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NUCLEAR ENERGY INSTITUTE

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

October xx, 2005

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REVISION 1 TO INDUSTRY GUIDELINE FOR
IMPLEMENTING PERFORMANCE-BASED
OPTION OF 10 CFR PART 50, APPENDIX J

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ACKNOWLEDGMENTS

This guidance document, Industry Guideline for Implementing Performance-Based Option of 10 CFR 50, Appendix J, NEI 94-01, Revision 1, was developed by the Nuclear Energy Institute (NEI) Type A Integrated Leakage Rate Test Interval Extension Task Force. 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 that 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.

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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 revised industry Appendix J guideline.

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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” and in extending Type A Integrated Leak Rate Test (ILRT) surveillance intervals beyond ten years.

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In response to NRC data gathering inquiries, the industry collected, evaluated, and provided summary data that supported the NRC’s independent data analysis of NUREG-1493. To support this 2005 revision, many licensees responded to an NEI request and provided pertinent leakage rate testing experience information covering the period from 1995 to 2005.

Deleted: 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 and for extending the Type A ILRT interval to up to fifteen years. 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 criterion for Type A tests is a performance leakage rate (as defined in this guideline) of less than 1.0L_a. Extension of Type A test intervals are allowed based upon two consecutive successful Type A tests and other requirements stated in Section 9.2.3 of this guideline. These additional requirements include supplemental inspections and a confirmatory plant-specific risk impact assessment. Type A testing shall be performed at a frequency of at least once per 15 years. If the Type A performance leakage rate is not acceptable, the performance criterion is not met, and 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 demonstrating an acceptable performance leakage rate 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 at least once per 15 years. 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. Intervals for Type B and Type C may be increased from 30 months up to a maximum of 120 months (except for containment airlocks), or as specified in Regulatory Guide 1.163. 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_a prior to a preoperational Type A test. 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 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.

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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.

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

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APPENDIX A

■ NRC Rule for Implementing
Performance-Based Leakage Test
Requirements

LIST OF ILLUSTRATIONS

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Project Report 4114-22

1.0 INTRODUCTION

1.1 Background

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, Containment Leakage Rate Testing Program, 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 that penetrate the containment.

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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.

In 1995, the NRC amended the regulations to provide an Option B to the 10CFR50, Appendix J. Option B is a performance-based approach to Appendix J leakage testing requirements. This option, in concert with Regulatory Guide 1.163 and NEI 94-01, Revision 1, allows licensees with good ILRT performance history to reduce the Type A Integrated Leakage Rate Test (ILRT) frequency from three tests in 10 years to at least one test in 15 years. The initial 1995 relaxation of ILRT frequency was based on the NRC risk assessment contained in "Performance-Based Containment Leak-Test Program (NUREG-1493) and EPRI Risk Impact Assessment of Revised Containment Leak Rate Testing Intervals (TR-104285) both of which found that there was a very low increase in risk associated with increasing ILRT surveillance intervals to ten years. Furthermore, the NRC assessment stated that there was an imperceptible increase in risk associated with increasing ILRT intervals up to twenty years. In 2001, many licensees began to submit requests for

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one-time ILRT interval extensions beyond ten years, and it was deemed appropriate to assess the risk involved in extending ILRT intervals beyond ten years. EPRI Product No. 1009325, Revision 1, “Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals” demonstrated that generically there is little risk associated with extension of ILRT intervals of up to fifteen years. However, plant-specific confirmatory risk impact assessments are required.

For Type B and Type C tests, Option B, in concert with Regulatory Guide 1.163 and NEI 94-01, Revision 1, ~~allows~~ 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.

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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.

Plants that have elected to invoke 10CFR50, Appendix J, Option B in concert with NEI 94-01 (1995) and Regulatory Guide 1.163 (1995) and who do not wish to extend ILRT surveillance intervals beyond ten years are not required to comply with this current revision of NEI 94-01, Revision 1.

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 the performance history necessary to extend test intervals as well as the 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. EPRI Product No. 1009325, Revision 1, “Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals” concludes that reducing the frequency of Type A tests (ILRTs) from the current 3 per 10 years to 1 per 15 years leads to a small increase in risk. The approach of the EPRI Risk Impact Assessment included compliance with appropriate current risk-informed guidance of Regulatory Guide 1.174 (1998), “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions in Plant-Specific Changes to the Licensing Basis.”

Type A tests focus 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. These tests collectively satisfy the requirements of 10CFR50, Appendix J, Option B summarized as follows: “These test requirements ensure that (a) leakage through these containments or systems and components penetrating these containments does not exceed allowable leakage rates specified in the Technical Specifications and (b) integrity of the containment structure is maintained during its service life.”

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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;
- ▼ A framework to acknowledge good performance;
- Utilization of risk and performance–based methods, including an awareness of the plant-specific risk impact of extension of ILRT intervals of up to fifteen years: ▼
- An awareness of and attention to supplemental means of assessing and maintaining containment integrity, particularly for ILRT interval extensions

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beyond ten years. Specifically, this includes the Maintenance Rule and ASME Boiler and Pressure Vessel Code, Section XI, Subsections IWE/IWL inspections and

- Licensee flexibility to implement cost-effective testing 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).

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3.0 RESPONSIBILITY

Each licensee should determine if the requirements of the initial 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, or Type B and Type C tests) only.

Plants that have elected to adopt 10CFR50, Appendix J, Option B in concert with NEI 94-01 (1995) and Regulatory Guide 1.163 (1995) and who do not wish to extend ILRT surveillance intervals beyond ten years are not required to comply with this current revision of NEI 94-01, Revision 1.

