## AMP 121 ONE-TIME INSPECTION OF CLASS 1 SMALL BORE PIPING (VERSION 2020)

### Programme Description

This is a one-time inspection programme to determine whether cracking in Class 1 small-bore piping resulting from stress corrosion, cyclical (including thermal, mechanical, and vibration fatigue) loading, or thermal stratification and thermal turbulence [1-5] is an issue. This programme is applicable to small-bore Class 1 piping and systems less than 4 inches (100 mm)nominal pipe size(NPS 4)and greater than or equal to NPS 1 (25 mm). The programme includes pipes, fittings, branch connections, and all full and partial penetration (socket) welds. For a one-time inspection to detect cracking resulting from thermal and mechanical loading or intergranular stress corrosion of full-penetration welds, the inspection is a volumetric examination. For a one-time inspection to detect cracking in socket welds, the inspection is either a volumetric or opportunistic destructive examination. (Opportunistic destructive examination is performed when a weld is removed from service for other considerations, such as plant modifications. A sampling basis is used if more than 1 weld is removed.) These examinations provide additional assurance that either ageing of small-bore Class 1 piping is not occurring or the ageing is insignificant.

This programme is applicable to systems that have not experienced cracking of Class 1 small-bore piping. This programme can also be used for systems that experienced cracking but have implemented design changes to effectively mitigate cracking. (Measure of effectiveness includes (1) the one-time inspection sampling is statistically significant; (2) samples will be selected as described in attribute 3, Detection of ageing effects below; and (3) no repeated failures over an extended period of time.) For systems that have experienced cracking and operating experience indicates that design changes have not been implemented to effectively mitigate cracking, periodic inspection is proposed. Should evidence of cracking be revealed by a one-time inspection, periodic inspection is implemented using a plant-specific AMP.

If small bore piping in a particular plant system has experienced cracking, small bore piping in all plant systems are evaluated to determine whether the cause for the cracking affects other systems (corrective action programme).

### Evaluation and Technical Basis

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

This programme is a one-time inspection of a sample of Class 1 piping less than NPS 4 (100 mm) and greater than or equal to NPS 1 (25 mm). This programme includes measures to verify that degradation is not occurring, thereby either confirming that there is no need to manage age-related degradation or validating the effectiveness of any existing AMP for the period of extended operation. The one-time inspection programme for Class 1 small-bore piping includes locations that are susceptible to cracking [2-8].

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

This programme is a condition monitoring activity independent of methods to mitigate or prevent degradation.

Regarding the risk for stress corrosion cracking, the main preventive action in operation is the control of the primary water chemistry (e.g. in accordance with the EPRI guidelines for PWR environment [9] and for BWR environment [10]).

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

This one-time inspection is designed to provide assurance that ageing of Class 1 small-bore piping is not occurring, or that the effects of ageing are not significant. This programme is applicable to systems that have not experienced cracking of Class 1 small-bore piping and can also be used for systems that experienced cracking but have implemented design changes to effectively mitigate cracking. For a one-time inspection to detect cracking in socket welds, the inspection is either a volumetric or opportunistic destructive examination. (Opportunistic destructive examination is performed when a weld is removed from service for other considerations, such as plant modifications [11-16]. A sampling basis is used if more than one weld is removed. For a one-time inspection to detect cracking resulting from thermal and mechanical loading or intergranular stress corrosion of full penetration welds, the inspection is a volumetric examination. Volumetric examination is performed using demonstrated techniques that are capable of detecting the ageing effects in the examination volume of interest. This inspection is performed at a sufficient number of locations to ensure an adequate sample. This number, or sample size, is based on susceptibility, inspectability, dose considerations, operating experience, and limiting locations of the total population of Class 1 small-bore piping locations.

