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DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-1115

DEMONSTRATING CONTROL ROOM ENVELOPE INTEGRITY AT NUCLEAR POWER REACTORS

A. INTRODUCTION

Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” establishes the principal design criteria for the design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety. General Design Criterion 19 (GDC-19), “Control Room,” of Appendix A requires that a control room be provided from which actions can be taken to operate the nuclear reactor safely under normal conditions and maintain the reactor in a safe condition under accident conditions, including a loss-of-coolant accident (LOCA). Adequate radiation protection is to be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of specified values. Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” to 10 CFR Part 50 establishes quality assurance requirements for the design, construction, and operation of those structures, systems, and components that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public. Criterion III, “Design Control,” of Appendix B requires that design control measures be provided for verifying or checking the adequacy of design. A suitable testing program is identified as one method of accomplishing this verification.

This guide endorses Appendix I, “Testing Program,” of Nuclear Energy Institute report NEI 99-03, “Control Room Habitability Assessment Guidance” (Ref. 1), with the exceptions and clarifications stated in the Regulatory Position, as an acceptable approach to measuring inleakage

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This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received complete staff review or approval and does not represent an official NRC staff position.

Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rules and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted electronically or downloaded through the NRC’s interactive web site at <WWW.NRC.GOV> through Rulemaking. Copies of comments received may be examined at the NRC Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by **June 28, 2002.**

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into the control room and associated rooms and areas at nuclear power reactors. The amount of inleakage is an input to the design of the control room and periodic verification of the inleakage provides assurance that the control room will be habitable during normal and accident conditions. Appendix I of NEI 99-03 provides guidance on preparing for and performing inleakage tests to demonstrate conformance with the criteria of GDC-19.

Regulatory guides are issued to describe to the public methods acceptable to the NRC staff for implementing specific parts of NRC's regulations, to explain techniques used by the staff in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with regulatory guides is not required. Regulatory guides are issued in draft form for public comment to involve the public in developing the regulatory positions. Draft regulatory guides have not received complete staff review; they therefore do not represent official NRC staff positions.

The information collections contained in this draft regulatory guide are covered by the requirements of 10 CFR Part 50, which were approved by the Office of Management and Budget (OMB), approval number 3150-0011. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

B. DISCUSSION

The control room is that plant area in which actions can be taken to operate the plant safely under normal conditions and to maintain the reactor in a safe condition during accident situations. The control room envelope (CRE) encompasses the control room and may encompass the alternate shutdown panel and other rooms and areas to which personnel access may be necessary to accomplish plant control functions in the event of an accident. The structures that make up the CRE are designed to limit the inleakage of radioactive and toxic materials[1] from areas external to the CRE. Control room habitability systems (CRHSs) typically provide the functions of shielding, isolation, pressurization, heating, ventilation, air conditioning and filtration, monitoring, and sustenance and sanitation necessary to ensure that the control room operators can remain in the control room and take actions to operate the plant under normal conditions and maintain it in a safe condition during accident situations. The personnel protection features incorporated into the design of a particular plant's CRHS depend on the nature and scope of the plant-specific challenges to maintaining CRE habitability. In the majority of the CRHS designs, isolation of the CRE atmosphere from that of adjacent areas is fundamental to ensuring a habitable control room.

During the design of a nuclear power plant, analyses are performed to demonstrate that the design of the CRE and the CRHSs will provide a habitable environment for postulated design basis events. These design analyses are performed assuming a certain amount of inleakage. Unanticipated increases in the amount of contaminants entering the CRE may have an adverse effect on the ability of the operator to perform plant control functions. If the response of the operator to accident events is impaired, there could be increased consequences to the public health and safety. Plants with a CRE design based on isolation and pressurization (i.e., positive CRE) have generally implemented testing programs that verify that the CRE is at a positive differential pressure (ΔP) relative to adjacent areas. This testing program was generally

[1] See Regulatory Guide 1.78, Revision 1, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release" (Ref. 2), for guidance on identifying hazardous chemicals that may impact CRE habitability.

implemented via Technical Specification surveillance requirements for the CRHS. Plants with a CRE design based on isolation without intentional pressurization (i.e., neutral[2] CRE) typically do not have an integrity testing program.

Recent CRE integrity tests performed by approximately 30 percent of the licensed facilities have measured inleakage greater than that assumed in the design analyses, in some cases by several orders of magnitude. Some of these facilities had routinely performed surveillance tests demonstrating a positive ΔP relative to adjacent areas. Although the affected facilities were subsequently able to demonstrate compliance to GDC-19, the testing experience showed that ΔP testing may not be reliable in identifying the amount of inleakage. The ΔP surveillance test has two inherent deficiencies. First, it is not a direct measurement of CRE inleakage. An inference is made from the ΔP measurement that contamination will be unable to enter the CRE if it is at a higher pressure than adjacent areas. Second, since this test only ascertains the ΔP achieved, it cannot assess whether there may be unrecognized sources of pressurization that, in an emergency, could introduce contaminants into the CRE. Inleakage to CRHS fan suction ductwork located outside the CRE or leakage from pressurized ductwork traversing a lower pressure CRE en route to another plant area are examples of possible contamination pathways.