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 most commonly accepted terms used in this guideline may be found in ANSI/ANS-56.8-1994. The following additional term and its definition is used in this guideline:

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- The performance leakage rate is calculated as the sum of the Type A upper confidence limit (UCL) and as-left minimum pathway leakage rate (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 leakage must be factored into the performance determination.

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174 **6.0 GENERAL REQUIREMENTS**

175
176 Option B of 10 CFR 50, Appendix J states: “Type A tests to measure the
177 containment system overall integrated leakage rate must be conducted under
178 conditions representing design basis loss-of-coolant accident containment peak
179 pressure. A Type A test must be conducted (1) after the containment system has
180 been completed and is ready for operation and (2) at a periodic interval based on
181 the historical performance of the overall containment system as a barrier to fission
182 product releases to reduce the risk from reactor accidents. A general visual
183 inspection of the accessible interior and exterior surfaces of the containment system
184 for structural deterioration which may affect the containment leak-tight integrity
185 must be conducted prior to each test, and at a periodic interval between tests based
186 on the performance of the containment system. The leakage rate must not exceed
187 the allowable leakage rate (La) with margin, as specified in the Technical
188 Specifications. The test results must be compared with previous results to examine
189 the performance history of the overall containment system to limit leakage.”

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190
191 ▼ A review of leakage rate testing experience indicates that only a small
192 percentage of Type A tests have exhibited excessive leakage. Furthermore, the
193 observed leakage rates for the few Type A test failures were only marginally above
194 current limits. These observations, together with the insensitivity of public risk to
195 containment leakage rate at these low levels, suggest that for Type A tests,
196 intervals may be established based on performance. The Type A test is the primary
197 means to detect containment leakage that is not detectable by the Type B and Type
198 C testing programs, and is also used to verify at periodic intervals the accident
199 leakage (La) assumptions in the accident analysis. ▼

Deleted: 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.

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Deleted: Specific details of Type A test requirements are discussed in ANSI/ANS 56.8–1994.

200
201 An LLRT is a test performed on Type B and Type C components. An LLRT is
202 not required for the following cases:

- 203
- 204 • Primary containment boundaries that do not constitute potential primary
205 containment atmospheric pathways during and following a Design Basis
206 Accident (DBA);
 - 207
 - 208 • Boundaries sealed with a qualified seal system; or,
 - 209
 - 210 • Test connection vents and drains between primary containment isolation
211 valves which are one inch or less in size, administratively secured closed and
212 consist of a double barrier.
 - 213

214 For Type B and Type C tests, intervals shall be established based on the
215 performance history of each component. Performance criterion for each component
216 is determined by designating an administrative leakage limit for each component in
217 the Type B and Type C testing program. The acceptance criteria for Type B and
218 Type C tests is based upon demonstrating that the sum of leakage rates at DBA
219 pressure for containment penetrations and valves that are testable, is less than the
220 total allowable leakage rate specified in the plant Technical Specifications.
221

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

- 231
- 232 • Such valves have been demonstrated to have fluid leakage rates that do
233 not exceed those specified in the technical specifications or associated
234 bases, and
- 235
- 236 • The installed isolation valve seal-water system fluid inventory is
237 sufficient to assume the sealing function for at least 30 days at a pressure
238 of 1.10 Pa.
- 239
- 240

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241 7.0 UTILIZATION OF EXISTING PROGRAMS

242

243 Licensees should use existing industry programs, studies, initiatives and
244 data bases, where possible.
245

246 8.0 TESTING METHODOLOGIES FOR TYPE A, B AND C TESTS

247

248 Type A, Type B and Type C tests should be performed using the technical
249 methods and techniques specified in ANSI/ANS-56.8–1994, or other alternative
250 testing methods that have been approved by the NRC. However, because
251 ANSI/ANS 56.8–1994 is not performance-based, certain exceptions and

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252 clarification to methods, techniques and definitions contained in that document are
253 required. These are discussed in the following paragraphs.

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

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257
258 All Appendix J pathways must be properly drained and vented during the
259 performance of the ILRT, with the following exceptions:

- 260
261 • Pathways in systems which are required for proper conduct of the Type A
262 test or to maintain the plant in a safe shutdown condition during the Type
263 A test;
- 264
265 • Pathways in systems that are normally filled with fluid and operable
266 under post-accident conditions;
- 267
268 • Portions of the pathways outside primary containment that are designed
269 to Seismic Category I and at least Safety Class 2; or,
- 270
271 • For planning and scheduling purpose, or ALARA considerations,
272 | pathways which are Type B or C tested within the previous ~~30~~ calendar
273 months need not be vented or drained during the Type A test.

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274
275 The proper methods for draining and venting are specified in ANSI/ANS 56.8–1994.

276
277 It should be noted that the Type B or C tests performed on those pathways
278 must test all of its containment barriers. This includes bonnets, packings, flanged
279 joints, threaded connections, and compression fittings. If the Type B or C test
280 pressurizes any of the pathway's containment barriers in the reverse direction, it
281 must be shown that test results are not affected in a nonconservative manner by
282 | directionality. The ~~as~~-found and the ~~as~~-left leakage rate for all pathways that are
283 not drained and vented must be determined by Type B and Type C testing within
284 | the previous ~~30~~ calendar months of the time that the Type A test is performed and
285 must be added to the Type A leakage rate UCL to determine the overall L_a
286 surveillance acceptance criteria in accordance with the definition in ANSI/ANS
287 56.8–1994.

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288
289 | The ~~as~~-found Type A test results described in ANSI/ANS 56.8–1994 are
290 defined to include the positive differences between the ~~as~~-found and ~~as~~-left LLRT
291 leakage rates for each pathway tested and adjusted prior to the performance of the
292 Type A test (leakage savings). For purposes of determining an acceptable Type A

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293 test for operability considerations, the definitions and discussions found in
294 | ANSI/ANS 56.8–1994 for ~~as~~-found Type A leakage rate should be followed.

