U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

6.2.3 SECONDARY CONTAINMENT FUNCTIONAL DESIGN

REVIEW RESPONSIBILITIES:

Primary - Organization responsible for review of containment integrity

Secondary - None

I. AREAS OF REVIEW

The scope of review is the applicant's safety analysis report (SAR) information on the functional capability of the secondary containment system, which includes the outer containment structure of dual containment plants, and systems that mitigate the radiological consequences of postulated accidents. The secondary containment structure and supporting systems collect and process radioactive material that may leak from the primary containment following an accident. The supporting systems maintain a negative pressure within the secondary containment and process this leakage. Review of plant areas and systems contiguous to the secondary containment also collecting and processing radioactive material that may leak from the primary containment following an accident is the same as for the secondary containment. The specific areas of review are as follows:

1. Analyses of the pressure and temperature response of the secondary containment to a loss-of-coolant accident (LOCA) within the primary containment.

Rev. 4 - [Month] 2007

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in the Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of the standard format have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) will be based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," until the SRP itself is updated.

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

Requests for single copies of draft or active SRP sections (which may be reproduced) should be made to the U.S. Nuclear Regulatory Commission, Washington, DC 20555, Attention: Reproduction and Distribution Services Section, or by fax to (301) 415-2289; or by email to DISTRIBUTION@nrc.gov. Electronic copies of this section are available through the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0800/, or in the NRC's Agencywide Documents Access and Management System (ADAMS), at http://www.nrc.gov/reading-rm/adams.html, under Accession # MLxxxxxxxxx.

2. Analyses of the effect of openings in the secondary containment on the capability of the depressurization and filtration system to accomplish its design objective of establishing a negative pressure within a prescribed time.

3. Analyses of the pressure and temperature response of the annular region between the primary and secondary containment to a high-energy line rupture within the secondary containment.

4. The functional design criteria applied to guard pipes surrounding high-energy lines within the secondary containment.

5. Analyses of any primary containment leakage paths that bypass the secondary containment.

6. Design provisions for periodic leakage testing of secondary containment bypass leakage paths.

7. Analyses of the pressure response of the secondary containment to inadvertent depressurization of the primary containment with vacuum relief from the secondary containment.

8. The acceptability of the mass and energy release data for the analysis of the secondary containment pressure response to postulated high-energy line breaks.

9. Inspection, Test, Analysis, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the applicant's proposed information on the ITAAC associated with the systems, structures, and components (SSCs) related to this SRP section is reviewed in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria - Design Certification." The staff recognizes that the review of ITAAC is performed after review of the rest of this portion of the application against acceptance criteria contained in this SRP section. Furthermore, the ITAAC are reviewed to assure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

10. COL Action Items and Certification Requirements and Restrictions. COL action items may be identified in the NRC staff's final safety evaluation report (FSER) for each certified design to identify information that COL applicants must address in the application. Additionally, DCs contain requirements and restrictions (e.g., interface requirements) that COL applicants must address in the application. For COL applications referencing a DC, the review performed under this SRP section includes information provided in response to COL action items and certification requirements and restrictions pertaining to this SRP section, as identified in the FSER for the referenced certified design.

Review Interfaces

The listed SRP sections interface with this section as follows:

1. Section 3.6.1: evaluation of plant design for protection against postulated pipe ruptures in auxiliary areas outside the primary containment serving as the secondary containment.

2. Section 3.6.2: evaluation of break locations and dynamic effects of postulated rupture of piping outside the primary containment.

3. Section 6.2.6: evaluation of design requirements and the periodic inspection and operability test program for the depressurization and filtration systems.

4. Section 6.4: determination of whether plant design adequately protects control room personnel against radiation exposure during accidents.

5. Sections 6.5.1 and 6.5.3: evaluation of design requirements and periodic inspection and operability test program for the depressurization and filtration systems, evaluation of fission product removal capability of the secondary containment supporting systems.

6. Sections 7.1 through 7.5: review and evaluation of instrumentation necessary for secondary containment actuation and control features function.

7. Section 15.6.5, Appendices A, B, and D: evaluation of analyses of the radiological consequences of design-basis LOCAs, including assumptions for the secondary containment.

8. Section 16.0: review at the operating licensing stage of review, and during design certification reviews of technical specifications proposed for the functional capability of the secondary containment system and the leakage testing of bypass leakage paths.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. General Design Criterion (GDC) 4 of Appendix A to Part 50 of Title 10, Code of Federal Regulations (10 CFR Part 50 Appendix A) as to SSCs important to safety designed to accommodate the effects of environmental conditions of normal operation, maintenance, testing, and postulated accidents with protection against dynamic effects (e.g., effects of missiles, pipe whipping, and discharging fluids) that may result from equipment failures.

