## AMP 124 OPEN-CYCLE COOLING WATER SYSTEM (VERSION 2020)

### Programme Description

An open-cycle cooling water (OCCW) (or service water) system transfers heat from safety-related structures, systems, and components (SSCs) to the ultimate heat sink (UHS). The programme ensures that the effects of ageing will not affect the functionality of an OCCW system. The programme includes:

* Surveillance and control of biofouling;
* Test programme to verify heat transfer capabilities;
* Inspection and a maintenance programme to ensure that corrosion, erosion, protective coating failure, sediment deposition (silting), and biofouling cannot degrade the performance of safety-related systems serviced by OCCW;
* System walk-down inspection to ensure compliance with the licensing basis;
* Review of maintenance, operating, and training practices and procedures.

For buried OCCW piping, the ageing effects on the external surfaces are managed by AMP 125, but the internal surfaces are managed by this programme. The ageing management of closed-cycle cooling water (CCCW) systems is described in AMP 117 and is not included as part of this programme. The OCCW System programme applies to components constructed of various materials, including steel, stainless steel, aluminum, copper alloys, titanium, polymeric materials, and concrete. Piping may be lined with internal coatings or unlined.

### Evaluation and Technical Basis

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

The ageing management programme addresses the ageing effects of material loss and fouling due to micro- or macro-organisms and various corrosion mechanisms generally found in OCCW systems or intermediate system between safety related SSC and system transfering heat to the UHS, and OCCW components with or without protective coating [1-4]. This programme may also be used to manage loss of coating integrity for those OCCW components with a protective coating or lining. The structural integrity of the civil structures that are part of the UHS as well as the structures submerged in OCCW is managed by the AMP 307. These ageing effects are managed by a combination of preventive, condition, and performance monitoring activities [3, 4].

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

Preventive actions begin with the use of appropriate material for construction (i.e., degradation resistant materials). Piping system components are typically lined or coated to protect the underlying metal surfaces from exposure to corrosive cooling water environments. Control or preventive measures, such as chemical treatment whenever the potential for biological fouling exists or flushing of infrequently used systems is applied if possible.

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

Inspections (and inspection frequency) for biofouling, damaged coatings and linings, degraded material condition (e.g., loss of material, cracking, and flow blockage are conducted in accordance with national regulations or governing documents. Visual inspections on the inner surfaces are typically performed to determine whether damaged coatings and linings, corrosion, erosion, or biofouling are occurring in the system. Perform examinations of polymeric materials consistent with the examinations described in AMP 135. Nondestructive testing, such as ultrasonic testing, eddy current testing, and radiography are effective methods to measure surface conditions or the extent of wall thinning associated with the service water system piping and components. National regulations, codes, standards and guidelines provide an acceptable basis for managing ageing effects associated with concrete piping included in this programme.

For those portions of the OCCW system where flow monitoring is not performed, test results from the monitored portions of the system are used to determine friction (or roughness) factors and are used to confirm that design flow rates will be achieved with the overall fouling identified in the system.

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

Heat transfer testing results are documented in plant test procedures and trended. Cleanliness and material integrity of piping, components, heat exchangers, elastomers, and their internal linings or coatings (when applicable) that are part of the OCCW system or that are cooled by the OCCW system are periodically inspected and monitored. If corrosion buildup or fouling is noted, the system also is evaluated for their impact on the heat transfer capability of the system. Evidence of corrosion in these systems also is evaluated for its potential impact on the integrity of the piping. For relevant indications, inspections or nondestructive testing is used to determine the extent of biofouling, the condition of the surface coating, the magnitude of localized pitting, and the amount of microbiologically-influenced corrosion (MIC), if applicable. Friction (or roughness) factors can be trended to confirm design flow rates are achievable in the portions of the OCCW system where flow monitoring is not performed.

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

Treatment with chemicals mitigates MIC and buildup of macroscopic biological fouling debris from biota, such as blue mussels, oysters, or clams. Periodic flushing of the system removes accumulations of biofouling agents, corrosion products, and debris or silt.