The CRE integrity results discussed above were performed using the standard test methods described in American Society for Testing and Materials (ASTM) consensus standard E741-95, “Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution” (Ref. 3). The standard test method is a direct measurement of the total CRE inleakage from all sources and is well suited for assessing integrity of positive or neutral CREs. Basically, the method involves homogeneously dispersing a nontoxic tracer gas throughout the CRE envelope and measuring the dilution of the tracer gas caused by inleakage.

Although maintaining CRE integrity will minimize the inleakage of radioactive materials released during an accident and thereby minimize operator exposure to radiation, radiation is only one of the potential design basis challenges to the protection of the operator. Although the focus of many CRE integrity testing programs is on radiological concerns, inleakage of other contaminants can often have a greater impact on CRE habitability. An inleakage rate tolerable for one contaminant may not be tolerable for another. The CRE licensing basis describes the hazardous chemical releases considered in the CRE design and the design features and administrative controls implemented to mitigate the consequences of these releases on the control room operator. Regulatory Guide 1.78 (Ref. 2) provides guidance on evaluating control room habitability during postulated hazardous chemical releases. Although Section 3.4 of Regulatory Guide 1.78 provides guidance on inleakage testing, it defers to this proposed draft guide for further guidance. Smoke and other byproducts from fires within the CRE and in adjacent areas can have an adverse impact on control room habitability. CRE integrity testing for smoke and other fire byproducts is not specifically addressed by this draft guide. Refer to guidance being developed in Draft Regulatory Guide DG-1114, “Control Room Habitability at Nuclear Power Reactors” (Ref.4), for qualitative evaluations to ensure that the control room and the alternate shutdown capability are not likely to be simultaneously contaminated and rendered uninhabitable by a fire.

The performance of the CRE and the CRHSs can be affected by gradual degradation in associated equipment such as seals, floor drain traps, fans, ductwork and other components; drift in throttled dampers; maintenance on the CRE boundary or the CRHS; changes in

[2] The term *neutral* is used here. With no intentional pressurization, the pressure of the CRE relative to adjacent areas may be either negative or positive.

differential pressures caused by ventilation system changes, and inadvertent misalignments of the CRHSs. Since inleakage is a function of pressure differentials between the CRE and external areas, changes in ambient pressures in these areas can impact the CRE inleakage. These changes could be the result of modification or degradation of the ventilation systems serving these areas. Preventive and corrective maintenance programs, in conjunction with periodic integrity testing, provide a level of assurance of adequate CRE performance. Draft Regulatory Guide DG-1114 is being developed to provide guidance on CRE maintenance programs. Periodic inleakage testing provides a measure of the effectiveness of these maintenance programs.

C. REGULATORY POSITION

Appendix I, “Testing Program,” of Nuclear Energy Institute report NEI 99-03, “Control Room Habitability Assessment Guidance” (Ref. 1), dated June 2001, is an approach acceptable to the NRC staff for measuring inleakage into the CRE at nuclear power reactors, with the exceptions and clarifications stated in this Regulatory Position. Appendix F, “Compensatory Measures Allowable on an Interim Basis,” Appendix H, “System Assessment,” and Appendix J, “Control Room Envelope Sealing Program,” are referenced by Appendix I and are endorsed as useful resources for use with Appendix I, with clarifications stated in this Regulatory Position. Except as stated herein, the staff’s endorsement of Appendices F, H, I, and J should not be considered an endorsement of the remainder of NEI 99-03 or any other document that is referenced in these appendices.

1. EXCEPTIONS

1.1 Baseline Testing

Section 5.3 of Appendix I discusses the selection of a method for baseline testing. Two methods are identified: (1) an integrated tracer gas test using methods described in ASME E741-95 (Ref. 3), and (2) a component testing procedure. Section 5.3 of Appendix I (Ref. 1) also allows for unspecified alternative tests that may be applicable in certain situations. Although Section 5.3 of Appendix I provides some guidance, the selection is largely at the discretion of the licensee.

The staff has determined that a baseline integrated inleakage test should be performed, using test methods described in ASME E741-95 (Ref. 3), for each CRE at plants holding operating licenses. These tests should provide an experience base for decisions on the nature and frequency of subsequent periodic testing. See Regulatory Position 3 for guidance on frequency of testing. Newly constructed plants should perform the integrated test as part of plant startup testing activities.[3] The staff bases this exception on the following considerations:

- The staff cannot make a finding regarding the acceptability of an alternative test method since the general attributes discussed in Section 5.3.3 do not provide an adequate basis for making that determination.

[3] The staff will consider alternatives for advanced reactor designs in which the consequences of design basis accidents and hazardous material releases are such that compliance with GDC-19 can be shown without crediting isolation of the CRE.

