## AMP 308 PROTECTIVE Coating Monitoring and Maintenance Programme (VERSION 2020)

### Programme Description

Proper maintenance of protective coatings inside containment of Nuclear Power Plants (i.e. defined as Service Level I in USNRC Regulatory Guide 1.54, rev.2 [1]) is essential to ensure operability of post-accident safety systems that rely on water recycled through the containment sump/drain system. Degradation of coating can be caused by chemical reaction, temperature, irradiation, ultraviolet light [2], etc. and can lead to clogging of Emergency Core Cooling Systems (ECCS) suction strainers, which reduces flow through the system and could cause unacceptable head loss for the pumps. Protective coatings against corrosion are main requirement for most properties like having resistance to fire, capable to survive and withstand to irradiation, adequate for refinement, etc.

Maintenance of these Service Level I coatings apply to carbon steel and concrete surfaces inside containment (e.g., steel liner, steel containment shell, structural steel, supports, penetrations, and concrete walls and floors) and also serve to prevent or minimize loss of material due to corrosion of carbon steel components and aids in decontamination.

USNRC RG 1.54, rev.2 [1] describes an acceptable technical basis for a Service Level I coatings monitoring and maintenance programme that can be credited for managing the effects of corrosion for carbon steel elements inside containment adequate for ageing management of structures.

ASTM D 5163-08 [3] guidelines provide acceptable and consistent with ageing management requisites for structures. EPRI Report 1019157 [4] provides additional information on the ASTM standard guidelines. Additional guidance document from other Member States, such as [5] from the Japan Electric Association, on protective coating material can also be consulted.

Even though Service Level I coatings, credited for preventing corrosion of steel containments and steel liners for concrete containments, are subject to requirements specified by AMP 301, the provisions of AMP 308 ensure that the protective coating monitoring and maintenance programme are adequate for ageing management of structures.

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### Evaluation and Technical Basis

1. ***Scope of the ageing management programme based on understanding ageing:***

The minimum scope of the programme is Service Level I coatings applied to steel and concrete surfaces inside containment (e.g., steel liner, steel containment shell, structural steel, supports, penetrations, and concrete walls and floors), defined as follows: "Service Level I coatings are used in areas inside the reactor containment where the coating failure could adversely affect the operation of post-accident fluid systems and thereby impair safe shutdown."

The scope of the programme also includes any Service Level I coatings that are credited for preventing loss of material due to corrosion in accordance with AMP 301.

1. ***Preventive actions to minimize and control ageing degradation:***

The programme is a condition monitoring programme and does not recommend any preventive actions. However, for NPPs with credited coatings to minimize loss of material, this programme is a preventive action.

1. ***Detection of ageing effects:***

Inspection plan and inspection methods to be used are a general visual inspection conducted on all readily accessible coated surfaces during a walk-through. After a walk-through, or during the general visual inspection, thorough visual inspections are carried out on previously designated areas and on areas noted as deficient during the walk-through. A thorough visual inspection is also carried out on all coatings near sumps or screens associated with the ECCS.

Inspection frequency is each refueling outage or during other major maintenance outages, as needed. The inspection personnel, inspection coordinator and the inspection results evaluator is qualified in accordance with accepted procedures. Field documentation of inspection results are identified and instruments and equipment needed for inspection is qualified.

Parameters monitored or inspected are to be any visible defects, such as blistering, cracking, flaking, peeling, delamination, rusting, and physical damage.

Technical guidelines as ASTM D 5163-08 [3] are a valid reference for detailed information how to prepare an inspection plan.

1. ***Monitoring and trending of ageing effects:***

Monitoring and trending activities specify a pre-inspection review of the previous two monitoring reports, and the inspection report prioritizes repair areas as either needing repair during the same outage or as postponed to future outages, but under surveillance in the interim period. The assessment from periodic inspections and analysis of total amount of degraded coatings in the containment is compared with the total amount of permitted degraded coatings to ensure post-accident operability of the ECCS.

Technical guidelines as ASTM D 5163-08 [3] are a valid reference for detailed information how to monitor and trend ageing effects.

1. ***Mitigating ageing effects:***

Technical guidelines as ASTM D 5163-08 [3] are a valid reference for establishing an in-service coating monitoring programme for Service Level I coating systems in NPPs.

