## **AMP 102 IN-SERVICE INSPECTION/ PERIODIC INSPECTION (Version 2020)**

### Programme Description

The In-service Inspection (ISI) / Periodic Inspection Programme defines the NPP components which must be inspected, as well as methods for non-destructive testing (NDT) and the intervals between inspections.

The programme generally includes periodic visual, surface, and/or volumetric examination and pressure tests of all safety class pressure-retaining components and their integral attachments. Repair/replacement activities for these components and acceptance by analysis (such as flaw analysis) are also covered.

The programme has been shown to be generally effective in managing ageing effects of safety classified components and their integral attachments in water cooled power plants. The ISI programmes for all types of nuclear power plant rely mostly on national codes and regulation [1-11], as well as some international in-service inspection requirements or guidance documents [12-17].

In relation to Section XI of the ASME Code [2-3], it has two Divisions:

* Section XI, Division 1, ‘Rules for Inspection and Testing of Components of Light-Water-Cooled Plants’, provides rules for a mandatory programme of examinations, testing, and inspections of components of light-water-cooled plants to evidence adequate safety and to manage deterioration and ageing effects.
* Section XI, Division 2, ‘Requirements for Reliability and Integrity Management Programmes for Nuclear Power Plants’, provides requirements for the development of a Reliability and Integrity Management Programme that considers the combination of design, fabrication, degradation mechanisms, inspection, examination, monitoring, operation, and maintenance of SSCs to ensure they will meet their required reliability target values. This Division is a technology-neutral standard. Also, it is applicable regardless of the Construction Code classification used for a SSC if the SSC is designated as important to the safety and reliability of an operating plant.

The use of Division 2 of Section XI as part of this programme is either subject to the approval of the national regulator or permitted if its use is consistent with national regulations.

**Evaluation and Technical Basis**

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

The programme provides the requirements for ISI, repair and replacement of safety classified pressure-retaining components and their integral attachments in water cooled nuclear power plants. AMP303 can be used alternatively for supports of safety class 1, 2 and 3 piping and metal containment components supports. The programme also includes for acceptance by analysis (such as flaw evaluations), repair or replacement of degradation identified by the ISI.

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

This is a condition monitoring programme. It does not implement preventive actions.

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

The programme detects degradation of components by using examination and inspection requirements for safety classified components.

Standards for examination methods, procedures, and personnel are provided in the programme, with preference to well-established examination methods. These methods include three types of examinations: visual, surface and volumetric. Various visual (e.g. VT-1, and VT-3 for IAEA Member States which apply ASME Codes) as well as augmented techniques (EVT-1) [18] examinations are applied to detect general surface conditions and surface-breaking discontinuities.

For IAEA Member States which apply the main requirements of [19], a description of the visual examination is given in national rules and procedures developed on the basis of [19].

Surface examinations may be used as an alternative to visual examinations for detection and sizing of surface-breaking discontinuities.

Surface examination uses magnetic particle, liquid penetrant, or eddy current examinations to identify the presence of surface discontinuities and flaws. Volumetric examination uses radiographic, ultrasonic, or eddy current examinations to identify the presence of discontinuities or flaws throughout the required inspection volume. The extent and schedule of the inspection and test techniques prescribed by the programme are designed to maintain structural integrity and ensure that ageing effects are discovered and corrected (repair or replacement) before the loss of intended function of the component. Inspection can reveal cracking, loss of material due to corrosion, leakage of coolant, and indications of degradation due to wear or stress relaxation of fitted connections such as bolts and keys, through detection of changes in clearances, settings, physical displacements, loose or missing parts, debris, wear, erosion, or loss of integrity at bolted or welded connections.

Components are examined and tested as specified in the pertinent governing requirements or guidance documents, such as ASME, JSME, etc., which specify the examination methods for the components of the pressure-retaining boundaries.

For example, some specific rules for ISI of equipment and pipelines on NPPs of Russian design are given in [19-21], and for ISI of PWR and BWR reactor vessel internals on Japanese NPPs are given in [22-28].

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

For safety class components, the schedule, extent and frequency of inspections in accordance with the pertinent governing requirements or guidance documents, such as ASME, JSME, etc., provide for timely detection of degradation. The sequence of component examinations that is established during the first inspection interval is repeated during each successive inspection interval, to the extent practical. Volumetric and surface examination results are compared with recorded preservice examination and prior in-service examinations. If flaw conditions or relevant conditions of degradation are evaluated in accordance with guidelines and the component is qualified as acceptable for continued service, the areas containing such flaw indications and relevant conditions are reexamined during the specified inspection periods.

Examinations that reveal indications that exceed the acceptance standards described are extended to include additional examinations in accordance with pertinent governing requirements or guidance. Examination results that exceed the acceptance criteria are repaired/replaced or accepted by analytical evaluation.

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

This is a condition monitoring programme. It does not implement mitigating actions. However, methods for water chemistry control are established to control and monitor any adverse effects of the water chemistry conditions on the ageing effects. The programme description and evaluation and technical basis of monitoring and maintaining reactor coolant chemistry are addressed in AMP 103.

1. ***Acceptance criteria:***

Any indication or relevant conditions of degradation is evaluated for acceptance in accordance with the pertinent governing requirements or guidance documents. Examination results are evaluated in accordance the documents mentioned above.

1. ***Corrective actions:***

Repair and replacement activities are performed in conformance with the pertinent governing requirements or guidance documents when indications or relevant conditions of degradation cannot be demonstrated to be acceptable.

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.

This programme includes provisions for continuing review of plant-specific and industry-wide operating experience, and research and development results, such that impact on the programme is evaluated and any necessary actions or modifications to the programme are performed.

Some specific examples of operating experience of component degradation are given in [13, 29].

Because ISI has been widely used over a long period, it has been shown to be generally effective in managing ageing effects in safety classified components and their integral attachments in water cooled power plants.

Component specific information on operating experience feedback and on feedback of R&D results is given in [30-44].

1. ***Quality management:***

Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the different national regulatory requirements (e.g., 10 CFR 50, Appendix B [45]).

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