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INDUSTRY GUIDELINE FOR IMPLEMENTING PERFORMANCE-BASED OPTION OF 10 CFR PART 50, APPENDIX J

July 21, 1995

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ACKNOWLEDGMENTS

This guidance document, Industry Guideline for Implementing Performance-Based Option of 10 CFR 50, Appendix J, NEI 94-01, was developed by the Nuclear Energy Institute (NEI) Appendix J Working Group and the Task Force for the Implementation of Appendix J Alternative Containment Testing Rule. We appreciate the direct participation of the many licensees who contributed to the development of the guideline and the participation of the balance of the industry who reviewed and submitted comments to improve the document clarity and consistency. The dedicated and timely effort of the many Task Force participants, including their management's support of the effort, is greatly appreciated.

NEI also wishes to express its appreciation to the Electric Power Research Institute (EPRI) who devoted considerable time and resources to the development of this industry Appendix J guideline.

NOTICE

FOREWORD

The purpose of this guidance is to assist licensees in the implementation of Option B to 10 CFR 50, Appendix J, "Leakage Rate Testing of Containment of Light Water Cooled Nuclear Power Plants." In response to NRC data gathering inquiries, the industry collected, evaluated, and provided summary data that supported the NRC's independent data analysis.

Licensees can minimize the redundant and overlapping engineering and evaluation efforts associated with these related regulatory requirements by internal coordination. NEI will continue to monitor these and other activities to provide focus on opportunities for safety improvement and cost avoidance.

EXECUTIVE SUMMARY

This document describes an acceptable approach for implementing the optional performance-based requirements of Option B to 10 CFR 50, Appendix J. It delineates a performance-based approach for determining Type A, Type B, and Type C containment leakage rate surveillance testing frequencies. Justification of extending test intervals is based on the performance history and risk insights.

This guideline discusses the performance factors that licensees must consider in determining test intervals. It does not address how to perform the tests because these details can be found in existing documents (e.g., ANSI/ANS 56.8-1994).

The performance criteria for Type A tests is less than $1.0L_a$. Extension in Type A test intervals are allowed based upon two consecutive successful Type A tests and consideration of performance factors as described in Section 11 of this guideline. Type A testing shall be performed at a frequency of at least once per 10 years. If the As-found Type A results are not acceptable, a determination should be performed to identify the cause of unacceptable performance and determine appropriate corrective actions. Once completed, acceptable performance should be reestablished by performing a Type A test within 48 months following the unsuccessful Type A test. Following a successful Type A test, the surveillance frequency may be returned to once per 10 years.

Extensions in 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. Intervals for Type B and Type C may be increased from 24 months up to a maximum of 120 months (except for containment airlocks). 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 as specified in this document.

Containment airlock(s) shall be tested at an internal pressure of not less than P_{ac} prior to a preoperational Type A test. Subsequent periodic tests shall be performed at a frequency of at least once per 24 months. When containment integrity is required, airlock door seals should be tested within 7 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.

The performance factors that have been identified as important and should be considered in establishing testing intervals include past performance, service, design, safety impact, and cause determination as described in Section 11.3.1.

If a licensee considers extended test intervals of greater than 60 months or three refueling cycles for Type B or Type C tested components, the review should include the additional considerations of As-found tests, schedule and review as described in Section 11.3.2.

Finally, this document discusses the general requirements for recordkeeping for implementation of Option B to Appendix J.

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1.0 INTRODUCTION

1.1 Background

Currently, containment leakage rate testing is performed in accordance with 10 CFR 50, Appendix J, "Leakage Rate Testing of Containment of Light Water Cooled Nuclear Power Plants." Appendix J specifies containment leakage testing requirements, including the types of tests required. In addition, for each type of test, Appendix J discusses leakage rate acceptance criteria, test methodology, frequency of testing, and reporting requirements. The specific testing requirements are discussed in a variety of sources, including Technical Specifications, Final Safety Analysis Reports (FSARs), National Standards (e.g., ANSI/ANS 56.8–1994, "Containment System Leakage Testing Requirements"), and licensee/NRC correspondence. These documents require that periodic testing be conducted to verify the leakage integrity of the containment and those containment systems and components which penetrate the containment.

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

The NRC has amended the regulations to provide an Option B to the existing Appendix J. Option B is a performance–based approach to Appendix J leakage testing requirements. This option would allow licensees with good ILRT performance history to reduce the Type A testing frequency from three tests in 10 years to one test in 10 years. For Type B and Type C tests, NRC will allow licensees to reduce testing frequency on a plant–specific basis based on experience history of each component, and established controls to ensure continued performance during the extended testing interval.

Generally, a FSAR describes plant testing requirements, including containment testing. In some cases, FSAR testing requirements differ from those of Appendix J. In many cases, Technical Specifications were approved that incorporated exemptions to provisions of Appendix J. Additionally, some licensees have requested and received exemptions after their Technical Specifications were issued. The alternate performance–based testing requirements contained in Option B of Appendix J will not invalidate such exemptions.

1.2 Discussion

This guideline describes an approach that may be used to meet the alternate testing requirements described in Option B to Appendix J. The performance history of containment, penetrations, and containment isolation valves is used as the means to justify extending test intervals for containment Type A, Type B, and Type C tests. This guideline provides a method for determining the extended test intervals based on performance.

Under Option B, test intervals for Type A, Type B, and Type C testing may be determined by using a performance–based approach. Performance–based test intervals are based on consideration of operating history of the component and resulting risk from its failure. Performance–based for Appendix J refers to both performance history necessary to extend test intervals as well as criteria necessary to meet the requirements of Option B. The performance–based approach to leakage rate testing discussed in NUREG–1493, "Performance–Based Leak–Test Program," concludes that the impact on public health and safety due to extended intervals is negligible.

The objective for monitoring performance of Type A tests focuses on verifying the leakage integrity of a passive containment structure. Type B and C testing focuses on assuring that containment penetrations are essentially leak tight.