- The component testing method described in Sections 5.3.2 and 5.4.2 relies on the performance of differential pressure testing to establish that a positive pressure differential exists between the CRE and all adjacent areas. An inleakage test is then performed for any component that cannot be verified to have a positive differential pressure across the CRE boundary. The staff finds this test method to be an extension of the traditional ΔP surveillance test discussed in Section B, "Discussion," of this guide. Industry experience with tests performed with tracer gas methods has shown that the ΔP tests can underestimate the amount of inleakage, in some cases by orders of magnitude. The ΔP test method has two inherent limitations. First, these tests are not a direct measurement of inleakage. Second, the test cannot identify any unrecognized source of inleakage that results in pressurization of the CRE. A component test performed as described in Section 5.4.2 would only quantify the inleakage through those components that were selected for testing. This protocol compensates for the first inherent deficiency of a ΔP test, but only to the extent that the sum of the inleakage through the components selected for testing constitutes a substantial fraction of the total leakage through all inleakage paths. The industry experience with tracer gas testing performed to date indicates that unexpectedly high inleakage results were obtained at CREs that had previously undergone ΔP testing and that these unexpected results were often associated with unrecognized inleakage pathways. Section 5.4.2.2 provides for licensees to consider each component that is vulnerable to inleakage and references Appendix H. Although the staff has determined that Appendix H provides useful guidance for assessing the CRE, the selection of components to be tested based on this guidance is subjective. The staff believes that an integrated test using the test methods of ASME E741-95 is necessary to confirm the appropriateness of these selections.

The NRC staff acknowledges the Advisory Committee on Reactor Safeguards (ACRS) comment that "The staff should require that the results of component testing be validated by comparison with those of tracer gas testing in several control room configurations prior to the staff agreeing to the exclusive use of component testing for pressurized control rooms" (Ref. 5). The ACRS also stated that "The staff will need to confirm that component testing can reliably establish the total unfiltered in-leakage" (Ref. 5). To date, no formal industry justification for component testing has been provided to the staff. Therefore, the NRC staff sees no viable option other than the baseline testing presented in this Regulatory Position.

After an integrated inleakage test has been performed on a particular CRE, licensees may propose a component test as described in Section 5.3.1 or an alternative test as addressed in Section 5.3.3, as the test method to be used in subsequent periodic testing. The staff expects to reconsider its position after the test experience of facilities that have not yet performed integrated inleakage tests becomes available.

1.2 Component Testing

Section 5.3.2 provides four characteristics of a CRE design that support the use of component testing. The NRC staff considers these characteristics prerequisites to be met for a component test to be found acceptable. In addition, the staff finds that the following three additional conditions are to be met for component testing to be acceptable:

- An integrated inleakage test, as discussed in Sections 5.3.1 and 5.4.1, is performed to determine the total boundary leakage,

- Component testing accounts for no less than 95 percent of the total boundary leakage,[4]

- Approximately 20 percent margin exists between the radiation doses or hazardous chemical concentrations calculated using the measured total boundary leakage and the corresponding acceptance criterion.

If a licensee commits to use this regulatory guide, the staff will not find component testing acceptable unless all three of these conditions are met.

The first condition is consistent with the NRC staff's position taken in Regulatory Position 1.1. The 95 percent correlation is consistent with the confidence levels used in other design basis applications. The staff has determined that there should be margin in the analyzed radiation dose or hazardous chemical concentrations to account for the greater uncertainties involved with component testing. Although the inleakage tests for the individual components may have lesser uncertainty, the staff considers the stated 20 percent margin a reasonable value to compensate for the uncertainties involved with the companion differential pressure testing and the identification of vulnerable components.

Section 5.4.2.1, "Differential Pressure Measurements," provides guidance on performing a ΔP test as a precursor to component testing to show that the CRE is at a positive pressure so that it can be concluded that inleakage will not occur across the CRE walls, floors, ceilings, and roofs. The guidance establishes a 0.125-inch water gage differential pressure criterion for adjacent areas that are essentially outside atmosphere and a 0.05-inch water gage criterion for adjacent areas inside a building where conditions are more stable. The NRC staff does not consider that an adequate basis exists for making this distinction. A 0.125-inch water gage criterion should be used for both types of adjacent areas. Although the environmental conditions within an adjacent area may be stable during the relatively short duration of the test, the conditions may not be as stable over the longer-term duration (e.g., 30 days) of the accident. The larger criterion provides margin for temperature and pressure gradients that cannot be adequately simulated in a test, such as those caused by accident-induced leakage or ruptures in areas adjacent to the CRE.

2. CLARIFICATIONS

2.1 Licensing Bases

Several references are made in Appendix I to NEI 99-03 to "licensing bases"[5] and "design bases." The licensing bases should be considered in establishing all aspects of the CRE integrity test program. Guidance on establishing the licensing bases for the CRE and CRHS is being developed in Draft Regulatory Guide DG-1114 (Ref. 4). In developing the various aspects of the CRE integrity test program, consideration should be given to the licensing bases as they apply to all CRHS operating modes: normal, hazardous chemical, and radiological. The licensing bases of ventilation systems in areas adjacent to the CRE should be considered since these systems can often affect the pressure differential across the CRE boundary and increase inleakage. The

[4] Filtered air intake for the purpose of intentional CRE pressurization is not considered in total boundary leakage when assessing inleakage for radiological challenges. Adjustments for projected ingress and egress are not included for radiological or hazardous chemical cases.

