## AMP 131 FIRE WATER SYSTEM (VERSION 2017)

### Programme Description

This AMP applies to water-based fire protection systems that consist of sprinklers, nozzles, fittings, valves, fire pump casings, hydrants, hose stations, standpipes, water storage tanks, and aboveground, buried, and underground piping and components that are tested in accordance with the applicable Fire Protection regulation, codes, standards and guidelines [1-5]. Full‑flow testing and visual inspections are conducted to ensure that loss of material due to general, pitting, and crevice corrosion, microbiologically-induced corrosion or fouling, and increased flow resistance due to fouling is adequately managed, to assure the minimum functionality of the systems. Portions of the water based fire protection system that are: (a) normally dry but periodically are subject to flow (e.g., dry-pipe or pre-action sprinkler system piping and valves) and (b) that cannot be drained or allow water to collect, are subjected to augmented testing or inspections. Also, these systems are normally maintained at required operating pressure and monitored such that loss of system pressure is immediately detected and corrective actions initiated.

AMP 125 describes the ageing management programme for the external surfaces of buried and underground water-based fire protection system piping and tanks.

A description of augmented ageing management activities for water-based fire protection systems are provided in [6].

### Evaluation and Technical Basis

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

The programme focuses on managing loss of material due to general corrosion, crevice corrosion, microbiologically influenced corrosion (MIC), pitting corrosion, or fouling, and increased flow resistance due to fouling of components in fire protection systems exposed to water. Components within the scope of water-based fire protection systems include items such as sprinklers, nozzles, fittings, valve bodies, fire pump casings, hydrants, hose stations, fire water storage tanks, fire service mains, and standpipes. Fire hose stations and standpipes are considered as piping in the AMP. Fire hoses and gaskets can be excluded from the scope of review if the standards that are relied upon to prescribe replacement of the hose and gaskets are identified in the scoping methodology description. The internal surfaces of water-based fire protection system piping that is normally drained, such as dry pipe sprinkler system piping, are included within the scope of this AMP.

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

Periodic flushes mitigate or prevent fouling, which can cause increased flow resistance or loss of material, by clearing corrosion products and sediment.

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

Loss of material could reduce wall thickness of the fire protection piping system and result in system failure. Therefore, the parameters monitored are the system’s ability to maintain pressure and internal system corrosion conditions. Periodic flow testing of the fire water system is performed using the applicable guidelines, or wall thickness evaluations (e.g., non-intrusive volumetric testing or plant maintenance visual inspections) may be performed to ensure that the system maintains its intended function. These inspections are performed before the end of the current operating term and at plant-specific intervals thereafter during the period of long term operation (LTO). The plant-specific inspection intervals are determined by engineering evaluation of the fire protection piping to ensure that degradation is detected before the loss of intended function. The purpose of the full flow testing and wall thickness evaluations is to ensure that corrosion, MIC, or fouling is managed such that the system function is maintained.

As an alternative to non-intrusive testing, the plant maintenance process may include a visual inspection of the internal surface of the fire protection piping upon each entry to the system for routine or corrective maintenance, as long as it can be demonstrated that inspections are performed (based on past maintenance history) on a representative number of locations on a reasonable basis. These inspections are capable of evaluating (a) the conditions of the internal surfaces of components that could indicate wall loss or cracking, and (b) the inner diameter of the piping as it applies to the design flow of the fire protection system (i.e., to verify that corrosion product buildup has not resulted in flow blockage due to fouling). Internal visual inspections used to detect loss of material are capable of detecting surface irregularities that could be indicative of an unexpected level of degradation due to corrosion and corrosion product deposition. Where such irregularities are detected, follow-up volumetric examinations are performed.

If the environmental and material conditions that exist on the interior surface of the below grade fire protection piping are similar to the conditions that exist within the above grade fire protection piping, the results of the inspections of the above grade fire protection piping can be extrapolated to evaluate the condition of below grade fire protection piping. If not, additional inspection activities are needed to ensure that the intended function of below grade fire protection piping is maintained consistent with the current licensing basis for the intended period of operation.

Continuous system pressure monitoring, system flow testing, and wall thickness evaluations of piping are effective means to ensure that corrosion and fouling are not occurring and that the system’s intended function is maintained.

General requirements of existing fire protection programmes include testing and maintenance of fire detection and protection systems and surveillance procedures to ensure that fire detectors as well as fire protection systems and components are operable.

Visual inspection of yard fire hydrants, performed with the frequency that the applicable standard establishes, ensures timely detection of signs of degradation, such as corrosion. Fire hydrant hose hydrostatic tests, gasket inspections, and fire hydrant flow tests, performed annually, ensure that fire hydrants can perform their intended function and provide opportunities to detect degradation before a loss of intended function can occur. Sprinkler heads, according to [5], are tested before the end of the 50-year sprinkler head service life and at 10-year intervals thereafter during the period of LTO to ensure that signs of degradation, such as corrosion, are detected in a timely manner.

For water based fire protection system components that have been wetted but are normally dry (such as dry-pipe or preaction sprinkler system piping and valves), those portions that cannot be drained or allow water to collect are subjected to augmented testing and inspections.