2.0 PURPOSE AND SCOPE

This guideline describes an acceptable method for implementing the optional performance–based requirements of Appendix J. This method uses industry performance data, plant–specific performance data, and risk insights in determining the appropriate testing frequency. Licensees may elect to use other suitable methods or approaches to comply with Option B, but must obtain NRC approval prior to implementation.

The approach described in this guideline to implement Appendix J, Option B includes:

- Continued assurance of the leakage integrity of the containment without adversely affecting public health and safety;
- Licensee flexibility to implement cost–effective testing methods;

- A framework to acknowledge good performance; and
- Utilization of risk and performance–based methods.

This guideline delineates the basis for a performance–based approach for determining Type A, Type B, and Type C containment leakage rate surveillance testing frequencies. It does not address how to perform the tests because these details can be found in existing documents (e.g., ANSI/ANS 56.8–1994). Licensees that select Option B are urged to coordinate the implementation of Appendix J, as described in this guideline, with their plans for implementation of the Maintenance Rule and other changes in the regulations as they are finalized.

3.0 RESPONSIBILITY

Each licensee should determine if the requirements of the existing Appendix J (Option A) or the alternate requirements (Option B) are most appropriate for its facility. If a licensee elects to implement the Option B requirements, the guidance described in this document has been reviewed and endorsed by the NRC as an acceptable method of implementing the requirements.

In addition, if a licensee elects to adopt Option B, it may elect to adopt the requirements that apply to a specific category of tests (i.e., Type A, Type B or Type C tests) only.

4.0 APPLICABILITY

This guideline is applicable to licensees holding an operating license issued in accordance with 10 CFR 50.21(b) and 50.22, and 10 CFR Part 52, Subpart C.

Industry operating experience and plant modifications that may affect Type A, Type B, and Type C testing program(s) should be reviewed to assure test and maintenance programs are appropriately adjusted to reflect these changes.

5.0 DEFINITIONS

Definitions of commonly accepted terms used in this guideline may be found in ANSI/ANS 56.8–1994.

6.0 GENERAL REQUIREMENTS

Option B of 10 CFR 50, Appendix J states, in part, that a Type A test which measures both the containment system overall integrated leakage rate at the containment pressure and system alignments assumed during a large break loss of coolant accident (LOCA), and demonstrates the capability of the primary-containment to withstand an internal pressure load may be conducted at a periodic interval based on the performance of the overall containment system. The leakage rate must not exceed what is allowed as specified in a plant's Technical Specifications.

A review of leakage rate testing experience indicates that only a small percentage of Type A tests have excessive leakage. Furthermore, the observed leakage rates for the few Type A test failures were only marginally above current limits. These observations, together with the insensitivity of public risk to containment leakage rate at these low levels, suggest that for Type A tests, intervals may be established based on performance. Type A test is the primary test to detect significant leakage from the containment that would not be detected by the Type B and Type C testing programs, and to verify at periodic intervals the accident leakage (L_a) assumptions in the accident analysis. Specific details of Type A test requirements are discussed in ANSI/ANS 56.8–1994.

An LLRT is a test performed on Type B and Type C components. An LLRT is not required for the following cases:

- Primary containment boundaries that do not constitute potential primary containment atmospheric pathways during and following a Design Basis Accident (DBA);

- Boundaries sealed with a qualified seal system; or,

- Test connection vents and drains between primary containment isolation valves which are one inch or less in size, administratively secured closed and consist of a double barrier.

For Type B and Type C tests, intervals shall be established based on the performance history of each component. Performance criterion for each component is determined by designating an administrative leakage limit for each component in the Type B and Type C testing program. The acceptance criteria for Type B and Type C tests is based upon demonstrating that the sum of leakage rates at DBA pressure for containment penetrations and valves that are testable, is less than the total allowable leakage rate specified in the plant Technical Specifications.

Primary containment barriers sealed with a qualified seal system shall be periodically tested to demonstrate their functionality in accordance with the plant Technical Specifications. Specific details of the testing methodology and requirements are contained in ANSI/ANS 56.8–1994 and should be adopted by licensees with applicable systems. Test frequency may be set using a performance basis in a manner similar to that described in this guideline for Type B and Type C test intervals. Leakage from containment isolation valves that are sealed with a qualified seal system may be excluded when determining the combined leakage rate provided that:

- Such valves have been demonstrated to have fluid leakage rates that do not exceed those specified in the technical specifications or associated bases, and

- The installed isolation valve seal-water system fluid inventory is sufficient to assume the sealing function for at least 30 days at a pressure of 1.10 Pa.

7.0 UTILIZATION OF EXISTING PROGRAMS

Licensees should use existing industry programs, studies, initiatives and data bases, where possible.

8.0 TESTING METHODOLOGIES FOR TYPE A, B AND C TESTS

Type A, Type B and Type C tests should be performed using the technical methods and techniques specified in ANSI/ANS 56.8–1994, or other alternative testing methods that have been approved by the NRC. However, because ANSI/ANS 56.8–1994 is not performance–based, certain exceptions and clarification to methods, techniques and definitions contained in that document are required. These are discussed in the following paragraphs.

Test intervals in ANSI/ANS 56.8–1994 are not performance–based. This guideline should be implemented when establishing test intervals for Type A, Type B and Type C testing.

All Appendix J pathways must be properly drained and vented during the performance of the ILRT, with the following exceptions:

- Pathways in systems which are required for proper conduct of the Type A test or to maintain the plant in a safe shutdown condition during the Type A test;

- Pathways in systems that are normally filled with fluid and operable under post–accident conditions;

- Portions of the pathways outside primary containment that are designed to Seismic Category I and at least Safety Class 2; or,

- For planning and scheduling purpose, or ALARA considerations, pathways which are Type B or C tested within the previous 24 calendar months need not be vented or drained during the Type A test.