[5] As used in this guide, licensing basis is the documentation that describes how the plant meets applicable regulations. Design Bases are defined in 10 CFR 50.2. Regulatory Guide 1.186, "Guidance and Examples for Identifying 10 CFR 50.2 Design Bases" (Ref. 6), provides additional guidance. The design bases are a subset of the licensing bases. Thus, licensing bases will be used in this draft guide to refer to both.

impact of licensing basis assumptions regarding loss of offsite power and single failures should also be considered.

2.2 CRHS Alignment and Operation

One of the attributes in Section 4, "Test Attributes," of Appendix I provides that testing be conducted with systems and components in their accident configuration. Similar statements are made in Section 5.1 and elsewhere in Appendix I. The NRC staff recommends that periodic surveillance tests that assess performance of these systems be scheduled prior to conducting the integrity test to ensure that system flows and alignments are appropriate. The staff generally agrees that system alignment and operation should be in the accident mode alignments as established by the licensing bases. However, consideration should also be given to manual re-alignments directed by alarm response, abnormal operating, and emergency operating procedures. The staff recognizes that accident alignments may need to be modified, for test purposes, to properly simulate conditions such as the loss of offsite power and single failures. For neutral CREs, ventilation systems may need to be placed in abnormal alignments in order to develop the pressure differential across the CRE boundary needed to accomplish the test. In order to promote good mixing within the CRE during a tracer gas test, it may be necessary to install temporary mixing fans and open normally closed internal doors. These temporary modifications should be minimized to the extent possible. If such deviations from the licensing bases alignments are needed, a sensitivity evaluation should be performed to demonstrate with reasonable assurance that the measured inleakage is bounding for the licensing bases configuration that would exist during an accident. This evaluation should be documented with the test results.

2.3 Limiting Condition

The limiting condition with regard to CRE integrity testing[6] is the licensing basis configuration that results in the maximum amount of inleakage as measured in flow rate units (e.g., cfm). The limiting condition may depend on the following variables:

- The CRHS operating mode
- Most limiting single failure
- Availability of offsite power
- Response of ventilation systems serving areas adjacent to the CRE
- Automatic or manually initiated configuration changes during the event
- Possible synergies between the above variables.

Given the number of variables, it may not always be possible to identify the limiting condition for a CRE integrity test a priori. Testing of multiple configurations could be necessary and may be desirable. Nonetheless, it may be possible to develop a bounding case. The CRE integrity test should be performed for the limiting condition, and any other configuration for which an engineering evaluation cannot show with reasonable assurance that the associated inleakage would be bounded by that value measured for the alignment tested.

[6] The *overall* limiting condition for control room habitability is the product of the source concentration, source mitigation (e.g., filters), and the amount of inleakage. These factors are considered in establishing the acceptance criteria (see Regulatory Position 2.4). The objective of the inleakage testing is to measure the maximum possible inleakage for the licensing basis configurations.

Pre-conditioning of the CRE boundary by seal replacement or adjustment, ventilation re-balancing, or other similar maintenance actions should not be performed closely prior to a scheduled integrity test. Only by obtaining a true "as found" inleakage measurement can gradual degradation be assessed and corrective action taken to preclude re-occurrence.

2.4. Inleakage Test Acceptance Criteria

The acceptance criteria for CRE habitability are provided in GDC-19, with additional guidance provided in Regulatory Position 3.1 of Regulatory Guide 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release" (Ref. 2); Regulatory Position 4.4 of Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors" (Ref. 7); and guidance being developed in Regulatory Position 4.5 of Draft Regulatory Guide DG-1113, "Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light-Water Nuclear Power Reactors" (Ref. 8), as applicable. These acceptance criteria are specified in terms of the consequences to the control room operator. The amount of inleakage that results in consequences no greater than the applicable acceptance criterion is the maximum allowable inleakage. The maximum allowable inleakage for any CRHS operating mode and contaminant is the inleakage test acceptance criterion.[7] If multiple tests are performed as identified in Regulatory Position 2.3, there will be an acceptance criterion for each CRHS operating mode and or contaminant.

The determination of the maximum allowable inleakage should be based on consequence analyses that incorporate the same licensing bases assumptions used for demonstrating compliance with GDC-19. References 2, 7, and 8 provide analysis guidance. Inleakage during ingress and egress should be included. The staff considers 10 cfm as a reasonable projection. The analyses should be performed for each hazardous chemical applicable to the plant, and each design basis accident (DBA) analyzed in the plant's safety analysis report. It is generally not sufficient to analyze only the DBA LOCA, since other DBAs may be more limiting with regard to control room habitability and may necessitate a smaller maximum allowable inleakage.[8]

2.5 Alternative Test Methods

Section 5.3.3 of Appendix I addresses alternative test methods. The guidance states that the test proposal should include sufficient information to allow a knowledgeable reviewer to ascertain the acceptability of the test. The following information should be submitted:

- Summary of the test method
- Description of the test apparatus and tolerances
- Parameter specifications
- Material requirements

[7] Applicants and licensees may wish to use a lesser value as the test acceptance criteria to provide margin for potential changes in plant parameters used in the analyses.