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295
296 However, because of the performance-based emphasis on Type A testing,
297 criteria for Type A tests have been defined differently, and do not use the leakage
298 savings value. The performance criteria use a calculated performance leakage rate,
299 | which is defined as the sum of the Type A UCL and ~~as~~-left MNPLR leakage rate for
300 all Type B and Type C pathways that were in service, isolated or not lined up in
301 their test position (i.e., drained and vented to containment atmosphere) prior to
302 performing the Type A test. In addition, any leakage pathways that were isolated
303 during performance of the test because of excessive leakage must be factored into
304 the performance determination. If the ~~pathway~~ leakage can be determined by a
305 local leakage rate test, the ~~as~~-left MNPLR for that leakage path must also be added
306 to the Type A UCL. If ~~the pathway~~ leakage cannot be determined by local leakage
307 rate testing, the performance criteria for the Type A test were not met.

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308
309 ANSI/ANS 56.8–1994 also specifies surveillance acceptance criteria for Type
310 B and Type C tests. The ANSI/ANS 56.8–1994 definition is that the combined
311 leakage rate for all penetrations subject to Type B or Type C tests is limited to less
312 | than or equal to $0.60L_a$, when determined on a MNPLR basis from ~~as~~-found LLRT
313 results; and limited to less than or equal to $0.60L_a$, as determined on a Maximum
314 | Pathway Leakage Rate (MXPLR) basis from the ~~as~~-left LLRT results.

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315
316 Due to the performance-based nature of Option B to Appendix J and this
317 | guideline, it is recommended that acceptance criteria for the combined ~~as~~-found
318 leakage rate for all penetrations subject to Type B or Type C testing be the same as
319 that defined in ANSI/ANS 56.8–1994, with the following additions. The combined
320 | ~~as~~-left leakage rates determined on a MXPLR basis for all penetrations shall be
321 verified to be less than $0.60L_a$ prior to entering a mode where containment
322 integrity is required following an outage or shutdown that included Type B and
323 | Type C testing only. The combined ~~as~~-found leakage rates determined on a
324 MNPLR basis for all penetrations shall be less than $0.60L_a$ at all times when
325 containment integrity is required. These combined leakage rate determinations
326 shall be done with the latest leakage rate test data available, and shall be kept as a
327 running summation of the leakage rates.

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329 9.0 DETERMINING PERFORMANCE-BASED TEST INTERVAL FOR 330 TYPE A TESTS

331 9.1 Introduction

333
334 Determination of the surveillance frequency of Type A tests is based upon
335 satisfactory performance of leakage tests that meet the requirements of Appendix J.
336 Performance in this context refers to both the performance history necessary to
337 determine test intervals as well as overall criteria needed to demonstrate leakage
338 integrity performance. Performance is also used as a basis for demonstrating
339 negligible impact on public health and safety.

340
341 The purpose of Type A testing is to verify the leakage integrity of the
342 containment structure. The primary performance objective of the Type A test is not
343 to quantify an overall containment system leakage rate. The Type A testing
344 methodology as described in ANSI/ANS-56.8-1994, and the modified testing
345 frequencies recommended by this guideline, serves to ensure continued leakage
346 integrity of the containment structure. Type B and Type C testing assures that
347 individual penetrations are essentially leak tight. In addition, aggregate Type B
348 and Type C leakage rates support the leakage tightness of primary containment by
349 minimizing potential leakage paths. A review of performance history has concluded
350 that ~~almost all~~ containment leakage is identified by local leakage rate testing.

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351
352 This section discusses a method to determine a testing frequency for Type A
353 testing based on performance. The extended test interval is based upon industry
354 performance data that was compiled to support development of Option B to
355 Appendix J, and is intended for use by any licensee. In adopting extended test
356 intervals recommended in this guideline, a licensee should perform Type A testing
357 in accordance with recommended industry practices. Additional technical
358 information concerning data analysis may be found in NUREG-1493 and EPRI
359 Product No. 1009325, Revision 1, "Risk Impact Assessment of Extended Integrated
360 Leak Rate Testing Intervals".

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361
362 Consistent with standard scheduling practices for Technical Specifications
363 Required Surveillances, intervals for recommended Type A testing given in this
364 section may be extended by up to 15 months. This option should be used only in
365 cases where refueling schedules have been changed to accommodate other factors.

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366 9.1.1 Performance Criteria

367
368 Performance criteria for establishing Type A test intervals should provide
369 both the standard against which performance is to be measured and basis for
370 determining that performance is acceptable. Because of the performance-based
371 emphasis on Type A testing, the criteria to determine extended Type A test
372

373 intervals have been defined differently than the surveillance acceptance criteria
374 discussed in ANSI/ANS 56.8-1994. This is to make the performance leakage rate
375 more of an indicator of the overall condition of containment leakage integrity.
376

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377 The performance ~~criteria for Type A test allowable leakage is a performance~~
378 ~~leakage rate of~~ less than $1.0L_a$. This allowable performance leakage rate is
379 calculated as the sum of the Type A UCL and ~~as-left~~ MNPLR leakage rate for all
380 Type B and Type C pathways that were in service, isolated, or not lined up in their
381 test position (i.e., drained and vented to containment atmosphere) prior to
382 performing the Type A test. In addition, leakage pathways that were isolated
383 during performance of the test because of excessive leakage must be factored into
384 the performance determination. If the leakage can be determined by a local leakage
385 rate test, the ~~as-left~~ MNPLR for that leakage path must also be added to the Type
386 A UCL. If the ~~pathway~~ leakage cannot be determined by local leakage rate testing,
387 the performance criteria are not met.

