6]

$Risk_{Class\ 3A\ BASE}$ = Class 3A person-rem/yr = 3.30E+1 person-rem/yr [Table B2-6]

$Risk_{Class\ 3B\ BASE}$ = Class 3B person-rem/yr = 3.96E+0 person-rem/yr [Table B2-6]

$Total_{BASE}$ = total dose/year for baseline interval = 78270 person-rem/year [Table B2-6]

$$\%Risk_{BASE} = [(4.58E+1 + 3.30E+1 + 3.96E+0) / 78270] \times 100$$

$$\mathbf{\%Risk_{BASE} = 0.11\ \%}$$

Therefore, the total baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.11 %.

B2.2.3 Risk Impact of Extending Type A Test Interval From 10 To 15 And 20 Years

Using the methodology described in the main report that was used above to determine baseline risk values (see Table B2-6), the risk values were determined for the Current 10 year ILRT test interval, a 15 year ILRT test interval, and a 20 year ILRT test interval. These risk values are presented below in Table B2-7.

Table B2-7
CCNPP Risk Values vs ILRT Interval (Person-Rem/yr to 50-Miles)

Class	Description	Current 10 year ILRT interval	15 year ILRT interval	20 year ILRT interval
1	No Containment Failure	4.31E+01	4.11E+01	3.91E+01
2	Large Isolation Failures (failure to close)	2.43E+01	2.43E+01	2.43E+01
3A	Small Pre-existing Containment Leak	9.89E+01	1.48E+02	1.98E+02
3B	Large Pre-existing Containment Leak	1.19E+01	1.78E+01	2.37E+01
4	Small Isolation Failure to Seal (Type B Test)	N/A	N/A	N/A
5	Small Isolation Failure to Seal (Type C Test)	N/A	N/A	N/A
6	Other Isolation Failures (e.g., dependent failures)	2.42E+02	2.42E+02	2.42E+02
7	Failure Induced by Phenomena (early and late failures)	7.44E+04	7.44E+04	7.44E+04
8	Bypass (SGTR/ISLOCA)	3.54E+03	3.54E+03	3.54E+03
Total	All CET End States	78341	78395	78448

Based on the above values, and using the methodology described in the main report, the percent risk contribution ($\%Risk_N$, for values of N of 10, 15 and 20 years) for Class 1 and Class 3 is determined and yields the results summarized in Table B2-8, below. Also, the percent change in risk due to ILRT interval extensions is determined and presented in Table B2-8.

Table B2-8
CCNPP Percent Risk Increases from ILRT Interval Extensions

	Description	Current 10 year ILRT interval	15 year ILRT interval	20 year ILRT interval
$\%Risk_N$	Percent risk contribution for Class 1 and Class 3	0.20%	0.26%	0.33%
$\Delta\%Risk_{Base\ to\ N}$	Percent increase in total risk due to an N-year ILRT over the baseline case	0.09%	N/A	N/A
$\Delta\%Risk_{10\text{-}N}$	Percent increase in risk due to an N-year ILRT over the 10 year case	N/A	0.07%	0.14%

B2.2.4 Change In Risk In Terms Of Large Early Release Frequency (LERF)

Section 5.2.4 of the main body of this report discusses the quantification of LERF. This analysis assumes that Class 2, 3B, 6, 7 and 8 lead to large leak rates. The baseline LERF frequency, for the 3 in 10 year inspection interval, is determined as shown in Table B2-9. The estimate for Class 7 includes only the portion of Class 7 identified in the PSA as representing early containment failure.

Table B2-9
CCNPP Baseline LERF Frequency Calculation

Class	Description	LERF
2	Large Isolation Failures (failure to close)	4.97E-8
3B	Large Pre-existing Containment Leak	8.08E-9
6	Other Isolation Failures (e.g., dependent failures)	1.41E-6
7 (Early)	Failure Induced by Phenomena (early failures)	7.39E-6
8	Bypass (SGTR / ISLOCA)	6.47E-6
LERF	(total)	**1.533E-5**

Impact of ILRT Test Interval Extensions on Large Early Release Frequency (LERF)

Table B2-10 presents the frequencies for each large release class, for each of four ILRT intervals. The total LERFs are also listed, along with the increase in LERF from the current LERF, and the percent increase from the current LERF.

As the only class contributor to the change in large early release is due to Class 3B events, the $\Delta LERF = F_{Class\ 3B}$ (evaluated at the new inspection interval) – $F_{Class\ 3B}$ (of the baseline interval or the current interval, as appropriate).

The percent change in LERF is calculated as:

$$\%\Delta LERF = [\Delta LERF/LERF_{Total}] \times 100$$

Where:
$LERF_{Total}$ = The sum of the Frequencies of Sequences 2, 3B, 6, 8, and the "early" portion of Class 7, (7.39E-6).

Table B2-10
CCNPP LERF Variation as a Function of Change in Inspection Interval

Class	Description	3 per 10 Years	10 Years	15 Years	20 Years
2	Large Isolation Failures (failure to close)	4.97E-8	4.97E-8	4.97E-8	4.97E-8
3B	Large Pre-existing Containment Leak	8.08E-9	2.42E-8	3.64E-8	4.85E-8
6	Other Isolation Failures (e.g., dependent failures)	1.41E-6	1.41E-6	1.41E-6	1.41E-6
7 (Early)	Failure Induced by Phenomena (early failures)	7.39E-6	7.39E-6	7.39E-6	7.39E-6
8	Bypass (SGTR)	6.47E-6	6.47E-6	6.47E-6	6.47E-6
LERF	Total	**1.533E-5**	**1.534E-5**	**1.536E-5**	**1.537E-5**
ΔLERF	Increase from Current LERF	N/A	0.0	1.21E-8	2.42E-8
%ΔLERF	% Increase from Current LERF	N/A	0.0%	0.08%	0.16%

B3.0 SUMMARY OF RESULTS

Baseline ILRT Interval Results (For this evaluation, the baseline risk contribution is taken as the original inspection interval at the time that the IPE was done; that is, three inspections per 10 year interval.)

1. The baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.11 % of total risk.

2. The baseline LERF is 1.533E-5 per year.

Ten Year ILRT Interval Results

1. The current Type A 10-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.20 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the baseline interval to current 10 year interval is 0.09 %.

3. The LERF with a 10 year ILRT interval is 1.534E-5 per year.

4. The increase in LERF from extending the ILRT test interval from the baseline interval to the current 10 year interval is 1.62E-8 per year.

5. The % increase in LERF from extending the ILRT test interval from the baseline interval to 10 years is 0.11 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.11 %) in conditional containment unreliability.

Fifteen Year ILRT Interval Results

1. Type A 15-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.26 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the current 10 year interval to 15 years is 0.07 %.

3. The LERF for the 15 year interval is 1.536E-5 per year.

4. The increase in LERF from extending the ILRT test interval from the 10 year interval to 15 years is 1.212E-8 per year.

5. The % increase in LERF from extending the ILRT test interval from the 10 year interval to 15 years is 0.08 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.08 %) in conditional containment unreliability.

Twenty Year ILRT Interval Results

1. Type A 20-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.33 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the current 10 year interval to 20 years is 0.14 %.

3. The LERF for the 20 year interval is 1.537E-5 per year.

4. The increase in LERF from extending the ILRT test interval from the 10 year interval to 20 years is 2.424E-8 per year.

5. The % increase in LERF from extending the ILRT test interval from the 10 year interval to 20 years is 0.16 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.16 %) in conditional containment unreliability.

B4.0 REFERENCES

B-1. Calvert Cliffs Nuclear Power Plant Individual Plant Examination, BGE, December 1993.

B-2. NEI 94-01, Revision 0 "Industry Guideline for Implementing Performance-Based Option of 10 CFR Part 50," Appendix J, July 26, 1995.

B-3. EPRI TR-104285, "Risk Assessment of Revised Containment Leak Rate Testing Intervals," August 1994.

B-4. CCNPP UFSAR, BGE, Revision 26.

B-5. NUREG-1437, Supplement 1 "Generic Environmental Impact Statement for License Renewal of Nuclear Plants - Regarding the Calvert Cliffs Nuclear Power Plant Final Report," USNRC, October, 1999.

B-6. NUREG/CR-6604, Supplement 1, RADTRAD: A Simplified Model for RADionuclide Transport And Dose estimation, SNL, Bixler, N.E. et al, June, 1999.

