December 5, 2007

Mr. John C. Butler, Director
Safety Focused Regulation, Nuclear Generation Division
Nuclear Energy Institute
Suite 400
1776 I Street, NW
Washington, DC 20006-3708

SUBJECT: DRAFT SAFETY EVALUATION FOR NUCLEAR ENERGY INSTITUTE (NEI) TOPICAL REPORT (TR) 94-01, REVISION 2, "INDUSTRY GUIDELINE FOR IMPLEMENTING PERFORMANCE-BASED OPTION OF 10 CFR PART 50, APPENDIX J" AND ELECTRIC POWER RESEARCH INSTITUTE (EPRI) REPORT NO. 1009325, REVISION 2, AUGUST 2007, "RISK IMPACT ASSESSMENT OF EXTENDED INTEGRATED LEAK RATE TESTING INTERVALS" (TAC NO. MC9663)

Dear Mr. Butler:

By letter dated December 19, 2005, NEI submitted TR 94-01, Revision 1j, "Industry Guideline For Implementing Performance-Based Option of 10 CFR Part 50, Appendix J," and Electric Power Research Institute (EPRI) Report No. 1009325, Revision 1, December 2005, "Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals," to the U.S. Nuclear Regulatory Commission (NRC) staff for review. By letter dated February 21, 2007, the NRC staff issued a Request for Additional Information (RAI). By letter dated May 25, 2007, the RAI responses were submitted to the NRC. As a result of the RAI, both the NEI and EPRI reports were revised to address NRC staff comments and recommendations. By letter dated August 31, 2007, NEI submitted TR 94-01, Revision 2, "Industry Guideline For Implementing Performance-Based Option of 10 CFR Part 50, Appendix J," and EPRI Report No. 1009325, Revision 2, August 2007, "Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals," to the NRC staff for review. Enclosed for NEI review and comment is a copy of the NRC staff's draft safety evaluation (SE) for the TR.

Twenty working days are provided to you to comment on any factual errors or clarity concerns contained in the SE. The final SE will be issued after making any necessary changes and will be made publicly available. The NRC staff's disposition of your comments on the draft SE will be discussed in the final SE.

To facilitate the NRC staff's review of your comments, please provide a marked-up copy of the draft SE showing proposed changes and provide a summary table of the proposed changes.

If you have any questions, please contact Jon Thompson at 301-415-1119.

Sincerely,

/RA/

Stacey L. Rosenberg, Chief
Special Projects Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 689

Enclosure: Draft SE

cc w/encl: See next page

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OFFICE	PSPB/PM	PSPB/LA	SCVB/BC*	APLA/BC*	EMCB/BC*	RES/PRAB*	PSPB/BC
NAME	JThompson	DBaxley	BDennig	MRubin	KManoly	MCheok	SRosenberg
DATE	11/27/07	11/27/07	10/03/07	9/26/07	10/18/07	10/19/07	12/05/07

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cc:

Mr. Anthony Pietrangelo, Vice President
Regulatory Affairs
Nuclear Energy Institute
1776 I Street, NW, Suite 400
Washington, DC 20006-3708
arp@nei.org

Mr. Jack Roe, Director
Operations Support
Nuclear Energy Institute
1776 I Street, NW, Suite 400
Washington, DC 20006-3708
jwr@nei.org

Mr. Charles B. Brinkman
Washington Operations
ABB-Combustion Engineering, Inc.
12300 Twinbrook Parkway, Suite 330
Rockville, MD 20852
brinkmcb@westinghouse.com

Mr. Gary L. Vine, Executive Director
Federal and Industry Activities, Nuclear Sector
EPRI
2000 L Street, NW, Suite 805
Washington, DC 20036
gvine@epri.com

Mr. James Gresham, Manager
Regulatory Compliance and Plant Licensing
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355
greshaja@westinghouse.com

Ms. Barbara Lewis
Assistant Editor
Platts, Principal Editorial Office
1200 G St., N.W., Suite 1100
Washington, DC 20005
Barbara_lewis@platts.com

Mr. Alexander Marion, Executive Director
Nuclear Operations & Engineering
Nuclear Energy Institute
1776 I Street, NW, Suite 400
Washington, DC 20006-3708
am@nei.org

Mr. Jay Thayer, Vice President
Nuclear Operations
Nuclear Energy Institute
1776 I Street, NW, Suite 400
Washington, DC 20006-3708
jkt@nei.org

Mr. John Butler, Director
Safety-Focused Regulation
Nuclear Energy Institute
1776 I Street, NW, Suite 400
Washington, DC 20006-3708
jcb@nei.org

Mike Melton, Senior Project Manager
1776 I Street, NW, Suite 400
Washington, DC 20006-3708
man@nei.org

DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

NUCLEAR ENERGY INSTITUTE (NEI) TOPICAL REPORT (TR) 94-01, REVISION 2,

"INDUSTRY GUIDELINE FOR IMPLEMENTING

PERFORMANCE-BASED OPTION OF 10 CFR PART 50, APPENDIX J" AND

ELECTRIC POWER RESEARCH INSTITUTE (EPRI) REPORT NO. 1009325, REVISION 2,

AUGUST 2007, "RISK IMPACT ASSESSMENT OF EXTENDED

INTEGRATED LEAK RATE TESTING INTERVALS"

NUCLEAR ENERGY INSTITUTE

PROJECT NO. 689

1.0 INTRODUCTION AND BACKGROUND

In 1995, the U.S. Nuclear Regulatory Commission (NRC) amended Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix J, "Primary Reactor Containment Leakage Testing For Water-Cooled Power Reactors," to provide a performance-based Option B for the containment leakage testing requirements. Option B requires that test intervals for Type A, Type B, and Type C testing be determined by using a performance-based approach. Performance-based test intervals are based on consideration of the operating history of the component and resulting risk from its failure. The use of the term "performance-based" in Appendix J to 10 CFR Part 50 refers to both the performance history necessary to extend test intervals as well as to the criteria necessary to meet the requirements of Option B.

Type A tests focus on verifying the leakage integrity of a passive containment structure. Type B and C testing focus on assuring that containment penetrations are essentially leak tight. These tests collectively satisfy the requirements of 10 CFR Part 50, Appendix J, Option B as stated in the Introduction section to this Appendix:

> The purposes of the tests are to assure that (a) leakage through the primary reactor containment and systems and components penetrating primary containment shall not exceed allowable leakage rate values as specified in the technical specifications (TSs) or associated bases; and (b) periodic surveillance of reactor containment penetrations and isolation valves is performed so that proper maintenance and repairs are made during the service life of the containment, and systems and components penetrating primary containment.

ENCLOSURE

In 1995, Regulatory Guide (RG) 1.163, "Performance-Based Containment Leak-Test Program" (Reference 1), was developed that endorsed the NEI TR 94-01, Revision 0, "Industry Guideline for Implementing Performance-Based Option of 10 CFR Part 50, Appendix J" (Reference 2), with certain modifications and additions. Option B, in concert with RG 1.163 and NEI TR 94-01, Revision 0, allows licensees with a satisfactory integrated leak rate testing (ILRT) performance history (i.e., two consecutive, successful Type A tests) to reduce the test frequency for the Type A containment ILRT from three tests in 10 years to one test in 10 years. This relaxation was based on an NRC risk assessment contained in NUREG-1493, "Performance-Based Containment Leak-Test Program (Reference 3)," and the EPRI document TR-104285, "Risk Impact Assessment of Revised Containment Leak Rate Testing Intervals" (Reference 4), both of which showed that the risk increase associated with extending the ILRT surveillance interval was very small.

In 2001, the NEI initiated a project to justify further reduction of the ILRT test frequency from one test in 10 years to as low as one test in 20 years based on performance history and risk insights. In view of the time required to develop, approve, and promulgate generic guidance material, the NEI tasked the EPRI to develop interim guidance to licensees for developing uniform risk assessments supporting one-time extensions of the ILRT surveillance interval to 15 years (i.e., a test frequency of one test in 15 years). The NEI disseminated the interim guidance/methodology to licensees in November 2001 (References 5 and 6). This methodology has been subsequently used by licensees as the technical basis to support risk-informed, performance-based, one-time ILRT interval extensions to 15 years at approximately 75 operating reactors.