The proper methods for draining and venting are specified in ANSI/ANS 56.8–1994.

It should be noted that the Type B or C tests performed on those pathways must test all of its containment barriers. This includes bonnets, packings, flanged joints, threaded connections, and compression fittings. If the Type B or C test pressurizes any of the pathway's containment barriers in the reverse direction, it must be shown that test results are not affected in a nonconservative manner by directionality. The As–found and the As–left leakage rate for all pathways that are not drained and vented must be determined by Type B and Type C testing within the previous 24 calendar months of the time that the Type A test is performed and must be added to the Type A leakage rate UCL to determine the overall L_a surveillance acceptance criteria in accordance with the definition in ANSI/ANS 56.8–1994.

The As–found Type A test results described in ANSI/ANS 56.8–1994 are defined to include the positive differences between the As–found and As–left LLRT leakage rates for each pathway tested and adjusted prior to the performance of the Type A test (leakage savings). For purposes of determining an acceptable Type A test for operability considerations, the definitions and discussions found in ANSI/ANS 56.8–1994 for As–found Type A leakage rate should be followed.

However, because of the performance–based emphasis on Type A testing, criteria for Type A tests have been defined differently, and do not use the leakage savings value. The performance criteria use a calculated performance leakage rate, which is defined as the sum of the Type A UCL and As–left MNPLR leakage rate for all Type B and Type C pathways that were in service, isolated or not lined up in their test position (i.e., drained and vented to containment atmosphere) prior to performing the Type A test. In addition, any leakage pathways that were isolated during performance of the test because of excessive leakage must be factored into the performance determination. If the leakage can be determined by a local leakage rate test, the As–left MNPLR for that leakage path must also be added to the Type A UCL. If leakage cannot be determined by local leakage rate testing, the performance criteria for the Type A test were not met.

ANSI/ANS 56.8–1994 also specifies surveillance acceptance criteria for Type B and Type C tests. The ANSI/ANS 56.8–1994 definition is that the combined leakage rate for all penetrations subject to Type B or Type C tests is limited to less than or equal to $0.60L_a$, when determined on a MNPLR basis from As–found LLRT results; and limited to less than or equal to $0.60L_a$, as determined on a Maximum Pathway Leakage Rate (MXPLR) basis from the As–left LLRT results.

Due to the performance–based nature of Option B to Appendix J and this guideline, it is recommended that acceptance criteria for the combined As–found leakage rate for all penetrations subject to Type B or Type C testing be the same as that defined in ANSI/ANS 56.8–1994, with the following additions. The combined As–left leakage rates determined on a MXPLR basis for all penetrations shall be verified to be less than $0.60L_a$ prior to entering a mode where containment integrity is required following an outage or shutdown that included Type B and Type C testing only. The combined As–found leakage rates determined on a MNPLR basis for all penetrations shall be less than $0.60L_a$ at all times when containment integrity is required. 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.

9.0 DETERMINING PERFORMANCE–BASED TEST INTERVAL FOR TYPE A TESTS

9.1 Introduction

Determination of the surveillance frequency of Type A tests is based upon satisfactory performance of leakage tests that meet the requirements of Appendix J. Performance in this context refers to both the performance history necessary to determine test intervals as well as overall criteria needed to demonstrate leakage integrity performance. Performance is also used as a basis for demonstrating negligible impact on public health and safety.

The purpose of Type A testing is to verify the leakage integrity of the containment structure. The primary performance objective of the Type A test is not to quantify an overall containment system leakage rate. The Type A testing methodology as described in ANSI/ANS 56.8–1994, and the modified testing frequencies recommended by this guideline, serves to ensure continued leakage integrity of the containment structure. Type B and Type C testing assures 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. A review of performance history has concluded that most, if not all, containment leakage is identified by local leakage rate testing.

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This section discusses a method to determine a testing frequency for Type A testing based on performance. The extended test interval is based upon industry performance data that was compiled to support development of Option B to Appendix J, and is intended for use by any licensee. In adopting extended test intervals recommended in this guideline, a licensee should perform Type A testing in accordance with recommended industry practices. Additional technical information concerning data analysis may be found in NUREG–1493.

Consistent with standard scheduling practices for Technical Specifications Required Surveillances, intervals for recommended Type A testing given in this section may be extended by up to 15 months . This option should be used only in cases where refueling schedules have been changed to accommodate other factors.

9.1.1 Performance Criteria

Performance criteria for establishing Type A test intervals should provide both the standard against which performance is to be measured and basis for determining that performance is acceptable. Because of the performance–based emphasis on Type A testing, the criteria to determine extended Type A test intervals have been defined differently than the surveillance acceptance criteria discussed in ANSI/ANS 56.8–1994. This is to make the performance leakage rate more of an indicator of the overall condition of containment leakage integrity.

The performance criteria for Type A test allowable leakage is less than $1.0L_a$. This allowable leakage rate is calculated as the sum of the Type A UCL and As–left MNPLR leakage rate for all Type B and Type C pathways that were in service, isolated, or not lined up in their test position (i.e., drained and vented to containment atmosphere) prior to performing the Type A test. In addition, leakage pathways that were isolated during performance of the test because of excessive

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leakage must be factored into the performance determination. If the leakage can be determined by a local leakage rate test, the As–~~found~~ MNPLR for that leakage path must also be added to the Type A UCL. If the leakage cannot be determined by local leakage rate testing, the performance criteria are not met.

Performance criteria do not include addition of the positive differences between the As–found MNPLR and the As–left MNPLR for each pathway tested and adjusted prior to Type A testing (total leakage savings). Total leakage savings are identified through performance of Type B and Type C testing and do not contribute significantly to performance of a Type A test. Failure of Type B and Type C test components found during performance of a Type A test should be reviewed for cause determination and corrective actions.

