Aging Management Briefing Report

Performance Monitoring of Systems and Active Components

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Background

This briefing report on the performance monitoring of systems and active components was prepared by the Chockie Group International as part of the project for The Petroleum Safety Authority Norway entitled, *Design Life Extension Regulations* (PSA Project Reference Number: NO 99B16)

The objective of this report is to provide an overview of the nature of performance monitoring regulations within the United States nuclear power industry.

Because active components in mechanical and electrical systems are normally operating, their performance can be monitored and trended to detect incipient degradation. Representative parameters that can be measured must be established for both the local components and for the complete system. Examples of local component parameters include flow, differential pressure, vibration, and delta temperature. Reliability and availability are examples of typical *system* performance parameters.

Within the nuclear power generation industry in the United States, the US Nuclear Regulatory Commission (USNRC) has promulgated a “Maintenance Rule” for the purpose of improving the performance monitoring of critical systems at all nuclear power plants in the United States. This briefing report describes the principal elements of the Maintenance Rule, the implementation and application process and the lessons learned.

Regulatory Requirements

During the 1980s, the USNRC became concerned with the maintenance of nuclear power plants and the attendant decline in reliability. No regulatory provisions were in force to require uniform application of maintenance, except for the Technical Specifications, which required periodic surveillance testing, and the American Society of Mechanical Engineers (ASME) Code, which required periodic inspections of the safety related pressure boundary components. With the assistance of a number of volunteer plant owners, the USNRC conducted a survey of utility practices in an effort to establish the effectiveness of various maintenance programs (i.e. experience based, vendor recommended, preventive, corrective, run-to-failure), allocation of utility resources among safety and non-safety (power production) equipment and utility methods of monitoring and benchmarking performance. The survey results led the USNRC to conclude that more consistent and rigorous monitoring and reporting of individual system performance parameters was needed. Using industry input, to the

USNRC developed a performance-based regulation that would allow individual plants to define the scope of the program, the performance parameters and the acceptance criteria. The plant specific application and implementation would be subject to inspection by the USNRC. The original Rule was issued in July 1991 and became effective in July of 1996 and the USNRC began their implementation inspections. The Rule was revised a number of times to incorporate lessons learned, clarifications and new requirements, which are commonly called the A(4) Rule.

The Maintenance Rule Provisions

The Maintenance Rule was issued under the United States Code of Federal Regulations. This is a mandatory rule that all commercial nuclear power plants must follow. A copy of the full text of the Maintenance Rule is provided in Attachment A. Although the Rule consists of only a single page, the underlying documentation, interpretations, and guidance reports amounts to thousand of additional pages of material and information.

The Maintenance Rule analysis process is shown below in Figure 1.