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388 Performance criteria do not include addition of the positive differences
389 between the ~~as-found~~ MNPLR and the ~~as-left~~ MNPLR for each pathway tested and
390 adjusted prior to Type A testing (total leakage savings). Total leakage savings are
391 identified through performance of Type B and Type C testing and do not contribute
392 significantly to performance of a Type A test. Failure of Type B and Type C test
393 components found during performance of a Type A test should be reviewed for cause
394 determination and corrective actions. ~~If the pathway leakage cannot be determined~~
395 ~~by local leakage rate testing, the Type A performance criteria are not met.~~

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397 9.1.2 Test Interval

399 Extensions in test intervals are allowed based upon two consecutive, periodic
400 ~~successful~~ Type A tests and ~~requirements stated in Section 9.2.3 of this guideline.~~
401 The elapsed time between the first and the last tests in a series of consecutive
402 passing tests used to determine performance shall be at least 24 months.
403

Deleted: consideration of performance factors as described in Section 11.3, "Plant-Specific Testing Program Factors."

405 9.2 Type A Test

407 9.2.1 Pretest Inspection and Test Methodology

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

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414 | and components. It is recommended that these inspections be performed in
415 | conjunction or coordinated with the ASME Boiler and Pressure Vessel Code, Section
416 | XI, Subsection IWE/IWL required examinations.

417 |
418 | ANSI/ANS ~~56.8–1994 testing~~ methodology states that pathways open to the
419 | primary containment atmosphere under post-DBA conditions shall be drained and
420 | vented to the primary containment atmosphere during a Type A test. There are
421 | three exceptions discussed in ANSI/ANS 56.8–1994 that allow penetrations to be
422 | tested under the LLRT program and the results added to the Type A leakage rate
423 | Upper Confidence Limit (UCL). One exception states that pathways in systems
424 | that are required for proper conduct of the Type A test or to maintain the plant in a
425 | safe condition during the Type A test may be operable in their normal mode.
426 | Proper outage planning should identify systems that are important to shutdown
427 | safety. A sufficient number of systems should be available so as to minimize the
428 | risk during the performance of the Type A test.

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429 |
430 | For planning and scheduling purposes, or ALARA considerations, licensees
431 | may want to consider not venting and draining additional penetrations that are
432 | capable of local leakage rate testing. It should be noted that the Type B or C tests
433 | performed on those pathways must test all of its containment barriers. This
434 | includes bonnets, packings, flanged joints, threaded connections, and compression
435 | fittings. If the Type B or C test pressurizes any of the pathway's containment
436 | barriers in the reverse direction, it must be shown that test results are not affected
437 | in a non-conservative manner by directionality. The ~~as-found~~ and the ~~as-left~~
438 | leakage rate for all pathways that are not drained and vented must be determined
439 | by Type B and Type C testing within the previous ~~30~~ calendar months of the time
440 | that the Type A test is performed and must be added to the Type A leakage rate
441 | UCL to determine the overall L_a surveillance acceptance criteria in accordance with
442 | the definition in ANSI/ANS 56.8–1994.

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444 | 9.2.2 Initial Test Intervals

445 |
446 |
447 | A preoperational Type A test shall be conducted prior to initial reactor
448 | operation. If initial reactor operation is delayed longer than 36 months after
449 | completion of the preoperational Type A test, a second preoperational Type A test
450 | shall be performed prior to initial reactor operations.

451 |
452 | The first periodic Type A test shall be performed within 48 months after the
453 | successful completion of the last preoperational Type A test. Periodic Type A tests
454 | shall be performed at a frequency of at least once per 48 months, until acceptable
455 | performance is established in accordance with Section 9.2.3. The interval for

456 testing should begin at initial reactor operation. Each test interval begins upon
457 completion of a Type A test and ends at the start of the next test.

458
459 If the test interval ends while primary containment integrity is either not
460 required or it is required solely for shutdown activities, the test interval may be
461 extended indefinitely. However, a successful Type A test shall be completed prior to
462 entering the operating mode requiring primary containment integrity.

463 9.2.3 Extended Test Intervals

464
465 Type A testing shall be performed during a period of reactor shutdown at a
466 frequency of at least once per 15 years based on acceptable performance history.
467 Acceptable performance history is defined as successful completion of two
468 consecutive periodic Type A tests where the calculated performance leakage rate
469 was less than 1.0 L_a. A preoperational Type A test may be used as one of the two
470 Type A tests that must be successfully completed to extend the test interval,
471 provided that an engineering analysis is performed to document why a
472 preoperational Type A test can be treated as a periodic test. Elapsed time between
473 the first and last tests in a series of consecutive satisfactory tests used to determine
474 performance shall be at least 24 months.

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475
476 For purposes of determining an extended test interval, the performance
477 leakage rate is determined by summing the UCL (determined by containment
478 leakage rate testing methodology described in ANSI/ANS 56.8–1994) with as-left
479 MNPLR leakage rates for penetrations in service, isolated or not lined up in their
480 accident position (i.e., drained and vented to containment atmosphere) prior to a
481 Type A test. In addition, any leakage pathways that were isolated during
482 performance of the test because of excessive leakage must be factored into the
483 performance determination. If the pathway leakage can be determined by a local
484 leakage rate test, the as-left MNPLR for that leakage path must also be added to
485 the Type A UCL. If the pathway leakage cannot be determined by local leakage
486 rate testing, the performance criteria for the Type A test are not met.