In December 2003, the NEI submitted draft NEI TR 94-01, Revision 1j, and EPRI Report No. 1009325, Revision 0, to support an industry effort to extend the ILRT surveillance interval to 20 years. The technical basis for the 20-year extension relied heavily on the use of new containment leakage probability values developed through an expert elicitation conducted by EPRI. Following the NRC staff's identification of a number of concerns regarding the expert elicitation, EPRI subsequently withdrew EPRI Report No. 1009325, Revision 0. Section 3.2 of this safety evaluation (SE) provides additional NRC staff discussion regarding the expert elicitation conducted by EPRI.

By letter dated December 19, 2005, the NEI submitted NEI TR 94-01, Revision 1j, "Industry Guideline for Implementing Performance-Based Option of 10 CFR Part 50, Appendix J" and EPRI Report No. 1009325, Revision 1, December 2005, "Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals" (Reference 7) for NRC staff review. EPRI Report No. 1009325, Revision 1, provides a generic assessment of the risks associated with a more limited, permanent extension of the ILRT surveillance interval to 15 years, and a risk-informed methodology/template to be used by licensees to confirm the risk impact of the ILRT extension on a plant-specific basis. The methodology is substantially similar to the NEI interim guidance/methodology, with minor enhancements to reflect experience from the analyses and reviews of one-time ILRT extensions and to reflect additional leak rate data from 35 recently completed ILRTs.

By letter dated February 21, 2007 (Reference 8), the NRC staff submitted a request for additional information (RAI) identifying information needed to continue the review. By letter dated May 25, 2007 (Reference 9), the NEI submitted its RAI responses. As a result of the RAI responses, NEI TR 94-01, Revision 1j, and EPRI Report No. 1009325, Revision 1, were revised to address NRC staff comments and recommendations. By letter dated August 31, 2007, the NEI submitted TR 94-01, Revision 2, "Industry Guideline For Implementing Performance-Based

Option of 10 CFR Part 50, Appendix J," and EPRI Report No. 1009325, Revision 2, August 2007, "Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals" (Reference 10), to the NRC staff for review.

NEI TR 94-01, Revision 2, describes an approach for implementing the optional performance-based requirements of Option B described in 10 CFR Part 50, Appendix J, which includes provisions for extending Type A ILRT intervals to up to 15 years and incorporates the regulatory positions stated in RG 1.163. It delineates a performance-based approach for determining Type A, Type B, and Type C containment leakage rate surveillance testing frequencies. This method uses industry performance data, plant-specific performance data, and risk insights in determining the appropriate testing frequency. NEI TR 94-01, Revision 2, also discusses the performance factors that licensees must consider in determining test intervals. However, it does not address how to perform the tests because these details can be found in existing documents (e.g., ANSI/ANS-56.8-2002) (Reference 11).

EPRI Report No. 1009325, Revision 2, provides a risk impact assessment for optimized ILRT intervals of up to 15 years, utilizing current industry performance data and risk-informed guidance, primarily Revision 1 of RG 1.174, "An Approach for using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (Reference 12).

This SE documents the NRC staff's evaluation and acceptance of NEI TR 94-01, Revision 2, and EPRI Report No. 1009325, Revision 2, subject to the limitations and conditions identified in this SE and summarized in Section 4.0.

NEI TR 94-01, Revision 2, includes provisions related to permanently extending the ILRT surveillance interval to 15 years and incorporates the regulatory positions stated in RG 1.163, "Performance-Based Containment Leak-Test Program." Section 3.1 of this SE provides the NRC staff position on the adequacy of NEI TR 94-01, Revision 2, in addressing the performance-based Type A, Type B, and Type C test frequencies. It also addresses the adequacy of pre-test inspections, procedures to be used after major modifications to the containment structure, deferral of tests beyond 15 years interval, and the relation of containment in-service inspection requirements mandated by 10 CFR 50.55a to the containment leak rate testing requirement.

With regard to EPRI Report No. 1009325, Revision 2, Section 3.2 of this SE provides the NRC staff's evaluation of the methodology for assessing the plant-specific risk of permanently extending the ILRT surveillance interval to 15 years.

2.0 REGULATORY EVALUATION

2.1 Applicable Regulations

The regulation at 10 CFR 50.54(o), requires primary reactor containments for water-cooled power reactors to be subject to the requirements of Appendix J to 10 CFR Part 50, "Leakage Rate Testing of Containment of Water Cooled Nuclear Power Plants." Appendix J specifies containment leakage testing requirements, including the types of tests required to ensure the leak-tight integrity of the primary reactor containment and systems and components which penetrate the containment. In addition, Appendix J discusses leakage rate acceptance criteria, test methodology, frequency of testing, and reporting requirements for each type of test.

In the context of Option B, the TS associated with ensuring the leak-tight integrity of containment must adequately address the risk-informed criteria described in Section 2.2 of this SE, as well as the deterministic implementation provisions that are necessary to ensure that the associated hardware components are properly monitored and maintained during the interval.

NEI TR 94-01, Revision 2, provides guidance for implementing the Appendix J performance-based requirements and incorporates, by reference, the provisions of ANSI/ANS-56.8-2002 and the requirements of Subsections IWE and IWL of Section XI of the American Society of Mechanical Engineers (ASME) Boiler & Pressure Vessel Code (Code) (References 13 and 14). The ASME Code requirements are incorporated by reference in 10 CFR 50.55a, with modifications and limitations. The modifications and limitations vary in accordance with the edition and the addenda of the ASME Code as required by 10 CFR 50.55a.

2.2 Applicable Regulatory Criteria/Guidelines

As discussed in Section 1.0 of this SE, RG 1.163 was developed in 1995 to endorse NEI TR 94-01, Revision 0, with certain modifications and additions.

General guidance for evaluating the technical basis of proposed risk-informed changes is provided in RG 1.174 and Section 19.2 of the NRC Standard Review Plan (SRP) (Reference 15). More specific guidance related to risk-informed TS changes is provided in RG 1.177, “An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications” (Reference 16) and Section 16.1 of the SRP. RG 1.174 and SRP Section 19.2 state:

> For each risk-informed application, reviewers should ensure that the proposed changes meet the following principles. (Subsections of this SRP section dealing with review guidance for each principle are identified in brackets).
>
> 1. The proposed change meets the current regulations unless it is explicitly related to a requested exemption, i.e., a "specific exemption" under 10 CFR 50.12. [Subsection III.2.1].
>
> 2. The proposed change is consistent with the defense-in-depth philosophy. [Subsection III.2.1].
>
> 3. The proposed change maintains sufficient safety margins. [Subsection III.2.1].
>
> 4. When proposed changes result in an increase in core damage frequency (CDF) or risk, the increases should be small and consistent with the intent of the Commission’s safety Goal Policy Statement (60 FR 42622). [Subsections III.2.2 and III.2.3].
>
> 5. The impact of the proposed change should be monitored using performance measurement strategies. [Subsection III.3].

In addition, RG 1.177, Section 2.3.1 and parallel language in SRP Section 16.1 state in part that:

> The quality of the PRA [Probabilistic Risk Assessment] must be compatible with to the safety implications of the TS change being requested and the role that the PRA plays in justifying that change.

SRP Section 19.1 provides guidance for determining the technical adequacy of PRA results for risk-informed activities.

The NRC staff considered this guidance in assessing the methodology contained in EPRI Report No. 1009325, Revision 2.

3.0 <u>TECHNICAL EVALUATION</u>

3.1 NRC Staff Evaluation of NEI TR 94-01, Revision 2

The purpose of NEI TR 94-01, Revision 2, is to assist licensees in the implementation of Option B to 10 CFR Part 50, Appendix J, and in extending Type A ILRT intervals beyond 10 years. Specifically, NEI TR 94-01, Revision 2, includes guidance that would permit the licensees to permanently extend the ILRT surveillance interval to 15 years and incorporates the regulatory positions stated in RG 1.163. It delineates a performance-based approach for determining Type A, Type B, and Type C containment leakage rate testing frequencies.

The reactor containment leakage test program includes performance of an ILRT, also termed as a Type A test; and performance of Local Leakage Rate Tests (LLRTs), also termed as either Type B or Type C tests. The Type A test measures the overall leakage rate of the primary reactor containment. Type B tests are intended to detect leakage paths and measure leakage rates for primary reactor containment penetrations. Type C tests are intended to measure containment isolation valve leakage rates.

Sections 3.1.1 through 3.1.4 of this SE provide the NRC staff's evaluation of the adequacy of NEI TR 94-01, Revision 2, for addressing the performance-based Type A, Type B, and Type C test frequencies. Sections 3.1.1 through 3.1.4 also address the adequacy of pre-test inspections, procedures to be used after major modifications have been made to the containment structure, deferral of tests beyond a 15 years interval, and the relationship of containment in-service inspection requirements as mandated by 10 CFR 50.55a to the containment leak rate testing requirement.