9.1.2 Test Interval

Extensions in test intervals are allowed based upon two consecutive, periodic Type A tests and consideration of performance factors as described in Section 11.3, "Plant-Specific Testing Program Factors." The elapsed time between the first and the last tests in a series of consecutive passing tests used to determine performance shall be at least 24 months.

9.2 Type A Test

9.2.1 Pretest Inspection and Test Methodology

Prior to initiating a Type A test, a visual examination shall be conducted of accessible interior and exterior surfaces of the containment system for structural problems which may affect either the containment structure leakage integrity or the performance of the Type A test. This inspection should be a general visual inspection of accessible interior and exterior surfaces of the primary containment and components.

ANSI/ANS 56.8–1994 testing methodology states that pathways open to the primary containment atmosphere under post–DBA conditions shall be drained and vented to the primary containment atmosphere during a Type A test. There are three exceptions discussed in ANSI/ANS 56.8–1994 that allow penetrations to be tested under the LLRT program and the results added to the Type A leakage rate Upper Confidence Limit (UCL). One exception states that pathways in systems which are required for proper conduct of the Type A test or to maintain the plant in a safe condition during the Type A test may be operable in their normal mode. Proper outage planning should identify systems that are important to shutdown safety. A sufficient number of systems should be available so as to minimize the risk during the performance of the Type A test.

For planning and scheduling purposes, or ALARA considerations, licensees may want to consider not venting and draining additional penetrations that are capable of local leakage rate testing. It should be noted that the Type B or C tests performed on those pathways must test all of its containment barriers. This includes bonnets, packings, flanged joints, threaded connections, and compression fittings. If the Type B or C test pressurizes any of the pathway's containment barriers in the reverse direction, it must be shown that test results are not affected in a nonconservative manner by directionality. The As–found and the As–left leakage rate for all pathways that are not drained and vented must be determined by Type B and Type C testing within the previous 24 calendar months of the time that the Type A test is performed and must be added to the Type A leakage rate UCL to determine the overall L_a surveillance acceptance criteria in accordance with the definition in ANSI/ANS 56.8–1994.

9.2.2 Initial Test Intervals

A preoperational Type A test shall be conducted prior to initial reactor operation. If initial reactor operation is delayed longer than 36 months after completion of the preoperational Type A test, a second preoperational Type A test shall be performed prior to initial reactor operations.

The first periodic Type A test shall be performed within 48 months after the successful completion of the last preoperational Type A test. Periodic Type A tests shall be performed at a frequency of at least once per 48 months, until acceptable performance is established in accordance with Section 9.2.3. The interval for testing should begin at initial reactor operation. Each test interval begins upon completion of a Type A test and ends at the start of the next test.

If the test interval ends while primary containment integrity is either not required or it is required solely for shutdown activities, the test interval may be extended indefinitely. However, a successful Type A test shall be completed prior to entering the operating mode requiring primary containment integrity.

9.2.3 Extended Test Intervals

Type A testing shall be performed during a period of reactor shutdown at a frequency of at least once per 10 years based on acceptable performance history. Acceptable performance history is defined as completion of two consecutive periodic Type A tests where the calculated performance leakage rate was less than 1.0 L_a. 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.

For purposes of determining an extended test interval, the performance leakage rate is determined by summing the UCL (determined by containment leakage rate testing methodology described in ANSI/ANS 56.8–1994) with As–left MNPLR leakage rates for penetrations in service, isolated or not lined up in their accident position (i.e., drained and vented to containment atmosphere) prior to a Type A test. In addition, any leakage pathways that were isolated during performance of the test because of excessive leakage must be factored into the performance determination. If the leakage can be determined by a local leakage rate test, the As–~~found~~ MNPLR for that leakage path must also be added to the Type A UCL. If the leakage cannot be determined by local leakage rate testing, the performance criteria for the Type A test are not met.

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In reviewing past performance history, Type A test results may have been calculated and reported using computational techniques other than the Mass Point method from ANSI/ANS 56.8–1994 (e.g., Total Time or Point–to–Point). Reported test results from these previously acceptable Type A tests can be used to establish the performance history. Additionally, a licensee may recalculate past Type A UCL (using the same test intervals as reported) in accordance with ANSI/ANS 56.8–1994 Mass Point methodology and its adjoining Termination criteria in order to determine acceptable performance history. In the event where previous Type A tests were performed at reduced pressure, at least one of the two consecutive periodic Type A tests shall be performed at peak accident pressure (P_{ac}).

9.2.4 Containment Repairs and Modifications

Repairs and modifications that affect the containment leakage integrity require leakage rate testing (Type A testing or local leakage rate testing) prior to returning the containment to operation. Testing may be deferred to the next regularly scheduled Type A test for the following repairs or modifications:

- Welds of attachments to the surface of steel pressure–retaining boundary;

- Repair cavities, the depth that does not penetrate required design steel wall by more than 10%; or

- Welds attaching to steel pressure–retaining boundary penetrations, where the nominal diameter of the welds or penetrations does not exceed one inch.

9.2.5 Surveillance Acceptance Criteria

The As–found Type A test leakage rate must be less than the acceptance criterion of 1.0 L_a given in the plant Technical Specifications. Prior to entering a mode where containment integrity is required, the As–left Type A leakage rate shall not exceed 0.75 L_a. The As–left and As–found values are as determined by the appropriate testing methodology specifically described in ANSI/ANS 56.8–1994.

9.2.6 Corrective Action

If the As–found Type A results are not acceptable, then a determination should be performed to identify the cause of unacceptable performance and determine appropriate corrective actions. Cause determination and corrective action should reinforce achieving acceptable performance. Once the cause determination and corrective actions have been completed, acceptable performance should be reestablished by performing a Type A test within 48 months following the unsuccessful Type A test. Following a successful Type A test, the surveillance frequency may be returned to once per 10 years.