2. GDC 16 as to reactor containment and associated systems establishing an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment.

3. GDC 43 as to reactor containment and associated systems designed to permit appropriate periodic pressure and functional testing to assure structural integrity and operability.

4. 10 CFR Part 50, Appendix J as it relates to secondary containment leakage rate testing in accordance with the procedures specified in the technical specifications, or associated bases, so that bypass leakage paths are identified and associated bypass leakage rates are determined.

5. 10 CFR 52.47(a)(1)(vi), as it relates to ITAAC (for design certification) sufficient to assure that the SSCs in this area of review will operate in accordance with the certification.

6. 10 CFR 52.97(b)(1), as it relates to ITAAC (for combined licenses) sufficient to assure that the SSCs in this area of review have been constructed and will be operated in conformity with the license and the Commission's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for review described in Subsection I of this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

1. In meeting GDC 16 requirements for functional capability of the secondary containment, the analysis of pressure and temperature response of the secondary containment to a LOCA in the primary containment should follow these guidelines:

   A. Heat transfer from the primary to the secondary containment should be considered.

      (i Heat transfer from the primary containment atmosphere to the primary containment structure should be calculated by conservative heat transfer coefficients like those in Branch Technical Position (BTP) CSB 6-1 (Reference 6).

      (ii) Conductive heat transfer through the primary containment structure and convective heat transfer to the secondary containment atmosphere should be considered.

      (iii) Radiant heat transfer to the secondary containment should be considered.

   B. Adiabatic boundary conditions should be assumed for the surface of the secondary containment structure exposed to the outside environment.

   C. The compressive effect of primary containment expansion on the secondary containment atmosphere should be considered.

   D. Secondary containment in-leakage should be considered.

   E. No credit should be taken for secondary containment out-leakage.

F. For secondary containment response analyses loss of offsite power and the most severe single active failure in the emergency power system (e.g., a diesel generator failure), in the primary containment heat removal systems, in the core cooling systems, or in the secondary containment depressurization and filtration system should be assumed. Any delay due to system design in secondary containment depressurization and filtration system actuation should be considered.

G. Heat loads generated within the secondary containment (e.g., equipment heat loads) should be considered.

H. Fan performance characteristics should be considered in evaluating secondary containment depressurization.

2. To meet the GDC 4 requirement to protect SSCs important to safety against dynamic effects, high-energy lines passing through the secondary containment should have guard pipes. Design criteria for guard pipes are in SRP Section 3.6.2. If there are no guard pipes, analyses should demonstrate that both primary containment and secondary containment structures are capable of withstanding the effects of a high-energy pipe rupture inside the secondary containment without loss of integrity.

3. In meeting GDC 16 requirements for the functional capability of the secondary containment, the following criteria apply:

A. The secondary containment depressurization and filtration systems should meet the guidelines of Regulatory Guide (RG) 1.52 and be capable of maintaining a uniform negative pressure throughout the secondary containment as well as other areas served by the systems.

B. The negative pressure differential to be maintained in the secondary containment and other contiguous plant areas should be no less than 0.063 kPa (0.25 inches water gauge) compared to adjacent regions under all wind conditions up to the wind speed at which diffusion becomes sufficient to assure site boundary exposures less than those calculated for the design basis accident even if exfiltration occurs. If the leakage rate exceeds 100 percent of the volume per day, there should be a special exfiltration analysis.

C. All openings like personnel doors and equipment hatches should be under administrative control with readout position indicators and alarms in the main control room. The effect of open doors or hatches on the functional capability of the depressurization and filtration systems should be evaluated and confirmatory preoperational tests conducted.

D. Some plants may have only portions of the primary containment enclosed rather than a secondary containment structure or shield building completely enclosing the primary containment. These enclosures are areas into which the primary containment most likely would leak, and they may be equipped with air filtration systems. Quantitative credit cannot be given for the holdup effect of these

enclosed areas or for the air filtration systems to mitigate the radiological consequences of a postulated accident unless the magnitude of unprocessed leakage can be adequately demonstrated. Quantitative credit for leakage collection in a partial-dual containment will be reviewed case by case.

E. The external design pressure of the secondary containment structure should provide an adequate margin above the maximum expected external pressure.

4. In meeting GDC 43 and 10 CFR Part 50, Appendix J, requirements for secondary containment system testing the following criteria apply:

A. The fraction of primary containment leakage bypassing the secondary containment and escaping directly to the environment should be specified. BTP 6-3 (Reference 7) provides guidance for detecting leakage paths to the environment which may bypass the secondary containment. The periodic leakage rate testing program for measuring the fraction of primary containment leakage that may directly bypass the secondary containment and other contiguous areas served by ventilation and filtration systems should be described. Individual tests should be according to procedures from technical specifications or their bases.