3.1.1 Performance-Based Type A Test (ILRT) Frequencies

NEI TR 94-01, Revision 2, states that, "Type A, Type B, and Type C tests should be performed using the technical methods and techniques specified in ANSI/ANS-56.8-2002, or other alternative testing methods that have been approved by the NRC staff." The NRC staff agrees with the methodology used in ANSI/ANS-56.8-2002 and accepts this as a reference for how licensees should perform the tests.

3.1.1.1 Type A Performance Leakage Rate

Determination of the surveillance frequency of Type A tests is based upon satisfactory performance of leakage tests that meet the requirements of Appendix J to 10 CFR Part 50. The use of the term "performance" refers to both the performance history necessary to determine future test intervals as well as the overall criteria needed to demonstrate leakage integrity. The performance leakage rate can also used as a basis for demonstrating the impact on public health and safety.

Section 5.0 of NEI TR 94-01, Revision 2, uses a definition of "performance leakage rate" for Type A tests that is different from that of ANSI/ANS-56.8-2002 (Reference 11). The definition contained in NEI TR 94-01, Revision 2, is more inclusive because it considers excessive leakage in the performance determination. In defining the minimum pathway leakage rate, NEI TR 94-01, Revision 2, includes the leakage rate for all Type B and Type C pathways that were in service, isolated, or not lined up in their test position prior to the performance of the Type A test. Additionally, the NEI TR 94-01, Revision 2, definition of performance leakage rate requires consideration of the leakage pathways that were isolated during performance of the test because of excessive leakage in the performance determination. The NRC staff finds this modification of the definition of "performance leakage rate" used for Type A tests to be acceptable.

Section 9.2.3 of NEI TR 94-01, Revision 2, states that, "Type A testing shall be performed during a period of reactor shutdown at a frequency of at least once per 15 years based on acceptable performance history. Acceptable performance history is defined as successful completion of two consecutive periodic Type A tests where the calculated performance leakage rate was less than 1.0 La [the maximum allowable Type A test leakage rate at Pa, where Pa equals the calculated peak containment internal pressure related to the design-basis loss-of-coolant accident]. A preoperational Type A test may be used as one of the two Type A tests that must be successfully completed to extend the test interval, provided that an engineering analysis is performed to document why a preoperational Type A test can be treated as a periodic test. Elapsed time between the first and last tests in a series of consecutive satisfactory tests used to determine performance shall be at least 24 months."

If the Type A performance leakage rate is not acceptable, then the performance criterion is not met and a determination should be performed by the licensee to identify the cause of unacceptable performance and determine appropriate corrective actions. Once completed, acceptable performance should be reestablished by demonstrating an acceptable performance leakage rate during a subsequent Type A test before resuming operation and by performing another successful Type A test within 48 months following the unsuccessful Type A test. Following these successful Type A tests, the surveillance frequency may be returned to the extended test interval.

3.1.1.2 Deferral of Tests Beyond The 15-Year Interval

As noted above, Section 9.2.3, NEI TR 94-01, Revision 2, states, "Type A testing shall be performed during a period of reactor shutdown at a frequency of at least once per 15 years based on acceptable performance history." However, Section 9.1 states that the "required surveillance intervals for recommended Type A testing given in this section may be extended by up to 9 months to accommodate unforeseen emergent conditions but should not be used for routine scheduling and planning purposes." The NRC staff believes that these two guideline recommendations are inconsistent with each other. Therefore, if a licensee wants to use the provisions of Section 9.1 in NEI TR 94-01, Revision 2, the licensee will have to demonstrate to the NRC staff that an unforeseen emergent condition exists.

3.1.1.3 Adequacy of Pre-Test Inspections (Visual Examinations)

NEI TR 94-01, Revision 2, Section 9.2.3.2, states that: "To provide continuing supplemental means of identifying potential containment degradation, a general visual examination of accessible interior and exterior surfaces of the containment for structural deterioration that may affect the containment leak-tight integrity must be conducted prior to each Type A test and during at least three other outages before the next Type A test if the interval for the Type A test has been extended to 15 years." NEI TR 94-01, Revision 2, recommends that these inspections be performed in conjunction or coordinated with the examinations required by ASME Code, Section XI, Subsections IWE and IWL. The NRC staff finds that these visual examination provisions, which are consistent with the provisions of regulatory position C.3. of RG 1.163, are acceptable considering the longer 15 year interval. Regulatory Position C.3 of RG 1.163 recommends that such examination be performed at least two more times in the period of 10 years. The NRC staff agrees that as the Type A test interval is changed to 15 years, the schedule of visual inspections should also be revised. Section 9.2.3.2 in NEI TR 94-01, Revision 2, addresses the supplemental inspection requirements that are acceptable to the NRC staff.

Subsections IWE and IWL (References 13 and 14) of the ASME Code, Section XI, as incorporated by reference in 10 CFR 50.55a, require general visual examinations two times within a 10-year interval for concrete components (Subsection IWL), and three times within a 10-year interval for steel components (Subsection IWE). To avoid duplication or deletion of examinations, licensees using NEI TR 94-01, Revision 2, have to develop a schedule for containment inspections that satisfy the provisions of Section 9.2.3.2 of this TR and ASME Code, Section XI, Subsection IWE and IWL requirements.

3.1.2 Performance-Based Type B & C Test (LLRT) Frequencies

Individual licensees may adopt a testing interval and approach provided that certain performance factors and programmatic controls are reviewed and applied as appropriate. The performance factors that have been identified as important, and that should be considered in establishing testing intervals, include past performance, service design, safety impact, and cause determination. A licensee should develop bases for new frequencies based upon satisfactory performance of leakage tests that meet the requirements of 10 CFR Part 50, Appendix J. Additional considerations used to determine appropriate frequencies may include service life, environment, past performance, design, and safety impact.

3.1.2.1 Type B & C Performance Leakage Rate

Leakage rates less than the administrative leakage rate limits are considered acceptable to the NRC staff. Administrative limits for leakage rates shall be established, documented and maintained for each Type B and Type C component prior to the performance of LLRT in accordance with the guidance provided in ANSI/ANS-56.8-2002, Sections 6.5 and 6.5.1. Administrative limits are specific to individual penetrations or valves, and not the surveillance acceptance criteria for Type B and Type C tests. Acceptance criteria for the combined leakage rate for all penetration subject to Type B or Type C testing should be defined in accordance with ANSI/ANS-56.8-2002, Sections 6.4 and 6.5.

3.1.2.2 Extending Type B&C Test Intervals

The regulation at 10 CFR Part 50, Appendix J, states that Type B and Type C tests shall be performed prior to initial reactor operation. In accordance with the guidance in NEI TR 94-01, Revision 2, subsequent periodic Type B and Type C tests shall be performed at a frequency of at least once per 30 months, until adequate performance history is established. Extensions of Type B and Type C test intervals are allowed based upon completion of two consecutive periodic as-found tests where the results of each test are within a licensee's allowable administrative limits.

NEI TR 94-01, Revision 2 (page iv, Executive Summary) states that: "Intervals may be increased from 30 months up to a maximum of 120 months for Type B tests (except for containment airlocks) and up to a maximum of 60 months for Type C tests… If a licensee considers extended test intervals of greater than 60 months for Type B tested components, the review should include the additional considerations of as-found tests, schedule and review... If the Type B and C test results are not acceptable, the test frequency should be set at the initial test intervals. Once the cause determination and corrective actions have been completed, acceptable performance may be reestablished and the testing frequency returned to the extended intervals…."

NEI TR 94-01, Revision 2, Sections 10.2.1.3 (Type B testing) and 10.2.3.3 (Type C testing) stipulate that the performance of these shall be performed at a frequency of at least once per 30 months if a penetration is replaced or engineering judgment determines that modification of a penetration has invalidated the valve's performance history; and that testing shall continue at this frequency until an adequate performance history is established.

The regulation at 10 CFR Part 50, Appendix J, requires that containment airlock(s) are tested at an internal pressure of not less than P_a prior to a preoperational Type A test. In accordance with the guidance in NEI TR 94-01, Revision 2, subsequent periodic tests shall be performed at a frequency of at least once per 30 months. When containment integrity is required, airlock door seals should be tested within seven days after each containment access. For periods of multiple containment entries where the airlock doors are routinely used for access more frequently than once every 7 days (e.g., shift or daily inspection tours of the containment), door seals may be tested once per 30 days during this time period.