[8] Accident-specific differences include but are not limited to (1) the location and height of accident-specific release points relative to the CRHS outside air intakes and inleakage paths, (2) differences in the timing and duration of radioactivity releases, and (3) differences in the means of actuating CRE protective measures, including instrumentation sensitivity to the various radionuclide mixes and the inherent delays involved in detecting and responding to the initiating condition.

- Safety implications of the test (e.g., personnel safety, impact on plant operations, plant equipment)
- Preparations before initiation of the test
- Calibration of the test equipment
- Test procedure
- Manner of calculating inleakage and associated error from test results
- Uncertainty (e.g., precision, accuracy) of results obtained with the test method
- Results obtained from at least two other applications of the test method on CREs of similar design, configuration, operation, and performance. These results should demonstrate that the method is at least as reliable in measuring inleakage as the ASME E741-95 (Ref. 3) test methods.

Footnote 3 to Table I-1 identifies a tracer gas test method that is under development. This new test method should be treated as an alternative test method.

2.6 Compensatory Actions

Section 5.1, "Prerequisites to Testing," of Appendix I provides for the development of contingency plans, including compensatory measures to contend with unacceptable results. Guidance is being developed in Regulatory Position 2.7.3 of DG-1114 (Ref. 4) on the use of personal respiratory protection devices and the use of potassium iodide (KI) on an interim basis while corrective actions are being taken to resolve the unacceptable integrity testing results.

3. TESTING FREQUENCY

All CREs should be tested prior to initial reactor startup and thereafter on a performance-based periodic frequency. Facilities that have not tested their CREs for integrity should perform an integrated test to establish the baseline value for unfiltered inleakage for each CRE. Subsequent tests should be conducted at 24-month intervals following the initial test. Thereafter, based on actual industry experience from the initial and first 24-month subsequent testing, the NRC staff will reconsider this guidance with input from interested stakeholders to develop an appropriate performance-based frequency.

In addition to the above, CRE testing should be performed when changes are made to the structures, systems, components, and procedures that could impact CRE integrity. Such structures, systems, and components could be within the envelope itself or could serve or be within areas adjacent to the envelope. Additional testing may be warranted if the limiting condition should change. This testing should be commensurate with the type and degree of modifications or repairs that have been made.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This proposed guide has been released to encourage public participation in its development. Except when an applicant or licensee proposes an acceptable alternative method for complying with specified portions of the NRC's regulations, the methods to be

described in the active guide reflecting public comments will be used by the NRC staff for evaluating the adequacy of CRE integrity testing for plants for which the construction permit or license application (but not for license renewal if the current licensing basis is maintained) is docketed after the issue date of this guide and plants for which the licensee voluntarily commits to the provisions of this guide.

REFERENCES

1. "Control Room Habitability Assessment Guidance," NEI 99-03, Revision 0, Nuclear Energy Institute, June 2001.[1]

2. USNRC, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," Regulatory Guide 1.78, Revision 1, January 2002.[2]

3. "Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution," ASTM E741-95, American Society for Testing and Materials, 1995.[3]

4. USNRC, "Control Room Habitability at Nuclear Power Reactors," Draft Regulatory Guide DG-1114, March 2002.[2]

5. D.A. Powers, ACRS, Letter to W.D. Travers, USNRC, Subject: Nuclear Energy Institute Draft Report, NEI 99-03, "Control Room Habitability Assessment Guidance," December 14, 2002.[1]

6. USNRC, "Guidance and Examples for Identifying 10 CFR 50.2 Design Bases," Regulatory Guide 1.186, December 2000.[2]

7. USNRC, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Regulatory Guide 1.183, July 2000.[2]

8. USNRC, "Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light-Water Nuclear Power Reactors," Draft Regulatory Guide DG-1113, January 2002.[2]

[1] Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or 1-(800)397-4209; fax (301)415-3548; e-mail <PDR@NRC.GOV>.

[2] Single copies of regulatory guides, both active and draft, and draft NUREG documents may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555-0001, or by fax to (301)415-2289, or by email to <DISTRIBUTION@NRC.GOV>. Active guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161; telephone (703)487-4650; online <http://www.ntis.gov/ordernow>. Certain documents are also available through the NRC's Electronic Reading Room at <www.NRC.GOV>.

[3] American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

APPENDIX A
Acronyms

ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CRE	Control room envelope
CRHS	Control room habitability system
DBA	Design basis accident
GDC	General Design Criterion (10 CFR Part 50, Appendix A)
LOCA	Loss-of-coolant accident
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
OMB	Office of Management and Budget
ΔP	Differential pressure

REGULATORY ANALYSIS

I. STATEMENT OF PROBLEM

The NRC staff is proposing to develop and issue a new regulatory guide, "Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors," that will endorse, with exceptions and clarifications, Appendix I, "Testing Program," of the Nuclear Energy Institute's (NEI's) report, NEI 99-03, "Control Room Habitability Assessment Guidance," which is dated June 2001 (Ref. RA-1). Appendix F, "Compensatory Measures Allowable on an Interim Basis"; Appendix H, "System Assessment"; and Appendix J, "Control Room Envelope Sealing Program," are referenced by Appendix I and are endorsed, with clarifications, as useful resources for use with Appendix I. The NRC staff proposes to issue a draft guide for public review and comment, and upon resolution of public comments, to finalize and implement the guide.

