U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

6.1.2 PROTECTIVE COATING SYSTEMS (PAINTS) - ORGANIC MATERIALS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of chemical engineering issues and component integrity.

Secondary - None.

I. AREAS OF REVIEW

The specific areas of review are as follows:

1. The protective coating systems (paints) used inside the containment are evaluated as to suitability for design basis accident (DBA) conditions.

2. The stability of materials including protective coatings and organics are examined to determine the potential formation of decomposition products under DBA conditions. Radiation and chemical effects are considered.

3. 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.

4. 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

The review organization as part of its primary review responsibility for SRP Section 6.5.2 also reviews the fission product removal effectiveness of the containment spray system as well as the deposition of fission products on containment protective coating systems.

Other SRP sections interface with this section as follows:

1. Review of the radiation and chemical environments of equipment under DBA conditions as part of review responsibility for SRP Section 3.11.

2. Review of the control of combustible gases that can potentially be generated from the coating systems and organic materials and review the consequences of solid debris that can reach the containment recirculation sump as part of review responsibility for SRP Sections 6.2.5 and 6.2.2, respectively.

3. Review of the effects of solid debris on operations of fluid systems during post-accident conditions as part of review responsibilities for SRP Sections 5.4.7 and 6.3.

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. Appendix B to 10 CFR Part 50 as it relates to the quality assurance requirements for the design, fabrication and construction of safety-related structures, systems and components (SSCs).

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.

As discussed in Regulatory Guide 1.54 Rev. 1, to the extent that failure of protective coatings could prevent safety related SSCs from fulfilling their safety related function, the maintenance rule, 10 CFR 50.65, requires that licensees monitor the effectiveness of maintenance for protective coatings, or demonstrate that their performance or condition is being effectively controlled through the performance of appropriate preventative maintenance. Acceptance criteria include verification that coating monitoring and maintenance procedures are capable of ensuring that the coatings will not fail (delaminate from the substrate) and therefore become a debris source that could prevent the Emergency Core Cooling System (ECCS) from performing its safety related function.

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.

1. A coating system to be applied inside a containment is acceptable if it meets the regulatory positions of Regulatory Guide 1.54 and the standards of ASTM D5144-00 and ASTM D3911-03.

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. Appendix B to 10 CFR Part 50 requires a quality assurance program which comprises all those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service. It is important to prevent the deterioration of protective coatings by one, all, or a combination of the following conditions: ionizing radiation; contamination by radioactive nuclides and subsequent decontamination processes; chemical and water sprays; high-temperature; high-pressure steam; and abrasion or wear. The protective coatings must be resistant to causing generation of combustible gases like hydrogen and methane and gaseous

formation of radioactive organic iodides. If the protective coatings deteriorate by flaking, peeling, etc., they may form solid debris which can reach the containment recirculation sump and have a negative impact on the performance of post-accident cooling safety systems. Regulatory Guide 1.54, Rev. 1, describes an acceptable method of complying with the quality assurance requirements in regard to protective coatings applied to ferritic steels, aluminum, stainless steel, zinc-coated (galvanized) steel, concrete, or masonry surfaces of nuclear facilities. Compliance with Appendix B to 10 CFR Part 50 is important to ensure the overall quality and safety performance of protective coatings under normal and accident conditions.

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.

At the construction permit review stage, the reviewer verifies that the applicant has committed to using protective coating systems which meet the acceptance criteria.

At the operating license review stage, the reviewer determines the types and quantities of radiation and chemical decomposition products that can be produced from all the paints and organic materials which are exposed to the containment atmosphere. The paints and organic materials to be considered include those paints that are specified in the Safety Analysis Report (SAR), unspecified protective coatings on small machinery and equipment, and organic materials such as cable insulation. The determination is based on documented test data provided by the applicant. If test data are unavailable, a conservative analysis is required. The environmental conditions for the test and analysis must be comparable to those specified in Section 3.11 of the SAR. In the absence of test data on specific coating systems and organic materials, the data in Reference 5 may be used to estimate the rates of hydrogen formation from zinc primers and from zinc primers plus topcoats. Cable insulation is assumed to generate hydrogen by radiolysis with a yield comparable to that of polyethylene. Unqualified paints (organic or inorganic), those that do not meet the acceptance criteria of this Standard Review Plan section, are assumed to form solid debris under DBA conditions. Unqualified paints that contain only organic materials and that do not meet the acceptance criteria of this Standard Review Plan section, are assumed to generate hydrogen by radiolytic decomposition with a yield comparable to that of organic polymers.

If combustible gases such as hydrogen and methane can be generated, the reviewer notifies the appropriate reviewer if this source is not included in Section 6.2.5 of the SAR. If a system to control combustible vapors is not provided, then the release of volatile alkanes to form organic iodides is of additional concern. The yield of organic iodides relative to the total iodine released after a DBA is estimated using the data of Reference 7 and any applicable experimental results submitted by the applicant. The appropriate interfacing reviewer should be notified of the estimated organic iodide formation.

If solid debris can be produced, the interfacing reviewer responsible for solid debris should be notified of the quantity of debris that can result from decomposition of unqualified materials. The interfacing reviews should determine the effects of the debris on operation of post accident fluid systems.

Any exception to Regulatory Guide 1.54 involving quality assurance and quality control requirements should be referred to the appropriate interfacing reviewer for review and resolution.

Adverse interactions, if any, under DBA conditions, between the potential decomposition products, namely hydrogen and solid debris, and the engineered safety features are evaluated under SRP Sections 6.2.5 and 6.2.2, respectively.

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 concludes that the protective coating systems and their applications are acceptable and meet the requirements of Appendix B to 10 CFR Part 50. This conclusion is based on the applicant having met the quality assurance requirements of Appendix B to 10 CFR Part 50 since the coating systems and their applications meet the positions of Regulatory Guide 1.54, Rev. 1, “Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants,” and the quality assurance standards of ASTM D5144-00, “Standard Guide for Use of protective Coating Standards in Nuclear Power Plants,” and ASTM D3911-03, “Standard Test Method for Evaluating Coatings Used in Light Water Nuclear Power Plants at Simulated Design Basis Accident (DBA)Conditions.” Also, the containment coating systems have been evaluated as to their suitability to withstand a postulated design basis accident (DBA) environment. The coating systems chosen by the applicant have been qualified under conditions which take into account the postulated DBA conditions.

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.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guide.

VI. REFERENCES

1. 10 CFR Part 50, Appendix B, Quality Assurance Criteria For Nuclear Power Plants and Fuel Reprocessing Plants.

2. Regulatory Guide 1.54, "Service Level I, II, and III Protective Coatins Applied to Nuclear Power Plants."

3. ASTM D5144-00, "Standard Guide for Use of Protective Coating Standards in Nuclear Power Plants."

4. ASTM D3911-03, "Standard Test Method for Evaluating Coatings Used in Light Water Nuclear Power Plants at Simulated Design Basis Accident (DBA) Conditions."

5. H. E. Zittel, "Post-Accident Hydrogen Generation from Protective Coatings in Power Reactors," Nuclear Technology, Volume 17, pp. 143-146.

6. R. O. Bolt and J. G. Carroll, "Radiation Effects on Organic Materials," Academic Press, New York.

7. A. K. Postma and R. W. Zavadoski, "Review of Organic Iodide Formation Under Accident Conditions in Water-Cooled Reactors," WASH-1233 (1972).