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487
488 In reviewing past performance history, Type A test results may have been
489 calculated and reported using computational techniques other than the Mass Point
490 method from ANSI/ANS 56.8–1994 (e.g., Total Time or Point-to-Point). Reported
491 test results from these previously acceptable Type A tests can be used to establish
492 the performance history. Additionally, a licensee may recalculate past Type A UCL
493 (using the same test intervals as reported) in accordance with ANSI/ANS 56.8–1994
494 Mass Point methodology and its adjoining Termination criteria in order to
495 determine acceptable performance history. In the event where previous Type A
496

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tests were performed at reduced pressure (as described in 10 CFR 50, Appendix J, Option A), at least one of the two consecutive periodic Type A tests shall be performed at peak accident pressure (P_a).

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9.2.3.1 General Requirements for ILRT Interval Extensions Beyond Ten Years

Type A ILRT intervals of up to fifteen years are allowed by this guideline. The Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals, EPRI report 1009325, Revision 1, October 2005, indicates that, generically, the risk impact associated with ILRT interval extensions for intervals up to fifteen years is small. However, plant-specific confirmatory analyses are required. In addition, although the historical containment leak-tight performance has been very good, a few instances of degradation have occurred and have been detected by supplemental means other than Type A ILRTs. These means include ASME Boiler and Pressure Vessel Code Section XI, Subsection IWE/IWL examinations and Maintenance Rule inspections. The following paragraphs summarize the additional requirements for extending ILRT intervals beyond ten years.

9.2.3.2 Supplemental Inspection Requirements

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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 at periodic intervals between Type A tests as specified by the applicable year and addenda of the ASME Boiler and Pressure Vessel Code, Section XI, Subsections IWE and IWL.

9.2.3.3 Plant-Specific Confirmatory Analyses

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To provide plant-specific assurance of the acceptability of the risk impact of extending ILRT intervals up to a maximum of fifteen years, a confirmatory risk impact assessment is required. The assessment should be performed using the approach and methodology described in Chapters 4 and 5 of EPRI Report 1009325, Revision 1.

“Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals”. The analysis is to be performed by the licensee and retained in the plant documentation and records as part of the basis for extending the ILRT interval.

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:

- o Welds of attachments to the surface of steel pressure-retaining boundary;
- o Repair cavities, the depth that does not penetrate required design steel wall by more than 10%, or
- o Welds attaching to steel pressure-retaining boundary penetrations where the nominal diameter of the welds or penetrations do 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-found~~ and ~~as-left~~ values are as determined by the appropriate testing methodology specifically described in ANSI/ANS 56.8-1994.

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9.2.6 Corrective Action

If the Type A performance leakage rate is not acceptable, the performance criterion is not met, and 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 demonstrating an acceptable performance leakage rate 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 at least once per 15 years.

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578 |
579 | Performance criteria do not include addition of the positive differences
580 | between the as-found MNPLR and the as-left MNPLR for each pathway tested and
581 | adjusted prior to Type A testing (total leakage savings). Total leakage savings are
582 | identified through performance of Type B and Type C testing and do not contribute
583 | significantly to performance of a Type A test. As discussed in Section 9.2.3, leakage
584 | paths detected during a Type A test that are caused by failures of Type B and Type
585 | C test components are not required to be included in determination of adequate
586 | performance and Type A test intervals. However, if the pathway leakage cannot be
587 | determined by local leakage rate testing, the Type A performance criteria are not
588 | met. Corrective actions for Type B and Type C failures should be taken in
589 | accordance with Sections 10.2.1.4, 10.2.2.3, or 10.2.3.4 of this guideline.
590 |
591 |
592 |

Deleted: 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. ¶

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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 that 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.

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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

634 documented for each Type B and Type C component prior to the performance of
635 local leakage rate testing. The administrative limits assigned to each component
636 should be specified such that they are an indicator of potential valve or penetration
637 degradation. Administrative limits for airlocks may be equivalent to the
638 surveillance acceptance criteria given for airlocks in Technical Specifications.

639
640 Administrative limits are specific to individual penetrations or valves, and
641 are not the surveillance acceptance criteria for Type B and Type C tests. Due to the
642 performance-based nature of Option B to Appendix J and this guideline, it is
643 recommended that acceptance criteria for the combined leakage rate for all
644 penetrations subject to Type B or Type C testing be defined as follows:

645
646 • The combined ~~as~~-left leakage rates determined on a MXPLR basis for all
647 penetrations shall be verified to be less than $0.60L_a$ prior to entering a
648 mode where containment integrity is required following an outage or
649 shutdown that included Type B and Type C testing only. These combined
650 leakage rate determinations shall be done with the latest leakage rate
651 test data available, and shall be kept as a running summation of the
652 leakage rates.

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653
654 • The ~~as~~-found leakage rates, determined on a MNPLR basis, for all newly
655 tested penetrations when summed with the ~~as~~-left MNPLR leakage rates
656 for all other penetrations shall be less than $0.60L_a$ at all times when
657 containment integrity is required.

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658
659 The surveillance acceptance criteria for airlocks are as specified in Technical
660 Specifications. In addition, there is other leakage rate testing specified in the
661 Technical Specifications that contain Surveillance Acceptance Criteria and
662 Surveillance Frequencies. This guideline does not address the performance-based
663 frequency determination of those surveillances.