Performance criteria do not include addition of the positive differences between the As–found MNPLR and the As–left MNPLR for each pathway tested and adjusted prior to Type A testing (total leakage savings). Total leakage savings are identified through performance of Type B and Type C testing and do not contribute significantly to performance of a Type A test. As discussed in Section ~~9.2.2,~~ leakage paths detected during a Type A test that are caused by failures of Type B and Type C test components are not required to be included in determination of adequate performance and Type A test intervals. Corrective actions for Type B and Type C failures should be taken in accordance with Sections 10.2.1.4, 10.2.2.3, or 10.2.3.4 of this guideline.

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10.0 DETERMINING PERFORMANCE–BASED TEST FREQUENCIES FOR TYPE B AND TYPE C TESTS

10.1 Introduction

This section discusses the method to determine extended test intervals for Type B and Type C tests based on performance. It presents a range of acceptable intervals based upon industry data which have been analyzed through a process similar to that used by NRC in NUREG–1493, and have been reviewed for safety significance. Individual licensees may adopt a testing interval and approach as discussed in this guideline provided that certain performance factors and programmatic controls are reviewed and applied as appropriate. Programmatic controls may be necessary to ensure that assumptions utilized in analysis of the industry data are reasonably preserved at individual facilities.

The range of recommended frequencies for Type B and Type C tests are discussed in Section 11.0. The proposed frequencies are in part based upon industry performance data that was compiled to support the development of Option B to Appendix J, and a review of their safety significance. A licensee should develop bases for new frequencies based upon satisfactory performance of leakage tests that meet the requirements of Appendix J. Additional considerations used to determine appropriate frequencies may include service life, environment, past performance, design, and safety impact. Additional technical information concerning the data may be found in NUREG–1493.

Consistent with standard scheduling practices for Technical Specifications Required Surveillances, intervals for 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 15 months.

10.2 Type B and Type C Testing Frequencies

The testing interval for each component begins after its Type B or Type C test is completed and ends at the beginning of the next test. If the testing interval ends while primary containment integrity is not required or is required solely for cold shutdown or refueling activities, testing may be deferred; however, the test must be completed prior to the plant entering a mode requiring primary containment integrity.

Leakage rates less than the administrative leakage rate limits are considered acceptable. Administrative limits for leakage rates shall be established and documented for each Type B and Type C component prior to the performance of local leakage rate testing. The administrative limits assigned to each component should be specified such that they are an indicator of potential valve or penetration degradation. Administrative limits for airlocks may be equivalent to the surveillance acceptance criteria given for airlocks in Technical Specifications.

Administrative limits are specific to individual penetrations or valves, and are not the surveillance acceptance criteria for Type B and Type C tests. Due to the performance–based nature of Option B to Appendix J and this guideline, it is recommended that acceptance criteria for the combined leakage rate for all penetrations subject to Type B or Type C testing be defined as follows:

- The combined As–left leakage rates determined on a MXPLR basis for all penetrations shall be verified to be less than $0.60L_a$ prior to entering a mode where containment integrity is required following an outage or shutdown that included Type B and Type C testing only. 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 As–found leakage rates, determined on a MNPLR basis, for all newly tested penetrations when summed with the As–left MNPLR leakage rates for all other penetrations shall be less than $0.60L_a$ at all times when containment integrity is required.

The surveillance acceptance criteria for airlocks are as specified in Technical Specifications. In addition, there is other leakage rate testing specified in the Technical Specifications that contain Surveillance Acceptance Criteria and Surveillance Frequencies. This guideline does not address the performance–based frequency determination of those surveillances.

10.2.1 Type B Test Intervals

10.2.1.1 Initial Test Intervals (Except Containment Airlocks)

Type B tests shall be performed prior to initial reactor operation. Subsequent periodic Type B tests shall be performed at a frequency of at least once per 30 months, until acceptable performance is established per Section 10.2.1.2.

10.2.1.2 Extended Test Intervals (Except Containment Airlocks)

The test intervals for Type B penetrations may be increased based upon completion of two consecutive periodic As–found Type B tests where results of each test are within a licensee's allowable administrative limits. Elapsed time between the first and last tests in a series of consecutive satisfactory tests used to determine performance shall be 24 months or the nominal test interval (e.g., refueling cycle) for the component prior to implementing Option B to Appendix J. An extended test interval for Type B tests may be increased to a specific value in a range of frequencies from greater than once per 24 months up to a maximum of once per 120 months. The specific test interval for Type B penetrations should be determined by a licensee in accordance with Section 11.0.

10.2.1.3 Repairs or Adjustments (Except Containment Airlocks)

In addition to the periodic As–found Type B test, an As–found Type B test shall be performed prior to any maintenance, repair, modification, or adjustment activity if the activity could affect the penetration's leak tightness. An As–left Type B test shall be performed following maintenance, repair, modification or adjustment activity. In addition, if a primary containment penetration is opened following As–found testing, a Type B test shall be performed prior to the time primary containment integrity is required. If the As–found and As–left Type B test results are both less than a component's allowable Administrative Limit, a change in test frequency is not required. If As–found or As–left test results are greater than the allowable administrative limit, provisions of Section 10.2.1.4 apply.

Frequency for a Type B testing shall be in accordance with Section 10.2.1.1 if the penetration is replaced or engineering judgment determines that modification of the penetration has invalidated the performance history. Testing shall continue at this frequency until adequate performance is established in accordance with Section 10.2.1.2.

10.2.1.4 Corrective Action

If Type B test results are not acceptable, then the testing frequency should be set at the initial test interval per Section 10.2.1.1. In addition, a cause determination should be performed and corrective actions identified that focus on those activities that can eliminate the identified cause of failure[1] with appropriate steps to eliminate recurrence. Cause determination and corrective action should reinforce achieving acceptable performance. Once the cause determination and corrective actions have been completed, acceptable performance may be reestablished and the testing frequency returned to the extended interval in accordance with Section 10.2.1.2.