NEI TR 94-01, Revision 2, Section 10.1, states that the: "… recommended surveillance frequency for Type B and Type C testing given in this section may be extended by up to 25 percent of the test interval, not to exceed nine months." The NRC staff agrees with this extension as being consistent with scheduling practices for TS.

3.1.3 Type A Test (ILRT), Type B and Type C Tests (LLRTs), and Containment In-Service Inspections (ISIs)

In Sections 9.2.1 and 9.2.3.2, NEI TR 94-01, Revision 2, references the visual examinations and IWE/IWL inspections. However, with the relatively longer intervals allowed for performing the ILRTs and LLRTs compared to the requirements that existed prior to 1995, the containment inspections play an important role in ensuring the leak tightness of containments between the tests. In approving for Type A tests the one-time extension from 10 years to 15 years, the NRC staff has identified areas that need to be specifically addressed during the IWE and IWL inspections including a number of containment pressure-retaining boundary components (e.g., seals and gaskets of mechanical and electrical penetrations, bolting, penetration bellows) and a number of the accessible and inaccessible areas of the containment structures (e.g., moisture barriers, steel shells, and liners backed by concrete, inaccessible areas of ice-condenser containments that are potentially subject to corrosion). Risk-informed analysis (both plant-specific and generic (i.e., EPRI Report No. 1009326)) has included specific consideration of degradation in inaccessible areas. However, this consideration is based on the availability of data related to the containment degradation in inaccessible areas. Therefore, licensees referencing NEI TR 94-01, Revision 2, in support of a request to amend their TS should also consider such degradation-susceptible areas in plant-specific inspections.

3.1.4 Major and Minor Containment Repairs and Modifications

Section 9.2.4 of NEI TR 94-01, Revision 2, states that: "Repairs and modifications that affect the containment leakage integrity require LLRT or short duration structural tests as appropriate to provide assurance of containment integrity following the modification or repair. This testing shall be performed prior to returning the containment to operation." Article IWE-5000 of the ASME Code, Section XI, Subsection IWE (up to the 2001 Edition and the 2003 Addenda), would require a Type A test after major repair or modifications to the containment. In general, the NRC staff considers the cutting of a large hole in the containment for replacement of steam generators or reactor vessel heads, replacement of large penetrations, as major repair or modifications to the containment structure. At the request of a number of licensees, the NRC staff has agreed to a relief request from the IWE requirements for performing the Type A test and has accepted a combination of actions consisting of ensuring that: (1) the modified containment meets the pre-service non-destructive evaluation (NDE) test requirements (i.e., as required by the construction code), (2) the locally welded areas are examined for essentially zero leakage using a soap bubble, or an equivalent, test, and (3) the entire containment is subjected to the peak calculated containment design basis accident pressure for a minimum of 10 minutes (steel containment) and 1 hour (concrete containment), and (4) the outside surfaces of concrete containments are visually examined as required by the ASME Code, Section XI, Subsection IWL, during the peak pressure, and that the outside and inside surfaces of the steel surfaces are examined as required by the ASME Code, Section XI, Subsection IWE, immediately after the test. This is defined as a short duration structural test of the containment. For minor modifications (e.g., replacement or addition of a small penetration), or modification of attachments to the pressure retaining boundary (i.e., repair/replacement of steel containment stiffeners), leakage integrity of the affected pressure retaining areas should be verified by a LLRT.

3.1.5 Summary Of The NRC Staff Evaluation of NEI TR 94-01, Revision 2

The NRC staff finds that the guidance in NEI TR 94-01, Revision 2, is acceptable for referencing by licensees in the implementation for the optional performance-based requirements of Option B as described in 10 CFR Part 50, Appendix J, subject to the limitations and conditions noted in Section 4.0 of this SE.

3.2 NRC Staff Evaluation of EPRI Report No. 1009325, Revision 2

EPRI Report No. 1009325, Revision 2, provides a generic assessment of the risks associated with a permanent extension of the ILRT surveillance interval to 15 years, and a risk-informed methodology/template to be used to confirm the risk impact of the ILRT extension on a plant-specific basis. PRA methods are used, in combination with ILRT performance data and other considerations, to justify the extension of the ILRT surveillance interval. This is in accordance with guidance provided in RGs 1.174 and 1.177 in support of changes to surveillance test intervals.

The guidance provided in EPRI Report No. 1009325, Revision 2, for PRA modeling is substantially the same as that found in the NEI interim guidance/methodology used to support one-time, 15-year ILRT extensions for approximately seventy-five nuclear units, with minor enhancements to reflect experience from the analyses and reviews of one-time ILRT extensions, and additional leak rate data from 35 recently completed ILRTs.

RGs 1.174 and 1.177 identify five key safety principles (summarized in Section 2.2 of this SE) to be met for risk-informed applications. These principles are addressed in the sections below.

3.2.1 The Proposed Change Meets the Current Regulations unless it is Explicitly Related to a Requested Exemption or Rule Change

NEI TR 94-01, Revision 2, provides guidance for implementing the 10 CFR Part 50, Appendix J, performance-based requirements and incorporates, by reference, the provisions of ANSI/ANS-56.8-2002 and the requirements of Subsections IWE and IWL of Section XI of the ASME Code (References 13 and 14, respectively). The ASME Code requirements are incorporated by reference in 10 CFR 50.55a, with modifications and limitations. The modifications and limitations vary in accordance with the edition and the addenda of the ASME Code as required by 10 CFR 50.55a.

3.2.2 The Proposed Change is Consistent with the Defense-in-Depth Philosophy

Defense-in-depth consists of a number of elements as summarized in RG 1.174 and 1.177. Regarding the proposed change to the ILRT interval, the defense-in-depth philosophy is maintained if independence of barriers is not degraded, and a reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation.

The requested change involves reducing the ILRT test frequency from one test in 10 years to one test in 15 years based on performance history and risk insights. Containment leak-tight integrity will continue to be verified through periodic in-service inspections conducted in accordance with the requirements of the ASME Code, Section XI, Subsections IWE and IWL. These requirements will not be changed as a result of the extended ILRT interval. In addition, Type B and C local leak rate tests performed to verify the leak-tight integrity of containment penetrations bellows, airlocks, and gaskets are also not affected by the change to the ILRT test frequency. Thus, the impact of the requested change on the reliability/availability of the containment barrier will be small.

The impact of the proposed change on the reactor barrier and CDF is not a key consideration in the methodology since, in general, CDF is not affected by an extension of the ILRT interval. As an exception, there are a limited number of licensees that operate plants which rely on containment over-pressure for net positive suction head (NPSH) for the emergency core cooling system (ECCS) injection for certain accident sequences. Section 4.2.6 of EPRI Report No. 1009325, Revision 2, includes guidance for licensees that operate plants that rely on containment over-pressure for NPSH for ECCS injection, and that may experience an increase in CDF as a result of the proposed change in the ILRT interval. EPRI Report No. 1009325, Revision 2, ensures that any potential increases in the likelihood of large containment leakage that could eliminate the containment over-pressure relied upon for ECCS performance are specifically addressed and that any increases in CDF will be small when compared to with the risk acceptance guidelines of RG 1.174. As such, the independence of barriers will not be degraded as a result of the requested change.

EPRI Report No. 1009325, Revision 2, uses three separate metrics, which are discussed in more detail in the following sections of this SE, to evaluate the impact of the proposed change on the ILRT interval. These metrics are, specifically, Large Early Release Frequency (LERF), population dose within a 50-mile radius of the plant, and conditional containment failure probability (CCFP). The use of these metrics collectively ensures that the balance between prevention of core damage, prevention of containment failure, and consequence mitigation is preserved.

LERF is a surrogate for the NRC's early fatality quantitative health objective (QHO). Compliance with the risk acceptance guidelines for LERF contained in RG 1.174 ensures that the impact of the proposed change on the LERF metric is small and that the intent of the NRC's Safety Goal Policy Statement for operating nuclear power plants will continue to be met. Compliance with the guidelines concerning changes to LERF is achieved by a PRA-based evaluation, as discussed in Section 3.2.4 of this SE.

EPRI Report No. 1009325, Revision 2, also includes an assessment of the impact of the proposed change on the radiological dose to the population within a 50-mile radius of the plant. The population dose metric reflects the combined impact of the proposed change on all containment release modes/categories (including minimal, small, and large releases in both the early and late time periods), in lieu of focusing only on large early releases. This metric provides perspective on the overall impact of the proposed change on offsite consequences and ensures that these impacts will be small.

