U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

6.2.1.1.A PWR DRY CONTAINMENTS, INCLUDING SUBATMOSPHERIC CONTAINMENTS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of Containment Integrity

Secondary - None

I. AREAS OF REVIEW

The specific areas of review are as follows:

1. The temperature and pressure conditions in the containment due to a spectrum (including break size and location) of postulated loss-of-coolant accidents (i.e., reactor coolant system pipe breaks) and secondary system steam and feedwater line breaks.

2. The maximum expected external pressure to which the containment may be subjected.

3. The minimum containment pressure that is used in analyses of emergency core cooling system capability.

4. The effectiveness of static and active heat removal mechanisms.

5. The pressure conditions within subcompartments that act on system components and supports due to high energy line breaks.

6. The range and accuracy of instrumentation that is provided to monitor and record containment conditions during and following an accident.

7. 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.

8. 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. The electrical design of the instrumentation provided to monitor and record containment conditions during and following an accident; and the effectiveness of the administrative controls and the instrumentation and control provisions to prevent inadvertent operation of the containment heat removal systems or system trains under SRP Section 7.5.

2. The design adequacy of the containment and its internal structures under SRP Section 3.8.3.

3. The design adequacy of mechanical components and their supports under SRP Section 3.9.3.

4. The proposed technical specifications that pertain to the surveillance requirements for spring or weight loaded check valves used in subatmospheric containments and vacuum relief devices under SRP Section 16.0.

5. The environmental qualification of the containment system under SRP Section 3.11.

6. Offsite and control room dose under SRP 15.6.5 Appendix A.

7. For new plant applicants, shutdown risk assessment reviews, including containment analysis issues, under SRP Section 19.1.

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) 16, as it relates to the reactor containment and associated systems being designed to assure that containment design conditions important to safety are not exceeded for as long as postulated accident conditions require. Since the primary reactor containment is the final barrier of the defense-in-depth concept to protect against the uncontrolled release of radioactivity to the environs, preserving containment integrity under the dynamic conditions imposed by postulated loss of coolant accidents is essential.

2. GDC 50, as it relates to the reactor containment structure and associated heat removal system(s) being designed so that the containment structure and its internal compartments can accommodate the calculated pressure and temperature conditions resulting from any loss-of-coolant accident without exceeding the design leakage rate and with sufficient margin.

3. GDC 38, as it relates to the containment heat removal system(s) function to rapidly reduce the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

4. GDC 13, as it relates to instrumentation and control, requires instrumentation be provided to monitor variables and systems over their anticipated ranges for normal operation and for accident conditions as appropriate to assure adequate safety.

5. GDC 64, as it relates to monitoring radioactivity releases, requires means be provided for monitoring the reactor containment atmosphere for radioactivity that may be released from normal operations and from postulated accidents.

6. For those applicants subject to 10 CFR 50.34(f): 10 CFR 50.34(f)(3)(v)(A)(1), as it relates to containment integrity being maintained during an accident that releases hydrogen generated from a 100-percent fuel clad metal-water reaction accompanied by hydrogen burning.

7. 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.

8. 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. To satisfy the requirements of GDC 16 and 50 regarding sufficient design margin, for plants at the construction permit (CP) stage of review, the containment design pressure should provide at least a 10% margin above the accepted peak calculated containment pressure following a loss-of-coolant accident, or a steam or feedwater line break. For plants at the operating license (OL) stage of review, the peak calculated containment pressure following a loss-of-coolant accident, or a steam or feedwater line break, should be less than the containment design pressure. In general, the peak calculated containment pressure should be approximately the same as at the construction permit or design certification stage of review. However, revised or upgraded analytical models or minor changes in the as-built design of the plant may result in a decrease in the margin.

2. To satisfy the requirements of GDC 38 to rapidly reduce the containment pressure, the containment pressure should be reduced to less than 50% of the peak calculated pressure for the design basis loss-of-coolant accident within 24 hours after the postulated accident. If analysis shows that the calculated containment pressure may not be reduced to 50% of the peak calculated pressure within 24 hours, the organization responsible for SRP Section 15.6.5 Appendix A should be notified.