Failures of Type B penetrations discovered during performance of a Type A test should be considered as failures of a Type B test for purposes of cause determination and corrective action. This includes failures of penetrations that were not previously identified by a Type B testing program.

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[1] A failure in this context is exceeding an administrative limit and not the total failure of the penetration. Administrative limits are established at a value low enough to identify and allow early correction of potential total penetration failures.

10.2.2 Containment Airlocks

10.2.2.1 Test Interval

Containment airlock(s) shall be tested at an internal pressure of not less than P_{ac} prior to a preoperational Type A test. Subsequent periodic tests shall be performed at a frequency of at least once per 24 months. Containment airlock tests should be performed in accordance with ANSI/ANS 56.8–1994. In addition, equalizing valves, door seals, and penetrations with resilient seals (i.e., shaft seals, electrical penetrations, view port seals and other similar penetrations) which are testable, shall be tested at a frequency of once per 24 months.

Airlock door seals should be tested prior to a preoperational Type A test. When containment integrity is required, airlock door seals should be tested within 7 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.

Door seals are not required to be tested when containment integrity is not required, however they must be tested prior to reestablishing containment integrity. Door seals shall be tested at P_{ac}, or at a pressure stated in the plant Technical Specifications.

10.2.2.2 Repairs or Adjustments of Airlocks

Following maintenance on an airlock pressure retaining boundary, one of the following tests shall be completed:

- Airlock shall be tested at a pressure of not less than P_{ac}; or
- Leakage rate testing at P_{ac} shall be performed on the affected area or component.

10.2.2.3 Corrective Action

If containment airlock Type B test results are not acceptable, then a cause determination should be performed and corrective actions identified that focus on those activities that can eliminate the identified cause of a failure[2] with appropriate steps to eliminate recurrence. Cause determination and corrective action should reinforce achieving acceptable performance.

10.2.3 Type C Test Interval

10.2.3.1 Initial Test Interval

Type C tests shall be performed prior to initial reactor operation. Subsequent periodic Type C tests shall be performed at a frequency of at least once per 30 months, until adequate performance has been established consistent with Section 10.2.3.2.

10.2.3.2 Extended Test Interval

Test intervals for Type C valves may be increased based upon completion of two consecutive periodic As–found Type C tests where the result of each test is within a licensee's allowable administrative limits. Elapsed time between the first and last tests in a series of consecutive passing tests used to determine performance shall be 24 months or the nominal test interval (e.g., refueling cycle) for the valve prior to implementing Option B to Appendix J. Intervals for Type C testing may be increased to a specific value in a range of frequencies from 24 months up to a maximum of 120 months. Test intervals for Type C valves should be determined by a licensee in accordance with Section 11.0.

10.2.3.3 Repairs or Adjustments

In addition to the periodic As–found Type C test, an As–found Type C test or an alternative test or analysis shall be performed prior to any maintenance, repair, modification, or adjustment activity if it could affect a valve's leak tightness. An As–left Type C test shall be performed following maintenance, repair, modification or adjustment activity unless an alternate testing method or analysis is used to provide reasonable assurance that such work does not affect a valve's leak tightness and a valve will still perform its intended function.

If As–found and As–left Type C test results are both less than a valve's allowable administrative limit, a change of the test frequency is not required. If As–found or As–left test results are greater than the allowable administrative limit, then provisions of Section 10.2.3.4 apply.

The frequency for Type C testing shall be in accordance with Section 10.2.3.1 if a valve is replaced or engineering judgment determines that modification of a valve has invalidated the valve's performance history. Testing shall continue at

[2] A failure in this context is exceeding performance criteria for the airlock, not a total failure.

this frequency until an adequate performance history is established in accordance with Section 10.2.3.2.

10.2.3.4 Corrective Action

If Type C test results are not acceptable, then the testing frequency should be set at the initial test interval per Section 10.2.3.1. In addition, a cause determination should be performed and corrective actions identified that focus on those activities that can eliminate the identified cause of a failure[3] with appropriate steps to eliminate recurrence. Cause determination and corrective action should reinforce achieving acceptable performance. Once the cause determination and corrective actions have been completed, acceptable performance may be reestablished and the testing frequency returned to the extended interval in accordance with Section 10.2.3.2.

Failures of Type C valves that are discovered during performance of a Type A test should be considered as a failure of a Type C test for purposes of cause determination and corrective action. This includes failures of valves that were not previously identified by a Type C test.

11.0 BASIS FOR PERFORMANCE AND RISK–BASED TESTING FREQUENCIES FOR TYPE A, TYPE B, AND TYPE C TESTS

11.1 Introduction

This section provides guidance on establishing leakage testing frequencies and provides information regarding the risk impact of such actions. Extended test intervals in Sections 9.0 and 10.0 have been selected based on performance, and have been assessed for risk impact using historical performance data. The various factors and discussion in this section should be considered when establishing different plant–specific testing frequencies.

Section 10.0 presents a range of acceptable extended test intervals for Type B and Type C tests. Individual licensees may adopt specific testing intervals of up to 60 months or three refueling cycles as discussed in Section 10.0 without additional detailed analysis provided the performance factors discussed in Section 11.3.1 are considered. Additional programmatic controls are discussed in Section 11.3.2 and

[3] A failure in this context is exceeding an administrative limit and not the total failure of the valve. Administrative limits are established at a value low enough to identify and allow early correction of total valve failures.

should be considered when the extended test intervals are greater than 60 months or three refueling cycles.

11.2 Discussion

The effect of extending containment leakage rate testing intervals is a corresponding increase in the likelihood of containment leakage. The degree to which intervals can be extended, if at all, is a direct function of the potential effects on the health and safety of the public that occur due to an increased likelihood of containment leakage.

