U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

3.5.1.2 INTERNALLY-GENERATED MISSILES (INSIDE CONTAINMENT)

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of plant design for protection of structures, systems, and components from internal and external hazards

Secondary - None

I. AREAS OF REVIEW

All structures, systems, and components (SSCs) (inside containment) are to be protected from internally-generated missiles to ensure compliance with 10 CFR 50, Appendix A, General Design Criterion (GDC) 4 requirements. This includes all SSCs within the containment and the containment itself. The review includes internally-generated missiles from component overspeed failures, missiles that could originate from high-energy fluid system failures, and missiles caused by or as a consequence of gravitational effects.

The review includes identification, functional operations and performance requirements for all SSCs (inside containment), necessary for the safe shutdown of the reactor facility and the failure of SSCs that could cause a significant release of radioactivity. The review also includes adequacy of methods of protection from internally-generated missiles for all SSCs necessary to perform functions required to attain and maintain a safe shutdown or to mitigate the consequences of an accident.

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The specific areas of review are as follow:

1. Protection from internally-generated missiles including identification of structures, systems or portions of systems, components and the methods of protection provided. Determination of the potential of pressurized components and systems for generating missiles such as valve bonnets and hardware-retaining bolts, relief valve parts, instrument wells and reactor vessel seal rings (PWR). Determination of the potential of high-speed rotating machinery for generating missiles from component overspeed or such failures as the pump itself (from seizure), pump or component parts, and rotating segments (e.g., impellers and fan blades).

2. Internal missile effects on nonsafety-related SSCs in areas with safety-related SSCs if the failure of the nonsafety-related SSCs could affect an intended safety function of the safety-related SSCs.

3. Plausible secondary missiles generated as a result of impact with primary missiles.

4. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

5. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

   For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

1. Review of the acceptability of the analytical procedures and criteria for structures or barriers that protect the containment structure and liner, essential systems, and safety-related components from internally-generated missiles is performed under SRP section 3.5.3. The results of this review can be utilized to complete the overall evaluation of the protection against internally-generated missiles.

2. Review of dynamic effects associated with the postulated rupture of piping inside the containment is performed under SRP section 3.6.2. Typically included in SRP Section 3.6.2 is the review of any high-energy line spatial separation analyses by an

applicant. The results of this review can be utilized to complete the overall evaluation of the protection against internally-generated missiles.

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

II. ACCEPTANCE CRITERIA

Requirements

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

1. 10 CFR Part 50, Appendix A, GDC 4 as it relates to the design of the SSCs important to safety if the design affords protection from the internally generated missile that may result from equipment failure.

2. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;

3. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC'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 the review described in 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.

The design of the SSCs important to safety is acceptable if the integrated design affords protection from the internally generated missiles (inside containment) that may result from equipment failure, in order to maintain their safety functions in accordance with GDC 4.

1. The applicant's statistical significance of an identified missile can be evaluated by a probability analysis. The statistical significance for a potential missile is determined by calculating the probability of missile occurrence. If this probability is less than 10^{-7} per

year, the missile is not considered significant. If the probability of occurrence is greater than 10^{-7} per year, the probability that it will impact a significant target is determined. If the product of these two probabilities is less than 10^{-7} per year, the missile is not considered significant. If the product is greater than 10^{-7} per year, the probability of significant damage is determined. If the combined probability (product of all three) is less than 10^{-7} per year, the missile is not considered significant. If the combined probability is greater than 10^{-7} per year, missile protection of SSCs important to safety, and of nonsafety -related SSCs whose failure could affect an intended safety function of the safety related SSCs, should be provided by one or more of the six methods listed below.

2. The missile protection for SSCs important to safety is adequate if provided by one or more of the following methods: (1) locating the system or component in a missile-proof structure, (2) separating redundant systems or components for the missile path or range, (3) providing shields and barriers for systems and components, (4) designing the equipment to withstand the impact of the most damaging missile, (5) providing design features to prevent the generation of missiles, or (6) orienting missile sources to prevent missiles from striking equipment important to safety.