3. To satisfy the requirement of GDC 38 to rapidly reduce the containment pressure, the containment pressure for subatmospheric containments should be reduced to below atmospheric pressure within one hour after the postulated accident, and the subatmospheric condition maintained for at least 30 days.

4. To satisfy the requirements of GDC 38 and 50 with respect to the containment heat removal capability and design margin, the loss-of-coolant accident analysis should be based on the assumption of loss of offsite power and the most severe single failure in the emergency power system (e.g., a diesel generator failure), the containment heat removal systems (e.g., a fan, pump, or valve failure), or the core cooling systems (e.g., a pump or valve failure). The selection made should result in the highest calculated containment pressure.

5. To satisfy the requirements of GDC 38 and 50 with respect to the containment heat removal capability and design margin, the containment response analysis for postulated secondary system pipe ruptures should be based on the most severe single active failure in the containment heat removal systems (e.g., a fan, pump, or valve failure) or the secondary system isolation provisions (e.g., main steam isolation valve failure or feedwater line isolation valve failure). The analysis should also be based on a spectrum of pipe break sizes and reactor power levels. The accident conditions selected should result in the highest calculated containment pressure or temperature depending on the purpose of the analysis. Acceptable methods for the calculation of the containment environmental response to main steam line break accidents are found in NUREG-0588 (Reference 14).

6. To satisfy the requirements of GDC 38 and 50 with respect to the functional capability of the containment heat removal systems and containment structure under loss-of-coolant accident conditions, provisions should be made to protect the containment structure against possible damage from external pressure conditions that may result, for example, from inadvertent operation of containment heat removal systems. The provisions made should include conservative structural design to assure that the containment structure is

capable of withstanding the maximum expected external pressure; or interlocks in the plant protection system and administrative controls to preclude inadvertent operation of the systems. If the containment is designed to withstand the maximum expected external pressure, the external design pressure of the containment should provide an adequate margin above the maximum expected external pressure to account for uncertainties in the analysis of the postulated event.

7. In accordance with the requirements of GDC 13 and 64, and 10 CFR 50.34(f)(2)(xvii) (for those applicants subject to 10 CFR 50.34(f)), instrumentation capable of operating in the post-accident environment should be provided to monitor the containment atmosphere pressure and temperature and the sump water level and temperature following an accident. The instrumentation should have adequate range, accuracy, and response to assure that the above parameters can be tracked and recorded throughout the course of an accident. See Item II.F.1 of NUREG-0737 and NUREG-0718 (References 19 and 18), and Branch Technical Position 7-10, "Guidance on Application of Regulatory Guide 1.97."

8. In accordance with 10 CFR 50.46 Appendix K, I.D.2, the minimum calculated containment pressure should not be less than that used in the analysis of the emergency core cooling system capability (See SRP Section 6.2.1.5, "Minimum Containment Pressure Analysis for Emergency Core Cooling System Performance Capability Studies").

9. In accordance with GDC 4, containment internal structures and system components (e.g., reactor vessel, pressurizer, steam generators) and supports should be designed to withstand the differential pressure loadings that may be imposed as a result of pipe breaks within the containment subcompartments (See SRP Section 6.2.1.2, "Subcompartment Analysis").

10. In meeting the requirements of 10 CFR 50.34(f)(3)(v)(A)(1), applicants subject to this section should evaluate an accident that releases hydrogen generated from a 100% fuel clad metal-water reaction. The evaluation should demonstrate that the appropriate article for service level C limits (considering pressure and dead load only), for either concrete or steel containments, from ASME Boiler Pressure Vessel Code, Section III, are met. In addition to the containment pressurization caused directly by this accident, the increase in pressure from hydrogen burning in containment should be analyzed.

<u>Technical Rationale</u>

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

1. GDC 16 requires containment to be designed as a leak tight barrier that will withstand the most extreme accident conditions for the duration of any postulated accident. This SRP section evaluates the peak pressure and temperature conditions for which the containment must be designed. The containment must be leak tight and withstand accidents because it is the final barrier against the release of radioactivity to the environment. Meeting GDC 16 provides assurance that radioactivity will not be released to the environment.