APPENDIX C

APPLICATION OF THE JOINT APPLICATION REPORT TO SAINT LUCIE UNIT 1

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C1.0 System Description and Operating Experience

C1.1 System Description

The primary function of containment is to prevent the release of radioactive material from either the containment atmosphere or the reactor coolant system to the outside environment.

The Saint Lucie Unit 1 containment vessel, including all its penetrations, is a low leakage steel shell designed to withstand a postulated Design Basis Accident (DBA) and to confine the radioactive materials that could be released by accidental loss of integrity of the reactor coolant pressure boundary. The containment vessel is a right circular cylinder (~2 in. thick) with hemispherical dome (~1 in. thick) and ellipsoidal bottom (~2 in. thick) which houses the Reactor Vessel, the Reactor Coolant System piping and pumps, the steam generators, the pressurizer and the pressurizer quench tank, and other branch connections of the Reactor Coolant System including the safety injection tanks. The containment vessel penetrations include a construction hatch, a maintenance hatch, a personnel airlock, an escape lock and various sized penetration nozzles. The containment vessel is also equipped with a dome inspection walkway, access ladder and a circular crane girder with a crane rail attached to the shell of the vessel. The containment vessel is enclosed by the reinforced concrete Shield Building.

An annular space is provided between the walls and domes of the containment vessel and the Shield Building in order to permit construction operations and in-service inspection, and to filter any leakage from containment during a Loss of Coolant Accident (LOCA) to minimize site doses. The containment vessel is an independent freestanding structure with a net free volume of approximately 2.5 million cubic ft. The containment vessel is rigidly supported at its base near the elevation of its bottom spring line. Both the Shield Building and the containment vessel are supported on a common Foundation Mat. With the exception of the concrete placed underneath and near the knuckles at the sides of the vessel, there are no structural ties between the containment vessel and the Shield Building above the Foundation slab. Therefore there is virtually unlimited freedom for differential movement between the containment vessel and the Shield Building above the top of the concrete base at elevation 23-ft MSL. Concrete floor fill is placed above the ellipsoidal shell bottom. The cylindrical portion of the steel containment shell has a minimum thickness of 1.92 in. on an inside radius of 70 ft. The polar crane girder support plates are welded to the shell at approximately six-ft. on center. Except for some miscellaneous platform framing and some minor seismic restraints, no major floor framing or seismic restraint supports are attached to the shell. Immediately below the crane girder a heating and ventilating duct for the containment ring header, approximately five ft wide by five ft deep and running the entire containment circumference, is structurally supported at 30 places and attached to the shell by means of welded clips. The containment shell is also used to support temporary construction loads from the pedestal cranes. The 1.92-in. minimum shell plate thickness increases to a minimum of four in. adjacent to all penetrations and openings. The inside radius of the hemispherical dome is 70 ft. with a dome plate 0.96 in. thick connected to the cylindrical portion of the shell at the tangent line by means of a full penetration weld. The containment spray piping is attached to the dome by means of welded clips as are the dome inspection walkway and

platforms. The containment vessel is protected from external missiles by the Shield Building. Protection from internal missiles is provided by the primary and secondary shield walls and other containment internal structures.

C1.2 Saint Lucie Unit 1 Operating Experience

Summary Type A Testing History

St. Lucie has an inspection program and procedure for visual inspection of all accessible areas of the steel containment vessel and the concrete shield building. This inspection has been performed prior to each ILRT from Unit startup until the most recent ILRT in 1993. Subsequent to then, the inspection was performed on the same interval of 3 times in 10 years. These inspections indicate that there have been no problems with structural integrity or materiel condition of the steel containment vessel and only minor coatings issues. The ASME Section XI Subsection IWE inspection plan was approved and implemented at St. Lucie Unit 1 on April 7, 2000. Inspections have been completed for the first period of the first 10-year interval with similar results to those determined under the previously mentioned program.

The historical results of the Type A tests for St. Lucie Unit 1 are included in the following table. Data is reported using the 95% upper confidence limit with the exception of the Unit 1 pre-op test.

Saint Lucie Unit 1			
Date	**Note**	**Leak Rate (wt% /Day)**	**Acceptance Criteria (wt% /Day)**
7/5/75	(1)	0.025	0.375
5/26/79	(2)	0.057	0.240
4/28/83		0.153	0.375
3/21/87	(3,4)	0.335	0.375
4/6/90	(3,4)	0.195	0.375
5/20/93	(3,4)	0.319	0.375

(1) Pre-operational test
(2) Reduced pressure test
(3) Test results obtained using BN-TOP-1
(4) Includes difference of as-found/as-left LLRT results

C2.0 ASSESSMENT OF RISK FOR SAINT LUCIE UNIT 1

The purpose of this section is to provide a risk informed assessment for extending the Saint Lucie Unit 1 Integrated Leak Rate Test (ILRT) interval from ten to fifteen or twenty years. The risk assessment is performed as described in the main body of this report.

In addition, the results and findings from the Saint Lucie Unit 1 Individual Plant Examination (IPE) (Reference C-1) are used for this risk assessment. Specifically the approach combines the use of the Saint Lucie Unit 1 Individual Plant Examination (IPE) results and findings with the methodology described in EPRI TR-104285 to estimate public risk associated with extending the containment Type A testing.

The change in plant risk is evaluated based on the change in the predicted releases in terms of person-rem/year and Large Early Release Frequency (LERF). Changes to Type A testing have no impact on CDF.

C2.1 Overview

In October 26, 1995, the NRC revised 10 CFR 50, Appendix J. The revision to Appendix J allowed individual plants to select containment leakage testing under Option A "Prescriptive Requirements" or Option B "Performance-Based Requirements." Saint Lucie Unit 1 selected the requirements under Option B as its testing program.

The current surveillance testing requirement, as outlined in NEI 94-01 (Reference C-1) for Type A testing, is at least once per 10 years based on an acceptable performance history (define as two consecutive periodic Type A tests at least 24 months apart in which the calculated performance leakage was less than $1.0L_a$). However, Saint Lucie Unit 1 seeks to extend the test interval for Type A testing from ten years to fifteen years based on the substantial cost savings from extending this test interval and the low risk impact.

C2.2 Assessment of Risk

The risk impact of extending the ILRT (Type A) interval from its current interval of 10 years to 15 years, is evaluated from a potential public exposure impact (as measured in person-rem/year) and from a Large Early Release (LERF) perspective as identified in Regulatory Guide 1.174. The methodology used accounts for large releases and computes the LERF metric. The analysis examined the Saint Lucie Unit 1 IPE and subsequent Probabilistic Safety Analysis (PSA) upgrades for plant specific accident sequences which may impact containment performance. Specifically, as discussed in the main body of this report, core damage sequences were considered with respect to which EPRI event class they are in (EPRI TR-104285 Class 1, 2, 3, 4, 5, 6, 7 or 8 events in terms of containment integrity – Reference C-3).

Table C2-2 presents the Saint Lucie Unit 1 PSA frequencies for these eight accident classes.

C2.2.1 Quantification Of Base-Line Frequency For Accident Classes

The eight EPRI accident class frequencies were determined, using the methodology described in the main body of this report, as described in the following paragraphs:

Class 1 Sequences: This group consists of all core damage accident progression bins for which the containment remains intact. Class 1 sequences arise from those core damage sequences that have long term heat removal capability available via containment sprays or fan coolers. PSA upgrades performed over the past several years have resulted in an overall plant CDF estimate of 2.99E-5/year.

Based on a review of the core damage sequences, the intact containment frequency is estimated to be 2.26E-5 per year. For this analysis, it is assumed that the associated maximum containment leakage for this group is L_a (or 0.5 wt% per day) (Reference C-4). For this analysis, the events that the PSA categorizes as intact containment events are parsed into three categories, Class 3A, Class 3B and Class 1. As discussed in the text of the main report, as Class 1 and Class 3 events are related, the frequency for Class 1 events is calculated as:

$$F_{Class\ 1} = CDF_{Intact} - F_{Class\ 3A} - F_{Class\ 3B}$$

Class 1 event frequencies are presented in the discussion of Class 3 events, below.

Releases from Class 1 events are calculated based on the design basis L_a. This is consistent with the assumption that the containment is intact.

