## AMP 122 PWR FLUX thimble tube inspection (VERSION 2021)

**Programme Description**

The Flux Thimble Tube Inspection programme is a condition monitoring programme used to inspect for wear, which provides a path for the in-core neutron flux monitoring system detectors and forms part of the reactor coolant system (RCS) pressure boundary. Flux thimble tubes are subject to loss of material at certain locations in the reactor vessel where flow-induced fretting causes wear at discontinuities in the path from the reactor vessel instrument nozzle to the fuel assembly instrument guide tube. A nondestructive examination methodology, such as eddy current testing (ECT), is used to monitor for wear of the flux thimble tubes.

### Evaluation and Technical Basis

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

The flux thimble tube inspection programme manages wear of all flux thimble tubes that form part of the RCS pressure boundary. The instrument guide tubes are not in the scope of this programme.

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

The programme consists of inspection and evaluation and provides no specific guidance on preventive actions.

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

Flux thimble tube wall thickness is monitored to detect loss of material from the flux thimble tubes during the period of extended operation [1].

An inspection methodology (such as ECT) that has been demonstrated to be capable of adequately detecting wear of the flux thimble tubes is used to detect loss of material during the period of extended operation, for example WCAP-12866 [2]. Justification for methods other than ECT are provided unless use of the alternative method has been previously accepted by the regulatory authorities.

Examination frequency is based upon actual plant-specific wear data and wear predictions that have been technically justified as providing conservative estimates of flux thimble tube wear. The interval between inspections is established such that no flux thimble tube is predicted to incur wear that exceeds the established acceptance criteria before the next inspection. The examination frequency may be adjusted based on plant-specific wear projections. Re-baselining of the examination frequency is justified using plant-specific wear-rate data unless prior plant-specific acceptance for the re-baselining has been received. If design changes are made to use more wear-resistant thimble tube materials (e.g., chrome-plated stainless steel), sufficient inspections are conducted at an adequate inspection frequency, as described above, for the new materials.

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

Flux thimble tube wall thickness measurements are trended, and wear rates are calculated based on plant-specific data. Wall thickness is projected using plant-specific data and a methodology that includes sufficient conservatism to ensure that wall thickness acceptance criteria continue to be met during plant operation between scheduled inspections.

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

This programme is a condition monitoring programme and has no specific mitigating aspects. However, the plant can make design changes to minimize degradation by using more wear-resistant thimble tube materials (e.g., chrome-plated stainless steel).

1. ***Acceptance criteria:***

Appropriate acceptance criteria, such as percent through-wall wear, are established, and inspection results are evaluated and compared with the acceptance criteria. The acceptance criteria are technically justified to provide an adequate margin of safety to ensure that the integrity of the reactor coolant system pressure boundary is maintained. The acceptance criteria include allowances for factors such as instrument uncertainty, uncertainties in wear scar geometry, and other potential inaccuracies, as applicable, to the inspection methodology chosen for use in the programme.

1. ***Corrective actions:***

Flux thimble tubes with wall thickness that do not meet the established acceptance criteria are isolated, capped, plugged, withdrawn, replaced, or otherwise removed from service in a manner that ensures the integrity of the reactor coolant system pressure boundary is maintained. Analyses may allow repositioning of flux thimble tubes that are approaching the acceptance criteria limit. Repositioning of a tube exposes a different portion of the tube to the discontinuity that is causing the wear.

When changing flux thimble tubes the cleanliness is very important or this could lead to detector sticking issues. Cleaning recommendations are supplied in the Westinghouse Technical Bulletin TB-02-1 [3].

Flux thimble tubes that cannot be inspected over the tube length, that are subject to wear due to restriction or other defects, and that cannot be shown by analysis to be satisfactory for continued service are removed from service to ensure the integrity of the reactor coolant system pressure boundary.

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.

Specific operating experience with flux thimble tube wear is provided in NRC Information Notice 87-44 [4] and its supplement [5], and NRC Bulletin 88-09 [6].

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 different regulatory requirements (e.g., 10 CFR 50, Appendix B, [7]).

### References

1. Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines (MRP-227, REVISION 1-A); EPRI, PALO ALTO, CA. 2019. 3002017168
2. WESTINGHOUSE OWNER´S GROUP, WCAP-12866, Bottom mounted instrumentation flux thimble wear
3. WESTINGHOUSE TECHNICAL BULLETIN, TB-02-1, Bottom mounted instrumentation flux thimble detector sticking issue
4. UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Information Notice No. 87-44, Thimble Tube Thinning in Westinghouse Reactors, USNRC, September 16, 1987
5. UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC Information Notice No. 87-44, Supplement 1, Thimble Tube Thinning in Westinghouse Reactors*,* USNRC, March 28, 1988
6. UNITED STATES NUCLEAR REGULATORY COMMISSION, NRC IE Bulletin 88-09, Thimble Tube Thinning in Westinghouse Reactors, USNRC, July 26, 1988
7. UNITED STATES NUCLEAR REGULATORY COMMISION, 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 Administration, USNRC, Latest Edition