1. ***Acceptance criteria:***

Corrosion, erosion, and biofouling can cause significant loss of material in components. Inspected components are considered to exhibit adequate design margin regarding design dimensions (e.g., minimum required wall thickness). As applicable, coatings or linings are considered to be intact to protect the underlying metal. Heat removal capability is within allowable design values for the system and components tested. For ongoing degradation mechanisms (e.g., MIC), the programme includes criteria for the extent or rate of degradation that will prompt more comprehensive corrective actions. If concrete piping is being managed, acceptance criteria are derived from applicable national regulations, codes, standards and guidelines. The acceptance criteria for inspections of coatings or linings are consistent with those in AMP 157.

1. ***Corrective actions:***

Evaluations are performed for test or inspection results that do not satisfy established acceptance criteria, and a problem or condition report is initiated to document the concern in accordance with plant administrative procedures. The corrective actions programme with e.g., examination expansion or repair/replacement of components, ensures that the conditions adverse to quality are promptly corrected. Additional inspections may be necessary if corrective actions (i.e., repair or replacement) is not performed for all components constructed of the same material and exposed to the same environment. The overall effect of fouling is evaluated for reduction of heat transfer, flow blockage, loss of material, and (if applicable) chemical treatment effectiveness and its potential impact on the functionality of an OCCW system. For ongoing degradation mechanisms (e.g., MIC), the frequency and extent of wall thickness inspections are adjusted commensurate with the significance of the degradation. If the deficiency is assessed to be significantly adverse to quality, the cause of the condition is determined, and an action plan is developed to preclude repetition.

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 the ageing management.

Significant degradation has been found in many cases, e.g. MIC [5]. The elements that comprise inspections associated with this programme (the scope of the inspections and inspection techniques) are considered to be consistent with industry practice [3-4]. In the U.S.A., the guidance of NRC GL 89‑13 [6-7] has been implemented for more than 20 years and has been effective in managing ageing effects due to biofouling, corrosion, erosion, protective coating failures, and silting in structures and components serviced by OCCW systems [6-8].

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

1. ***Quality management:***

Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the different national regulatoryrequirements (e.g., 10 CFR 50, Appendix B [9]).

### References

[1] UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report — Final Report (NUREG-2191), USNRC, 2017

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Final Report of the Programme on Safety Aspects of Long Term Operation of Water Moderated Reactors, IAEA Programmatic Guidelines for Ageing Management No. IAEA-EBP-SALTO, IAEA, Vienna, 2007

[3] ELECTRIC POWER RESEARCH INSTITUTE, [[1010059](http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname=ObjMgr&parentid=2&control=SetCommunity&CommunityID=404&RaiseDocID=000000000001010059&RaiseDocType=Abstract_id), Service Water Piping Guideline,](http://my.epri.com/portal/server.pt?Abstract_id=000000000001021007)  EPRI, Palo Alto, CA, 2005

[4] ELECTRIC POWER RESEARCH INSTITUTE, [[1008282](http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname=ObjMgr&parentid=2&control=SetCommunity&CommunityID=404&RaiseDocID=000000000001008282&RaiseDocType=Abstract_id),](http://my.epri.com/portal/server.pt?Abstract_id=000000000001021007) Life Cycle Management Sourcebook for Nuclear Plant Service Water, EPRI, Palo Alto, CA, 2005

[5] ELECTRIC POWER RESEARCH INSTITUTE, NP[-4582,](http://my.epri.com/portal/server.pt?Abstract_id=000000000001021007) A Study of Microbiologically Influenced Corrosion in Nuclear Power Plants and a Practical Guide for Counter­measures EPRI, Palo Alto, CA, 1986

[6] UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Generic Letter 89-13, Service Water System Problems Affecting Safety-Related Components, USNRC, July 18, 1989

[7] UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Generic Letter 89-13, Supplement 1, Service Water System Problems Affecting Safety-Related Components, USNRC, April 4, 1990

[8] UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Information Notice 2007-06, Potential Common Cause Vulnerabilities in Essential Service Water Systems, USNRC, February 9, 2007

[9] UNITED STATES NUCLEAR REGULATORY COMMISSION, Title 10 Part 50 of the Code of Federal Regulations (10 CFR 50), Appendix B, Quality Assurance Criteria for Nuclear Power Plants, Office of the Federal Register, National Archives and Records, USNRC, Latest Edition