## **AMP 106 BWR** **FEEDWATER NOZZLE (Version 2020)**

### Programme Description

This programme includes enhanced in-service inspections. The programme includes periodic ultrasonic inspections of critical regions of the BWR feedwater nozzle.

### Evaluation and Technical Basis

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

The programme includes enhanced in-service inspections [1-3] to monitor the effects of cracking due to cyclic loading and its impact on the intended function of BWR feedwater nozzles, consistent with pertinent governing requirements or guidance documents for the plant.

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

This programme is a condition monitoring programme and has no preventive actions.

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

This AMP includes in-service inspections that detect and size cracks to monitor for cracking due to cyclic loading and its impact on the intended function of the BWR feedwater nozzle. The extent and schedule of the inspection which are implemented consistent with pertinent governing requirements or guidance documents for the plant prescribed by the programme are designed to ensure that ageing effects are discovered and repaired to adequately maintain the intended function of the component (e.g., [3, 4]). Note that plants in the U.S. no longer use [3] and only use [4].

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

Periodic inspections provide timely detection and sizing of cracks [2-5].

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

System modifications tomitigate cracking include removal of stainless steel cladding and installation of improved spargers [3, 6]. Mitigation also is accomplished by changes to plant-operating procedures, such as improved feedwater control to decrease the magnitude and frequency of temperature fluctuations. These modifications are design and operating changes instituted for many BWRs [3].

1. ***Acceptance criteria:***

Acceptance criteria are provided by pertinent governing requirements or guidance documents for the plant. Examples of acceptance criteria are provided in:

* 1. Any cracking is evaluated in accordance with ASME Code, Section XI [4], IWB-3100 by comparing inspection results with the acceptance standards of ASME Code, Section XI, IWB-3400 and IWB-3500.
  2. Inspection requirements specified in JSME S NA1 table IB-2500-4.

In addition, IAEA-TECDOC-1470[7]provides guidelines for the evaluation of detected cracks.

1. ***Corrective actions:***

Repair and replacement are performed in accordance with pertinent governing requirements or guidance documents for the plant.

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.

Appropriate sources of external operating experience are e.g. BWR Owner’s Groups, OECD-NEA, WANO, INPO, IAEA and NRC generic communications.

In the 1960’s and 1970’s, cracking occurred in several American BWR plants [5-9]. Hardware modifications, operational changes and augmented inspections were implemented [3].

In the development of the USNRC Generic Aging Lessons Learned for Subsequent License Renewal Report (GALL-SLR), NUREG-2191 [10], the USNRC solicited comments from the public regarding the proposed ageing management programmes. For the BWR Feedwater Nozzle AMP (XI.M5 in draft NUREG-2191), comments were provided that there was no longer a need for an AMP on feedwater nozzles. This was based on several things. First, since plants had changed the way the low-flow feedwater controller was operated (or replaced controllers), there had been no feedwater inner radius cracking (over 30 years of operation). Second, fracture mechanics evaluations show significant margin in the time between flaw initiation and a flaw reaching a critical size. Finally, the ultrasonic examination (UT) techniques had improved significantly in 30+ years since the last cracks initiated. These UT criteria are now fully endorsed in ASME Section XI, Appendix VIII [6] and endorsed by the USNRC. The USNRC evaluated the proposal and the technical rationale provided in support of eliminating the AMP. NRC agreed with the elimination of the BWR Feedwater Nozzle AMP and did not include it in the GALL-SLR [10]. NRC agreed that ageing management of feedwater nozzles is maintained through implementation of ASME Section XI [6]. The NRC’s technical basis for this change is documented in [11].

At the time when this AMP was produced, no relevant publicly available R&D for the specific case of feedwater cracking was identified.

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 [12].

### References

1. UNITED STATES NUCLEAR REGULATORY COMMISSION, BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking, NUREG-0619, USNRC, November 1980
2. JAPAN SOCIETY OF MECHANICAL ENGINEERS, IA, IB Code for Nuclear Power Generation Facilities - Rule on Fitness-for-Service for Nuclear Power Plants, JSME S NA1 -2012 (addendum 2015)
3. BWR OWNERS’ GROUP, Alternate BWR Feedwater Nozzle Inspection Requirements, GE-NE-523-A71-0594, Rev. 1, BWROG, August 1999
4. AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Rules for Inservice Inspection of Nuclear Power Plant Components, The ASME Boiler and Pressure Vessel Code, ASME Section XI, as approved in 10 CFR 50.55a, ASME, New York, NY
5. Nuclear Regulation Authority Japan, Operative guideline for extension of license application of the duration of nuclear reactor operation, NRA, 2014
6. ASME Press, Companion Guide to the ASME Code Boiler & Pressure Vessel Code, Volume 3, Chapter 41.3.2, BWR Reactor Internals and Other BWR Issues, Third Ed., 2009
7. INTERNATIONAL ATOMIC ENERGY AGENCY, Assessment and management of ageing of major nuclear power plant components important to safety: BWR pressure vessels, IAEA-TECDOC-1470, IAEA, Vienna, October 2005
8. UNITED STATES NUCLEAR REGULATORY COMMISSION, BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking (NUREG-0619)
9. UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Letter 81-11, USNRC, February 29, 1981
10. UNITED STATES NUCLEAR REGULATORY COMMISSION, Generic Aging Lessons Learned For Subsequent License Renewal (GALL-SLR) Report, NUREG-2191, USNRC, May 2017
11. UNITED STATES NUCLEAR REGULATORY COMMISSION, NUREG-2221, Technical Bases for Changes in the Subsequent License Renewal Guidance Documents NUREG–2191 and NUREG–2192
12. 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, USNRC, Latest Edition