U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

6.5.5 PRESSURE SUPPRESSION POOL AS A FISSION PRODUCT CLEANUP SYSTEM

REVIEW RESPONSIBILITIES

Primary - Organization responsible for review of design basis accident radiological consequence analysis.

Secondary - Organization responsible for review of chemical engineering issues.
Organization responsible for review of containment integrity.
Organization responsible for review of ventilation and air filtration.

I. AREAS OF REVIEW

The pressure suppression pool is reviewed under this plan only when the applicant claims credit for fission product scrubbing and retention by the suppression pool. The pressure suppression pool and the drywell, when considered as a barrier to the release of fission products, are reviewed to assess the degree to which fission products released during postulated reactor accidents will be retained in the suppression pool. Leakage paths that allow fission products to bypass the pool are identified and reviewed, and the maximum fractional bypass leakage is obtained, for use in the evaluation of radiological dose consequences.

The specific areas of review are as follows:

1. Fission Product Control Requirements. Sections of the applicant's safety analysis report (SAR) related to accident analyses, accident dose calculations, and fission product

control are reviewed to establish whether or not fission product scrubbing of the drywell or reactor compartment atmosphere is claimed or required for mitigation of radiological consequences following a postulated accident.

2. Design Bases. The design bases for the fission product removal function of the suppression pool and the drywell or reactor compartment are reviewed to verify that they are consistent with the assumptions made in the accident evaluations of SAR Chapter 15. The methodology used in this SRP section is not intended for containment venting evaluation. Containment venting will be considered in the evaluation of pressure suppression pools as fission product cleanup systems when the Commission approves the final guidance on containment venting.

3. System Design. The information on the design of the suppression pool is reviewed to familiarize the reviewer with the expected temperature histories, depth of fission product entry expected during postulated accidents, and potential leakage paths through drywell penetrations.

4. Testing and Technical Specifications. The details of the applicant's proposed preoperational tests and, at the operating license stage, the surveillance requirements are reviewed to ensure that the pool depth and amount of leakage bypassing the pool are maintained consistent with the assumptions used in assessing the pool's effectiveness in fission product cleanup.

5. 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.

6. 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. The organization responsible for review of chemical engineering issues reviews the drywell or containment spray systems for which fission product cleanup credit is claimed as part of its primary review responsibility for SRP Section 6.5.2.

2. In addition, the organization responsible for review of design basis accident radiological consequence analysis will coordinate staff evaluations that interface with the overall review of the system as follows:

   A. The organization responsible for review of containment integrity reviews containment leakage assumptions as part of its primary review responsibility for SRP Section 6.2.1.1.C.

   B. The organization responsible for review of ventilation and air filtration reviews the engineered safety feature atmosphere cleanup systems as part of its primary review responsibility for SRP Section 6.5.1.

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. General Design Criterion 41 as it relates to the control of fission products following postulated accidents.

2. General Design Criterion 42 as it relates to the periodic inspections of engineered safety features.

3. General Design Criterion 43 as it relates to the periodic functional testing of engineered safety features.

4. 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.

5. 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.

Where it can be shown to be in compliance with these criteria, the suppression pool may be given appropriate credit for fission product scrubbing and retention (except for noble gases, for which no pool retention credit is allowed) in the staff's evaluation of the radiological consequences of design-basis accidents. Other assumptions concerning the release of radioactivity are to be taken from: Regulatory Guide 1.3[1] (except for Position C.1.f which this SRP section replaces), Regulatory Guide 1.195, or Regulatory Guide 1.183[2] (see Appendix A.3.5).

Specific criteria that must be met to receive credit include:

1. The drywell and its penetrations must be designed to ensure that, even with a single active failure, all releases that include fission products from the reactor core must pass into the suppression pool, except for small bypass leakage.