2. GDC 50 requires the containment structure and associated heat removal system to be designed with margin to accommodate any loss-of-coolant accident such that the containment design leak rate is not exceeded. A loss-of-coolant accident potentially causes the greatest pressure surge and release of fission products when compared to

any other accident. Since it is the most severe challenge expected, containment must be designed to definitively withstand this accident. Meeting GDC 50 will ensure that containment integrity is maintained under the most severe accident conditions thus precluding the release of radioactivity to the environment.

3. GDC 38 requires the establishment of a containment heat removal system that will rapidly reduce containment pressure and temperature following any loss-of-coolant accident. The containment heat removal system supports the containment function by minimizing the duration and intensity of the pressure and temperature increase following a loss-of-coolant accident thus lessening the challenge to containment integrity. Meeting GDC 38 will help ensure that the containment can fulfill its role as the final barrier against the release of radioactivity to the environment.

4. GDC 13 requires that instrumentation be provided to monitor all expected parameters of normal operation, anticipated operational occurrences, and accidents to assure adequate reactor safety is maintained. Since containment plays a vital safety role, appropriate instrumentation, such as temperature and pressure, must be provided so that operators can verify containment is properly fulfilling its function. Regulatory Guide 1.97 provides specific criteria for the design of containment instrumentation which have been found acceptable by the NRC as fulfilling GDC 13. Meeting GDC 13 and the specific guidance of Regulatory Guide 1.97 will help ensure that containment accomplishes its mission of precluding the release of radioactivity to the environment. Branch Technical Position 7-10, “Guidance on Application of Regulatory Guide 1.97," provides the specific acceptance criteria to satisfy Regulatory Guide 1.97.

5. GDC 64 requires that the containment atmosphere be monitored for the release of radioactivity from normal operations, anticipated operational occurrences, and accidents. In order to ensure that the containment functions properly, operators must be aware of any radioactive releases within containment so that they can take appropriate manual action or monitor automatic action. Regulatory Guide 1.97 provides specific criteria for the design of containment instrumentation which have been found acceptable by the NRC as fulfilling GDC 64. Branch Technical Position 7-10, “Guidance on Application of Regulatory Guide 1.97," provides the specific acceptance criteria to satisfy Regulatory Guide 1.97. Meeting GDC 64 and the specific guidance of Regulatory Guide 1.97 will assist operators in ensuring that containment meets its safety function of preventing the release of radioactivity to the environment.

6. 10 CFR 50.34(f)(3)(v)(A)(1) requires that the containment be designed to withstand either hydrogen burning or initiation of the post-accident inerting system, if installed, during an accident that releases hydrogen from a 100% fuel clad metal-water reaction. During the accident at TMI-2, metal-water reactions generated hydrogen in excess of the amounts originally anticipated. As a result of this finding, the Commission issued requirements on hydrogen control in 10 CFR 50.34(f). Other criteria require the containment to be designed to withstand postulated accidents. If such a postulated accident releases or generates hydrogen, an added containment pressurization effect beyond the initial accident may be experienced due to burning of hydrogen. The containment must be designed to withstand this additional pressure to ensure that its integrity is maintained, thus precluding the release of radioactivity to the environment.

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.

1. Upon request from the primary reviewer, the coordinated review branches will provide input for the areas of review stated in Subsection I of this SRP section. The primary reviewer obtains and uses such input as required to assure that this review is complete.