Class 2 Sequences: This group consists of all core damage accident progression bins for which a pre-existing leakage due to failure to isolate the containment occurs. These sequences are dominated by failure-to-close large (>2-inch diameter) containment isolation valves. Such sequences contribute to the plant LERF. The frequency per year for these sequences is determined from the Saint Lucie Unit 1 PSA as the sum of those release classes that indicate core damage in the presence of an unisolated containment.

$$\mathbf{F_{Class\ 2} = 2.26E\text{-}08\ /year}$$

For this analysis the associated containment leakage for this group is assumed to be 100 wt% per day (See Table C2-2).

Class 2 releases for Saint Lucie Unit 1 analyses are associated with loss of isolation failures resulting in a through containment equivalent leakage from a pipe greater than 2 inches in diameter. In this study the Class 2 containment leakage is estimated by a 100 wt% /day containment leakage. A 100 wt% per day release is equivalent to a release from a pipe diameter of about 2.5 inches and containment operation at design pressure.

Class 3 Sequences: Class 3 endstates are developed specifically for this application. The Class 3 endstates include all core damage accident progression bins for which a pre-existing leakage in the containment structure exists. The containment leakage for these sequences can be grouped into two categories, small leaks or large.

The respective frequencies per year are determined as follows:

$F_{Class\ 3A} = PROB_{Class\ 3A} * CDF_{Intact}$

$F_{Class\ 3B} = PROB_{Class\ 3B} * CDF_{Intact}$

Where:

CDF_{Intact} = the Core Damage Frequency for the intact containment sequences, and is 2.26E-05/year.
$PROB_{Class\ 3A}$ = the probability of small pre-existing containment leakage in excess of design allowable.
$PROB_{Class\ 3B}$ = the probability of large pre-existing containment leakage.

$PROB_{Class\ 3A}$ and $F_{Class\ 3B}$ are a function of inspection interval and are obtained from Section 5.2.3, using Table 5-5 (reproduced here for convenience) as follows.

Probability of Type A Leakage for a Given Test Interval

Test Interval	Probability	
	Small Leak (Class 3A) ($PROB_{Class\ 3A}$)	Large Leak (Class 3B) ($PROB_{Class\ 3B}$)
3 per 10 Years	0.028	1.68E-4
10 Years	0.084	5.04E-4
15 Years	0.126	7.56E-4
20 Years	0.168	1.01E-3

The resulting values for $F_{Class\ 1}$, $F_{Class\ 3A}$, and $F_{Class\ 3B}$ as a function of ILRT interval are presented in Table C2-1.

Table C2-1
Frequency of Type A Leakage for a Given Test Interval

Test Interval	Release Class Frequency (per year)		
	$F_{Class\ 1}$	$F_{Class\ 3A}$	$F_{Class\ 3B}$
3 per 10 Years	2.20E-5	6.33E-7	3.80E-9
10 Years	2.07E-5	1.90E-6	1.14E-8
15 Years	1.97E-5	2.85E-6	1.71E-8
20 Years	1.88E-5	3.80E-6	2.28E-8

As Class 3A represents a small pre-existing containment leak, its value was set to bound the maximum quantified release identified in Table 4-2 of NUREG-1493. The largest identified release multiple was $21L_a$. Class 3A releases were therefore quantified as $25L_a$. For Saint Lucie Unit 1 this results in a containment leakage rate of 12.5 wt% per day.

Class 3B releases are assumed to be greater than $100L_a$ (or 50 wt% per day). Releases in this category were represented by a 100 wt% per day release, which is roughly equivalent to a release from a 2.5 inch orifice. This leakage is essentially equivalent to $200L_a$ (for Saint Lucie Unit 1) and is considered a very conservative estimate of potential containment releases that may result from extension of Type A containment Testing.

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

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

Class 6 Sequences: This group is similar to Class 2. These are sequences that involve core damage accident progression bins for which a failure-to-seal containment leakage due to failure to isolate the containment occurs. These sequences are dominated by misalignment of containment isolation valves following a test/maintenance evolution, typically resulting in a failure to close smaller containment isolation valves. All other failure modes are bounded by the Class 2 assumptions.

For Saint Lucie Unit 1 this class is lumped together with and included within Class 2. Thus

$$F_{Class\ 6} = 0.0\ /year$$

The associated maximum containment leakage for this group is 35 wt%/day (for Class 2 the maximum leakage is 100 wt%/day).

Releases for Class 6 events were established based on a release from a 1.5 inch orifice or roughly a release area of 1.8 square inches.

Class 7 Sequences: This group consists of all core damage accident progression bins in which containment failure induced by severe accident phenomena occurs (i.e. H_2 combustion).

$$F_{Class\ 7} = CDF_{CFL} + CDF_{CFE}$$

Where:
CDF_{CFE} = the CDF resulting from phenomena that lead to early containment failure.
CDF_{CFL} = the CDF resulting from phenomena that lead to late containment failure.

This frequency was determined by subtracting the intact, bypass (See Class 8 discussion) and loss of isolation CDFs from the total CDF. This results in the following Class 7 frequency:

$$\mathbf{F_{Class\ 7} = 3.15E\text{-}6\ /\ year}$$

These endstates include containment failure. For this analysis the associated containment leakage for this group is 280 wt%/day (this value is typical of a 0.1 ft^2 failure, see for example NUREG 1493). It was determined from the PRA that the early component of $F_{Class\ 7}$, CDF_{CFE}, is 4.21E-08.

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

Using the results of the most recent Saint Lucie Unit 1 PSA and including ISLOCA and SGTR sequences, the failure frequency for this class is 4.09E-6 / year.

$$\mathbf{F_{Class\ 8} = 4.09E\text{-}6\ /\ year}$$

For Saint Lucie Unit 1, the bypass leakages are based on an unmitigated bypass release of 100% of the core inventory of Noble Gases and 40% of the Iodine.

Table C2-2 provides a summary of the Saint Lucie Unit 1 Release Class frequencies and the assumed leakage for each Class.

Table C2-2
Saint Lucie Unit 1 Mean Containment Frequencies (from the PSA) and Representative Releases

Class	Description	Frequency (per Rx-year)	Estimated Leakage
1	No Containment Failure	2.20E-05	L_a
2	Large Containment Isolation Failures (failure-to-close)	2.26E-08	100 wt%/day
3A	Small Pre-existing Containment Leak	6.33E-07	25 L_a
3B	Large Pre-existing Containment Leak	3.80E-09	100 wt%/day
4	Small isolation failure - failure-to-seal (Type B test)	Not Analyzed	N/A
5	Small isolation failure - failure-to-seal (Type C test)	Not Analyzed	N/A
6	Containment Isolation Failures (dependent failures, personnel errors)	0.00E+00	35 wt%/day
7	Severe Accident Phenomena Induced Failure (early and late failures)	3.15E-06	280 wt%/day
8	Containment Bypassed (SGTR / ISLOCA)	4.09E-06	See Class 8 description, above
Total	All CET Endstates	2.99E-05	

C2.2.2 Saint Lucie Unit 1 population dose per reactor year

Plant-specific release analysis was performed for Saint Lucie Unit 1 to evaluate the doses to the population, within a 50-mile radius from the plant. The releases for Classes 1 through 7 are based on post large Loss of Coolant Accident (LOCA) as shown in Table C2-3 and the releases for Class 8 events are based on Bypass events as shown in Table C2-4. These tables tabulate the whole body population dose within 50 miles. Calculations were performed using RADTRAD Version 3 (Reference C-5) assuming a containment source term equivalent to TID-14844. Intact containment release computations were validated via comparisons with Saint Lucie Unit 1 FSAR results (Reference C-4).

LBLOCA dose models with defined leakages are assumed to be representative for all containment leakage release classes. Bypass releases based on iodine and noble gas releases are identified in the IPE study for the dominant sequence. Population estimates are based on Saint Lucie Unit 1 projections to 2025. Atmospheric dispersions are based on mean weather data obtained at the plant site and reported in the plant updated FSAR (Reference C-4).