Additional discussion of augmented ageing management activities for water-based fire protection systems are provided in [6].

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

This programme is a condition monitoring programme and does not mitigate degradation of water-based fire protection system

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

Visual inspection results are monitored and evaluated. System discharge pressure is monitored continuously. Results of system performance testing are monitored and trended as specified by the associated plant commitments pertaining to the applicable codes and standards. Degradation identified by non-intrusive or visual inspection is evaluated.

1. ***Acceptance criteria:***

The acceptance criteria are (a) the water-based fire protection system is able to maintain the required pressure, (b) no unacceptable signs of degradation are observed during non-intrusive or visual inspection of components, (c) minimum design pipe wall thickness is maintained, and (d) no fouling exists in the sprinkler systems that could cause corrosion in the sprinklers.

1. ***Corrective actions:***

Results that do not meet the acceptance criteria are addressed in the applicant’s corrective action programme. If the presence of sufficient foreign organic or inorganic material to obstruct pipe or sprinklers is detected during pipe inspections, the material is removed and its source is determined and corrected. Repair and replacement actions are initiated as necessary.

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.

Water-based fire protection systems designed, inspected, tested, and maintained in accordance with the minimum standards of the national regulation have demonstrated reliable performance. Operating experience (OE) shows that water-based fire protection systems are subject to loss of material due to corrosion, MIC, or fouling; and flow blockages due to fouling. Loss of material has resulted in sprinkler system flow blockages, failed flow tests, and piping leaks. Inspections and testing performed in accordance with NFPA standards coupled with visual inspections are capable of detecting degradation prior to loss of intended function. The following OE may be of significance to an applicant’s programme:

* 1. In October 2004, a fire main failed its periodic flow test due to a low cleanliness factor. The low cleanliness factor was attributed to fouling because of an accumulation of corrosion products on the interior of the pipe wall and tuberculation. Subsequent chemical cleaning to remove the corrosion products from the pipe wall revealed several leaks. Corrosion products removed during the chemical cleaning were observed to settle out in normally stagnant sections of the water-based fire protection system, resulting in flow blockages in small diameter piping and valve leak-by [7].
  2. In October 2010, a portion of a preaction spray system failed its functional flow test because of flow blockages. Two branch lines were found to have significant blockages. The blockage in one branch line was determined to be a buildup of corrosion products. A rag was found in the other branch line. [8]
  3. In August 2011, an intake fire protection preaction sprinkler system was unable to pass flow during functional testing. Subsequent visual inspections identified flow blockages in the inspector’s test valve, the piping leading to the inspector’s test valves, and three vertical risers. The flow blockages were determined to be a buildup of corrosion products. [9]
  4. In March 2012, the staff and licensee personnel found that a portion of the internally galvanized piping of a preaction sprinkler system could not be properly drained because the drainage points were located on a smaller diameter pipe that tied into the side of the pipe. A boroscopic inspection of the lower portions of the pipe showed that it contained residual water, that the galvanizing had been removed, and that significant quantities of corrosion products were present whereas in the upper dry portions, the galvanized coating was still intact. [10]

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

1. ***Quality management:***

Site QA procedures, review and approval processes, and administrative controls are implemented in accordance with the national requirements (e.g. [11]).

### References

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Fire Safety in the Operation of Nuclear Power Plants Safety Guide, IAEA Safety Standards Series No. NS-G-2.1, IAEA, Vienna, 2000.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Fire Protection in Nuclear Power Plants, Safety Series No. 50-SG-D2 (Rev. 1), IAEA, Vienna, 1999.

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Maintenance of Nuclear Power Plants, Safety Series No. 50-SG-O7 (Rev. 1), IAEA, Vienna, 1990.

[4] NATIONAL FIRE PROTECTION ASSOCIATION, NFPA 25, Inspection, Testing and Maintenance of Water-Based Fire Protection Systems, NFPA, Quincy, Massachusetts, USA, 1998.

[5] NATIONAL FIRE PROTECTION ASSOCIATION, NFPA 25, Inspection, Testing and Maintenance of Water-Based Fire Protection Systems, NFPA, Quincy, Massachusetts, USA, 2002.

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

[7] UNITED STATES NUCLEAR REGULATORY COMMISSION, Safety Evaluation Report Related to the License Renewal of Callaway Plant Unit 1, NUREG-2172, Washington, March 2015.

[8] EXELON NUCLEAR, Chemistry Lab Pre-action System Clogging - Presentation during September 2011 NEI Fire Protection Information Forum, September 12, 2011. (See USNRC Agency Document Access and Management System Accession No. ML13014A100.)

[9] UNITED STATES NUCLEAR REGULATORY COMMISSION, Licensee Event Report 50-263/2011-006-00, Intake Structure Fire Suppression System Blockage, USNRC, Washington, October 31, 2011.

[10] UNITED STATES NUCLEAR REGULATORY COMMISSION, Corrosion in Fire Protection Piping Due to Air and Water Interaction, NRC Information Notice 2013-06, USNRC, Washington, March 25, 2013.

[11] UNITED STATES NUCLEAR REGULATORY COMMISSION, 10 CFR Part 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants, Office of the Federal Register, National Archives and Records Administration, Washington, Latest Edition.