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664 10.2.1 Type B Test Intervals

665 666 10.2.1.1 Initial Test Intervals (Except Containment Airlocks)

667
668 Type B tests shall be performed prior to initial reactor operation.
669 Subsequent periodic Type B tests shall be performed at a frequency of at least once
670 per 30 months, until acceptable performance is established per Section 10.2.1.2.
671

672 **10.2.1.2 Extended Test Intervals (Except Containment Airlocks)**

673
674 The test intervals for Type B penetrations may be increased based upon
675 completion of two consecutive periodic as-found Type B tests where results of each
676 test are within a licensee's allowable administrative limits. Elapsed time between
677 the first and last tests in a series of consecutive satisfactory tests used to determine
678 performance shall be 24 months or the nominal test interval (e.g., refueling cycle)
679 for the component prior to implementing Option B to Appendix J. An extended test
680 interval for Type B tests may be increased to a specific value in a range of
681 frequencies from greater than once per 30 months up to a maximum of once per 120
682 months. The specific test interval for Type B penetrations should be determined by
683 a licensee in accordance with Section 11.0.
684

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685 **10.2.1.3 Repairs or Adjustments (Except Containment Airlocks)**

686
687 In addition to the periodic as-found Type B test, an as-found Type B test
688 shall be performed prior to any maintenance, repair, modification, or adjustment
689 activity if the activity could affect the penetration's leak tightness. An as-left Type
690 B test shall be performed following maintenance, repair, modification or adjustment
691 activity. In addition, if a primary containment penetration is opened following as-
692 found testing, a Type B test shall be performed prior to the time primary
693 containment integrity is required. If the as-found and as-left Type B test results
694 are both less than a component's allowable Administrative Limit, a change in test
695 frequency is not required. If as-found or as-left test results are greater than the
696 allowable administrative limit, provisions of Section 10.2.1.4 apply.
697

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698 Frequency for a Type B testing shall be in accordance with Section 10.2.1.1 if
699 the penetration is replaced or engineering judgment determines that modification of
700 the penetration has invalidated the performance history. Testing shall continue at
701 this frequency until adequate performance is established in accordance with
702 Section 10.2.1.2.
703

704 **10.2.1.4 Corrective Action**

705
706 If Type B test results are not acceptable, then the testing frequency should be
707 set at the initial test interval per Section 10.2.1.1. In addition, a cause
708 determination should be performed and corrective actions identified that focus on
709 those activities that can eliminate the identified cause of failure¹ with appropriate
710 steps to eliminate recurrence. Cause determination and corrective action should
711 reinforce achieving acceptable performance. Once the cause determination and
712 corrective actions have been completed, acceptable performance may be

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.

713 reestablished and the testing frequency returned to the extended interval in
714 accordance with Section 10.2.1.2.

715
716 Failures of Type B penetrations discovered during performance of a Type A
717 test should be considered as failures of a Type B test for purposes of cause
718 determination and corrective action. This includes failures of penetrations that
719 were not previously identified by a Type B testing program.

720 721 **10.2.2 Containment Airlocks**

722 723 **10.2.2.1 Test Interval**

724
725 Containment airlock(s) shall be tested at an internal pressure of not less
726 than P_{ac} prior to a preoperational Type A test. Subsequent periodic tests shall be
727 performed at a frequency of at least once per 30 months. Containment airlock tests
728 should be performed in accordance with ANSI/ANS-56.8-1994. In addition,
729 equalizing valves, door seals, and penetrations with resilient seals (i.e., shaft seals,
730 electrical penetrations, view port seals and other similar penetrations) that are
731 testable, shall be tested at a frequency of once per 30 months.

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732
733 Airlock door seals should be tested prior to a preoperational Type A test.
734 When containment integrity is required, airlock door seals should be tested within
735 7 days after each containment access.

736
737 For periods of multiple containment entries where the airlock doors are
738 routinely used for access more frequently than once every 7 days (e.g., shift or daily
739 inspection tours of the containment), door seals may be tested once per 30 days
740 during this time period.

741
742 Door seals are not required to be tested when containment integrity is not
743 required, however they must be tested prior to reestablishing containment
744 integrity. Door seals shall be tested at P_a , or at a pressure stated in the plant
745 Technical Specifications.

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746 747 **10.2.2.2 Repairs or Adjustments of Airlocks**

748
749 Following maintenance on an airlock pressure-retaining boundary, one of the
750 following tests shall be completed:

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- 751
752 • Airlock shall be tested at a pressure of not less than P_a ; or

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753

- 754 | • Leakage rate testing at P_a shall be performed on the affected area or
755 | component.

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756 | **10.2.2.3 Corrective Action**

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757 |
758 | If containment airlock Type B test results are not acceptable, then a cause
759 | determination should be performed and corrective actions identified that focus on
760 | those activities that can eliminate the identified cause of a failure² with appropriate
761 | steps to eliminate recurrence. Cause determination and corrective action should
762 | reinforce achieving acceptable performance.

764 | **10.2.3 Type C Test Interval**

766 | **10.2.3.1 Initial Test Interval**

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

773 | **10.2.3.2 Extended Test Interval**

775 | Test intervals for Type C valves may be increased based upon completion of
776 | two consecutive periodic ~~as~~-found Type C tests where the result of each test is
777 | within a licensee's allowable administrative limits. Elapsed time between the first
778 | and last tests in a series of consecutive passing tests used to determine performance
779 | shall be 24 months or the nominal test interval (e.g., refueling cycle) for the valve
780 | prior to implementing Option B to Appendix J. Intervals for Type C testing may be
781 | increased to a specific value in a range of frequencies from 30 months up to a
782 | maximum of 120 months, ~~or as specified in Regulatory Guide 1.163~~. Test intervals
783 | for Type C valves should be determined by a licensee in accordance with Section
784 | 11.0.

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786 | **10.2.3.3 Repairs or Adjustments**

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

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

796 | If ~~as~~-found and ~~as~~-left Type C test results are both less than a valve's
797 | allowable administrative limit, a change of the test frequency is not required. If ~~as~~-
798 | found or ~~as~~-left test results are greater than the allowable administrative limit,
799 | then provisions of Section 10.2.3.4 apply.

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801 | The frequency for Type C testing shall be in accordance with Section 10.2.3.1
802 | if a valve is replaced or engineering judgment determines that modification of a
803 | valve has invalidated the valve's performance history. Testing shall continue at
804 | this frequency until an adequate performance history is established in accordance
805 | with Section 10.2.3.2.