Table C2-3
Saint Lucie Unit 1 Population Dose – LOCA

Saint Lucie Doses and Population Doses due to LOCA			
		Doses (rem)	Doses (person - rem)
Zone (miles)	Population	Containment Leakage Events (based on leakage of 1 L_a)	Containment Leakage Events (based on leakage of 1 L_a)
0-1	0	7.40E+00	0.00E+00
1-2	475	4.71E+00	2.24E+03
2-5	29668	1.27E+00	3.77E+04
5-10	217819	3.72E-01	8.11E+04
10-15	125715	1.72E-01	2.16E+04
15-20	84166	9.53E-02	8.02E+03
20-30	172091	6.03E-02	1.04E+04
30-40	227718	3.77E-02	8.58E+03
40-50	533595	2.69E-02	1.44E+04
Totals	**1391247**		**1.84E+05**

Table C2-4
Saint Lucie Unit 1 Population Dose – Bypass Events

Saint Lucie Unit 1 Doses and Population Doses due to Bypass Events			
		Doses (rem)	Doses (person - rem)
Zone (miles)	Population	Bypass Events	Bypass Events
0-1	0	5.60E+03	0.00E+00
1-2	475	3.57E+03	1.69E+06
2-5	29668	9.61E+02	2.85E+07
5-10	217819	2.81E+02	6.12E+07
10-15	125715	1.29E+02	1.63E+07
15-20	84166	7.19E+01	6.05E+06
20-30	172091	4.55E+01	7.83E+06
30-40	227718	2.83E+01	6.45E+06
40-50	533595	2.02E+01	1.08E+07
Totals	**1391247**		**1.39E+08**

The population dose, out to 50 miles is determined based on the design-basis normal containment leak rate of 0.5% /day, and is 1.84E+05 person-rem per event. Since the containment release pathways are generally the same for containment Classes 1 through 7, the population doses are directly proportional to the ratio of the leakage rate to that of the intact nominal leakage case (Class 1). Therefore, the Class 2 through 7 leakage related doses are ratioed upwards to account for the increased leakages associated with event Classes 2 through 7. Classes 1 through 8 leakages and doses are summarized in Table C2-5.

Table C2-5
Saint Lucie Unit 1 Containment Leakage Rate and Dose – for Accident Classes

Class	Description	Leakage (wt%/day)	Release (50 miles) (person-rem)	Basis
1	No Containment Failure	0.5 (L_a)	1.84E+05	See Table C2-2
2	Large Containment Isolation Failures (failure-to-close)	100	3.68E+07	Ratio from class 1 baseline
3A	Small Isolation Failures (containment leak)	12.5 (25 L_a)	4.60E+06	Ratio from class 1 baseline
3B	Large Isolation Failures (containment leak)	100	3.68E+07	Ratio from class 1 baseline
4	Small isolation failure - failure-to-seal (Type B test)	Not analyzed	NA	
5	Small isolation failure - failure-to-seal (Type C test)	Not analyzed	NA	
6	Containment Isolation Failures (dependent failures, personnel errors)	35	1.29E+07	Ratio from class 1 baseline
7	Severe Accident Phenomena Induced Failure (early and late failures)	280	1.03E+08	Ratio from class 1 baseline
8	Containment Bypassed (SGTR / ISLOCA)	-	1.39E+08	No credit for containment. (See Class 8 description)

The above results when combined with the frequencies presented in Table C2-2 yields the Saint Lucie Unit 1 baseline mean consequence measures (risks, in terms of person-rem/yr) for each accident class. The resulting risks (in terms of person-rem/yr), for each accident class, are presented in Table C2-6 below.

Table C2-6
Saint Lucie Unit 1 Mean Baseline Risk - for Accident Classes

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr (50-Miles)
1	No Containment Failure	2.20E-05	1.84E+05	4.04E+00
2	Large Isolation Failures (failure to close)	2.26E-08	3.68E+07	8.32E-01
3A	Small Pre-existing Containment Leak	6.33E-07	4.60E+06	2.91E+00
3B	Large Pre-existing Containment Leak	3.80E-09	3.68E+07	1.40E-01
4	Small Isolation Failure to Seal (Type B Test)	Not Analyzed	NA	N/A
5	Small Isolation Failure to Seal (Type C Test)	Not Analyzed	NA	N/A
6	Other Isolation Failures (e.g., dependent failures)	0.00E+00	1.29E+07	0.00E+00
7	Failure Induced by Phenomena (early and late failures)	3.15E-06	1.03E+08	3.25E+02
8	Bypass (SGTR / ISLOCA)	4.09E-06	1.39E+08	5.69E+02
Total	All CET End States	2.99E-05	N/A	901.01

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

$$\%Risk_{BASE} = [(Risk_{Class\ 1\ BASE} + Risk_{Class\ 3A\ BASE} + Risk_{Class\ 3B\ BASE}) / Total_{BASE}] \times 100$$

Where:

$Risk_{Class\ 1\ BASE}$ = Class 1 person-rem/yr = 4.04E+00 person-rem/yr [Table C2-6]

$Risk_{Class\ 3A\ BASE}$ = Class 3A person-rem/yr = 2.91E+00 person-rem/yr [Table C2-6]

$Risk_{Class\ 3B\ BASE}$ = Class 3B person-rem/yr = 1.40E-01 person-rem/yr [Table C2-6]

$Total_{BASE}$ = total dose/year for baseline interval = 901.01 person-rem/year [Table C2-6]

$$\%Risk_{BASE} = [(4.04E+00 + 2.91E+00 + 1.40E-01) / 901.01] \times 100$$

$$\mathbf{\%Risk_{BASE} = 0.79\ \%}$$

Therefore, the total baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.79 %.

C2.2.3 Risk Impact of Extending Type A Test Interval From 10 To 15 And 20 Years

Using the methodology described in the main report that was used above to determine baseline risk values (see Table C2-6), the risk values were determined for the Current 10 year ILRT test interval, a 15 year ILRT test interval, and a 20 year ILRT test interval. These risk values are presented below in Table C2-7.

Table C2-7
Saint Lucie Unit 1 Risk Values vs ILRT Interval (Person-Rem/yr to 50-Miles)

Class	Description	Current 10 year ILRT interval	15 year ILRT interval	20 year ILRT interval
1	No Containment Failure	3.81E+00	3.63E+00	3.46E+00
2	Large Isolation Failures (failure to close)	8.32E-01	8.32E-01	8.32E-01
3A	Small Pre-existing Containment Leak	8.73E+00	1.31E+01	1.75E+01
3B	Large Pre-existing Containment Leak	4.19E-01	6.29E-01	8.38E-01
4	Small Isolation Failure to Seal (Type B Test)	N/A	N/A	N/A
5	Small Isolation Failure to Seal (Type C Test)	N/A	N/A	N/A
6	Other Isolation Failures (e.g., dependent failures)	0.00E+00	0.00E+00	0.00E+00
7	Failure Induced by Phenomena (early and late failures)	3.25E+02	3.25E+02	3.25E+02
8	Bypass (SGTR/ISLOCA)	5.69E+02	5.69E+02	5.69E+02
Total	All CET End States	906.88	911.28	915.68

Based on the above values, and using the methodology described in the main report, the percent risk contribution ($\%Risk_N$, for values of N of 10, 15 and 20 years) for Class 1 and Class 3 is determined and yields the results summarized in Table C2-8, below. Also, the percent change in risk due to ILRT interval extensions is determined and presented in Table C2-8.

Table C2-8
Saint Lucie Unit 1 Percent Risk Increases from ILRT Interval Extensions

	Description	Current 10 year ILRT interval	15 year ILRT interval	20 year ILRT interval
$\%Risk_N$	Percent risk contribution for Class 1 and Class 3	1.43%	1.90%	2.38%
$\Delta\%Risk_{Base\ to\ N}$	Percent increase in total risk due to an N-year ILRT over the baseline case	0.65%	N/A	N/A
$\Delta\%Risk_{10-N}$	Percent increase in risk due to an N-year ILRT over the 10 year case	N/A	0.49%	0.97%

C2.2.4 Change In Risk In Terms Of Large Early Release Frequency (LERF)

Section 5.2.4 of the main body of this report discusses the quantification of LERF. This analysis assumes that Class 2, 3B, 6, 7 and 8 lead to large leak rates. The baseline LERF frequency, for the 3 in 10-year inspection interval, is determined as shown in Table C2-9. The estimate for Class 7 includes only the portion of Class 7 identified in the PSA as representing early containment failure.

Table C2-9
Saint Lucie Unit 1 Baseline LERF Frequency Calculation

Class	Description	LERF
2	Large Isolation Failures (failure to close)	2.26E-08
3B	Large Pre-existing Containment Leak	3.80E-09
6	Other Isolation Failures (e.g., dependent failures)	0.00E+00
7 (Early)	Failure Induced by Phenomena (early failures)	4.21E-08
8	Bypass (SGTR / ISLOCA)	4.09E-06
LERF	(total)	**4.158E-06**

Impact of ILRT Test Interval Extensions on Large Early Release Frequency (LERF)

Table C2-10 presents the frequencies for each large release class, for each of four ILRT intervals. The total LERFs are also listed, along with the increase in LERF from the current LERF, and the percent increase from the current LERF.

