U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

RIC 2017




Office of Nuclear Reactor Regulation

Significant Aging Management Changes for Subsequent License Renewal

Long-Term Operation in the U.S.

The Atomic Energy Act (AEA) allows the U.S. Nuclear Regulatory Commission (NRC) to license commercial power reactors for an initial term of 40 years. The AEA allows renewal of licenses in 20-year increments. Eighty-six plants have received a first renewal, allowing operation up to 60 years. Forty-five renewed plants have entered the period of extended operation (PEO). A second, or "subsequent," renewal allows operation from 60 to 80 years. A subsequent license renewal (SLR) requires an application and NRC review to evaluate aging management of the facility. The NRC has revised its guidance for subsequent applications.

Objectives for Revised Guidance

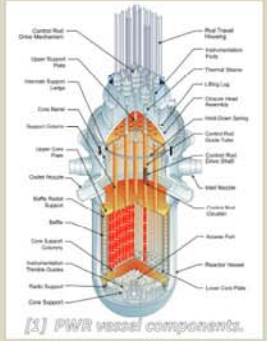
The NRC uses the Standard Review Plan (SRP) (NUREG-1800) and the Generic Aging Lessons Learned (GALL) Report (NUREG-1801) to guide the safety review of license renewal applications. Aging Management Programs (AMPs) in the GALL Report and the SRP are revised for SLR to do the following:

- Reflect expected aging differences for increased operating time from 60 to 80 years.
- Incorporate new plant operating experience.
- Close gaps and correct errors in the guidance.
- Improve the efficiency and effectiveness of applications and NRC reviews.
- Incorporate interim staff guidance.

Mechanical

XI.M16A PWR Vessel Internals The AMP is updated to allow the use of MRP-227-A with a gap analysis. MRP-227-A is the "Materials Reliability Program: Pressurized Water Reactor [PWR] Internals Inspection and Evaluation Guidelines," developed by the Electrical Power Research Institute for managing long-term aging of PWR vessel internals. Figure 1 shows the typical PWR vessel internals arrangement. MRP-227-A guides aging management up to 60 years, and the gap analysis identifies the aging management adjustments needed to safely continue operation through 80 years.


[2] Aluminum stress-corrosion cracking.


[3] PWR vessel components.

XI.M36 External Surfaces Monitoring & XI.M38 Internal Surfaces Monitoring The AMPs are revised to more thoroughly address the detection of cracking in stainless steel and aluminum through periodic visual inspections or surface examinations to maintain intended functions through 80 years of operation. Figure 2 shows stress-corrosion cracking of aluminum.


[3] Cherenkov radiation when reactor vessel is flooded for refueling.

XI.M41 Buried and Underground Piping and Tanks This AMP is changed to reduce the number of additional inspections that are required when a cathodic protection system does not meet performance goals. The change is based on the staff's review of industry operating experience, which shows no failures of intended function and improved awareness of cathodic protection and coating condition importance. Figure 4 shows corrosion of buried pipe mitigatable by cathodic protection or coating.

XI.M31 Reactor Vessel Surveillance The AMP addresses withdrawal of at least one surveillance capsule representing the PEO with a neutron fluence between one and two times the peak neutron fluence of interest projected to 80 years. Neutron fluence levels are evaluated to demonstrate that the effects on material properties (e.g., fracture toughness) will not exceed safety limits through 80 years of operation. Figure 3 shows radiation exposure of the reactor vessel.


[4] Corrosion of buried pipe.

XI.M32 One-Time Inspection The AMP is revised to recommend a one-time inspection of steel components exposed to environments that do not include corrosion inhibitors. This preventive action will be used to verify that long-term loss of material due to general corrosion will not cause a loss of intended function (e.g., pressure boundary, leakage boundary, structural integrity).

Electrical

XI.E7 High-Voltage Insulators This new AMP reflects operating experience, which shows some loss of intended function, corrosion, and coating failure. The lack of an effect on safety function cannot be assumed.

XI.E3 Electrical Insulation for Inaccessible Cables This is split into three separate AMPs: (1) Medium-Voltage Power, (2) Instrumentation and Control, and (3) Low-Voltage Power. This incorporates operating experience that suggests the need for separate testing, inspection, and evaluation methods. Dividing the AMP also aligns with industry guidance. Figure 5 shows corrosion of cable insulation.


[5] High-voltage cable corrosion

Structural

XI.S6 Structures Monitoring & XI.S7 Inspection of Water Control Structures The AMPs are revised to require the assessment of through-wall leakage or ground water infiltration. This may include engineering evaluation, more frequent inspections, or destructive testing of affected concrete to validate existing concrete properties, including concrete pH levels. When feasible, assessments may include analysis of the leakage pH, along with the mineral, chloride, sulfate, and iron content in the water.

XI.S3 ASME Section XI, Subsection IWF This AMP is revised to include a one-time inspection of an additional 5 percent of the pipe support sample size beyond that required by the ASME Boiler and Pressure Vessel Code for Class 1, 2, and 3 piping supports. Extra supports beyond the existing sample provide reasonable assurance that no age-related degradation would go undetected. Pipe support failure of a nonsafety-related system could cause damage to a nearby safety-related system. Figure 6 shows an arrangement where failure of pipe supports could cause damage to nearby pipe systems.


[6] Steam and water piping.

[1] NASA Kennedy Space Flight Center Corrosion Technology Laboratory. http://Corrosion.ksc.nasa.gov/stresscor.htm
[2] Westinghouse. "PWR Vessel Internals Plan for Aging Management of Reactor Internals at Robinson Nuclear Plant." http://pbadupws.nrc.gov/docs/ML0927/ML092750338.pdf
[3] "Cherenkov Radiation." http://www.nuclear-power.net/nuclear-power/reactor-physics/atomic-nuclear-physics/fundamental-particles/beta-particle/cherenkov-radiation
[4] Fairfax Water. "Water Infrastructure." http://www.fcwa.org/current/water_infrastructure.htm
[5] High Voltage Solutions. "Partial Discharge Mapping." http://www.highvoltagesolution.com.au/services/cables-pd/partial-discharge-mapping
[6] Madrigal, Alexis. "Steam Tech Gets Less Punk, More Stimulus Money." https://www.wired.com/2009/08/steam