In order to determine the acceptability of extended testing intervals, the methodology described in NUREG–1493 was applied, with some modifications, to historical representative industry leakage rate testing data gathered from approximately 1987 to 1993, under the auspices of NEI. The range of testing intervals recommended for Type B and Type C testing was evaluated to determine the level of increased risk in the event of an accident. The same methodology was also applied to the 10–year interval for Type A testing. In all cases, the increased risk corresponding to the extended test interval was found to be small and compares well to the guidance of the NRC's safety goals.

NUREG–1493 provides the technical basis to support rulemaking to revise leakage rate testing requirements contained in Option B to Appendix J. The basis consisted of qualitative and quantitative assessments of the risk impact (in terms of increased public dose) associated with a range of extended leakage rate testing intervals.

NUREG–1493 found the effect of Type B and Type C testing on overall accident risk is small and concluded that:

- Performance–based alternatives to local leakage rate testing requirements are feasible without significant risk impacts; and

- Although extended testing intervals led to minor increases in potential off–site dose consequences, the actual decrease in on–site (worker) doses exceeded (by at least an order of magnitude) the potential off–site dose increases.

NEI, in conjunction with EPRI, undertook a similar study in order to supplement NRC's rulemaking basis and provide added assurance the more detailed elements in this guideline have an adequate basis. Results of the EPRI study are documented in EPRI Research Project Report TR–104285, "Risk Impact Assessment of Revised Containment Leak Rate Testing Intervals."

EPRI developed an abbreviated methodology that was used to assess plant risk impact associated with containment leakage rate testing alternatives currently being proposed by this guideline. The overall approach involved an examination of the risk spectra from accidents reported in PWR and BWR IPEs. Plant risk was quantified for a PWR and a BWR representative plants. Quantification of the risk considered the consequences from containment leakage in more detail than reported in IPEs. The impact associated with alternative Type A, Type B and Type C test intervals, measured as a change in risk contribution to baseline risk, is presented in Table 1. The risk values compare well with the analysis in NUREG–1493.

The risk model was specifically quantified by using a "failure to seal" probability (as opposed to failure to close considered in IPEs). This required failure rates to be developed for this failure mode. Type B and Type C test data obtained by NEI allowed determination of failure rates where failure is defined as the measured leakage exceeding allowable administrative limits for a specific Type B or Type C component. The failure rate values were used in the containment isolation system fault tree, and used to calculate a failure–to–seal probability. Characterization of baseline risk (in terms of accident sequences that are influenced by containment isolation valve or containment penetration leakage rate) allowed the plant models to calculate the risk impact associated with changes in test intervals.

As indicated above, historical industry failure rate data was used to develop the component failure to seal probabilities used in the analysis. This approach is quite conservative because these guidelines require demonstration of performance prior to extending the component leakage rate testing interval. The performance demonstration consists of successful completion of two consecutive leakage rate tests to increase the interval from 24 to 60 months or three refueling cycles, and three consecutive leakage rate tests to increase the interval to greater than 60 months or three refueling cycles. This takes advantage of the findings of NUREG–1493, Appendix A, which suggests that "If the component does not fail within two operating cycles, further failures appear to be governed by the random failure rate of the component," and "Any test scheme considered should require a failed component pass at least two consecutive tests before allowing an extended test interval." In addition, the penetration failure analysis considered components which exceeded the administrative limits as failures. The containment leakage rate computation conservatively used maximum pathway leak rates derived from the upper bounds of the NEI data. Therefore, the analysis is very conservative, and the component performance trending provides the necessary confidence demonstration that component leakage is being managed at a low level.

For Type C test, a bounding analysis was performed that assumed all valves have test intervals that were extended to 48, 60, 72 and 120 months. For Type B tests, it was assumed that electrical penetrations were tested at a nominal 120 months frequency. In addition, it was assumed that some portion of the penetrations was tested periodically during the 120 months. Airlock tests were assumed to be conducted every 24 months. Blind flanges were assumed to be tested after each opening, or at 48–month intervals.

There are many points of similarity between the NUREG–1493 report and the EPRI study, both in methodology and assumptions, reflecting close agreement on elements important to safety for containment leakage rate testing. The similarity also extends to the results. The EPRI study confirms the low risk significance associated with Type A testing intervals of 10 years. Similarly, extending the Type B and Type C test intervals to 120 months was found acceptable provided the Type B or Type C components have successfully passed two consecutive tests, and provided that certain controls were imposed on the leakage rate testing program.

Changing Appendix J test intervals from those presently allowed to those in this guideline slightly increases the risk associated with Type A and Type B and Type C–specific accident sequences as discussed in Table 1. The data suggests that increasing the Type C test interval can slightly increase the associated risk, but this ignores the risk reduction benefits associated with increased test intervals. In addition, when considering the total integrated risk (representing all accident sequences analyzed in the IPE), the risk impact associated with increasing test intervals is negligible (less than 0.1 percent of total risk). This finding is further reinforced by the conservative assumptions used in the analysis. The EPRI study reaffirms the conclusion in NUREG–1493 that changes to leakage testing frequencies are "feasible without significant risk impact."

11.3 Plant–Specific Testing Program Factors

A licensee may adopt specific surveillance frequencies from Section 10.0 provided that plant–specific test performance history is acceptable as discussed in Section 10.0, and certain performance factors and controls are reviewed and applied as appropriate in the determination of test intervals. Each licensee should demonstrate by quantitative or qualitative review that plant–specific performance is adequate to support the extended test interval.

An extension of up to 25 percent of the test interval (not to exceed 15 months) may be allowed on a limited basis for scheduling purposes only.