As the only class contributor to the change in large early release is due to Class 3B events, the $\Delta LERF = F_{Class\ 3B}$ (evaluated at the new inspection interval) – $F_{Class\ 3B}$ (of the baseline interval or the current interval, as appropriate).

The percent change in LERF is calculated as:

$$\%\Delta LERF = [\Delta LERF/LERF_{Total}] \times 100$$

Where:
$LERF_{Total}$ = The sum of the Frequencies of Sequences 2, 3B, 6,8, and the "early" portion of Class 7, (4.21E-8).

Table C2-10
Saint Lucie Unit 1 LERF Variation as a Function of Change in Inspection Interval

Class	Description	3 per 10 Years	10 Years	15 Years	20 Years
2	Large Isolation Failures (failure to close)	2.26E-08	2.26E-08	2.26E-08	2.26E-08
3B	Large Pre-existing Containment Leak	3.80E-09	1.14E-08	1.71E-08	2.28E-08
6	Other Isolation Failures (e.g., dependent failures)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7 (Early)	Failure Induced by Phenomena (early failures)	4.21E-08	4.21E-08	4.21E-08	4.21E-08
8	Bypass (SGTR/ISLOCA)	4.09E-06	4.09E-06	4.09E-06	4.09E-06
LERF	Total	**4.158E-06**	**4.166E-06**	**4.172E-06**	**4.177E-06**
ΔLERF	Increase from Current LERF	N/A	0.0	5.695E-09	1.139E-08
%ΔLERF	% Increase from Current LERF	N/A	0.0%	0.14%	0.27%

C3.0 SUMMARY OF RESULTS

Baseline ILRT Interval Results (For this evaluation, the baseline risk contribution is taken as the original inspection interval at the time that the IPE was done; that is, three inspections per 10 year interval)

1. The baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.79 % of total risk.

2. The baseline LERF is 4.158E-06 per year.

Ten Year ILRT Interval Results

1. The current Type A 10-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 1.43 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the baseline interval to current 10-year interval is 0.65 %.

3. The LERF with a 10-year ILRT interval is 4.166E-06 per year.

4. The increase in LERF from extending the ILRT test interval from the baseline interval to the current 10-year interval is 7.594E-09 per year.

5. The % increase in LERF from extending the ILRT test interval from the baseline interval to 10 years is 0.18 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.18 %) in conditional containment unreliability.

Fifteen Year ILRT Interval Results

1. Type A 15-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 1.90 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the current 10-year interval to 15 years is 0.49 %.

3. The LERF for the 15-year interval is 4.172E-06 per year.

4. The increase in LERF from extending the ILRT test interval from the 10-year interval to 15 years is 5.695E-9 per year.

5. The % increase in LERF from extending the ILRT test interval from the 10-year interval to 15 years is 0.14 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.14 %) in conditional containment unreliability.

Twenty Year ILRT Interval Results

1. Type A 20-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 2.38 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the current 10 year interval to 20 years is 0.97 %.

3. The LERF for the 20-year interval is 4.177E-06 per year.

4. The increase in LERF from extending the ILRT test interval from the 10-year interval to 20 years is 1.139E-8 per year.

5. The % increase in LERF from extending the ILRT test interval from the 10-year interval to 20 years is 0.27 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.27 %) in conditional containment unreliability.

C4.0 REFERENCES

C-1. Saint Lucie Unit 1 Individual Plant Examination, FPL, July 19, 1993.

C-2. NEI 94-01, Revision 0 "Industry Guideline for Implementing Performance-Based Option of 10 CFR Part 50," Appendix J, July 26, 1995.

C-3. EPRI TR-104285, "Risk Assessment of Revised Containment Leak Rate Testing Intervals," August 1994.

C-4. Saint Lucie Unit 1 UFSAR, FPL, Amendment 18.

C-5. NUREG/CR-6604, Supplement 1, RADTRAD: A Simplified Model for RADionuclide Transport And Dose estimation, SNL, Bixler, N.E. et al, June 1999.

APPENDIX D

APPLICATION OF THE JOINT APPLICATION REPORT TO SAINT LUCIE UNIT 2

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D1.0 System Description and Operating Experience

D1.1 System Description

The primary function of containment is to prevent the release of radioactive material from either the containment atmosphere or the reactor coolant system to the outside environment.

The Saint Lucie Unit 2 containment vessel, including all its penetrations, is a low leakage steel shell designed to withstand a postulated Design Basis Accident (DBA) and to confine the radioactive materials that could be released by accidental loss of integrity of the reactor coolant pressure boundary. The containment vessel is a right circular cylinder (~2 in. thick) with hemispherical dome (~1 in. thick) and ellipsoidal bottom (~2 in. thick) which houses the Reactor Vessel, the Reactor Coolant System piping and pumps, the steam generators, the pressurizer and the pressurizer quench tank, and other branch connections of the Reactor Coolant System including the safety injection tanks. The containment vessel penetrations include a construction hatch, a maintenance hatch, a personnel airlock, an escape lock and various sized penetration nozzles. The containment vessel is also equipped with a dome inspection walkway, access ladder and a circular crane girder with a crane rail attached to the shell of the vessel. The containment vessel is enclosed by the reinforced concrete Shield Building.

An annular space is provided between the walls and domes of the containment vessel and the Shield Building in order to permit construction operations and in-service inspection, and to filter any leakage from containment during a Loss of Coolant Accident (LOCA) to minimize site doses. The containment vessel is an independent freestanding structure with a net free volume of approximately 2.5 million cubic ft. The containment vessel is rigidly supported at its base near the elevation of its bottom spring line. Both the Shield Building and the containment vessel are supported on a common Foundation Mat. With the exception of the concrete placed underneath and near the knuckles at the sides of the vessel, there are no structural ties between the containment vessel and the Shield Building above the Foundation slab. Therefore there is virtually unlimited freedom for differential movement between the containment vessel and the Shield Building above the top of the concrete base at elevation 23-ft MSL. Concrete floor fill is placed above the ellipsoidal shell bottom. The cylindrical portion of the steel containment shell has a minimum thickness of 1.92 in. on an inside radius of 70 ft. The polar crane girder support plates are welded to the shell at approximately six-ft. on center. Except for some miscellaneous platform framing and some minor seismic restraints, no major floor framing or seismic restraint supports are attached to the shell. Immediately below the crane girder a heating and ventilating duct for the containment ring header, approximately five ft wide by five ft deep and running the entire containment circumference, is structurally supported at 30 places and attached to the shell by means of welded clips. The containment shell is also used to support temporary construction loads from the pedestal cranes. The 1.92-in. minimum shell plate thickness increases to a minimum of four in. adjacent to all penetrations and openings. The inside radius of the hemispherical dome is 70 ft. with a dome plate 0.96 in. thick connected to the cylindrical portion of the shell at the tangent line by means of a full penetration weld. The containment spray piping is attached to the dome by means of welded clips as are the dome inspection walkway and

platforms. The containment vessel is protected from external missiles by the Shield Building. Protection from internal missiles is provided by the primary and secondary shield walls and other containment internal structures.

D1.2 Saint Lucie Unit 2 Operating Experience

Summary Type A Testing History

St. Lucie has an inspection program and procedure for visual inspection of all accessible areas of the steel containment vessel and the concrete shield building. This inspection has been performed prior to each ILRT from Unit startup until the most recent ILRT in 1992. Subsequent to then the inspection was performed on the same interval of 3 times in 10 years. These inspections indicate that there have been no problems with structural integrity or materiel condition of the steel containment vessel and only minor coatings issues. The ASME Section XI Subsection IWE inspection plan was approved and implemented at St. Lucie Unit 2 on August 9, 2000. Inspections have been completed for the first period of the first 10-year interval with similar results to those determined under the previously mentioned program.

The historical results of the Type A tests for St. Lucie Unit 2 are included in the following table. Data is reported using the 95% upper confidence limit.

Saint Lucie Unit 2			
Date	**Note**	**Leak Rate (wt%/Day)**	**Acceptance Criteria (wt%/Day)**
12/2/82	(1)	0.026	0.375
5/17/86	(2,4)	0.092	0.263
4/3/89	(3,4)	0.117	0.375
6/17/92	(3,4)	0.053	0.375

(1) Pre-operational test
(2) Reduced pressure test
(3) Test results obtained using BN-TOP-1
(4) Includes difference of as-found/as-left LLRT results

D2.0 ASSESSMENT OF RISK FOR SAINT LUCIE UNIT 2

The purpose of this section is to provide a risk informed assessment for extending the Saint Lucie Unit 2 Integrated Leak Rate Test (ILRT) interval from ten to fifteen or twenty years. The risk assessment is performed as described in the main body of this report.