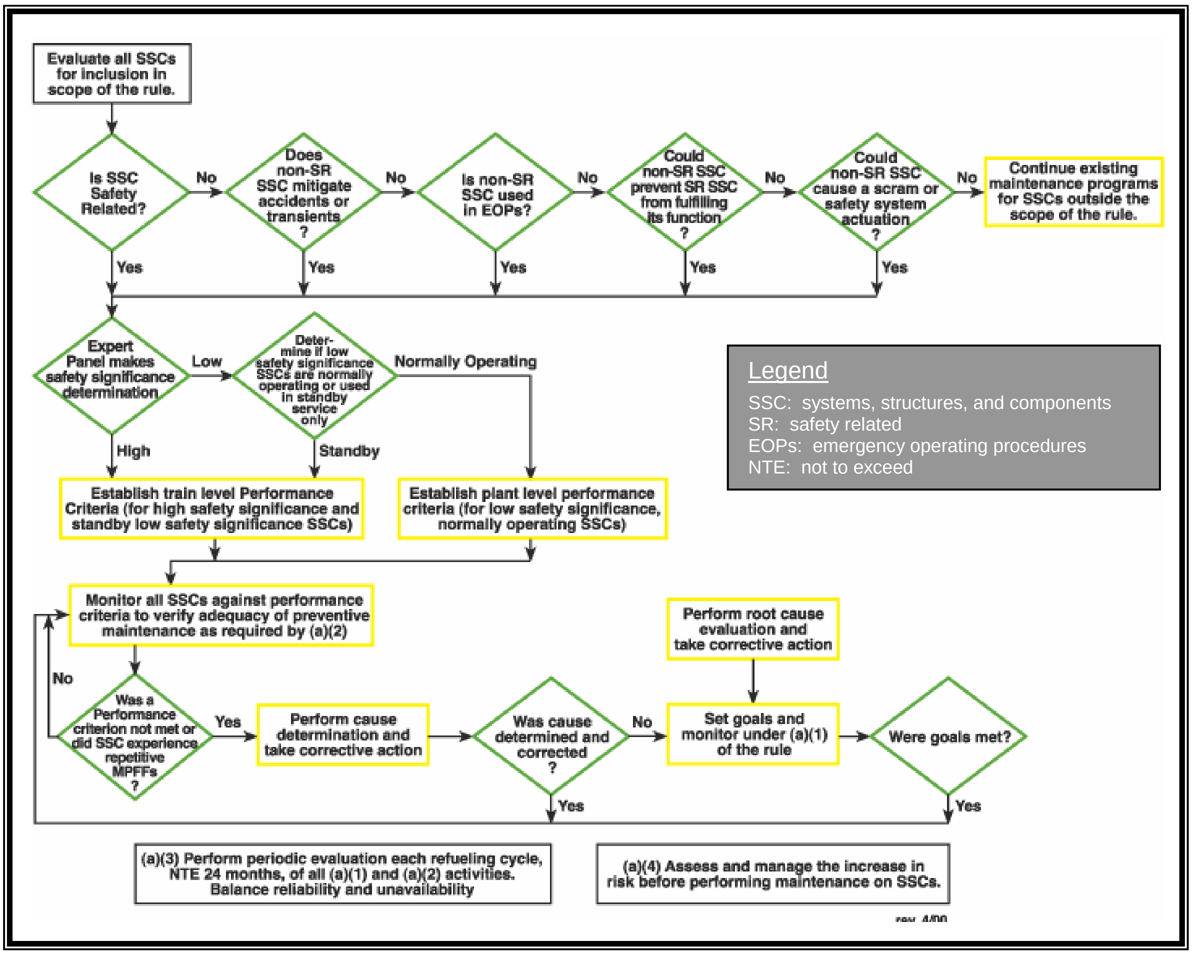

Figure 1: *Simplified Flow Chart of the Maintenance Rule (source: USNRC)*

The key provisions of the Rule are:

- defining systems monitoring requirements
- preventive maintenance versus availability/reliability
- corrective action goal setting
- operating experience considerations
- demonstrations of preventive maintenance (PM) effectiveness
- bi-annual performance reviews
- quantification of on-line risk

Each of these provisions is summarized below.

Systems Monitoring Requirements

The Rule makes a significant distinction between important systems that need to be performance monitored at the train level and those systems that can be monitored at the plant level. The systems that are considered to be safety significant with equally or diversely redundant safety systems typically have two or three trains or channels.

Standby systems (systems that are activated in response to an accident or fire or are required to mitigate accident consequences) are monitored using reliability as a performance parameter. Reliability can be measured by such indicators as fail-to-start or fail-to-run per 100 attempts.

Normally operating systems are monitored using availability as a performance measure. Availability is determined as the fraction of system available hours during the mission time divided by the mission time. When assessing reliability and availability, the success or ability of accomplishing the defined safety functions is considered. This permits some level of degradation, as long as the system's functions are not compromised.

Preventive Maintenance versus Availability/Reliability

The Rule recognizes the conflict between performing preventive (invasive) maintenance that requires the system or component to be removed from service and the need to maintain satisfactory availability and/or reliability. One of the requirements mandates that an adequate balance of the two be maintained and reported.

Corrective Action Goal Setting

If a system cannot meet its performance criteria over a period not exceeding 24 months, corrective action is required and a new and more specific performance criteria must be established (Goal Setting) to demonstrate that the corrective action has been effective. This Goal Setting assures that recurring problems are fixed.

Operating Experience Considerations

Operating experience must be considered when establishing the performance parameters and criteria. This experience may be based on generic industry experience or the historical plant performance, failure rates, or reliability / availability values assumed in the plant's probabilistic risk analysis (PRA).

Demonstrations of PM Effectiveness

Systems that are monitored at the plant level require demonstration that the preventive maintenance programs are effective. Plant level performance criteria can include repetitive failures, plant shutdowns, initiation of safety systems and lost production. If the established criteria levels are exceeded, the system must be elevated to "*system level monitoring*".

System level monitoring requires that an elevated level of monitoring must continue until it can be demonstrated that the system has achieved its new system level performance, before the system is returned to plant level.

Bi-Annual Performance Reviews

The result of the system monitoring and trending activities is subject to bi-annual review to highlight the:

- performance problems
- corrective actions taken
- changes in performance parameters or criteria
- assessment of the balance between maintenance outages and system availability
- evaluation of industry operating experience

The evaluation of industry operating experience is an attempt to identify precursors or incipient failures that may have occurred at other plants and may have generic implications.

Quantification of On-Line Risk

A new paragraph was added to the Rule in 2000 to address the risk associated with plant configuration changes made during operation. This includes systems that are taken out-of-service for maintenance or due to failure/degradation. The on-line risk is influenced by the importance of the unavailable system, the period of time that it is not available, as well as the status of other safety related systems. As a consequence, the USNRC now requires that the on-line risk must be quantified to support continued operation of the plant.