B. There should be provisions in the design of the secondary containment system for inspections and monitoring of the functional capability. Preoperational and periodic test programs determine the depressurization time, the secondary containment in-leakage rate, the uniformity of negative pressure throughout the secondary containment and other contiguous areas, and the potential for ex-filtration.

Technical Rationale

The technical rationale for application of these requirements to reviewing this SRP section is discussed in the following paragraphs:

1. GDC 4 requires that SSCs important to safety be designed to accommodate the effects of environmental conditions of normal operation, maintenance, testing, and postulated accidents (including LOCAs) and protected against dynamic effects that may result from equipment failures. The secondary containment minimizes offsite radioactive releases by confining a substantial fraction of leakage from the primary containment following a LOCA. Application of GDC 4 to the secondary containment provides assurance that the environmental conditions and equipment failures to which it may be exposed will not affect its capability to contain radioactive material under all operating conditions, including accidents.

2. GDC 16 requires the reactor containment and its systems establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment. The secondary containment minimizes radioactive releases by confining primary containment leakage following a LOCA. Application of GDC 16 to the secondary containment minimizes the likelihood and magnitude of exposures of control room personnel and the public to radiation from radioactive releases.

3. GDC 43 requires that containment atmosphere cleanup systems be designed for appropriate periodic pressure and functional testing for component integrity, operability of active components, operability of the system as a whole, and performance of the sequence that brings the system into operation. The depressurization and filtration systems of the secondary containment confine radioactive material in the event of primary containment leakage. Periodic application of GDC 43 to these systems periodically verifies capabilities to perform this function, detects and corrects deficiencies, and minimizes the likelihood of demand and inservice failures with the result of a high likelihood that a substantial portion of primary containment leakage will be confined.

4. Appendix J to 10 CFR Part 50 requires that structures of multiple barrier or subatmospheric containments (e.g., secondary containments for boiling water reactors and shield buildings for pressurized water reactors enclosing the entire primary reactor containment or portions of it) be subject to individual tests according to procedures from technical specifications or their bases. The secondary containment minimizes radioactive releases by confining a substantial fraction of primary containment leakage following a LOCA. The technical specifications establish conservative limits on the total fraction of primary containment leakage which may bypass secondary containment. The technical specifications also specify periodic testing to detect bypass leakage paths, determine leakage rates, and verify operability of secondary containment depressurization and filtration systems. Periodic application of Appendix J to the secondary containment system verifies capabilities to perform the confinement function, detects and corrects deficiencies, and minimizes the likelihood of excessive bypass leakage rates with the result of a high likelihood that a substantial portion of primary containment leakage will be confined.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from the procedures described below, as may be appropriate for a particular case.

For each area of review specified in Subsection I of this SRP section, the review procedure is identified below. These review procedures are based on the identified SRP acceptance criteria. For deviations from these specific acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives to the SRP criteria provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

Portions of the review may be done generically for aspects of secondary containment functional design common to a class of plants or may adopt the results of previous reviews of similar plants.

1. Upon request from the primary reviewer, other branches provide input for the areas of review stated in Subsection II of this SRP section. The reviewer uses such input as required for a complete review.

2. Analytical models used and assumptions made in the analyses of the pressure and temperature response of the secondary containment to LOCAs in the primary containment are reviewed. In general, the reviewer determines whether the analyses conservatively predict the secondary containment pressure response by comparing them to the guidelines in Subsection III of this SRP section. For new applications, the

reviewer verifies that analyses of ability to draw a negative pressure on the secondary containment volume following a LOCA assume that all lines not receiving an isolation signal are open and that the worst-case secondary containment isolation valve fails to close.

3. If considered necessary, there will be confirmatory analyses of the pressure and temperature response of the secondary containment for LOCAs within the primary containment and for high-energy line (e.g., steam line and feedwater line) ruptures occurring within the annular region formed by the secondary containment.

4. The analysis will be based on the guidelines of Subsection III of this SRP section and code input data from the SAR. The review determines whether the secondary containment design pressure is exceeded, whether the depressurization time is consistent with that assumed in the analysis of the radiological consequences of the accident, and whether the primary containment external design pressure is exceeded.

5. The review determines whether all direct leakage paths have been identified and from the proposed leakage testing program whether design of the plant provides for measurement of the fraction of total primary containment leakage that bypasses the secondary containment. Any inadequacies in the applicant's direct leakage assumptions in the radiological analysis are noted. At the operating license stage, reviews technical specifications of surveillance requirements for leakage testing of the secondary containment bypass leakage paths are performed.

6. Analyses of the capability of the secondary containment system to resist exfiltration under post-accident conditions are reviewed. If the secondary containment leakage rate exceeds 100 percent of the volume per day, a special exfiltration analysis is performed. The preoperational and periodic inservice testing programs are reviewed for testing to verify the extent of exfiltration.