2. The bypass leakage assumed for purposes of evaluating fission product retention must be no less than that accepted in the review under SRP Section 6.2.1.1.C, and must be demonstrated in periodic tests by the license technical specifications also reviewed under that section.

3. For plants that have already received a construction permit, the iodine retention calculated using this section must not be used to justify removal of the standby gas treatment or other filtered exhaust system from status as engineered safety features, and any change in plant design, proposed testing, surveillance or maintenance must be supported by considerations of lowered operator dose and other projected benefits. For such plants, the charcoal filters must be maintained at least to the minimum level of Table 1 in Regulatory Guide 1.52 , Rev. 3.

Acceptable methods for computing fission product retention by the suppression pool are given in this document in subsection III, "REVIEW PROCEDURES."

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[1]Regulatory Guides 1.3 and 1.4 provide guidance related to Technical Information Document (TID) 14844, "Calculation of Distance Factors for Power and Test Reactor Sites." This guidance is applicable to a holder of an operating license issued prior to January 10, 1997 or a holder of a renewed license under 10 CFR Part 54 whose initial operating license was issued prior to January 10, 1997. These license holders may voluntarily revise the accident source term.

[2]Regulatory Guide1.183 is applicable to applicants or license holders issued after January 10, 1997.

While granting credit for suppression pool scrubbing in the calculations of accident doses, the acceptance criteria of containment leakage in SRP Section 6.2.1.1.C and the acceptance criteria of the engineered safety feature atmosphere cleanup systems in SRP Section 6.5.1 should still be met.

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. GDC 41 requires, in part, that systems be provided as necessary to control fission products which may be released into the reactor containment to reduce the concentration and quality of fission products released to the environment following postulated accidents. The radiological consequences of accidents in Chapter 15 of the safety analysis report (SAR) are dependent on the quantity and quality of fission products released from containment. If Chapter 15 analysis takes credit for the suppression pool, then this system is relied upon to provide an effective means for removal of fission products released within the drywell during a design basis accident. Fission products are entrained in the suppression pool and are unavailable for leakage from containment. Compliance with GDC 41 ensures that the suppression pool will adequately meet its post accident safety function of fission product cleanup.

2. GDC 42 requires that the system be designed to permit appropriate periodic inspection of important components. If taken credit for in the Chapter 15 Accident Analysis, the suppression pool is relied upon to entrain fission products following design basis accidents. Inspection of important components of the suppression pool will validate the safety analysis assumptions regarding the system's effectiveness in fission product cleanup and assure the integrity and capability of the system to remove fission products following a design basis accident.

3. GDC 43 requires that the system be designed to permit appropriate periodic testing of important components. The capability of the suppression pool to clean up fission products is dependent upon the functionality of system components. Examples of functional testing performed on the suppression pool system components include: drywell leak testing, vacuum breaker operability tests, vacuum breaker position indicator and alarm testing, and water level instrument testing. The periodic functional testing of the suppression pool system components validates the safety analysis assumptions regarding the system's effectiveness in fission product cleanup and provides assurance of operability and the capability to remove fission products following a design basis accident.

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 first step in the review is to determine whether or not the suppression pool is to be used for mitigating radiological consequences. If no credit is claimed for fission product removal in the accident analyses, no further review is required under this SRP section.

If the suppression pool is intended as an engineered safety feature for mitigation of radiological doses, then the reviewer estimates its effectiveness in removing fission products from fluids expelled from the drywell or directly from the pressure vessel through the depressurization system.

If RG 1.183 assumptions are used, the basis for the amount of fission products that pass through the suppression pool must be provided by the applicant. If the values in Regulatory Guide 1.3, Position C.1.a, are used in the calculations of fission product removal, then deposition by plateout or natural deposition should not be considered as an additional removal mechanism. Deposition by plateout is already accounted for in Regulatory Guide 1.3, Position C.1.a.