Finally, EPRI Report No. 1009325, Revision 2, includes an assessment of the impact of the proposed change on the CCFP. This metric provides perspective on the impact of the proposed change on containment performance. By ensuring that the change in the CCFP is small, the balance among the goals of prevention of core damage and prevention of containment failure will be preserved.

In summary, the independence of barriers will not be degraded as a result of the requested change, and the use of the three quantitative risk metrics collectively ensures that the balance between prevention of core damage, prevention of containment failure, and consequence mitigation is preserved, satisfying the second key safety principle.

3.2.3 The Proposed Change Maintains Sufficient Safety Margins

The design, operation, testing methods, and acceptance criteria for Type A, B, and C containment leakage tests specified in applicable codes and standards (or alternatives approved for use by the NRC staff) will continue to be met as described in the plant licensing basis (including the final safety analysis report and the bases of the TS), since these are not affected by changes to the ILRT interval. Similarly, there is no impact to the safety analysis acceptance criteria as described in the plant licensing basis. Thus, safety margins are maintained by the proposed methodology, and the third key safety principle is satisfied.

3.2.4 When Proposed Changes Result in an Increase in CDF or Risk, the Increases Should be Small and Consistent with the Intent of the Commission's Safety Goal Policy Statement

RG 1.177 provides a framework for the risk evaluation of proposed changes to surveillance intervals which requires the identification of the risk contribution from impacted surveillances, determination of the risk impact due to the change in the proposed surveillance interval, and performance of sensitivity and uncertainty evaluations. EPRI Report No. 1009325, Revision 2, satisfies the intent of RG 1.177 requirements for evaluation of the change in risk, and for ensuring that such changes are small. Considerations in assessing the risk implications of the proposed change are discussed below relative to the six regulatory positions articulated in RG 1.177.

3.2.4.1 Quality of the PRA

Regulatory Position 2.3.1 of RG 1.177 states that the quality of the PRA must be compatible with the safety implications of the TS change being requested and the role that the PRA plays in justifying that change.

EPRI Report No. 1009325, Revision 2, provides the general conclusion that the risk impact associated with a permanent extension of the ILRT surveillance interval to 15 years is small, but it states that because of the possibility of an outlying plant, a confirmatory risk impact assessment is prudent. A risk-informed methodology/template to be used to confirm the risk impact of the ILRT extension on a plant-specific basis is provided in EPRI Report No. 1009325, Revision 2. The methodology relies on use of the plant-specific PRA for internal events and the available plant-specific risk analyses for external events. EPRI Report No. 1009325, Revision 2, does not address PRA quality.

Licensee requests for a permanent extension of the ILRT surveillance interval to 15 years pursuant to NEI TR 94-01, Revision 2, and EPRI Report No. 1009325, Revision 2, will be treated by NRC staff as risk-informed license amendment requests. Consistent with information provided to industry in Regulatory Issue Summary 2007-06, "Regulatory Guide 1.200 Implementation" (Reference 17), the NRC staff will expect the licensee's supporting Level 1/LERF PRA to address the technical adequacy requirements of RG 1.200, Revision 1 (Reference 18). Capability category I of ASME RA-Sa-2003 shall be applied as the standard, since approximate values of CDF and LERF and their distribution among release categories are sufficient for use in the EPRI methodology. Any identified deficiencies in addressing this standard shall be assessed further in order to determine any impacts on any proposed decreases to surveillance frequencies. If further revisions to RG 1.200 are issued which endorse additional standards, the NRC staff will evaluate any application referencing NEI TR 94-01, Revision 2, and EPRI Report No. 1009325, Revision 2, to examine if it meets the PRA quality guidance per the RG 1.200 implementation schedule identified by the NRC staff.

This level of PRA quality is sufficient to support the evaluation of changes to the ILRT surveillance frequencies, and is consistent with Regulatory Position C.2.3.1 of RG 1.177.

3.2.4.2 Scope of the PRA

Regulatory Position 2.3.2 of RG 1.177 states that: "The scope and the level of PRA necessary to fully support the evaluation of a TS change depend on the type of TS change being sought;" and indicates that "For containment systems, Level 2 evaluations are likely to be needed at least to the point of assessing containment structural performance in order to estimate the LERF."

The methodology provided in EPRI Report No. 1009325, Revision 2, uses three separate metrics to evaluate the impact of the proposed change to the ILRT interval, specifically, LERF, population dose within a 50-mile radius of the plant, and conditional containment failure probability.

Although the emphasis of the quantitative evaluation is on the risk impact from internal events, the guidance in EPRI Report No. 1009325, Revision 2, Section 4.2.7, "External Events," states that: "Where possible, the analysis should include a quantitative assessment of the contribution of external events (e.g., fire and seismic) in the risk impact assessment for extended ILRT intervals." This section also states that: "If the external event analysis is not of sufficient quality or detail to directly apply the methodology provided in this document [(i.e., EPRI Report No. 1009325, Revision 2)], the quality or detail will be increased or a suitable estimate of the risk impact from the external events should be performed." This assessment can be taken from existing, previously submitted and approved analyses or other alternate method of assessing an order of magnitude estimate for contribution of the external event to the impact of the changed interval."

The impact of the proposed change on CDF is not a key consideration in the methodology since in general CDF is not affected by an extension of the ILRT interval. An exception is plants that rely on containment over-pressure for NPSH for ECCS injection for certain accident sequences. EPRI Report No. 1009325, Revision 2, states that licensees should examine their NPSH requirements to determine if containment over-pressure is required for ECCS performance, and adjust the PRA model to account for this requirement if accident scenarios could be impacted by a large containment failure that eliminates the necessary containment over-pressure. As a first order estimate, it can be assumed that events assigned to EPRI Class 3b (large containment leakage) would result in loss of containment over-pressure and unavailability of systems that depend on this contribution to NPSH. The impact on CDF would be accounted for in a similar manner as the LERF contribution from EPRI Class 3b. The combined impacts on CDF and LERF will be considered in the ILRT evaluation and compared with the risk acceptance guidelines in RG 1.174.

The guidance provided in EPRI Report No. 1009325, Revision 2, is sufficient to ensure that the scope of the risk contribution from each surveillance is properly identified for evaluation and is consistent with Regulatory Position C.2.3.2 of RG 1.177.

3.2.4.3 PRA Modeling

Regulatory Position 2.3.3 of RG 1.177 states that: "To evaluate a TS change, the specific systems or components involved should be modeled in the PRA." Additional guidance is provided in this regulatory position regarding the modeling of initiating events, screening criteria, and truncation limits, but is not applicable to the proposed change.

The methodology provided in EPRI Report No. 1009325, Revision 2, employs a simplified risk model that distinguishes between those accident sequences that are affected by the status of the containment isolation system and those that are a direct function of severe accident phenomena. The methodology involves binning core damage sequences from the plant-specific

Level 2 PRA into one of eight EPRI accident classes used to define the spectrum of plant releases. Two specific accident classes are included to represent events in which the containment has either a small pre-existing leakage (Class 3a) or a large pre-existing leakage (Class 3b).

Class 3a is considered representative of a range of leaks from those with a magnitude greater than the maximum allowable leakage rate for containment to those with less leakage than that which would contribute to LERF (leakage greater than 1 x La, but less than 10 x La). For dose assessment purposes, Class 3a is assigned a leakage rate equivalent to ten times the maximum allowable TS leakage rate for the containment (i.e., 10 x La).

Class 3b is considered to represent leaks with a magnitude equal to or greater than that which would contribute to LERF, and is assigned a leakage rate equivalent to 35 times the maximum allowable TS leakage rate for the containment (i.e., 35 x La).

The NRC staff identified deficiencies in EPRI Report No. 1009325, Revision 2, regarding the magnitude of the leakage assigned to Class 3b. Class 3b is treated in EPRI Report No. 1009325, Revision 2, as if it corresponded exactly to a leak rate of 35 La. Based upon NRC staff review, the correct treatment is to recognize that accident case 3b corresponds to leak rates greater than or equal to 35 La, not exactly equal to 35 La. Section 3.7 (and elsewhere) in EPRI Report No. 1009325, Revision 2, states that the use of 35 La to represent a large early release is conservative. The NRC staff agrees that the frequency of leak rates greater than 35 La is a conservative estimate of the frequency of leak rates greater than 600 percent per day, which is generally regarded as the criterion for a large early release. However, 35 La is not a conservative estimate of the leak rate associated with a large early release (600 La or 6000 La, depending on the TS leak rate).