Table 1

Risk Results for Type A, Type B, and Type C Test Intervals

Test Type	*Risk–Impact Current Test Intervals*	*Risk–Impact Extended Test Intervals*	*Comment*
		PWR Representative Plant Summary	
Type A	0.0032% incremental risk contribution, based on $2xL_a$ leakage	0.035% incremental risk contribution, based on test interval 1 in 10 years	Compares well with Surry risk contribution of 0.07%. A range of 0.002 to 0.14 percent is reported for other plants in NUREG–1493.
Type B	«0.001% incremental risk contribution 6.9E–05 person–rem/yr rebaselined risk	<0.001% incremental risk contribution, 1.3E–04 person–rem/yr rebaselined risk. Based on testing with some components tested periodically during time interval months. In addition, blind flanges and penetrations would be removed and retested during every refueling outage. Airlocks to be tested every 24 months.	A range of 0.2 to 4.4 percent is provided for other plants for both Type B and Type C penetrations in NUREG–1493.
Type C	0.022% of total risk 4.9E–03 person–rem/yr	0.04% incremental risk contribution, 8.8E–03 person–rem/yr rebaselined risk, based on 48 month test intervals. 1E–2, 1.2E–2, and 1.64E–2 person–rem/yr risk, based on 60, 72, and 120 month test intervals	A range of 0.2 to 4.4 percent of total risk is provided for other plants for both Type B and Type C penetrations in NUREG–1493.

Table 1 (continued)

BWR Representative Plant Summary			
Type A	0.026% incremental risk contribution, based on $2xL_a$ leakage	0.029% incremental risk contribution, based on test interval 1 in 10 years	Compares well with the Peach Bottom estimated value of 0.038%. A range of 0.02 to 0.14 percent is reported for other plants in NUREG–1493.
Type B	<0.001% of total risk 8.0E–06 person–rem/yr	0.001%, 1.85E–05 person–rem/yr Based on testing with some components tested periodically during time interval months. In addition, blind flanges and penetrations would be removed and retested during every refueling outage. Airlocks to be tested every 24 months.	A range of 0.2 to 4.4 percent is provided for other plants for both B and C penetration types in NUREG–1493.
Type C	0.002% of total risk 4.5E–06 person–rem/yr	0.006% of total risk, 1.1E–04 person–rem/yr, based on 48 months test intervals. 1.8E–4, 2.3E–4, and 5.01E–4 person–rem/yr risk, based on 60, 72, and 120 month test intervals.	A range of 0.2 to 4.4 percent is provided for other plants for both B and C penetration types in NUREG–1493.

11.3.1 Performance Factors

Prior to determining and implementing extended test intervals for Type B and Type C components, an assessment of the plant's containment penetration and valve performance should be performed and documented. The following are some factors that have been identified as important and should be considered in establishing testing intervals:

- *Past Component Performance* — Based on a survey sample of industry data from approximately 1987 to 1993, 97.5% of the industry's containment penetrations have not failed a Type B test, and 90% of the isolation valves have never failed a Type C test in over 500 reactor–years of commercial operation. Of the 10% of the Type C tests that have failed, only 22% of those have failed more than once. A licensee should ensure that leakage rate testing intervals are not extended until plant–specific component performance of two successful consecutive As–found tests are performed.

- *Service* — The environment and use of components are important in determining its likelihood of failure. For example, a plant may have experienced high leakage in valves in a high–flow steam environment due to effects of valve seat erosion. Certain valves that open and close frequently during normal plant operations may have experienced higher leakage. The licensee's existing testing program should identify these types of components to establish their testing intervals based on their performance history.

- *Design* — Valve type and penetration design may contribute to leakage. For example, motor operated valves in a plant may be found to leak less frequently than check valves, and may support a longer test interval. Vendor recommendations for valve or penetration subcomponent service life may be a factor in determining test intervals. Certain passive penetrations, such as electrical penetrations, may have had excellent performance history. Test intervals for these penetrations may be relatively longer.

- *Safety Impact* — The relative importance of penetrations can be judge in terms of the potential impact of failure in limiting releases from containment under accident conditions. Due to size or system inter–connections, some components or penetrations may be more important than others in ensuring the safety function of a containment penetration is achieved. This relative importance should be considered in determining the test interval.

- *Cause Determination* — For failures identified during an extended test interval, a cause determination should be conducted and appropriate corrective actions identified. Part of a corrective action process should be to identify and address common–mode failure mechanisms.

11.3.2 Programmatic Controls

If a licensee considers extended test intervals of greater than 60 months or three refueling cycles for a Type B or Type C tested component, the review to establish surveillance test intervals should include the additional considerations:

- *As–found Tests* — In order to provide additional assurance that the increased probability of component leakage is kept to a minimum, and is reasonably within the envelope of industry data, a licensee should consider requiring three successive periodic As–found tests to determine adequate performance.

- *Schedule* — To minimize any adverse effects of unanticipated random failures, and to increase the likelihood unexpected common–mode failure mechanisms will be identified in a timely manner, a licensee should implement a testing program that ensures components are tested at approximate evenly– distributed intervals across the extended testing interval for valves or groups of valves. A licensee should schedule a portion of the tests during each regularly scheduled outage or on some regular periodic basis, such that some percentage of the components are tested periodically, and all components are tested at the new extended test interval of greater than 60 months or three refueling cycles.

- *Review* — A review of the entire process should be performed prior to establishing alternate test intervals under Option B to 10 CFR 50, including plant–specific performance history, data analysis, establishment of surveillance frequencies, and, if available and applicable, any risk–impact assessment. This review should include adjustments to the program as required, based on expert insight or engineering judgment. Results of the review should be documented.

12.0 RECORDKEEPING

12.1 Report Requirements

A post–outage report shall be prepared presenting results of the previous cycle's Type B and Type C tests, and Type A, Type B, and Type C tests, if performed during that outage. The technical contents of the report are generally described in ANSI/ANS 56.8–1994, and will be available on–site for NRC review. The report shall also show that the applicable performance criteria are met, and serves as a record that continuing performance is acceptable.

12.2 Records

Documentation developed for implementation of Option B to Appendix J should be done in accordance with licensee established procedures. Sufficient documentation shall be collected and retained so that the effectiveness of the implementation of Option B to Appendix J can be reviewed and determined. This documentation shall be available for internal and external review, but is not required to be submitted to the NRC.