1. ***Acceptance criteria:***

Technical guidelines as ASTM D 5163-08 [3] contain acceptable methods for the characterization, documentation and testing of defective or deficient coating surfaces.

Other recognized guidelines give test methods available for use in characterizing the severity of observed defects and deficiencies. The evaluation covers blistering, cracking, flaking, peeling, delamination, and rusting.

The inspection report is evaluated by the responsible evaluation personnel, who prepare a summary of findings and recommendations for future surveillance or repair, including an analysis of reasons or suspected reasons for failure. Repair work is prioritized into major or minor defective areas.

1. ***Corrective actions:***

Results that do not meet the acceptance criteria should be evaluated and appropriate corrective actions should be taken.

A recommended corrective action plan is required for major defective areas so that these areas can be repaired during the same outage, if appropriate.

1. ***Operating experience feedback and feedback of research and development results:***

This AMP addresses the industry-wide generic experience. Relevant plant-specific operating experience is considered in the development of the plant AMP to ensure the AMP is adequate for the plant. The plant implements a feedback process to periodically evaluate plant and industry-wide operating experience and research and development (R&D) results, and, as necessary, either modifies the plant AMP or takes additional actions (e. g. develop a new plant-specific AMP) to ensure the continued effectiveness of ageing management.

The following instances of operating experience regarding protective coating have been reported:

* Corrosion and degraded coating in some BWR containments [6];
* Protective coatings have not been properly applied, maintained, or qualified for their intended use [7];
* Plugging of ECCS strainers by debris [8-9];
* Flaking, peeling and corrosion of the coatings in some plants [10].

Appropriate source(s) of external operating experience is Ageing Management of Concrete Structures in Nuclear Power Plants [11].

It is necessary to consider the above documents and any other related operating experience identified in the future.

At the time when this AMP was produced, no relevant R&D was identified.

1. ***Quality management:***

Site quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the different national regulatory requirements (e.g. 10 CFR Part 50, Appendix B[12]).

### References

[1] UNITED STATES NUCLEAR REGULATORY COMMISSION, Regulatory Guide 1.54, Rev.2, Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants. USNRC, October 2010.

[2] ELECTRIC POWER RESEARCH INSTITUTE, Field Guide: Coatings Assessment, EPRI Report 1025323, EPRI, Palo Alto, CA: 2012.

[3] AMERICAN SOCIETY FOR TESTING AND MATERIALS. ASTM D 5163-08, Standard Guide for Establishing a Programme for Condition Assessment of Coating Service Level I Coating Systems in Nuclear Power Plants, ASTM, 2008.

[4] ELECTRIC POWER RESEARCH INSTITUTE, Guideline on Nuclear Safety-Related Coatings, Rev. 2, EPRI Report 1019157 (Formerly TR-109937 and 1003102), EPRI, Palo Alto, CA, December 2009.

[5] JAPAN ELECTRIC ASSOCIATION, Guide for Coatings in Reactor Containment Vessel, Japan, JEAG 4628-2010, JEA, December 2010.

[6] UNITED STATES NUCLEAR REGULATORY COMMISSION, Information Notice 88-82, Torus Shells with Corrosion and Degraded Coatings in BWR Containments, USNRC, November 14, 1988.

[7] UNITED STATES NUCLEAR REGULATORY COMMISSION, Information Notice 97-13, Deficient Conditions Associated With Protective Coatings at Nuclear Power Plants, USNRC, March 24, 1997.

[8] UNITED STATES NUCLEAR REGULATORY COMMISSION, Bulletin 96-03, Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors, USNRC, May 6, 1996.

[9] UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Letter 04-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors, USNRC, September 13, 2004.

[10] UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Letter 98-04, Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss-Of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment, USNRC, July 14, 1998.

[11] INTERNATIONAL ATOMIC ENERGY AGENCY, Ageing Management of Concrete Structures in Nuclear Power Plants (IAEA Nuclear Energy Series No. NP-T-3.5, (2016).

[12] UNITED STATES NUCLEAR REGULATORY COMMISION, 10 CFR Part 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants, Office of the Federal Register, National Archives and Records Administration, USNRC, 2015.