In a correct treatment, the leak rate in each infinitesimal leak rate range should be multiplied by the probability (given core damage) of the leak rate in that range and then these products should be integrated over the range above 35 La. If the result is then divided by the probability of an accident in that range (i.e., the probability of accident case 3b), one obtains the average leak rate over the accident case 3b range.

In the attachment to this SE, this approach is used, with the complementary cumulative distribution function for the leak rate provided in Table D-1 of EPRI Report No. 1009325, Revision 2. When this approach is used, an average leak rate over the accident case 3b range of 100 La is obtained. The population dose estimates for accident case 3b should be multiplied by (100 La)/ (35 La) to obtain a corrected estimate of the expected population dose.

As a result of these considerations, the method given in EPRI Report No. 1009325, Revision 2, for calculating the expected population dose (per year of operation) is not completely acceptable to the NRC staff. In order to make the method acceptable, the average leak rate for the containment pre-existing large leak rate case, accident case 3b, must be increased from 35 La to 100 La.

The frequencies associated with Class 3a and Class 3b are determined by multiplying the frequency of accident sequences affected by the ILRT extension by the conditional probability of a small or a large leak; the frequency of Class 1 events (intact containment) is then reduced by that amount. The Class 3a and Class 3b probability values are based on ILRT test data developed through two industry surveys plus additional leak rate data from 35 recently completed ILRTs.

The LERF will generally increase as a result of the increase in the time between containment ILRT. The model used assumes that the large early release frequency (from preexisting containment leakage) increases linearly with the test interval. For the base case of one ILRT every three years, the following procedure is followed. A Jefferys prior is assumed, and is updated with zero large leaks in two-hundred seventeen tests. The mean of the resulting posterior distribution is taken as the estimate of the large early release probability given core damage, from accident sequences affected by the change in ILRT test interval. This probability is then multiplied by the CDF from those accident sequences which do not already lead to a large early release to obtain the LERF which is affected by the change in ILRT test intervals. Denote the value obtained by F. This value is assumed to apply to the base case, with a test interval of every three years, since most of the data was gathered during the time when the test interval was three years. The value of F is assumed, as already noted, to be proportional to the test interval. Thus for a test interval of 15 years, the value of F is five times the value for the base case, or it increases by four times the base case value of F. There were 217 tests with zero large leak rates. The Jefferys procedure leads to the result that the probability of a large leak given a core damage event is 0.0023 (0.5/217), for the base case (See Section 3.5 of EPRI Report No. 1009325, Revision 2). The increase of the test interval to 15 years, therefore, increases the probability of a large leak by 4 and is approximately 0.009 (4 x 0.0023). For a CDF of 1E-4 per year, this leads to about a 9E-7 per year increase in the LERF, which is in the acceptable range for plants where the LERF is less than 1E-5 per year. This procedure for calculating the increase in the LERF from the increase in the ILRT test interval is acceptable to the NRC staff.

The model is separately quantified for the baseline ILRT frequency (i.e., three tests in 10 years), as well as for the reduced test frequencies (i.e., one test in 10 years and one test in 15 years). For the cases with a reduced test frequency, the Class 3a and 3b frequencies are increased (from the baseline values) by a factor to account for longer exposure period between tests. For example, relaxing the ILRT frequency from three tests in 10 years to one test in 15 years is assumed to increase the average time that a leak goes undetected from 18 to 90 months (one half the surveillance interval) resulting in a factor of five increase in the Class 3a and 3b frequencies. The risk impacts of the extended test interval are assessed based on the change in the risk metrics between the baseline case and the extended test interval cases. The methodology also includes a separate, plant-specific assessment of the likelihood and risk implications of corrosion-induced leakage of steel liners going undetected during the extended ILRT interval.

Subject to the aforementioned corrections to the population dose for Class 3b, the NRC staff considers that the guidance provided in EPRI Report No. 1009325, Revision 2, for PRA modeling is sufficient to ensure an acceptable evaluation of risk due to the change in surveillance frequency, and is consistent with Regulatory Position C.2.3.3 of RG 1.177.

3.2.4.4 Assumptions

Regulatory Position 2.3.4 of RG 1.177 states that: “Using PRAs to evaluate TS changes requires consideration of a number of assumptions made within the PRA that can have a significant influence on the ultimate acceptability of the proposed changes. Such assumptions should be discussed in the submittal requesting the TS changes."

The potential for pre-existing containment leakage that is detectable only through an ILRT is not typically addressed in a PRA. The methodology in EPRI Report No. 1009325, Revision 2, establishes two specific accident classes to represent events in which the containment has either a small pre-existing leakage (Class 3a) or a large pre-existing leakage (Class 3b), and populates these classes based on ILRT data developed through two industry surveys plus additional leak rate data from 35 recently completed ILRTs. Based on an examination of the combined ILRT database, consisting of 217 documented ILRTs, EPRI identified no large containment leakage events (leakage greater than 35 x La), and only two small leakage events (leakage greater than 1 x La but less than 10 x La) that would be detectable only though an ILRT. EPRI determined the Class 3a probability based on the maximum likelihood estimate (arithmetic average) of the data (2/217 = 0.0092) and the Class 3b probability based on Jefferys Non-Informative Prior distribution (0.5/217 = 0.0023).

The NRC staff concludes that EPRI Report No. 1009325, Revision 2, employs reasonable assumptions with regard to the extensions of surveillance test intervals, and is consistent with Regulatory Position C.2.3.4 of RG 1.177.

3.2.4.5 Sensitivity and Uncertainty Analyses

Regulatory Position 2.3.5 of RG 1.177 states that: "Sensitivity analyses may be necessary to address the important assumptions in the submittal made with respect to TS change analyses."

EPRI Report No. 1009325, Revision 2, requires a sensitivity analysis to assess the impact of assumptions regarding corrosion-induced leakage of steel containments/liners. The methodology calls for a separate, plant-specific assessment of the likelihood and risk implications of corrosion-induced leakage of steel liners going undetected during the extended ILRT interval. The results of the corrosion assessment are used to ensure that the risk impact of corrosion-induced leakage over the extended test interval remains very small. The inclusion of corrosion-induced leakage results in an increase in the estimated risk impacts of the ILRT extension. However, the two example methodology applications contained in EPRI Report No. 1009325, Revision 2, as well as the previous reviews performed for the one-time 15-year extensions, have shown the risk impact of the corrosion contribution is very small.

The methodology also requires a sensitivity analysis to assess the impact of alternative probability values for Class 3a and Class 3b events. The methodology calls for an assessment of the impact if the leakage probability values were based on an EPRI-sponsored expert elicitation rather than the previously discussed Jefferys Non-Informative Prior distribution. The results of the expert elicitation are then used as a sensitivity case to demonstrate the conservative nature of the baseline assumptions. Based on the expert elicitation, EPRI estimated a Class 3a probability of 0.00388 and a Class 3b probability of 0.000986 (i.e., approximately sixty percent lower than the values used in the baseline analysis), and proportionally smaller risk impacts.

The NRC staff has not accepted the EPRI expert elicitation as presented in the appendices of EPRI Report No. 1009325, Revision 2. The NRC staff concerns with the EPRI expert elicitation are documented in an NRC letter dated April 22, 2005 (Reference 19). These concerns were never addressed satisfactorily. Instead of relying primarily on the results of the expert elicitation, EPRI Report No. 1009325, Revision 2, uses the Jefferys distribution to determine the probability of a large pre-existing containment leakage in the base case calculation. However, EPRI relies on the results of the expert elicitation in a sensitivity analysis. The use of the Jefferys distribution in the baseline analysis is acceptable to the NRC staff. However, the use of the expert elicitation results in the sensitivity analysis is subject to the same issues described in Reference 19.

In addition, the NRC staff identified several mathematical errors in the use of the EPRI expert elicitation results in the sensitivity calculations. For example, in Table 5-13 of EPRI Report No. 1009325, Revision 2, the expert elicitation mean probability of a leak rate of 10 La is given as 0.00388. This value is used to represent the Class 3a accident class in the sensitivity analysis. However, rather than assessing the probability of a leak rate of 10 La, the methodology should assess the probability of a leak rate in the Class 3a range of leak rates (i.e., between 1 La and 35 La). From Table D-1 of EPRI Report No. 1009325, Revision 2, the probability of a leak rate between 1 La and 35 La is 0.0255 (0.0265 – 0.000986 = 0.0255) rather than 0.00388. The attachment to this SE gives more detail on the basis of the NRC staff estimate method.

