## AMP159 PWR EMERGENCY CORE COOLING SYSTEM HYDRO-ACCUMULATORS (VERSION 2019)

### Programme Description

Emergency core cooling system (ECCS) provides core cooling in the event of a loss of coolant accident (LOCA). During the short-term cooling (cold leg injection) phase, the ECCS prevents excessive core temperature to minimize or prevent core damage by rapidly injecting borated water into the reactor vessel and re-flooding the core. During the long-term cooling phase, the ECCS recirculates the collected water from the containment recirculation sump and to remove the decay heat from the reactor core as long as it is required.

The objective of this programme is to manage the ageing of the ECCS hydro-accumulators in PWR NPPs. Hydro-accumulator performance monitoring, ageing effects identification, mitigation and corrective actions plan development and its implementation are parts of this programme which are necessary to ensure that the hydro-accumulators continue to perform their intended function and meet performance objectives throughout the design life and for long term operation.

This ageing management programme is a component-specific AMP for the hydro-accumulator, that covers multiple potential degradation mechanisms the hydro-accumulator may be subjected to and the activities necessary to manage the ageing mechanisms. As such, this AMP refers to other degradation-specific and/or monitoring type of AMPs that deal with particular degradation mechanisms and ageing effects.

**Evaluation and Technical Basis**

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

This programme is applicable to managing ageing of hydro-accumulator in ECCS in PWR NPPs. Periodic assessment of ageing mechanisms associated with shell, nozzles, manhole, shielding plate, lifting lug, head (upper and lower), skirt support and dampers is performed.

The following degradation mechanisms are considered in this AMP, although not every mechanism applies to each item in the scope of this AMP [1], [2]:

* Stress corrosion cracking (SCC);
* General corrosion;
* Wear and loss of preload due to self-loosening;
* Boric acid corrosion.

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

As a preventive action, ageing effects of hydro-accumulators can be managed by water chemistry control programme e.g. AMP 103 and [3].

Other preventive actions are done in the framework of preventive maintenance (such as general repair, coating, inspection of sealing and screw tightness etc.).

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

The hydro-accumulator is inspected and tested according to AMP 102. Non-destructive methods such as visual inspection, penetration test to detect surface cracks, dimensional control and ultrasonic inspection may be used. It is expected that visual, surface or volumetric inspection performed within AMP 102 will detect cracking due to SCC, or loss of material due to general corrosion, wear.

The impact of boric acid leakage on bolting materials is addressed by AMP 110.

Inspection and leak detection for hydro-accumulators are conducted in accordance with national regulations or governing documents. Hydraulic test is carried out according to the national regulation.

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

Water chemistry sampling results are monitored periodically and parameters are trended so that corrective actions can be taken prior to loss of intended function. Inspection results are trended with time so that the progression of any corrosion or cracking can be evaluated and predicted.

Monitoring and trending is performed as per the AMPs listed in attribute 3.

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

Recommendations for mitigation of ageing effects are based on AMP103.

1. ***Acceptance criteria:***

Acceptance criteria are part of referred AMPs in attribute 3, and maintenance procedures. Any indication or relevant conditions of degradation may be evaluated for acceptance in accordance with the governing requirements also general guidance documents can be used as for example [4], [5], [6].

1. Outer surface examination
   1. Outer surface/welds of tank and nozzle attachments - No blistering, no indication of wear, no water leakage, no N2 leakage during layup condition, no coating damage, no corrosion.
   2. Outer surface of manhole cover (corners) - No looseness of bolts, no coating damage, no corrosion
   3. Skirt supports - No looseness, no corrosion
   4. Foundation anchor bolts/nuts - No looseness, no corrosion
2. Hydraulic test
3. No leakage, no abnormal distortion on test pressure of hydro-accumulator.
4. Water chemistry control
5. Chemistry parameters are in line with national norms and standards.
6. Wall thickness measured by NDE that shows material erosion/corrosion losses that do not exceed the acceptable limits of design code (such as [8]) for the next periodic inspection interval, are considered acceptable.
7. Indications detected by NDE meet the acceptable limits of design code (such as [7]) are considered acceptable

Conditions that do not comply with the general acceptance criteria mentioned above may be considered acceptable provided that the fitness-for-service of the component has been demonstrated by engineering analyses until the end of the next periodic inspection interval.

1. ***Corrective actions:***

A variety of maintenance actions are available, as a corrective action, to manage ageing effects when the acceptance criteria are not met. Decisions on the type and timing of the maintenance actions are based on an assessment of the observed ageing effects and the available maintenance technologies.

Following actions could be taken to correct the ageing effects:

1. Repair of coating/painting of component is carried out when blistering is found. It should comply with the maintenance procedure of hydro-accumulator.
2. Repair of weld and joints in case of leakage or indications is carried out in accordance to the national procedure (e.g., [8]).
3. If any damage is detected in studs/fasteners/gaskets of components; they are replaced.
4. ***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.

Review and evaluation of plant-specific and industry-wide operating experience have shown that current inspection and leak testing programmes for the hydro-accumulators used in PWR NPPs are generally effective in managing ageing effects.

Research and development efforts and an effective experience exchange are important elements for implementing continuous improvement in this programme and in defining adequate corrective actions.

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 different national regulatory requirements e.g., [9] and [10].

### References

1. UNITED STATES NUCLEAR REGULATORY COMMISSION, Information Notice No. 91-05: Intergranular Stress Corrosion Cracking in Pressurized Water Reactor Safety Injection Accumulator Nozzles, US NRC 1991.
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Ageing Lessons Learned (GALL) Report, NUREG-1801 Revision 2.
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Specific Safety Guide SSG-13, Chemistry Programme for Water Cooled Nuclear Power Plants, 2011.
4. INTERNATIONAL ATOMIC ENERGY AGENCY, Ageing Management and Development of Programme for Long Term Operation of Nuclear Power Plants, Specific Safety Guide SSG-48, 2018.
5. ELECTRIC POWER RESEARCH INSTITUTE, Primary System Corrosion Research Program: EPRI Materials Degradation Matrix, EPRI 3002013781, Revision 4, EPRI, Palo Alto, CA, May 2018
6. UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report, NUREG-2191, 2017
7. AMERICAN SOCIETY OF MECHANICAL ENGINEERS, BPVC, Section XI (Edition 2017)
8. ASCEN, RSE-M 2010, Appendix 3.1, Table CD 330-2 are attached at ANNEXURE-III
9. UNITED STATES NUCLEAR REGULATORY COMMISSION, 10 CFR Part 50, Appendix B
10. Hungarian Atomic Energy Agency: Guideline 4.12. Ageing management during the operation of NPPs, April 2013.