7. Review of the proposed secondary containment system testing program and the surveillance requirements is for assurance that periodic tests will confirm maintenance of the assumed negative pressure throughout the secondary containment. Review of the testing program and surveillance requirements is for assurance that periodic tests will verify the secondary containment design in-leakage rate and the analysis of the depressurization of the secondary containment.

8. Review of proposed technical specifications assures exercise of adequate administrative control over secondary containment openings like personnel access doors and equipment hatches. Review of the descriptive information in the SAR determines whether all doors and hatches have position indicators with readout and alarm capability in the main control room and ascertains whether normally open doors were considered in the analyses of the functional capability of the secondary containment system.

9. For reviews of DC and COL applications under 10 CFR Part 52, the reviewer should follow the above procedures to verify that the design set forth in the SAR, and if applicable, site interface requirements meet the acceptance criteria. For DC applications, the reviewer should identify necessary COL action items. As to COL applications, the scope of the review is dependent on whether the COL applicant references a DC, an ESP, or other NRC-approved material, applications, or reports.

After this review, SRP Section 14.3 should be followed for the review of Tier I information for the design, including the postulated site parameters, interface criteria, and ITAAC.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The scope of review of the functional design of the secondary containment system for the [plant name] has included plan and elevation drawings, system drawings, and descriptive information. This system controls the atmosphere within the secondary containment and contiguous areas. The review has included the applicant's proposed design bases and analyses of the functional capability of the secondary containment system.

The staff concludes that the secondary containment functional design is acceptable and meets the requirements of GDCs 4, 16, and 43 and 10 CFR Part 50, Appendix J. The conclusion is based on the following: [The reviewer should discuss each item of the regulations or related set of regulations as indicated.]

1. The applicant has met the requirements of [regulation(s)] as to [limits of review under regulation] by [for each item under review how it met its requirement(s) and why it is acceptable under the regulation(s)]:

    A. Meeting the requirement(s) of RG(s) [#];

    B. Submitting to meet requirements of RG(s) [#] an alternative method that the staff has reviewed and found acceptable;

    C. Meeting the position in BTP [#];

    D. Using for [what was evaluated] calculational methods previously reviewed by the staff and found acceptable; the staff has reviewed the impact parameters and found them suitably conservative or has verified the acceptability of their analysis by independent calculations; or

    E. Meeting the provisions of [industry standard number and title] that has been reviewed by the staff and found appropriate for this application.

2. Repeat discussion for each regulation cited in Subsection IV.1 of this SRP section.

For DC and COL reviews, the findings will also summarize (to the extent that the review is not discussed in other SER sections) the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable, and interface requirements and combined license action items relevant to this SRP section.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases."

2. 10 CFR Part 50, Appendix A, GDC 16, "Containment Design."

3. 10 CFR Part 50, Appendix A, GDC 43, "Testing of Containment Atmosphere Cleanup Systems."

4. 10 CFR Part 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors."

5. RG 1.52, "Design, Testing, and Maintenance Criteria for Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

6. BTP CSB 6-1, "Minimum Containment Pressure Model for PWR ECCS Performance Evaluation," attached to SRP Section 6.2.1.5.

7. BTP CSB 6-3, "Determination of Bypass Leakage Paths in Dual Containment Plants," attached to this SRP section.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the draft Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

SRP Section 6.2.3
Description of Changes

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Draft Revision 1, dated April 1996 of this SRP. See ADAMS accession number ML061710366.

In addition this SRP section was administratively updated in accordance with NRR Office Instruction, LIC-200, Revision 1, "Standard Review Plan (SRP) Process." The revision also adds standard paragraphs to extend application of the updated SRP section to prospective submittals by applicants pursuant to 10 CFR Part 52.

The technical changes are incorporated in Revision 4, dated [Month] 2007.

Review Responsibilities - Reflects changes in review branches resulting from reorganization and branch consolidation. Change is reflected throughout the SRP.

I. AREAS OF REVIEW
Reformatted the section with new numbering system. Incorporated reference to 10 CFR Part 52 from draft revision 1 - April 1996. Added NRC Inspection Manual Chapter IMC-2504, "Construction Inspection Program - Non-ITAAC Inspections," April 25, 2006. Incorporated generic paragraphs relating to ITAACs, certified designs, ESPs, and COLs.

II. ACCEPTANCE CRITERIA
Reformatted the section with new numbering system. Incorporated reference to 10 CFR Part 52 from draft revision 1 - April 1996.

III. REVIEW PROCEDURES
Reformatted the section with new numbering system. Incorporated reference to 10 CFR Part 52 from draft revision 1 - April 1996.

IV. EVALUATION FINDINGS

None

V. IMPLEMENTATION

None

VI. REFERENCES

None