XI.M37 FLUX THIMBLE TUBE INSPECTION

Program Description

The Flux Thimble Tube Inspection is a condition monitoring program used to inspect for thinning of the flux thimble tube wall, which provides a path for the incore 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) or other applicant-justified and U.S. Nuclear Regulatory Commission (NRC)-accepted inspection method, is used to monitor for wear of the flux thimble tubes. This program implements the recommendations of NRC IE Bulletin 88-09, as described below.

Evaluation and Technical Basis

1. ***Scope of Program:*** The flux thimble tube inspection encompasses all of the flux thimble tubes that form part of the RCS pressure boundary. The instrument guide tubes are not in the scope of this program. Within scope are the licensee responses to IE Bulletin 88-09, as accepted by the staff in its closure letters on the bulletin, and any amendments to the licensee responses as approved by the staff.

2. ***Preventive Actions:*** The program consists of inspection and evaluation and provides no guidance on preventive actions.

3. ***Parameters Monitored/Inspected:*** Flux thimble tube wall thickness is monitored to detect loss of material from the flux thimble tubes during the period of extended operation.

4. ***Detection of Aging Effects:*** 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. Justification for methods other than ECT should be provided unless use of the alternative method has been previously accepted by the NRC.

   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. Rebaselining of the examination frequency should be justified using plant-specific wear-rate data unless prior plant-specific NRC acceptance for the re-baselining is received outside the license renewal process. 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.

5. ***Monitoring and Trending:*** 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.

6. ***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 program. Acceptance criteria different from those previously documented in the applicant's response to IE Bulletin 88-09 and amendments thereto, as accepted by the NRC, should be justified.

7. ***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.

   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.

   The site corrective actions program, quality assurance procedures, site review and approval process, and administrative controls are implemented in accordance with 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.

8. ***Confirmation Process:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the confirmation process.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.

10. ***Operating Experience:*** In IE Bulletin 88-09 the NRC requested that licensees implement a flux thimble tube inspection program due to several instances of leaks and due to licensees identifying wear. Utilities established inspection programs in accordance with IE Bulletin 88-09, which have shown excellent results in identifying and managing wear of flux thimble tubes.

    As discussed in IE Bulletin 88-09, the amount of vibration the thimble tubes experience is determined by many plant-specific factors. Therefore, the only effective method for determining thimble tube integrity is through inspections, which are adjusted to account for plant-specific wear patterns and history.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

NRC IE Bulletin 88-09, *Thimble Tube Thinning in Westinghouse Reactors*, July 26, 1988.

NRC Information Notice No. 87-44, *Thimble Tube Thinning in Westinghouse Reactors*, September 16, 1987.

NRC Information Notice No. 87-44, Supplement 1, *Thimble Tube Thinning in Westinghouse Reactors*, March 28, 1988.