The control room envelope (CRE) encompasses the control room and may encompass the alternate shutdown panel and other rooms and areas to which personnel access may be necessary to accomplish plant control functions in the event of an accident. The structures that make up the CRE are designed to limit the inleakage of radioactive and toxic materials from areas external to the CRE. Control room habitability systems (CRHSs) incorporate personnel protection features necessary to ensure that the control room operators can remain in the control room and take actions to operate the plant under normal conditions and maintain it in a safe condition during accident situations. Isolation of the CRE atmosphere from that of adjacent areas is fundamental to ensuring a habitable control room. Unanticipated increases in the amount of contaminants that enter the CRE may have an adverse effect on the ability of the operator to perform plant control functions. If the response of the operator to accident events is impaired, there could be increased consequences to public health and safety.

The NRC identified CRE integrity as one of the control room habitability problems during a series of plant visits conducted between 1985-1987 as a part of the staff response to concerns and recommendations of the Advisory Committee on Reactor Safeguards (ACRS). NUREG/CR-4960, "Control Room Habitability Survey of Licensed Commercial Nuclear Power Generating Stations" (Ref. RA-2), presents the results of this survey. The major conclusion of the report is that the numerous observed discrepancies may be indicative of similar discrepancies throughout the industry. The issue of CRE integrity was identified by the NRC in Information Notice 86-76, "Problems Noted In Control Room Emergency Ventilation Systems" (Ref. RA-3), at various DOE/NRC Air Cleaning Conferences and at industry engineering society and engineering organizational meetings (e.g., American Society of Mechanical Engineers or Nuclear Heating, Ventilation, and Air Conditioning Users Group). In 1992, Zion became the first nuclear power plant to rigorously test its CRE for integrity. Since then, approximately 30 percent of the licensed facilities have performed integrated inleakage testing and have measured inleakage rates greater than that assumed in the original design analyses, in some cases by several orders of magnitude.

In March 1998, the staff briefed the Office of Nuclear Reactor Regulation (NRR) Executive Team (ET) on its concerns regarding control room habitability. The ET directed the staff to work with NEI to resolve the issues. The staff, with NEI and the Nuclear Heating, Ventilation, and Air Conditioning Users Group (NHUG) co-hosted a control room habitability workshop in July 1998. NEI prepared draft versions of a report entitled "Control Room Habitability Assessment Guidance," NEI 99-03. The staff reviewed the October 13, 2000,

revision and determined that, while there was much agreement on positions taken in the document, there were still areas in which the staff and industry were in disagreement. It was determined at that time that the staff would prepare and issue formal guidance. A task action plan was prepared. The action plan called for the preparation of a generic letter and four supporting regulatory guides, including the guide considered here.

II. EXISTING REGULATORY FRAMEWORK

Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," establishes the principal design criteria for the design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety. General Design Criterion 19 (GDC-19), "Control Room," of Appendix A requires that a control room be provided from which actions can be taken to operate the nuclear reactor safely under normal conditions and to maintain the reactor in a safe condition under accident conditions, including a loss-of-coolant accident (LOCA). Adequate radiation protection is to be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of specified values. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 establishes quality assurance requirements for the design, construction, and operation of those structures, systems, and components that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public. Criterion III, "Design Control," of Appendix B requires that design control measures be provided for verifying or checking the adequacy of design. A suitable testing program is identified as one method of accomplishing this verification.

Control rooms at currently licensed plants can be categorized into two groups with regard to pressurization of the CRE. The first group consists of CREs that have provisions for isolation and intentional pressurization of the CRE (i.e., positive CRE). The other group consists of CREs that have provisions for isolation of the CRE, but no provisions for intentional pressurization (i.e., neutral[4] CRE). These configurations primarily address radiological contaminants. Pressurization is generally not used for protection from hazardous chemicals. Most plants with positive CREs have implemented testing programs that verify that the CRE is at a positive differential pressure (ΔP) relative to adjacent areas. These testing programs were generally implemented via technical specification surveillance requirements for the CRHS. Plants with neutral CREs typically do not have an integrity testing program.

Many of the facilities that experienced higher than expected inleakage during integrated CRE integrity testing had routinely demonstrated a positive ΔP relative to adjacent areas during surveillance testing. Although the affected facilities were subsequently able to demonstrate compliance with GDC-19, the testing experience showed that ΔP testing may not be reliable in identifying the amount of inleakage.

III. OBJECTIVE OF THE REGULATORY ACTION

[4] The term neutral is used here. With no intentional pressurization, the pressure of the CRE relative to adjacent areas may be either negative or positive.

