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July 19, 2001
CEOG-01-184

NRC Project 692

Document Control Desk
US Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: Request for Review of CE Owners Group Report WCAP-15691, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," dated July 2001 (PROPRIETARY INFORMATION)

The purpose of this letter is to request formal NRC staff review and approval to extend the Type A containment integrated test interval as documented in the enclosed CEOG report WCAP-15691, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension." Three (3) bound copies of the proprietary report (WCAP-15691) and three (3) bound copies of the non-proprietary report (WCAP-15715) are enclosed for staff review. In addition, one unbound copy of the proprietary and the non-proprietary report are provided for entry into ADAMS.

Westinghouse has determined that the information contained in WCAP-15691 is proprietary in nature. It is requested that this information be withheld from public disclosure in accordance with the provisions of 10 CFR 2.790 and be appropriately safeguarded. The reasons for the classification of this information as proprietary are delineated in the enclosed affidavit.

The NRC should address any technical questions and invoices for review fees related to this report to Mr. Gordon Bischoff, CE Owners Group Project Office, with a copy to me. 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 (Proprietary Class 2)
WCAP-15715 (Non-proprietary Class 3)
Proprietary Affidavit

D047 1/4 prop. + non-prop.

3 copies of prop + NP sent to John Cushing

cc: Gordon Bischoff, Westinghouse (w/o attach)
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I, Philip W. Richardson, depose and say that I am the Licensing Project Manager of Westinghouse Electric Company, LLC (Westinghouse), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and described below.

I am submitting this affidavit in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations for withholding this information. I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged, or as confidential commercial or financial information.

The information for which proprietary treatment is sought, and which document has been appropriately designated as proprietary, is contained in the following:

- *WCAP-15691, "Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension," dated July 2001.*

Pursuant to the provisions of Section 2.790(b)(4) of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information included in the document listed above should be withheld from public disclosure.

i. The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse. It consists of risk-informed methodology and probabilistic data for justifying modifications to the containment integrated leak rate test interval.

ii. The information consists of test data or other similar data concerning a process, method or component, the application of which results in substantial competitive advantage to Westinghouse.

iii. The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public.

iv. The information is being transmitted to the Commission in confidence pursuant to 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.

v. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.

vi. Public disclosure of the information is likely to cause substantial harm to the competitive position of Westinghouse because:

   a. A similar product is manufactured and sold by major competitors of Westinghouse.

   b. Development of this information by Westinghouse required tens of thousands of dollars and hundreds of manhours of effort. In order to acquire equivalent information, a competitor would need to invest considerable time, expense and inconvenience to develop, verify and secure regulatory approval of the subject methodology.

   c. The information consists of methodology and evaluation results, the application of which provides Westinghouse a competitive economic advantage. The availability of such information to competitors would enable them to design their product to better compete with Westinghouse, take marketing or other actions to improve their product's position or impair the position of Westinghouse's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.

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e. Use of the information by competitors in the international marketplace would increase their ability to market services by reducing the costs associated with their technology development. In addition, disclosure would have an adverse economic impact on Westinghouse's potential for obtaining or maintaining foreign licenses.

Philip W. Richardson
Licensing Project Manager

Sworn to before me this 17th day of July 2001.

Joan C. Hastings
Notary Public

My Commission expires: JOAN C. HASTINGS
NOTARY PUBLIC
MY COMMISSION EXPIRES SEP 30, 2002

CEOG COMBUSTION ENGINEERING OWNERS GROUP

WCAP-15715
Rev. 00
July 2001

Joint Applications Report for Containment Integrated Leak Rate Test Interval Extension

CEOG Task 2027

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WCAP 15715, Rev. 00

Joint Applications Report
for
Containment Integrated Leak Rate Test Interval Extension

CEOG Task 2027

July 2001

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LIST OF ACRONYMS

ASME	American Society of Mechanical Engineers
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

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).

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.

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.

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.

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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.

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:

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.

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.

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.).

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.

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

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

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.

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

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	Note 2	Note 2

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.

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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.

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

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).

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 vs 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)

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)

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 (%ΔRisk$_N$) due to an N-year ILRT over the baseline case is as follows:

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

Table 5-8 shows %ΔRisk$_N$ as a function of ILRT interval for various plants. %ΔRisk 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

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.

<u>Quantification of LERF</u>

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.

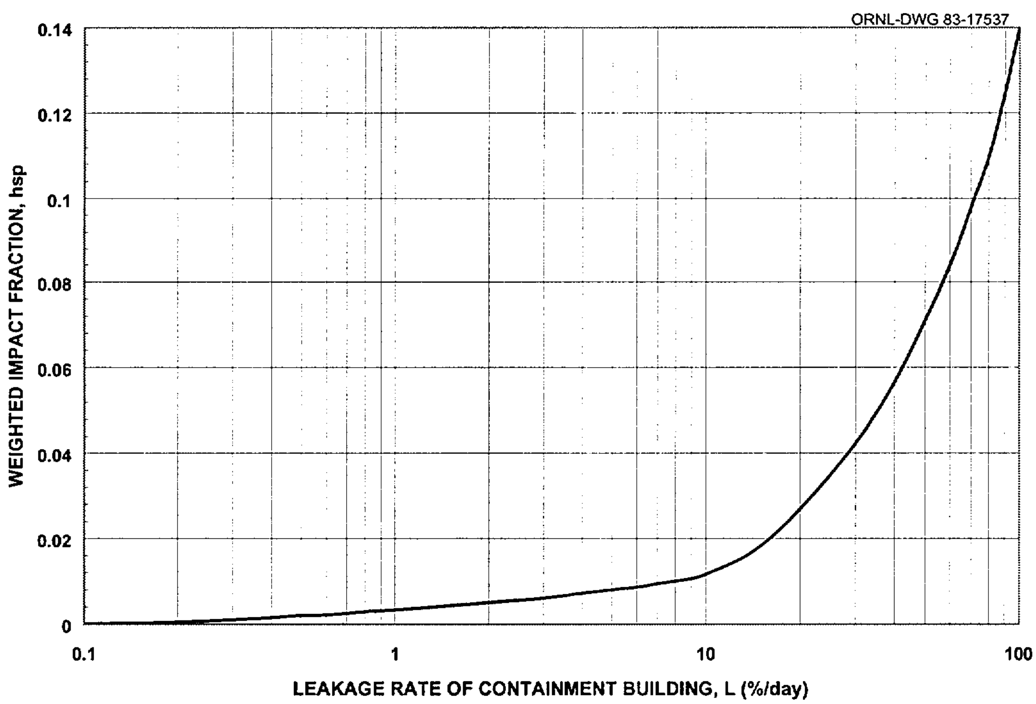
Type A tests have typically been used in the past to identify containment leaks that are on the order of the diameter of a quarter inch or less. An approximate assessment of the effect of containment leak size on the containment leak rate is presented in Figure 5-1. The assessment assumes that leakage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

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.

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.

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

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

Class	Description	LERF (per year)		

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

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

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

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, 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.

APPENDIX A

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

TABLE OF CONTENTS

LIST OF TABLES

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.

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:

<u>Class 3 Sequences:</u> 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.

Probability of Type A Leakage for a Given Test Interval

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

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:

<u>Class 7 Sequences:</u> 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).

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

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

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 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

Table A2-4
WSES Population Dose – Bypass Events

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

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

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:

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

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)

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%
$\Delta\%Risk_{\text{Base to N}}$	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 3 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

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.

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

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.

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