For example, this paragraph describes the approach used in the United States for Class 1 small-bore piping locations. If a plant has never experienced a failure in its Class 1 piping (a through-wall crack detected in the subject component by evidence of leakage, or through nondestructive or destructive examination) and has extensive operating history (more than 30 years of operation), the inspection sample size is at least 3 % of the weld population or a maximum of 10 welds of each weld type for each operating unit. If a plant has successfully mitigated any failures in its Class 1 piping, the inspection includes 10 % of the weld population or a maximum of 25 welds of each weld type (e.g., full penetration or socket weld) for each operating unit using a metho­do­logy to select the most susceptible and risk-significant welds. For socket welds, opportunistic destructive examination can be performed in lieu of volumetric examination. Because more information can be obtained from a destructive examination than from nondestructive examination, the plant may take credit for each weld destructively examined equivalent to having volumetrically examined two welds.

Specifically, one time inspections need to be completed early enough to ensure that the ageing effects that may affect intended functions early in the period of extended operation are appropriately managed. Conversely, inspections need to be timed to allow the inspected components to attain sufficient age to ensure that the ageing effects with long incubation periods (i.e., those that may affect intended functions near the end of the period of extended operation) are identified. Within these constraints, the inspection is performed in such a way as to minimize the impact on plant operations and after sufficient time of operation, e.g. as a plant will have operated for at least 30 years before inspections under this programme begin, sufficient time will have elapsed for any ageing effects to be manifested.

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

Evaluation of the inspection results may indicate the need for additional or periodic examinations (i.e., a plant-specific AMP for Class 1 small-bore piping using volumetric inspection methods).

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

This programme is a condition monitoring activity independent of methods to mitigate or prevent degradation.

1. ***Acceptance criteria:***

Detected flaws are evaluated with the pertinent governing requirements or guidance documents for the plant. Acceptance criteria may be based on applicable standards, design basis information, or vendor-specified requirements and recommendations.

1. ***Corrective actions:***

Should evidence of cracking be revealed by a one-time inspection, the scope of inspections is extended to other locations that are susceptible to cracking, and periodic inspection is implemented, as managed by a plant-specific AMP. If the acceptance criteria are not met, activities to mitigate the ageing effects, and/or to modify, repair or replace the affected component are undertaken. Alternatively, these actions can be undertaken at any time to resolve the effects of known or potential age-related degradation.

For example, in France, the regulator ASN issued in 2002 a directive concerning socket weld integrity [17]. According to this directive, socket welds not meeting the requirements for weld dimensions and/or weld integrity as specified by the French RCC-M Code had to be replaced with butt welds. In response to the ASN directive, EDF implemented a systematic socket weld integrity programme for all of its Class 900 MWe PWR plants [18-19].

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 inspection uses volumetric inspection techniques with demonstrated capability and a proven industry record to detect cracking in piping weld and base material [20].

Leaks due to thermal fatigue were reported in NRC Bulletins [21-24]. The fatigue cracks could not be detected in time by ISI inspection, either because they were not located in the inspection zones, or because the crack initiation and propagation time through the thickness was shorter than the interval between two inspections, or finally because they were not in the scope.

Worldwide operating experience shows that numerous vibration fatigue-related failures occurred in the past years on the connecting points between small-bore piping with diameter often equal or less than 1 inch (25 mm) connected to Class 1 large-bore circuit. However, this AMP is not intended to manage vibrational fatigue of piping less than NPS 1 (25 mm).

In primary water (PWR) environment, stress corrosion cracking occurred on dead spaces or other places which are difficult to reach due to the difficulty of the chemical control in those areas. The cause of this degradation is the internal or external contamination by chlorides or chemical composition out of the specifications. In general, work hardening also increases the susceptibility of the material. PWRs have experienced a low incidence of cracking in safety-related stainless steel piping systems and portions of systems outside the primary loop containing low temperature, oxygenated, stagnant or essentially stagnant, borated water.

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 the different national regulatory requirements (e.g., 10 CFR 50, Appendix B [25]).

### References

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