

## XI.M36 EXTERNAL SURFACES MONITORING OF MECHANICAL COMPONENTS

### Program Description

The External Surfaces Monitoring of Mechanical Components program is based on system inspections and walkdowns. This program consists of periodic visual inspections of metallic and polymeric components, such as piping, piping components, ducting, polymeric components, and other components within the scope of license renewal and subject to aging management review (AMR) in order to manage aging effects. The program manages aging effects through visual inspection of external surfaces for evidence of loss of material, cracking, and change in material properties. When appropriate for the component and material, manipulation may be used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength. Loss of material due to boric acid corrosion is managed by the Boric Acid Corrosion program (AMP XI.M10).

### Evaluation and Technical Basis

1. **Scope of Program:** This program visually inspects the external surface of in-scope mechanical components and monitors external surfaces of metallic components in systems within the scope of license renewal and subject to AMR for loss of material and leakage. Cracking of stainless steel components exposed to an air environment containing halides may also be managed. This program also visually inspects and monitors the external surfaces of polymeric components in mechanical systems within the scope of license renewal and subject to AMR for changes in material properties (such as hardening and loss of strength), cracking, and loss of material due to wear. This program manages the effects of aging of polymer materials in all environments to which these materials are exposed.

The program may also be credited with managing loss of material from internal surfaces of metallic components and with loss of material, cracking, and change in material properties from the internal surfaces of polymers, for situations in which material and environment combinations are the same for internal and external surfaces such that external surface condition is representative of internal surface condition. When credited, the program should describe the component internal environment and the credited similar external component environment inspected.

2. **Preventive Actions:** The External Surfaces Monitoring of Mechanical Components program is a condition monitoring program that does not include preventive actions.
3. **Parameters Monitored/Inspected:** The External Surfaces Monitoring of Mechanical Components program utilizes periodic plant system inspections and walkdowns to monitor for material degradation and leakage. This program inspects components such as piping, piping components, ducting, polymeric components, and other components. For metallic components, coatings deterioration is an indicator of possible underlying degradation. The aging effects for flexible polymeric components may be monitored through a combination of visual inspection and manual or physical manipulation of the material. "Manual or physical manipulation of the material" means touching, pressing on, flexing, bending, or otherwise manually interacting with the material. The purpose of the manual manipulation is to reveal changes in material properties, such as hardness, and to make the visual examination process more effective in identifying aging effects such as cracking.

Examples of inspection parameters for metallic components include:

- corrosion and material wastage (loss of material)
- leakage from or onto external surfaces (loss of material)
- worn, flaking, or oxide-coated surfaces (loss of material)
- corrosion stains on thermal insulation (loss of material)
- protective coating degradation (cracking, flaking, and blistering)
- leakage for detection of cracks on the external surfaces of stainless steel components exposed to an air environment containing halides

Examples of inspection parameters for polymers include:

- surface cracking, crazing, scuffing, and dimensional change (e.g., “ballooning” and “necking”)
- discoloration
- exposure of internal reinforcement for reinforced elastomers
- hardening as evidenced by a loss of suppleness during manipulation where the component and material are appropriate to manipulation

4. **Detection of Aging Effects:** This program manages aging effects of loss of material, cracking, and change in material properties using visual inspection. For coated surfaces, confirmation of the integrity of the paint or coating is an effective method for managing the effects of corrosion on the metallic surface.

When required by the ASME Code, inspections are conducted in accordance with the applicable code requirements. In the absence of applicable code requirements, plant-specific visual inspections are performed of metallic and polymeric component surfaces using plant-specific procedures implemented by inspectors qualified through plant-specific programs. The inspections are capable of detecting age-related degradation and are performed at a frequency not to exceed one refueling cycle. This frequency accommodates inspections of components that may be in locations that are normally only accessible during outages or access is physically restricted (underground). Surfaces that are not readily visible during plant operations and refueling outages are inspected when they are made accessible and at such intervals that would ensure the components’ intended functions are maintained. The inspections of underground components shall be conducted during each 10-year period beginning 10 years prior to entering the period of extended operation. These normally underground components should be clearly identified in the program scope and inspection intervals provided. Surfaces that are insulated may be inspected when the external surface is exposed (i.e., during maintenance) at such intervals that would ensure that the components’ intended functions are maintained. The intervals of inspections may be adjusted, as necessary, based on plant-specific inspection results and industry operating experience.

Visual inspection will identify indirect indicators of flexible polymer hardening and loss of strength and include the presence of surface cracking, crazing, discoloration, and, for

elastomers with internal reinforcement, the exposure of reinforcing fibers, mesh, or underlying metal. Visual inspection should be 100% of accessible components. Visual inspection will identify direct indicators of loss of material due to wear to include dimensional change, scuffing, and for flexible polymeric materials with internal reinforcement, the exposure of reinforcing fibers, mesh, or underlying metal. Manual or physical manipulation can be used to augment visual inspection to confirm the absence of hardening and loss of strength for flexible polymeric materials (e.g., HVAC flexible connectors) where appropriate. The sample size for manipulation should be at least 10 percent of available surface area. Hardening and loss of strength and loss of material due to wear for flexible polymeric materials are expected to be detectable prior to any loss of intended function.

This program is credited with managing the following aging effects.

- loss of material and cracking for external surfaces
- loss of material for internal surfaces exposed to the same environment as the external surface
- cracking and change in material properties (hardening and loss of strength) of flexible polymers

5. **Monitoring and Trending:** Visual inspection and manual or physical manipulation activities are performed and associated personnel are qualified in accordance with site controlled procedures and processes. The External Surfaces Monitoring of Mechanical Components program uses standardized monitoring and trending activities to track degradation. Deficiencies are documented using approved processes and procedures, such that results can be trended. However, the program does not include formal trending. Inspections are performed at frequencies identified in Element 4, Detection of Aging Effects.
6. **Acceptance Criteria:** For each component/aging effect combination, the acceptance criteria are defined to ensure that the need for corrective actions will be identified before loss of intended functions. For metallic surfaces, any indications of relevant degradation detected are evaluated. For stainless steel surfaces, a clean, shiny surface is expected. The appearance of discoloration may indicate the loss of material on the stainless steel surface. For aluminum and copper alloys exposed to marine or industrial environments, any indications of relevant degradation that could impact their intended function are evaluated. For flexible polymers, a uniform surface texture and uniform color with no unanticipated dimensional change is expected. Any abnormal surface condition may be an indication of an aging effect for metals and for polymers. For flexible materials, changes in physical properties (e.g., the hardness, flexibility, physical dimensions, and color of the material are unchanged from when the material was new) should be evaluated for continued service in the corrective action program. Cracks should be absent within the material. For rigid polymers, surface changes affecting performance, such as erosion, cracking, crazing, checking, and chalking, are subject to further investigation. Acceptance criteria include design standards, procedural requirements, current licensing basis, industry codes or standards, and engineering evaluation.
7. **Corrective Actions:** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 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:** External surface inspections through system inspections and walkdowns have been in effect at many utilities since the mid 1990s in support of the Maintenance Rule (10 CFR 50.65) and have proven effective in maintaining the material condition of plant systems. The elements that comprise these inspections (e.g., the scope of the inspections and inspection techniques) are consistent with industry practice.

## 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.

EPRI Technical Report 1007933, *Aging Assessment Field Guide*, December 2003.

EPRI Technical Report 1009743, *Aging Identification and Assessment Checklist*, August 27, 2004.

INPO Good Practice TS-413, *Use of System Engineers*, INPO 85-033, May 18, 1988.