2. The primary review organization reviews the containment response analyses to determine the acceptability of the calculated containment design pressure and temperature, and in addition, the containment depressurization time. The organization responsible for SRP Section 15.6.5.A must be notified if the containment depressurization time does not meet the acceptance criterion. The primary review organization for this SRP section reviews the assumptions made in the analyses to maximize the calculated containment pressure and temperature. The primary review organization for this SRP section determines the conservatism of the respective containment response analyses by comparing the analytical models, and the assumptions made, with the acceptance criteria in Subsection II of this SRP section and by performing appropriate confirmatory analyses. It is not necessary to perform accident pressure calculations for every plant. The primary review organization for this SRP section will ascertain, however, whether the adequacy of the applicant's calculational model has been demonstrated. The primary review organization for this SRP section determines whether the applicant has identified the pipe break(s) resulting in the highest containment pressure and temperature. Hot leg, cold leg (pump suction), and cold leg (pump discharge) pipe breaks of the reactor coolant system, and secondary system steam and feedwater line breaks, should be analyzed by the applicant. The primary review organization for this SRP section reviews the assumptions used to determine whether the analyses are acceptably conservative. Design Certification applicants should meet the CP containment design pressure margin criterion of Item 1 of the SRP Acceptance Criteria (above).

3. The primary review organization verifies that the containment is designed to withstand hydrogen burning during an accident that releases hydrogen from a 100% fuel clad metal-water reaction as described in Item 10 of the SRP Acceptance Criteria (above).

4. The primary review organization performs confirmatory containment response analyses when necessary. The purpose of these analyses is to confirm the applicant's predictions of the response of the containment to loss-of-coolant accidents and main steam and feedwater line breaks. In general, only the limiting pipe breaks, i.e., the pipe breaks which establish the containment design pressure and containment depressurization time, are analyzed. However, if in the reviewer's judgment the worst break has not been identified, other pipe breaks will be analyzed.

5. The primary review organization reviews analyses of the external pressure of the containment structure caused by pressure and temperature changes inside the containment due to inadvertent operation of containment heat removal systems. The primary review organization determines whether the most severe condition has been identified and whether the analysis was done in a conservative manner. For plants at the construction permit (CP) or design certification (DC) stage of review the external design pressure margin should be at least 10%. For plants at the operating license (OL) stage of review, the maximum expected external pressure should be less than the

containment external design pressure. In general, the maximum expected external pressure should be approximately the same as at the construction permit or design certification stage of review. However, revised or upgraded analytical models or minor changes in the as-built design of the plant may result in a decrease in the margin. If the primary containment is not designed to withstand the maximum external pressure, the primary review organization will evaluate the acceptability of the provisions made in the plant design to mitigate or withstand the consequences of the above postulated events, and will evaluate in conjunction with the primary review branch for SRP Section 7.5, the administrative controls and instrumentation and control provisions to preclude these events.

6. The primary review organization for this SRP section reviews the accuracy and range of the instrumentation provided to monitor the post-accident environment. The primary review organization for SRP Section 7.5, and the primary review organization for SRP Section 3.11, have review responsibility for the acceptability of, and the qualification test program for the sensing and actuation instrumentation of the plant protection system and the post-accident monitoring instrumentation and recording equipment.

7. For new plant applicants and those PWRs subject to Generic Letter 88-17 (Reference 61), the containment analyses should also consider shutdown conditions, when appropriate, to ensure that a basis is provided for procedures, instrumentation, operator response, equipment interactions, and equipment response during shutdown operations. The analyses should encompass shutdown thermodynamic states and physical configurations to which the plant can be subjected during shutdown conditions (such as containment closure time, temperature and time to uncover the core during loss of decay heat removal).

8. 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 safety analysis report, and if applicable, site interface requirements meet the acceptance criteria. For DC applications, the reviewer should identify necessary COL action items. With respect 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, and/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 (if applicable) 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.

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 superceded by a later revision.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides, regulations, and NUREGs.

VI. REFERENCES

The references for this SRP section are listed in SRP Section 6.2.1.

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 6.2.1.1.A
Description of Changes

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Draft Revision 3, dated April 1996 of this SRP. See ADAMS accession number ML061710390.

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 3, 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 3 - April 1996. Incorporated generic paragraphs relating to 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 3 - April 1996. Incorporated generic paragraphs relating to certified designs, ESPs, and COLs.

III. REVIEW PROCEDURES

Reformatted the section with new numbering system. Incorporated reference to 10 CFR Part 52 from draft revision 3 - April 1996. Incorporated generic paragraphs relating to certified designs, ESPs, and COLs.

IV. EVALUATION FINDINGS

None

V. IMPLEMENTATION

None

VI. REFERENCES

None