Also, in Table 5-13 of EPRI Report No. 1009325, Revision 2, the expert elicitation mean probability of a leak rate of 35 La is given as 0.000986. This value is used to represent the Class 3b accident class in the sensitivity analysis. However, the average leak rate for Class 3b is not 35 La, but rather approximately 100 La, as shown in the attachment to this SE. The population dose rate values in the expert elicitation columns of Table 6-1 and Table 6-2 of EPRI Report No. 1009325, Revision 2, are therefore incorrect.

For the above reasons, the NRC staff does not accept the validity of the EPRI expert elicitation sensitivity analysis as conducted in accordance with the EPRI methodology. However, as previously discussed, EPRI Report No. 1009325, Revision 2, uses the Jefferys estimate of the probability of a large pre-existing containment leak (Class 3b) in the base case calculation, which is acceptable to the NRC staff.

3.2.4.6 Acceptance Guidelines

Regulatory Position 2.4 of RG 1.177 recommends that surveillance test interval change requests: "… should also be evaluated against risk acceptance guidelines presented herein [RG 1.177], in addition to those in RG 1.174."

The methodology contained in EPRI Report No. 1009325, Revision 2, quantitatively evaluates the impact of the ILRT extension in terms in terms of the increase in LERF, and uses the acceptance guidelines in RG 1.174 to assess the acceptability of the increase. The relevant risk metric is LERF, since the Type A test does not generally impact CDF. However, the methodology includes guidance for plants that rely on containment over-pressure for NPSH for ECCS injection for certain accident sequences, and which may experience an increase in CDF as a result of the proposed change in the ILRT interval. For those plants, the impacts on both CDF and LERF will be considered in the ILRT evaluation and compared with the risk acceptance guidelines in RG 1.174.

Additional risk metrics, specifically the increase in population dose and the increase in conditional containment failure probability, are also evaluated to help ensure that the key safety principles in RG 1.174 are met. Because no NRC staff-endorsed acceptance guidelines exist for either of these metrics, EPRI Report No. 1009325, Revision 2, has defined threshold values for each metric based on consideration of the respective risk increase values reported in one-time 15-year ILRT extension requests previously approved by the NRC staff, as well as the annual doses received by the public from naturally occurring radiation sources, as discussed below.

EPRI Report No. 1009325, Revision 2, defines a small increase in population dose as 0.75 person-rem per year. The NRC staff notes that the original Type A ILRT extension from three tests in 10 years to one test in 10 years was granted based on its small impact on population dose. The risk assessment contained in NUREG-1493 found that a reduction in the ILRT frequency from three tests in 10 years to one test in twenty years leads to an "imperceptible" increase in risk that is on the order of 0.2 percent, or a fraction of one person-rem per year (for the population dose within a 50-mile radius from the plant). As noted in EPRI Report No. 1009325, Revision 2, the increase in population dose reported in previous one-time 15-year ILRT extension requests has ranged from <0.01 to 0.2 person-rem per year and/or 0.002 to 0.46 percent of the total accident dose, and is consistent with the findings in NUREG-1493. Rather than using the value of 0.75 person-rem per year provided in EPRI Report No. 1009325, Revision 2, the NRC staff concludes that a small increase in population dose should be defined in a manner consistent with that reported in NUREG-1493 and in previous one-time 15-year ILRT extension requests. This would require that the increase in population dose be less than 0.2 person-rem per year and/or 0.5 percent of the total accident dose. While acceptable for this application, the NRC staff is not endorsing these threshold values for other applications.

EPRI Report No. 1009325, Revision 2, defines a small increase in CCFP as an increase of up to 10 percent. The guidance is unclear as to whether this corresponds to a 10 percent increase in the baseline CCFP (e.g., an increase in CCFP from 10 percent to eleven percent), or an increase in CCFP of 10 percentage points (e.g., an increase in CCFP from 10 percent to 20 percent). The NRC staff notes that the increase in CCFP reported in previous one-time 15-year ILRT extension requests has typically been about 1 percentage point or less. Rather than using the value of 10 percent provided in EPRI Report No. 1009325, Revision 2, the NRC staff concludes that a small increase in CCFP should be defined in a manner consistent with that reported in previous one-time 15-year ILRT extension requests. This would require that the increase in CCFP be about 1 percentage point or less. While acceptable for this application, the NRC staff is not endorsing these threshold values for other applications.

Subject to adequate resolution of the issues noted above, EPRI Report No. 1009325, Revision 2, provides reasonable acceptance guidelines and methods for evaluating the risk increase of proposed changes to surveillance frequencies. It is also consistent with Regulatory Position C.2.4 of RG 1.177. Therefore, the proposed methodology satisfies the fourth key safety principle of RG 1.177 by assuring any increase in risk is small and consistent with the intent of the NRC's Safety Goal Policy Statement.

3.2.5 The Impact of the Proposed Change Should be Monitored Using Performance Measurements Strategies

In addition to maintaining the defense-in-depth philosophy as described in Section 3.2.2 of this SE, the applicants for TS amendments will continue to perform containment inspections during the Type A test interval as discussed in Sections 3.1.3 and 3.1.4 of this SE.

As documented in NUREG-1493, industry experience has shown that most ILRT failures result from leakage that is detectable by local leakage rate testing (Type B and C testing). Specific testing frequencies for the local leak rate tests are reviewed prior to every refueling outage

(18-month cycle). An outage scope document is issued to document the local leak rate test periodically and to ensure that all pre-maintenance and post-maintenance testing is complete. The post-outage report provides a written record of the extended testing interval changes and the reasons for the changes based on testing results and maintenance history. Based on the above measures, the LLRT program will provide continuing assurance that the most likely sources of leakage will be identified and repaired.

ANSI/ANS-56.8-2002, Section 6.4.4, also specifies surveillance acceptance criteria for Type B and Type C tests and states that: "The combined [as-found] leakage rate of all Type B and Type C tests shall be less than 0.6La when evaluated on a minimum pathway leakage rate basis, at all times when containment operability is required." It states, moreover, that: "The combined leakage rate for all penetrations subject to Type B and Type C test shall be less than or equal to 0.6La as determined on an maximum pathway leakage rate basis from the as-left LLRT results." These combined leakage rate determinations shall be done with the latest leakage rate test data available, and shall be kept as a running summation of the leakage rates.

The containment components' monitoring and maintenance activities will be conducted according to the requirements of 10 CFR 50, Appendix J, and 10 CFR 50.55a.

The above provisions are considered to be acceptable performance monitoring strategies for assuring that the risk of the proposed change will remain small.

4.0 LIMITATIONS AND CONDITIONS

4.1 Limitations and Conditions for NEI TR 94-01, Revision 2

The NRC staff finds that the use of NEI TR 94-01, Revision 2, is acceptable for referencing by licensees proposing to amend their TSs to permanently extend the ILRT surveillance interval to 15 years, provided the specific comments provided in Section 3.1 of this SE on the usage of NEI TR 94-01, Revision 2, are properly addressed in the proposed amendments. Licensees shall ensure that the following conditions are satisfied:

1. For calculating the Type A leakage rate, the licensee should use the definition in the NEI TR 94-01, Revision 2, in lieu of that in ANSI/ANS-56.8-2002. (Refer to SE Section 3.1.1.1).

2. The licensee submits a schedule of containment inspections to be performed prior to and between Type A tests. (Refer to SE Section 3.1.1.3).

3. The licensee addresses the areas of the containment structure potentially subjected to degradation. (Refer to SE Section 3.1.3).

4. The licensee addresses any tests and inspections performed following major modifications to the containment structure, as applicable. (Refer to SE Section 3.1.4).

5. The normal Type A test interval should be less than 15 years. If a licensee has to utilize the provision of Section 9.1 of NEI TR 94-01, Revision 2, related to extending the ILRT interval beyond 15 years, the licensee must demonstrate that it is an unforeseen emergent condition. (Refer to SE Section 3.1.1.2).

4.2 Limitations and Conditions for EPRI Report No. 1009325, Revision 2

The NRC staff finds that the methodology in EPRI Report No. 1009325, Revision 2, is acceptable for referencing by licensees proposing to amend their TSs to permanently extend the ILRT surveillance interval to 15 years provided the following conditions are satisfied:

1. The licensee submits documentation indicating that the technical adequacy of their PRA is consistent with the requirements of RG 1.200 relevant to the ILRT extension application.