In addition, the results and findings from the Saint Lucie Unit 2 Individual Plant Examination (IPE) (Reference D-1) are used for this risk assessment. Specifically the approach combines the use of the Saint Lucie Unit 2 Individual Plant Examination (IPE) results and findings with the methodology described in EPRI TR-104285 to estimate public risk associated with extending the containment Type A testing.

The change in plant risk is evaluated based on the change in the predicted releases in terms of person-rem/year and Large Early Release Frequency (LERF). Changes to Type A testing have no impact on CDF.

D2.1 Overview

In October 26, 1995, the NRC revised 10 CFR 50, Appendix J. The revision to Appendix J allowed individual plants to select containment leakage testing under Option A "Prescriptive Requirements" or Option B "Performance-Based Requirements." Saint Lucie Unit 2 selected the requirements under Option B as its testing program.

The current surveillance testing requirement, as outlined in NEI 94-01 (Reference C-1) for Type A testing, is at least once per 10 years based on an acceptable performance history (define as two consecutive periodic Type A tests at least 24 months apart in which the calculated performance leakage was less than $1.0L_a$). However, Saint Lucie Unit 2 seeks to extend the test interval for Type A testing from ten years to fifteen years based on the substantial cost savings from extending this test interval and the low risk impact.

D2.2 Assessment of Risk

The risk impact of extending the ILRT (Type A) interval from its current interval of 10 years to 15 years, is evaluated from a potential public exposure impact (as measured in person-rem/year) and from a Large Early Release (LERF) perspective as identified in Regulatory Guide 1.174. The methodology used accounts for large releases and computes the LERF metric. The analysis examined the Saint Lucie Unit 2 IPE and subsequent Probabilistic Safety Analysis (PSA) upgrades for plant specific accident sequences which may impact containment performance. Specifically, as discussed in the main body of this report, core damage sequences were considered with respect to which EPRI event class they are in (EPRI TR-104285 Class 1, 2, 3, 4, 5, 6, 7 or 8 events in terms of containment integrity – Reference D-3).

Table D2-2 presents the Saint Lucie Unit 2 PSA frequencies for these eight accident classes.

D2.2.1 Quantification Of Base-Line Frequency For Accident Classes

The eight EPRI accident class frequencies were determined, using the methodology described in the main body of this report, as described in the following paragraphs:

Class 1 Sequences: This group consists of all core damage accident progression bins for which the containment remains intact. Class 1 sequences arise from those core damage sequences that have long term heat removal capability available via containment sprays or fan coolers. PSA upgrades performed over the past several years have resulted in an overall plant CDF estimate of 2.44E-5/year.

Based on a review of the core damage sequences, the intact containment frequency is estimated to be 1.63E-5 per year. For this analysis, it is assumed that the associated maximum containment leakage for this group is L_a (or 0.5 wt% per day) (Reference D-4). For this analysis, the events that the PSA categorizes as intact containment events are parsed into three categories, Class 3A, Class 3B and Class 1. As discussed in the text of the main report, as Class 1 and Class 3 events are related, the frequency for Class 1 events is calculated as:

$$F_{Class\ 1} = CDF_{Intact} - F_{Class\ 3A} - F_{Class\ 3B}$$

Class 1 event frequencies are presented in the discussion of Class 3 events, below.

Releases from Class 1 events are calculated based on the design basis L_a. This is consistent with the assumption that the containment is intact.

Class 2 Sequences: This group consists of all core damage accident progression bins for which a pre-existing leakage due to failure to isolate the containment occurs. These sequences are dominated by failure-to-close large (>2-inch diameter) containment isolation valves. Such sequences contribute to the plant LERF. The frequency per year for these sequences is determined from the Saint Lucie Unit 2 PSA as the sum of those release classes that indicate core damage in the presence of an unisolated containment.

$$\mathbf{F_{Class\ 2} = 1.63E\text{-}08\ /year}$$

For this analysis the associated containment leakage for this group is assumed to be 100 wt% per day (See Table D2-2).

Class 2 releases for Saint Lucie Unit 2 analyses are associated with loss of isolation failures resulting in a through containment equivalent leakage from a pipe greater than 2 inches in diameter. In this study the Class 2 containment leakage is estimated by a 100 wt% /day containment leakage. A 100 wt% per day release is equivalent to a release from a pipe diameter of about 2.5 inches and containment operation at design pressure.

Class 3 Sequences: Class 3 endstates are developed specifically for this application. The Class 3 endstates include all core damage accident progression bins for which a pre-existing leakage in the containment structure exists. The containment leakage for these sequences can be grouped into two categories, small leaks or large.

The respective frequencies per year are determined as follows:

$F_{Class\ 3A} = PROB_{Class\ 3A} * CDF_{Intact}$

$F_{Class\ 3B} = PROB_{Class\ 3B} * CDF_{Intact}$

Where:

CDF_{Intact} = the Core Damage Frequency for the intact containment sequences, and is 1.63E-05/year.
$PROB_{Class\ 3A}$ = the probability of small pre-existing containment leakage in excess of design allowable.
$PROB_{Class\ 3B}$ = the probability of large pre-existing containment leakage.

$PROB_{Class\ 3A}$ and $F_{Class\ 3B}$ are a function of inspection interval and are obtained from Section 5.2.3, using Table 5-5 (reproduced here for convenience) as follows.

Probability of Type A Leakage for a Given Test Interval

Test Interval	Probability	
	Small Leak (Class 3A) ($PROB_{Class\ 3A}$)	Large Leak (Class 3B) ($PROB_{Class\ 3B}$)
3 per 10 Years	0.028	1.68E-4
10 Years	0.084	5.04E-4
15 Years	0.126	7.56E-4
20 Years	0.168	1.01E-3

The resulting values for $F_{Class\ 1}$, $F_{Class\ 3A}$, and $F_{Class\ 3B}$ as a function of ILRT interval are presented in Table D2-1.

Table D2-1
Frequency of Type A Leakage for a Given Test Interval

Test Interval	Release Class Frequency (per year)		
	$F_{Class\ 1}$	$F_{Class\ 3A}$	$F_{Class\ 3B}$
3 per 10 Years	1.58E-5	4.56E-7	2.74E-9
10 Years	1.49E-5	1.37E-6	8.22E-9
15 Years	1.42E-5	2.05E-6	1.23E-8
20 Years	1.35E-5	2.74E-6	1.64E-8

As Class 3A represents a small pre-existing containment leak, its value was set to bound the maximum quantified release identified in Table 4-2 of NUREG-1493. The largest identified release multiple was $21L_a$. Class 3A releases were therefore quantified as $25L_a$. For Saint Lucie Unit 2 this results in a containment leakage rate of 12.5 wt% per day.

Class 3B releases are assumed to be greater than $100L_a$ (or 50 wt% per day). Releases in this category were represented by a 100 wt% per day release, which is roughly equivalent to a release from a 2.5 inch orifice. This leakage is essentially equivalent to $200L_a$ (for Saint Lucie Unit 2) and is considered a very conservative estimate of potential containment releases that may result from extension of Type A containment Testing.

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

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

Class 6 Sequences: This group is similar to Class 2. These are sequences that involve core damage accident progression bins for which a failure-to-seal containment leakage due to failure to isolate the containment occurs. These sequences are dominated by misalignment of containment isolation valves following a test/maintenance evolution, typically resulting in a failure to close smaller containment isolation valves. All other failure modes are bounded by the Class 2 assumptions.

For Saint Lucie Unit 2 this class is lumped together with and included within Class 2. Thus

$$F_{Class\ 6} = 0.0\ /year$$

The associated maximum containment leakage for this group is 35 wt%/day (for Class 2 the maximum leakage is 100 wt%/day).

Releases for Class 6 events were established based on a release from a 1.5 inch orifice or roughly a release area of 1.8 square inches.

Class 7 Sequences: This group consists of all core damage accident progression bins in which containment failure induced by severe accident phenomena occurs (i.e. H_2 combustion).

$$F_{Class\ 7} = CDF_{CFL} + CDF_{CFE}$$

Where:
CDF_{CFE} = the CDF resulting from phenomena that lead to early containment failure.
CDF_{CFL} = the CDF resulting from phenomena that lead to late containment failure.