1. Pool Decontamination Factor. The decontamination factor (DF) of the pool is defined as the ratio of the amount of a contaminant entering the pool to the amount leaving. Decontamination factors for each fission product form as functions of time can be calculated by the SPARC code. An applicant may use the SPARC code or other methods to calculate the retention of fission products within the pool, provided that these methods are described in the SAR adequately to permit review. If the time-integrated DF values claimed by the applicant for removal of particulates and elemental iodine are 10 or less for a Mark II or a Mark III containment, or are 5 or less for a Mark I containment, the applicant's values may be accepted without any need to perform calculations. A DF value of one (no retention) should be used for noble gases and for organic iodides. The applicant should provide justification for any DF values greater than those given above.

   The reviewer has an option to perform an independent confirmatory calculation of the DF. If the SPARC code is used for a confirmatory calculation of fission product decontamination, the review should take care in proper establishment of the input parameters for the calculations.

2. Pool Bypass Fraction. The fraction of the drywell atmosphere bypassing the suppression pool by leaking through drywell penetrations is obtained as a product of the review under SRP Section 6.2.1.1.C. If B is the bypass fraction and DF is the time-integrated pool decontamination factor, then the overall decontamination, D, to be used for accident dose calculations, may be taken as:

$$D = \frac{DF}{1 + B(DF-1)}$$

   The reviewer should clearly distinguish that fraction of B, that may be further treated by the standby gas treatment system from that fraction of B that also bypasses the secondary containment building.

3. Other Containment Atmosphere Cleanup Systems. Drywell or containment spray systems for which fission product cleanup credit is claimed are reviewed under SRP Section 6.5.2, and credit for both suppression pool and spray cleanup can be given as a result of the separate reviews.

4. Technical Specifications. The technical specifications are reviewed to ensure that they require periodic inspection to confirm suppression pool depth and surveillance tests to confirm drywell leak tightness, consistent with the bypass fraction used in computing the overall decontamination.

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.

1. The staff has reviewed the fission product scrubbing function of the pressure suppression pool and finds that the pool will reduce the fission product content of the steam-gas mixture flowing through the pool following accidents that blow down through the suppression pool. The staff estimates that the pool will decontaminate the flow by a factor of _____ for molecular iodine vapor and by a factor of _____ for particulate fission products. No significant decontamination of noble gases and organic iodides will occur in the pool. The system is largely passive in nature, and the active components are suitably redundant so that its fission product attenuation function can be accomplished assuming a single failure. The applicant's proposed program for preoperational and surveillance tests will ensure a continued state of readiness, and that bypass of the pool is unlikely to exceed the assumptions used in the dose assessments.

2. The staff concludes that the pressure suppression pool as a fission product cleanup system is acceptable and meets the requirements of General Design Criterion 41 with respect to the iodine removal function following a postulated loss-of-coolant accident, General Design Criterion 42 with respect to the capability for periodic inspection of the

system, and General Design Criterion 43 with respect to the capability for periodic testing of the system.

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 Criterion 41, "Containment Atmosphere Cleanup."

2. 10 CFR Part 50, Appendix A, General Design Criterion 42, "Inspection of Containment Atmosphere Cleanup Systems."

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

4. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

5. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors."

6. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.195, "Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light-Water Nuclear Power Reactors."

7. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Post accident Engineered-Safety-Featured Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

8. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.”

9. P. C. Owczarski, R. I. Shreck, and A. K. Postma, "Technical Bases and Users Manual for the Prototype of a Suppression Pool Aerosol Removal Code (SPARC)," U.S. Nuclear Regulatory Commission Report, NUREG/CR-3317.

10. R. S. Denning et al., "Radionuclide Release Calculations for Selected Severe Accident Scenarios," U.S. Nuclear Regulatory Commission Report, NUREG/CR-4624, Volume 1.

11. P. C. Owczarski and W. K. Winegardner, "Capture of Iodine in Suppression Pools," 19th DOE/NRC Nuclear Air Cleaning Conference, Seattle..