807 | 10.2.3.4 Corrective Action

809 | ~~If Type~~ C test results are not acceptable, then the testing frequency should be
810 | set at the initial test interval per Section 10.2.3.1. In addition, a cause
811 | determination should be performed and corrective actions identified that focus on
812 | those activities that can eliminate the identified cause of a failure³ with appropriate
813 | steps to eliminate recurrence. Cause determination and corrective action should
814 | reinforce achieving acceptable performance. Once the cause determination and
815 | corrective actions have been completed, acceptable performance may be
816 | reestablished and the testing frequency returned to the extended interval in
817 | accordance with Section 10.2.3.2.

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

823

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.

11.0 **BASES FOR PERFORMANCE AND RISK-BASED TESTING FREQUENCIES FOR TYPE A, TYPE B, AND TYPE C TESTS**

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11.1 **Introduction**

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

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Section 9.0 provides guidance on extending Type A ILRT surveillance intervals.

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

11.2 **Discussion**

Assessments of the risk impact of extending leakage rate testing intervals have been performed at two different times to support similar objectives. The more recent risk impact assessment, completed in 2005, supported optimized ILRT interval extensions of up to fifteen years. The previous assessments completed in 1994-1995 supported Type A ILRT extensions of up to ten years, as well as extensions of Type B and Type C testing intervals.

The objective of the work concluded in 2005 and published as EPRI Product No. 1009325, Revision 1 "Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals" was to perform a generic risk impact assessment for optimized ILRT intervals of up to fifteen years, utilizing current industry performance data and risk-informed guidance, primarily NRC Regulatory Guide 1.174. This risk impact assessment complements the previous EPRI report, TR-104285, *Risk Impact Assessment of Revised Containment Leak Rate Testing Intervals*. The earlier report considered changes to local leak rate testing intervals as well as changes to ILRT testing intervals. The original risk impact assessment considered the change in risk based on population dose, whereas the revision considered dose as well as large early release frequency (LERF) and containment

conditional failure probability (CCFP). The following paragraphs discuss the approach taken and results of this assessment.

Approach

The first step was to obtain current containment leak rate testing and performance information. This was obtained through an NEI industry-wide survey conducted in 2001. A database was generated using this information supplemented with recent industry failure reports and previous survey information. The data indicate that there were no failures that could result in a risk-significant large early release. This information was used to develop the probability of a pre-existing leak in the containment. This information was further supplemented with an expert elicitation to assist in the determination of the risk-significant large failure magnitude and frequency.

Having both the conservative assessment failure probability as well as the expert elicitation, the risk impact was determined for two example plants, a PWR and BWR, with accident classes developed similar to the original EPRI report but with enhancements for assessing changes in LERF.

Results

Using the conservative assumptions concerning the leakage and timing associated with a large early release, the reduction in frequency of the type A ILRT test results in a change in LERF that ranges between the “very small” ($< 1\text{E-}07$) and “small” ($1\text{E-}07$ to $1\text{E-}06$) risk increase regions of Regulatory Guide 1.174. In the cases where the risk increase is conservatively calculated to be greater than the “very small” region, the total LERF is significantly lower than the Regulatory Guide 1.174 threshold criteria of total LERF less than $1\text{E-}05$ per year. The core damage frequency remains unchanged.

Other figures-of-merit have similar very small changes, including the population dose rate and the conditional containment failure probability (CCFP) changing very little over the range of ILRT interval extensions from 3 in 10 years to 1 in 15 years.

The use of less conservative expert elicited values for the frequency and magnitude of large early release probabilities, results in even smaller calculated increases to LERF as a result of changes in the ILRT interval extension.

As can be seen from the two examples as well as the approximately 30 plant-specific analyses developed to date to support one-time ILRT interval extensions, these results, and therefore the conclusions derived from them,

are generically applicable. However, as required in Sections 9.2.3.1 and 9.2.3.3 of this guideline, plant-specific confirmatory risk impact assessments are also required.

Defense-in-depth as well as safety margins are maintained through the continued inspection of containment as required by ASME Section XI, Subsections IWE and IWL, and other required inspections, such as those performed to satisfy the Maintenance Rule. In addition, this guideline requires acceptable historical performance of Type A Integrated Leak Rate Tests before integrated leak rate testing intervals can be extended.

This risk impact assessment confirms previous (NUREG-1493) conclusions regarding risk in extending ILRT intervals up to fifteen years, using current regulatory guidance and risk-informed concepts.

Similar approaches were taken in 1994-1995, although the guidance of Regulatory Guide 1.174 was not available at that time. The following paragraphs discuss these approaches.

The effect of extending containment leakage rate testing intervals is a corresponding increase in the ~~time that an excessive leak path would exist undiscovered and uncorrected~~. The degree to which intervals can be extended is a direct function of the potential effects on the health and safety of the public that occur due to an increased likelihood ~~of undiscovered~~ containment leakage.

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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 ~~provided~~ 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.

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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 PWR and 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 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.

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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 30 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 that 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.

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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

1036 integrated risk (representing all accident sequences analyzed in the IPE), the
1037 risk impact associated with increasing test intervals is negligible (less than
1038 0.1 percent of total risk). This finding is further reinforced by the
1039 conservative assumptions used in the analysis. The EPRI study reaffirms
1040 the conclusion in NUREG-1493 that changes to leakage testing frequencies
1041 are “feasible without significant risk impact.”