The objective of this proposed regulatory guide is to provide guidance on methods acceptable to the NRC staff for measuring inleakage into the control room and associated rooms and areas at nuclear power reactors. The amount of inleakage is an input to the design of the control room, and periodic verification of the inleakage will assure that the control room will be habitable during normal and accident conditions. This guide would describe the development of a testing program, provide attributes of an acceptable test, identify acceptable test methods, and provide interim guidance on test frequency.

IV. ALTERNATIVE APPROACHES

1. Alternative - Do Not Provide Guidance

Under this alternative, the staff would not issue regulatory guidance on CRE integrity testing. This is the no action alternative. Since only about 30 percent of the existing plants have performed integrated testing, the status of CREs at plants that have not tested is unknown. Extrapolation of the integrated testing experience to date suggests that many of these plants may also have inleakage rates in excess of their licensing bases and may not be in compliance with GDC-19. Not providing the needed guidance will result in increased unnecessary burden for the licensee and the staff in the form of preparation and response to requests for additional information (RAIs), re-analyses, and supplementation of license amendment applications. As such, this option is not supportive of any of the four nuclear reactor safety performance goals.

2. Alternative 2 - Endorse an Industry Initiative Addressing Control Room Habitability

Under this alternative, the staff would not develop its own regulatory guidance, but instead would endorse an acceptable industry document. As discussed above, NE has prepared NEI 99-03, “Control Room Habitability Assessment Guidance” (Ref. RA-1). The staff has determined that it could not endorse NEI 99-03, as after review and comment by the staff, areas remained where the staff and industry were in disagreement. Appendix I, “Testing Program,” of NEI 99-03 provides guidance on integrity testing. The staff found much of the guidance in this appendix to be acceptable, but there are some provisions that the staff finds unacceptable. The staff believes that Appendix I and the supporting Appendices F, H, and J, with some exceptions and clarifications, could provide the necessary testing guidance. To implement this alternative, the staff would prepare and issue a new regulatory guide that would endorse, with some exceptions and clarifications, the guidance of Appendices F, H, I, and J. This alternative would be supportive of the four reactor safety performance goals. Issuing a regulatory guide that endorses these appendices of NEI 99-03 would:

- Maintain public safety by providing needed guidance on ensuring that CRE integrity is consistent with the plant's licensing basis.
- Improve efficiency and effectiveness by minimizing reiterative discussions between staff and licensees to establish acceptable approaches by providing adequate formal guidance and through the use of acceptable work already performed by the industry.

- Minimize unnecessary regulatory burden by providing guidance on implementing a CRE integrity testing program that provides a basis for replacing the non-conclusive surveillance test currently used.

- Maintain public confidence by providing guidance that supports improved confidence in the ability of the control room operators to take necessary actions during an emergency condition.

The staff has determined that this alternative—issuing a new regulatory guide that endorses, with exceptions and clarification, Appendices F, H, I, and J to NEI 99-03—is the most advantageous approach to addressing the need for additional regulatory guidance on performing CRE integrity testing.

3. Alternative 3 - Endorse a National Consensus Standard

Although there are national consensus standards that address measurements of air exchange in buildings and flow in ventilation system components, the staff was not able to identify any national consensus standards that provide higher-level guidance on implementing a CRE integrity testing program for a nuclear power plant. As such, this alternative is not viable.

4. Alternative 4 - Issue New Regulatory Guide

This alternative would have the staff prepare a new regulatory guide to provide guidance on methods acceptable to the NRC staff for measuring inleakage into the control room and associated rooms and areas at nuclear power reactors, including development of a testing program, attributes of an acceptable test, and acceptable test methods.

This alternative would be supportive of the four reactor safety performance goals. Issuing a new regulatory guide would:

- Maintain public safety by providing needed guidance on ensuring that CRE integrity is consistent with the plant's licensing basis.

- Improve efficiency and effectiveness by minimizing reiterative discussions between staff and licensees to establish acceptable approaches by providing adequate formal guidance. However, this alternative would not be as efficient as Alternative 2 in that acceptable work already performed by the industry would not be used.

- Minimize unnecessary regulatory burden by providing guidance on implementing a CRE integrity testing program that provides a basis for replacing the non-conclusive surveillance test currently used.

- Maintain public confidence by providing guidance that supports improved confidence in the ability of the control room operators to take necessary actions during an emergency condition.

IV. EVALUATION OF VALUES AND IMPACTS

Since the proposed action is a new regulatory guide that endorses Appendices F, H, I, and J of NEI-99-03, compliance with its regulatory positions would be voluntary for currently licensed operating reactors. As with all regulatory guides, an applicant may propose alternative approaches to demonstrating compliance with the Commission's regulations.

- Regulatory efficiency would be improved by reducing uncertainty as to what is acceptable and by encouraging consistency in the performance of CRE integrity testing. The benefit to the industry and the NRC would be to the extent this occurs. The availability of this guidance should benefit licensees and applicants in structuring acceptable test programs thereby reducing the likelihood for follow-up questions and possible revisions in licensees' programs.