In summary, an Safety Analyses Report (SAR) statement that SSCs important to safety will be afforded protection by locating them in individual missile-proof structures, physically separating redundant systems or system components, or providing special protective shields or barriers is an acceptable method to meet this criterion.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. 10 CFR Part 50, Appendix A, GDC 4 establishes requirements for the ability of SSCs important to safety to be protected from dynamic effects, including the effects of internally-generated missiles. Equipment inside the containment like pressurized components, high-energy piping, and rotating equipment all have a potential for generating credible missiles. An internally-generated missile has a dynamic effect and its impact on SSCs important to safety must be evaluated to ensure that they are protected adequately and will be capable of performing their safety functions. Protecting SSCs important to safety from the adverse effects of internally-generated missiles prevents both failure of systems required for safe shutdown of the reactor facility and significant uncontrolled release of radioactivity.

III. REVIEW PROCEDURES

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

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

The review procedures below are used during the review to determine whether the design criteria and bases and the design in the SAR meets the acceptance criteria in subsection II of this SRP section.

1. The first objective in the review of SSCs requiring protection against internally-generated missiles is to determine whether the equipment is needed to perform a safety function. Some structures and systems are designed as safety-related in their entirety, others have safety-related portions, and others are not needed for safety. To determine the safety category, the SSCs are evaluated for their functions in achieving safe reactor shutdown conditions, preventing significant uncontrolled release of radioactivity, preventing accidents, or mitigating their consequences. The reviewer evaluates such input as required for completion of this review. SSCs that perform safety functions (inside containment) or by their failure could have adverse effects on safety functions should be protected from the effects of internally-generated missiles.

2. A review is conducted of the information provided in the SAR related to SSCs design bases and criteria, the listing of plausible primary and secondary missiles, damage to or failure of SSCs important to safety as a result of missile impingement, and missile protection capability. The reviewer may use failure mode and effect analyses and the results of reviews by other branches in evaluating SSCs to identify those requiring protection from internally-generated missiles, the origins of possible missiles, and the adequacy of the protection.

3. The reviewer determines whether controls ensure that unsecured maintenance equipment, including that required for maintenance and that undergoing maintenance, will be removed from containment prior to operation, moved to a location where it is not a potential hazard to SSCs important to safety, or seismically restrained to prevent it from becoming a missile.

4. The reviewer determines whether the separation analysis can demonstrate adequate protection for SSCs important to safety from missiles which may be generated inside the containment. The reviewer should utilize the results of any high-energy line separation analysis review in this evaluation. If an applicant uses spatial separation as adequate protection from missiles inside the containment, that evaluation should be consistent with the applicant's use of spatial separation for high-energy line breaks. If damage can occur to only one division of safety-related systems, the requirement for separation of redundant equipment is met. If more than one division can be damaged by high-energy piping, then barriers, shields, and enclosures must be utilized to protect SSCs important to safety.

5. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

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.

The review of possible effects of internally-generated missiles (inside containment) included SSCs whose failure could prevent safe shutdown of the plant or result in significant uncontrolled release of radioactivity. After review of the applicant's design bases and criteria for the SSCs important to safety necessary to maintain a safe plant shutdown, the staff concludes that the SSCs to be protected from internally-generated missiles (inside containment) meet 10 CFR 50, Appendix A, GDC 4 requirements for protection of SSCs important to safety, since the applicant:

1. Has used methods for identifying potential sources of internal missiles and for demonstrating the adequacy of the protection provided which have been reviewed and found acceptable by the staff in this application or in previous applications;

2. Has shown that the functions of SSCs important to safety will be protected from internally-generated missiles (inside containment) by locating the systems or components in individual missile-proof structures, providing adequate physical separation for redundant systems or components of the system, or providing special protective shields or barriers; and

3. Has shown that controls ensure that all unsecured maintenance equipment inside containment, including equipment required for maintenance and that undergoing maintenance, will not generate a potential missile hazard.

For DC and COL reviews, the findings will also summarize the staff’s evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

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 submitted 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, General Design Criteria 4, "Environmental and Dynamic Effects Design Bases."