This frequency was determined by subtracting the intact, bypass (See Class 8 discussion) and loss of isolation CDFs from the total CDF. This results in the following Class 7 frequency:

$$\mathbf{F_{Class\ 7} = 2.17E\text{-}6\ /\ year}$$

These endstates include containment failure. For this analysis the associated containment leakage for this group is 280 wt%/day (this value is typical of a 0.1 ft^2 failure, see for example NUREG 1493). It was determined from the PRA that the early component of $F_{Class\ 7}$, CDF_{CFE}, is 2.91E-08.

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

Using the results of the most recent Saint Lucie Unit 2 PSA and including ISLOCA and SGTR sequences, the failure frequency for this class is 5.88E-6 / year.

$$\mathbf{F_{Class\ 8} = 5.88E\text{-}6\ /\ year}$$

For Saint Lucie Unit 2, the bypass leakages are based on an unmitigated bypass release of 100% of the core inventory of Noble Gases and 40% of the Iodine.

Table D2-2 provides a summary of the Saint Lucie Unit 2 Release Class frequencies and the assumed leakage for each Class.

Table D2-2
Saint Lucie Unit 2 Mean Containment Frequencies (from the PSA) and Representative Releases

Class	Description	Frequency (per Rx-year)	Estimated Leakage
1	No Containment Failure	1.58E-05	L_a
2	Large Containment Isolation Failures (failure-to-close)	1.63E-08	100 wt%/day
3A	Small Pre-existing Containment Leak	4.56E-07	25 L_a
3B	Large Pre-existing Containment Leak	2.74E-09	100 wt%/day
4	Small isolation failure - failure-to-seal (Type B test)	Not Analyzed	N/A
5	Small isolation failure - failure-to-seal (Type C test)	Not Analyzed	N/A
6	Containment Isolation Failures (dependent failures, personnel errors)	0.00E+00	35 wt%/day
7	Severe Accident Phenomena Induced Failure (early and late failures)	2.17E-06	280 wt%/day
8	Containment Bypassed (SGTR / ISLOCA)	5.88E-06	See Class 8 description, above
Total	All CET Endstates	2.44E-05	

D2.2.2 Saint Lucie Unit 2 population dose per reactor year

Plant-specific release analysis was performed for Saint Lucie Unit 2 to evaluate the doses to the population, within a 50-mile radius from the plant. The releases for Classes 1 through 7 are based on post large Loss of Coolant Accident (LOCA) as shown in Table D2-3 and the releases for Class 8 events are based on Bypass events as shown in Table D2-4. These tables tabulate the whole body population dose within 50 miles. Calculations were performed using RADTRAD Version 3 (Reference D-5) assuming a containment source term equivalent to TID-14844. Intact containment release computations were validated via comparisons with Saint Lucie Unit 2 FSAR results (Reference D-1).

LBLOCA dose models with defined leakages are assumed to be representative for all containment leakage release classes. Bypass releases based on iodine and noble gas releases are identified in the IPE study for the dominant sequence. Population estimates are based on Saint Lucie Unit 2 projections to 2025. Atmospheric dispersions are based on mean weather data obtained at the plant site and reported in the plant updated FSAR (Reference D-4).

Table D2-3
Saint Lucie Unit 2 Population Dose – LOCA

Saint Lucie Doses and Population Doses due to LOCA			
		Doses (rem)	Doses (person - rem)
Zone (miles)	Population	Containment Leakage Events (based on leakage of 1 L_a)	Containment Leakage Events (based on leakage of 1 L_a)
0-1	0	7.40E+00	0.00E+00
1-2	475	4.71E+00	2.24E+03
2-5	29668	1.27E+00	3.77E+04
5-10	217819	3.72E-01	8.11E+04
10-15	125715	1.72E-01	2.16E+04
15-20	84166	9.53E-02	8.02E+03
20-30	172091	6.03E-02	1.04E+04
30-40	227718	3.77E-02	8.58E+03
40-50	533595	2.69E-02	1.44E+04
Totals	**1391247**		**1.84E+05**

Table D2-4
Saint Lucie Unit 2 Population Dose – Bypass Events

Saint Lucie Unit 2 Doses and Population Doses due to Bypass Events			
		Doses (rem)	Doses (person - rem)
Zone (miles)	Population	Bypass Events	Bypass Events
0-1	0	5.60E+03	0.00E+00
1-2	475	3.57E+03	1.69E+06
2-5	29668	9.61E+02	2.85E+07
5-10	217819	2.81E+02	6.12E+07
10-15	125715	1.29E+02	1.63E+07
15-20	84166	7.19E+01	6.05E+06
20-30	172091	4.55E+01	7.83E+06
30-40	227718	2.83E+01	6.45E+06
40-50	533595	2.02E+01	1.08E+07
Totals	**1391247**		**1.39E+08**

The population dose, out to 50 miles is determined based on the design-basis normal containment leak rate of 0.5% /day, and is 1.84E+05 person-rem per event. Since the containment release pathways are generally the same for containment Classes 1 through 7, the population doses are directly proportional to the ratio of the leakage rate to that of the intact nominal leakage case (Class 1). Therefore, the Class 2 through 7 leakage related doses are ratioed upwards to account for the increased leakages associated with event Classes 2 through 7. Classes 1 through 8 leakages and doses are summarized in Table D2-5.

Table D2-5
Saint Lucie Unit 2 Containment Leakage Rate and Dose – for Accident Classes

Class	Description	Leakage (wt%/day)	Release (50 miles) (person-rem)	Basis
1	No Containment Failure	0.5 (L_a)	1.84E+05	See Table D2-2
2	Large Containment Isolation Failures (failure-to-close)	100	3.68E+07	Ratio from class 1 baseline
3A	Small Isolation Failures (containment leak)	12.5 (25 L_a)	4.60E+06	Ratio from class 1 baseline
3B	Large Isolation Failures (containment leak)	100	3.68E+07	Ratio from class 1 baseline
4	Small isolation failure - failure-to-seal (Type B test)	Not analyzed	NA	Ratio from class 1 baseline
5	Small isolation failure - failure-to-seal (Type C test)	Not analyzed	NA	Ratio from class 1 baseline
6	Containment Isolation Failures (dependent failures, personnel errors)	35	1.29E+07	Ratio from class 1 baseline
7	Severe Accident Phenomena Induced Failure (early and late failures)	280	1.03E+08	Ratio from class 1 baseline
8	Containment Bypassed (SGTR / ISLOCA)	-	1.39E+08	No credit for containment. (See Class 8 description)

The above results when combined with the frequencies presented in Table D2-2 yields the Saint Lucie Unit 2 baseline mean consequence measures (risks, in terms of person-rem/yr) for each accident class. The resulting risks (in terms of person-rem/yr), for each accident class, are presented in Table D2-6 below.

Table D2-6
Saint Lucie Unit 2 Mean Baseline Risk - for Accident Classes

Class	Description	Frequency (per Rx-yr)	Person-Rem (50-Miles)	Person-Rem/yr (50-Miles)
1	No Containment Failure	1.58E-05	1.84E+05	2.91E+00
2	Large Isolation Failures (failure to close)	1.63E-08	3.68E+07	6.00E-01
3A	Small Pre-existing Containment Leak	4.56E-07	4.60E+06	2.10E+00
3B	Large Pre-existing Containment Leak	2.74E-09	3.68E+07	1.01E-01
4	Small Isolation Failure to Seal (Type B Test)	Not Analyzed	NA	N/A
5	Small Isolation Failure to Seal (Type C Test)	Not Analyzed	NA	N/A
6	Other Isolation Failures (e.g., dependent failures)	0.00E+00	1.29E+07	0.00E+00
7	Failure Induced by Phenomena (early and late failures)	2.17E-06	1.03E+08	2.24E+02
8	Bypass (SGTR / ISLOCA)	5.88E-06	1.39E+08	8.17E+02
Total	All CET End States	2.44E-05	N/A	1046.21

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

$$\%Risk_{BASE} = [(Risk_{Class\ 1\ BASE} + Risk_{Class\ 3A\ BASE} + Risk_{Class\ 3B\ BASE}) / Total_{BASE}] \times 100$$

Where:

$Risk_{Class\ 1\ BASE}$ = Class 1 person-rem/yr = 2.91E+0 person-rem/yr [Table D2-6]

$Risk_{Class\ 3A\ BASE}$ = Class 3A person-rem/yr = 2.10E+0 person-rem/yr [Table D2-6]

$Risk_{Class\ 3B\ BASE}$ = Class 3B person-rem/yr = 1.01E-1 person-rem/yr [Table D2-6]

$Total_{BASE}$ = total dose/year for baseline interval = 1046.21 person-rem/year [Table D2-6]

$$\%Risk_{BASE} = [(2.91E+0 + 2.10E+0 + 1.01E-1) / 1046.21] \times 100$$

$$\mathbf{\%Risk_{BASE} = 0.49\ \%}$$

Therefore, the total baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.49 %.