- A new regulatory guide endorsing industry guidance on the performance of CRE integrity testing would result in some cost savings to both the NRC and industry. The NRC would incur one-time incremental costs to develop the draft regulatory guide for comment and to finalize the regulatory guide. However, the NRC should also recognize cost savings associated with endorsing existing guidance in lieu of preparing its own guidance. The staff believes that the continuous and on-going cost savings associated with these reviews should offset the one-time development costs.

- This regulatory guide would provide a method acceptable to the NRC staff that is voluntarily initiated by the licensee. Since the acceptable test methods described in the regulatory guide and in Appendix I of NEI 99-03 would require more resources than the currently performed ΔP surveillance testing, there would be an increase in testing costs, especially at facilities that have no current testing program.

- CRE integrity is fundamental in providing an environment in which control room personnel can take actions to mitigate the consequences of certain postulated accidents, thereby providing for the health and safety of the public.

  There are expected increases in resources needed to develop a CRE integrity testing program and to perform periodic testing, especially at facilities that do not have current technical specification surveillance requirements for CRE integrity. This expense would be incurred only by licensees that voluntarily commit to this regulatory guide.

- With the possible exception of applicant agencies, such as TVA or municipal licensees, no other governmental agencies would be affected by the proposed regulatory guide. Pursuant to the categorical exclusion in 10 CFR 51.22(c)(16), the issuance of the proposed regulatory guide does not require an environmental review. Under the provisions of the National Technology Transfer Act of 1995, Pub. L. 104-113, no voluntary consensus standard has been identified that could be used instead of the proposed regulatory guide (government-unique standard).

The proposed regulatory guide was reviewed with regard to the impact on existing regulations and regulatory guidance. No changes in regulations are necessary to implement this

regulatory guide. Regulatory Guide 1.78, “Assumptions Used for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release” (Ref. RA-4), addresses control room habitability with regard to hazardous chemicals. Regulatory Position 3.4 of that guide refers to a future guide, which is this proposed guide. For plants that voluntarily commit to the new regulatory guide, changes to existing technical specification surveillance requirements would be necessary. This new regulatory guide would be prepared in conjunction with three other draft regulatory guides as part of the task action plan on control room habitability. Section 6.4, “Control Room Habitability System,” of the SRP (Ref. RA-5) does not provide guidance on integrity testing programs. There is no short-term need to revise Section 6.4.

V. CONCLUSION

Experience with CRE integrity testing has demonstrated the need for guidance in performing integrated tests of CRE inleakage to demonstrate compliance with the plant's licensing bases. Recent expressions of interest related to future licensing of new reactors also indicate a need for updated regulatory guidance. Based on this regulatory analysis, it is recommended that the NRC prepare a new regulatory guide that endorses, with exceptions and clarifications, Appendices F, H, I, and J of NEI-99-03; issue the draft regulatory guide for public comment; and upon resolution of public comments, finalize the regulatory guide.

REFERENCES FOR REGULATORY ANALYSIS

1. “Control Room Habitability Assessment Guidance,” NEI 99-03, Revision 0, Nuclear Energy Institute, June 2001.[1]

2. John Driscoll, “Control Room Habitability Survey of Licensed Commercial Nuclear Power Generating Stations,” NUREG/CR-4960, USNRC, October 1988.[2]

3. USNRC Information Notice 86-76, “Problems Noted In Control Room Emergency Ventilation Systems,” August 28, 1986.[1]

[1] Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike (first floor), Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or 1-(800)397-4209; fax (301)415-3548; e-mail <PDR@NRC.GOV>.

[2] Copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328 (telephone (202)512-1800); or from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161; <http://www.ntis.gov/ordernow>; (telephone (703)487-4650). Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR’s mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or (800)397-4209; fax (301)415-3548; email is PDR@NRC.GOV.

4. USNRC, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release,” Regulatory Guide 1.78 Revision 1, January 2002.[3]

5. USNRC, “Standard Review Plan For the Review of Safety Analysis Reports for Nuclear Power Plants,” Chapter 6.4, “Control Room Habitability System,” NUREG-0800, USNRC, 1987.[3]

[3] Single copies of regulatory guides, both active and draft, and draft NUREG documents may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555-0001, or by fax to (301)415-2289, or by email to <DISTRIBuTION@NRC.GOV>. Active guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161; telephone (703)487-4650; online <http://www.ntis.gov/ordernow>. Documents are also available through the NRC's Electronic Reading Room at <WWW.NRC.GOV>.

BACKFIT ANALYSIS

The regulatory guide does not require a backfit analysis as described in 10 CFR 50.109(c) because it does not impose a new or amended provision in the NRC's rules or a regulatory staff position interpreting the NRC's rules that is either new or different from a previous applicable staff position. In addition, this regulatory guide does not require the modification or addition to systems, structures, components, or design of a facility or the procedures or organization required to design, construct, or operate a facility. Rather, a licensee or applicant may select a different method for achieving compliance with a license or the rules or orders of the Commission as described in 10 CFR 50.109(a)(7). This regulatory guide provides an opportunity to use an industry-developed standard, if the licensee or applicant prefers that method.