2. The licensee submits documentation indicating that the estimated risk increase associated with permanently extending the ILRT surveillance interval to 15 years is small, and consistent with the clarification provided in Section 3.2.4.5 of this SE. Specifically, a small increase in population dose should be defined as less than 0.2 person-rem per year and/or 0.5 percent of the total accident dose, and a small increase in CCFP should be defined as an increase of one percentage point or less.

3. The methodology in EPRI Report No. 1009325, Revision 2, is acceptable except for the calculation of the increase in expected population dose (per year of reactor operation). In order to make the methodology acceptable, the average leak rate for the pre-existing containment large leak rate accident case (accident case 3b) used by the licensees shall be 100 La instead of 35 La.

5.0 CONCLUSION

The NRC staff reviewed NEI TR 94-01, Revision 2, and EPRI Report No. 1009325, Revision 2. For NEI TR 94-01, Revision 2, the NRC staff determined that it describes an acceptable approach for implementing the optional performance-based requirements of Option B to 10 CFR Part 50, Appendix J. This guidance includes provisions for extending Type A ILRT intervals to up to 15 years and incorporates the regulatory positions stated in RG 1.163. The NRC staff finds that the Type A testing methodology as described in ANSI/ANS-56.8-2002, and the modified testing frequencies recommended by NEI TR 94-01, Revision 2, serves to ensure continued leakage integrity of the containment structure. Type B and Type C testing ensures that individual penetrations are essentially leak tight. In addition, aggregate Type B and Type C leakage rates support the leakage tightness of primary containment by minimizing potential leakage paths. In addition, aggregate Type B and Type C leakage rates support the leakage tightness of primary containment by minimizing potential leakage paths.

For EPRI Report No. 1009325, Revision 2, a risk-informed methodology using plant-specific risk insights and industry ILRT performance data to revise ILRT surveillance frequencies, the NRC staff finds that the proposed methodology satisfies the key principles of risk-informed decision making applied to changes to TSs as delineated in RG 1.177 and RG 1.174.

The NRC staff, therefore, finds that this guidance is acceptable for referencing by licensees proposing to amend their TS in regards to containment leakage rate testing, subject to the limitations and conditions noted in Section 4.0 of this SE.

6.0 REFERENCES

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3. U.S. Nuclear Regulatory Commission, “Performance-Based Containment Leak-Test Program,” NUREG-1493, July 1995.

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Attachment: Population Dose Calculations for the Large Containment Leak Rate Accident Case

Principal Contributors: A Buslik
R. Palla
H. Ashar
B. Lee

Date:

Population Dose Calculations for the Large Containment Leak Rate Accident Case

This attachment will estimate the expected population dose rate for the large containment leak rate case, accident case 3b. Here, "expected population dose rate" means the expected population dose per year of reactor operation. First, the methodology will be developed, and then the average leak rate over the accident case 3b range will be estimated using the results of the EPRI expert elicitation given in Appendix D of EPRI Report No. 1009325, Revision 2, "Risk Impact Assessment of Extended Integrated leak Rate Testing Intervals" (the EPRI report). Then the expected population dose rate will be estimated by multiplying this average leak rate by the frequency of accident case 3b, as determined by the use of the Jefferys prior distribution, as given in the main body of the EPRI report.

The expected population dose (consequences), per year of operation, for containment leak rates L in the range (L_1, L_2) is given by:

(1)

$$C(L_1, L_2) = \lambda \int_{L_1}^{L_2} C(L) f(L) dL$$

where λ is the core damage frequency, C(L) are the consequences given a containment leak of magnitude L in a core damage accident, and f(L) dL is the probability of a leak rate in the range dL.

We assume the consequences C(L) are linear in the dose rate, so that:

(2) C(L) = L C(1) ,

where C(1) are the consequences for a leak rate of 1La (intact containment). This is the assumption made in the EPRI report.

Then:

(3)

$$C(L_1, L_2) = \lambda C(1) \int_{L_1}^{L_2} L f(L) dL$$

Denote the integral in eq(3) by I(L_1, L_2) so that:

(3a)

$$I(L_1, L_2) = \int_{L_1}^{L_2} L f(L) dL$$

and:

(3b)

$$C(L_1, L_2) = \lambda C(1) I(L_{1,} L_2)$$

We assume that the leak rate probability distribution is a Weibull distribution so that the complementary cumulative distribution function Q(L) is:

(4)

$$Q(L) = \exp(-\gamma L^{\beta})$$

Then the probability distribution function, f(L), is given by:

(5)

$$f(L) = -\frac{d}{dL}(e^{-\gamma L^{\beta}}) = \gamma\beta L^{\beta-1} e^{-\gamma L^{\beta}}$$

Using eq(5) in eq(3a) we obtain:

(6)

$$I(L_{1,} L_2) = \gamma\beta \int_{L_1}^{L_2} L^{\beta} e^{-\gamma L^{\beta}} dL$$

Let $y=\gamma L^{\beta}$. Then:

$$L = (\frac{y}{\gamma})^{\frac{1}{\beta}}$$

and:

$dL=(1/\gamma)^{1/\beta}\ (1/\beta)y^{(1/\beta-1)}$

One obtains after some algebra:

(7)

$$I(L_1, L_2) = \eta \int_{y_1}^{y_2} y^{1/\beta} e^{-y} dy$$

where $\eta=(1/\gamma)^{\beta}$, $y_1=\gamma L_1^{\beta}$, and $y_2=\gamma L_2^{\beta}$.

The integral in Equation (7) is the three parameter incomplete gamma function $\Gamma(1/\beta +1, y_1 , y_2)$. It can be evaluated in Excel by relating the three parameter incomplete gamma function to the two parameter incomplete gamma function by:

$\Gamma(a, y_1, y_2) = \Gamma(a, y_2) - \Gamma(a, y_1)$,

and using the fact that the gamma distribution is the ratio of the two parameter incomplete gamma function to the (complete) gamma function. The gamma distribution is a function in Excel, as is the natural log of the (complete) gamma function.

We may write $I(L_1,L_2)$ as

(8) $I(L_1, L_2) = pr\{L_1 < L < L_2\} [I(L_1, L_2) /pr\{L_1 < L < L_2\}] = pr\{L_1 < L < L_2\} L_{av}(L_1, L_2)$

The quantity in square brackets is the average leak rate over the range L_1 to L_2, and is denoted by $L_{av}(L_1, L_2)$. Then, using eq(3b),

(9) $C(L_1, L_2) = \lambda C(1) I(L_1, L_2) = = \lambda C(1)pr\{L_1 < L < L_2\} L_{av}(L_1 , L_2)$

This is essentially the same formula used in the EPRI report, Table 4-1, for the population dose; the difference is that $L_{av}(L_1, L_2)$ replaces the leakage rates given Table 4-1 for accident classes 3a and 3b.

The data in Table D-1 of the EPRI report for the leak-rate complementary cumulative distribution was fitted to a Weibull distribution. The value of β obtained was 0.173, and the value of γ obtained was 3.711.

For accident class 3b, the leak rate range is (35 La, L_{max}), where L_{max} was chosen as 10000 La, as in the EPRI report, Appendix D. We obtained an average leak rate from the results of the EPRI elicitation of 102 La, for this range. This increases the population dose for accident class 3b by a factor of about 3, over that given in the EPRI report (The EPRI report used 35 La). The frequency of accident case 3b derived from the Jefferys prior is used, so that the frequency used for accident case 3b is that used in the main body of the EPRI report. Thus, for the example Vogtle Electric Generating Plant (VEGP) (see Table 5-9 of the EPRI report), the population dose per year for the Integrated Leak Rate Testing (ILRT) frequency of 3 per 10 years is given as 2.76E-4 person-rem per year in the EPRI report, while our estimate is a factor 102/35 larger. For the VEGP, the increase in population dose per year from decreasing the ILRT frequency from 3 in 10 years to 1 in 15 years is 1.10E-3 person-rem per year in the EPRI report, while we estimate the increase as a 3.22E-3 person-rem per year (a factor 102/35 larger).

Note that the EPRI complementary cumulative distribution function for the leak rate can very well be non-conservative, since it involves extrapolation from small leak rates to large leak rates by fitting to a Weibull distribution (for each expert). Fitting to other distributions (for example, a lognormal) may lead to considerably higher estimates of the frequency of large leak rates.

In summary, for accident class 3b, the population dose results in the EPRI report are low by a factor of 3, as compared to our estimates.