Table 1

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

<i>Test Type</i>	<i>Risk-Impact Current Test Intervals</i>	<i>Risk-Impact Extended Test Intervals</i>	<i>Comment</i>
PWR Representative Plant Summary			
Type A	<u>The increase in ILRT test intervals from 3 in 10 years to 1 in 15 years results in a small change in LERF that ranges between the “very small” (<1E-07) and “small” (1E-07 to 1E-06) □ LERF risk increase regions of NRC Regulatory Guide 1.174. In cases where the risk increase is > the “very small” region, the total LERF is significantly lower than the Regulatory Guide 1.174 threshold criteria of total LERF < 1E-05 per year. Changes in population dose and CCFP are also very small.</u>		<u>Please refer to EPRI Report 1009325, Revision 1, PWR example discussion for more information.</u>
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.

Deleted: 0.0032% incremental risk contribution, based on 2xL_a leakage¶
0.035% incremental risk contribution, based on test interval 1 in 10 years¶

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Table 1 (continued)

BWR Representative Plant Summary			
Type A	<p><u>The increase in ILRT test interval from 3 in 10 years to 1 in 15 years results in a change in LERF that falls in the “very small” (<1E-07) □LERF risk increase region of NRC Regulatory Guide 1.174. Moreover, the total LERF is significantly lower than the Regulatory Guide 1.174 threshold criteria of total LERF < 1E-05 per year. Changes in population dose and CCFP are also very small.</u></p>		<p><u>Please refer to EPRI Report 1009325, Revision 1, BWR example discussion for more information.</u></p> <p>Deleted: 0.026% incremental risk contribution, based on 2xL_a leakage</p> <p>Deleted: 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.</p> <p>Deleted: 0.029% incremental risk contribution, based on test interval 1 in 10 years¶</p>
Type B	<p><0.001% of total risk</p> <p>8.0E-06 person-rem/yr</p>	<p>0.001%, 1.85E-05 person-rem/yr</p> <p>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.</p>	<p>A range of 0.2 to 4.4 percent is provided for other plants for both B and C penetration types in NUREG-1493.</p>
Type C	<p>0.002% of total risk</p> <p>4.5E-06 person-rem/yr</p>	<p>0.006% of total risk, 1.1E-04 person-rem/yr, based on 48 months test intervals.</p> <p>1.8E-4, 2.3E-4, and 5.01E-4 person-rem/yr risk, based on 60, 72, and 120 month test intervals.</p>	<p>A range of 0.2 to 4.4 percent is provided for other plants for both B and C penetration types in NUREG-1493.</p>

1048 11.3 Plant-Specific Testing Program Factors

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1050 A licensee may adopt specific surveillance frequencies from Section 10.0
1051 provided that plant-specific test performance history is acceptable as discussed in
1052 Section 10.0, and certain performance factors and controls are reviewed and applied
1053 as appropriate in the determination of test intervals. Each licensee should
1054 demonstrate by quantitative or qualitative review that plant-specific performance
1055 is adequate to support the extended test interval.

1056
1057 An extension of up to 25 percent of the test interval (not to exceed 15 months) may
1058 be allowed on a limited basis for scheduling purposes only.

1059 | 1060 11.3.1 **Performance Factors**

1061
1062 Prior to determining and implementing extended test intervals for Type B
1063 and Type C components, an assessment of the plant's containment penetration and
1064 valve performance should be performed and documented. The following are some
1065 factors that have been identified as important and should be considered in
1066 establishing testing intervals:

- 1067
- 1068 • Past Component Performance — Based on a survey sample of industry data
1069 from approximately 1987 to 1993, 97.5% of the industry's containment
1070 penetrations have not failed a Type B test, and 90% of the isolation valves
1071 have never failed a Type C test in over 500 reactor-years of commercial
1072 operation. Of the 10% of the Type C tests that have failed, only 22% of those
1073 have failed more than once. A licensee should ensure that leakage rate
1074 testing intervals are not extended until plant-specific component
1075 performance of two successful consecutive ~~as~~-found tests are performed.
 - 1076
 - 1077 • Service — The environment and use of components are important in
1078 determining its likelihood of failure. For example, a plant may have
1079 experienced high leakage in valves in a high-flow steam environment due to
1080 effects of valve seat erosion. Certain valves that open and close frequently
1081 during normal plant operations may have experienced higher leakage. The
1082 licensee's existing testing program should identify these types of components
1083 to establish their testing intervals based on their performance history.
 - 1084
 - 1085 • Design — Valve type and penetration design may contribute to leakage. For
1086 example, motor operated valves in a plant may be found to leak less
1087 frequently than check valves, and may support a longer test interval. Vendor
1088 recommendations for valve or penetration subcomponent service life may be a
1089 factor in determining test intervals. Certain passive penetrations, such as
1090 electrical penetrations, may have had excellent performance history. Test
1091 intervals for these penetrations may be relatively longer.

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- *Safety Impact* — The relative importance of penetrations can be judged 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.

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1135 **12.0 RECORDKEEPING**

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1137 **12.1 Report Requirements**

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1139 A post-outage report shall be prepared presenting results of the previous
1140 cycle's Type B and Type C tests, and Type A, Type B, and Type C tests, if performed
1141 during that outage. The technical contents of the report are generally described in
1142 ANSI/ANS 56.8-1994, and will be available on-site for NRC review. The report
1143 shall also show that the applicable performance criteria are met, and serve as a
1144 record that continuing performance is acceptable.

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1146 **12.2 Records**

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1148 Documentation developed for implementation of Option B to Appendix J
1149 should be done in accordance with licensee established procedures. Sufficient
1150 documentation shall be collected and retained so that the effectiveness of the
1151 implementation of Option B to Appendix J can be reviewed and determined. This
1152 documentation, including the plant-specific confirmatory risk impact assessment for
1153 extending ILRT intervals beyond ten years shall be available for internal and
1154 external review, but is not required to be submitted to the NRC.

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