D2.2.3 Risk Impact of Extending Type A Test Interval From 10 To 15 And 20 Years

Using the methodology described in the main report that was used above to determine baseline risk values (see Table D2-6), the risk values were determined for the Current 10 year ILRT test interval, a 15 year ILRT test interval, and a 20 year ILRT test interval. These risk values are presented below in Table D2-7.

Table D2-7
Saint Lucie Unit 2 Risk Values vs ILRT Interval (Person-Rem/yr to 50-Miles)

Class	Description	Current 10 year ILRT interval	15 year ILRT interval	20 year ILRT interval
1	No Containment Failure	2.75E+00	2.62E+00	2.49E+00
2	Large Isolation Failures (failure to close)	6.00E-01	6.00E-01	6.00E-01
3A	Small Pre-existing Containment Leak	6.30E+00	9.45E+00	1.26E+01
3B	Large Pre-existing Containment Leak	3.02E-01	4.53E-01	6.05E-01
4	Small Isolation Failure to Seal (Type B Test)	N/A	N/A	N/A
5	Small Isolation Failure to Seal (Type C Test)	N/A	N/A	N/A
6	Other Isolation Failures (e.g., dependent failures)	0.00E+00	0.00E+00	0.00E+00
7	Failure Induced by Phenomena (early and late failures)	2.24E+02	2.24E+02	2.24E+02
8	Bypass (SGTR/ISLOCA)	8.17E+02	8.17E+02	8.17E+02
Total	All CET End States	1050.45	1053.62	1056.79

Based on the above values, and using the methodology described in the main report, the percent risk contribution ($\%Risk_N$, for values of N of 10, 15 and 20 years) for Class 1 and Class 3 is determined and yields the results summarized in Table D2-8, below. Also, the percent change in risk due to ILRT interval extensions is determined and presented in Table D2-8.

Table D2-8
Saint Lucie Unit 2 Percent Risk Increases from ILRT Interval Extensions

	Description	Current 10 year ILRT interval	15 year ILRT interval	20 year ILRT interval
$\%Risk_N$	Percent risk contribution for Class 1 and Class 3	0.89%	1.19%	1.49%
$\Delta\%Risk_{Base\ to\ N}$	Percent increase in total risk due to an N-year ILRT over the baseline case	0.40%	N/A	N/A
$\Delta\%Risk_{10\text{-}N}$	Percent increase in risk due to an N-year ILRT over the 10 year case	N/A	0.30%	0.60%

D2.2.4 Change In Risk In Terms Of Large Early Release Frequency (LERF)

Section 5.2.4 of the main body of this report discusses the quantification of LERF. This analysis assumes that Class 2, 3B, 6, 7 and 8 lead to large leak rates. The baseline LERF frequency, for the 3 in 10-year inspection interval, is determined as shown in Table D2-9. The estimate for Class 7 includes only the portion of Class 7 identified in the PSA as representing early containment failure.

Table D2-9
Saint Lucie Unit 2 Baseline LERF Frequency Calculation

Class	Description	LERF
2	Large Isolation Failures (failure to close)	1.63E-08
3B	Large Pre-existing Containment Leak	2.74E-09
6	Other Isolation Failures (e.g., dependent failures)	0.00E+00
7 (Early)	Failure Induced by Phenomena (early failures)	2.91E-08
8	Bypass (SGTR / ISLOCA)	5.88E-06
LERF	(total)	**5.925E-06**

Impact of ILRT Test Interval Extensions on Large Early Release Frequency (LERF)

Table D2-10 presents the frequencies for each large release class, for each of four ILRT intervals. The total LERFs are also listed, along with the increase in LERF from the current LERF, and the percent increase from the current LERF.

As the only class contributor to the change in large early release is due to Class 3B events, the $\Delta LERF = F_{Class\ 3B}$ (evaluated at the new inspection interval) – $F_{Class\ 3B}$ (of the baseline interval or the current interval, as appropriate).

The percent change in LERF is calculated as:

$$\%\Delta LERF = [\Delta LERF/LERF_{Total}] \times 100$$

Where:
$LERF_{Total}$ = The sum of the Frequencies of Sequences 2, 3B, 6,8, and the "early" portion of Class 7, (2.91E-8).

Table D2-10
Saint Lucie Unit 2 LERF Variation as a Function of Change in Inspection Interval

Class	Description	3 per 10 Years	10 Years	15 Years	20 Years
2	Large Isolation Failures (failure to close)	1.63E-08	1.63E-08	1.63E-08	1.63E-08
3B	Large Pre-existing Containment Leak	2.74E-09	8.22E-09	1.23E-08	1.64E-08
6	Other Isolation Failures (e.g., dependent failures)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7 (Early)	Failure Induced by Phenomena (early failures)	2.91E-08	2.91E-08	2.91E-08	2.91E-08
8	Bypass (SGTR/ISLOCA)	5.88E-06	5.88E-06	5.88E-06	5.88E-06
LERF	Total	**5.925E-06**	**5.931E-06**	**5.935E-06**	**5.939E-06**
ΔLERF	Increase from Current LERF	N/A	0.0	4.108E-9	8.215E-9
%ΔLERF	% Increase from Current LERF	N/A	0.0%	0.07%	0.14%

D3.0 SUMMARY OF RESULTS

Baseline ILRT Interval Results (For this evaluation, the baseline risk contribution is taken as the original inspection interval at the time that the IPE was done; that is, three inspections per 10 year interval)

1. The baseline risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.49 % of total risk.

2. The baseline LERF is 5.925E-06 per year.

Ten Year ILRT Interval Results

1. The current Type A 10-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 0.89 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the baseline interval to current 10 year interval is 0.40 %.

3. The LERF with a 10-year ILRT interval is 5.931E-06 per year.

4. The increase in LERF from extending the ILRT test interval from the baseline interval to the current 10-year interval is 5.477E-9 per year.

5. The % increase in LERF from extending the ILRT test interval from the baseline interval to 10 years is 0.09 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.09 %) in conditional containment unreliability.

Fifteen Year ILRT Interval Results

1. Type A 15-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 1.19 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the current 10 year interval to 15 years is 0.30 %.

3. The LERF for the 15-year interval is 5.935E-06 per year.

4. The increase in LERF from extending the ILRT test interval from the 10-year interval to 15 years is 4.108E-9 per year.

5. The % increase in LERF from extending the ILRT test interval from the 10 year interval to 15 years is 0.07 %. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.07 %) in conditional containment unreliability.

Twenty Year ILRT Interval Results

1. Type A 20-year ILRT interval risk contribution of leakage, represented by Class 1 and Class 3 accident scenarios is 1.49 % of total risk.

2. The increase in total risk from extending the ILRT test interval from the current 10 year interval to 20 years is 0.60 %.

3. The LERF for the 20-year interval is 5.939E-06 per year.

4. The increase in LERF from extending the ILRT test interval from the 10-year interval to 20 years is 8.215E-9 per year.

5. The % increase in LERF from extending the ILRT test interval from the 10 year interval to 20 years is 0.14%. Since the CDF is not changed as a result of the extended ILRT interval, the increase in LERF is due only to the small increase (0.14 %) in conditional containment unreliability.

D4.0 REFERENCES

D-1. Saint Lucie Individual Plant Examination, FPL, July 19, 1993.

D-2. NEI 94-01, Revision 0 "Industry Guideline for Implementing Performance-Based Option of 10 CFR Part 50," Appendix J, July 26, 1995.

D-3. EPRI TR-104285, "Risk Assessment of Revised Containment Leak Rate Testing Intervals," August 1994.

D-4. Saint Lucie Unit 2 UFSAR, FPL, Amendment 13.

D-5. NUREG/CR-6604, Supplement 1, RADTRAD: A Simplified Model for RADionuclide Transport And Dose estimation, SNL, Bixler, N.E. et al, June 1999.

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