Modifications/Improvements to the Rule

Following the original issue of the rule in 1991, the Nuclear Energy Institute (NEI) formed a utility task group to develop an industry guide, *NEI-93-01,* to assist the plants with the implementation. The USNRC conducted a number of early plant implementation audits in 1996 and based on these audits it was determined that some interpretations and improvements were desirable. The nuclear industry, represented by the Nuclear Energy Institute (NEI), discussed the implementation issues with the USNRC and subsequently generated a Revision 1 to NEI-93-01 in 1996.

The USNRC reviewed the revised *NEI-93-01* for generic acceptability. In 1997 the guide was endorsed with some additional provisions (USNRC Regulatory Guide 1.160 Revision 2). The most significant addition was the inclusion of structures including concrete and steel structures that house or protect equipment covered within the scope of the Rule.

In 2000 the Rule was modified again to address on-line risks associated with maintenance activities. The USNRC added a new paragraph A-4 that then required the NEI to revise *NEI-93-01*. The new Section 11 provides guidance to the industry on how best to assess on-line risk associated with their maintenance activities. The USNRC endorsed the changes to NEI-93-01 in the USNRC Regulatory Guide 1.180.

Regulatory Inspections and Guidance

The USNRC started plant-specific inspections and audits in 1996 and 1997 to verify the acceptability of methods and procedures and the programmatic approaches taken. Because the rule is performance based, these inspections were unique and required substantial guidance and training of the inspector teams. The training guides and inspection procedures were made available to the industry. This allowed self-assessments and readiness reviews to be conducted prior to USNRC on-site inspections. Lessons learned from the inspections were communicated to the industry in a number of workshops and seminars.

Monitoring Issues

Monitoring important systems at the train level is considered an effective way to identify poorly performing equipment. A redundant high performance train could otherwise shadow the poorly performing train. Performance monitoring at the train or channel level is therefore mandated for risk significant systems. The USNRC was also concerned that generic problems in cross-system component groups (valves, motors, pumps, solenoids) would not be readily identified. As a result all plants are now tracking functional failures, which are periodically reviewed to identify trends of multiple component failures. A definition for a “Repetitive Functional Failure” was crafted to include: “Failures of another same component with identical cause”.

Determining meaningful performance parameters for structures became a difficult task. A “Structures Monitoring Program” was created and implemented to periodically inspect (i.e. five to ten year intervals) for functional degradation. The acceptance criteria were defined in the American Concrete Institute (ACI) standards or the American Institute of Steel Construction (AISC) standards. If performance problems are identified, corrective action is required and the structure must be re-inspected at shorter intervals until it can be demonstrated that the fix was effective.

Consistent Industry Implementation

There are many organizations which represent the US nuclear power industry and which have programs that assist with the implementation of the Maintenance Rule and other regulations. The overriding objective though is to promote consistency and thereby economics. The following is a brief synopsis of the major players:

- Nuclear Energy Institute (NEI), formerly named NUMARC, is an organization to assist the nuclear plant owners to interact with the Nuclear Regulatory Commission (USNRC) as a group. New regulations, changes, interpretations, regulatory guidance, inspection plans, Technical Specifications, new plant design reviews and all generic issues that arise are being tracked and managed by NEI. For major issues, NEI will assign task groups to develop generic guidance documents, such as *NEI-93-01* (*Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants)*.
- Institute of Nuclear Power Operation (INPO) is the equivalent of the World Association of Nuclear Operators (WANO). The organization was created in the aftermath of Three Mile Island and is a self-policing entity to which each nuclear plant officer has to pledge compliance. INPO conducts independent audits of nuclear plants and provides performance ranking (Grade 1, 2 and 3). The lower the grade, the higher the insurance costs and the more USNRC oversight. INPO also manages the industry operating experience (IOE) databases, including the Equipment Performance and Information Exchange 4.0 (EPIX), the recipient of all functional failures reported by the plants.
- Electric Power Research Institute (EPRI) performs research and development for the electric utilities, nuclear, fossil, hydro and others. The nuclear division assists the plants with resolution of generic issues and provides consulting, inspection and engineering assistance, including development of technical guidance documents, maintenance guides, training, and software.
- Owners Groups have been formed by nuclear plants that have the same original equipment manufacturers (OEM) or nuclear steam supply system (NSSS) supplier. Other Owners Groups have been formed based on the desire to cost share certain technical approaches, improvements or resources, including spare parts, motor refurbishment shop, etc.

Industry Application Guidance, *NEI-93-01*

As discussed above, NEI generated guidance for the implementation of the Maintenance Rule in 1993, *NEI-93-01* entitled, *Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants*. This became the key guidance source for the industry and was revised a number of times to incorporate industry experience and USNRC changes in the Rule. It provided the basis for implementation and inspection. The one-page Maintenance Rule required over 75 pages of explanation and guidance. The key topics contained in NEI-93-01 are:

- Scoping Issues
- Determination of Risk Significance
- Functional and Maintenance Preventable Functional Failures (MPFF)
- On-line Risk Management

- System Performance Monitoring
- Corrective Actions and Goal Setting
- Reporting and Data Collection

Each is briefly described below.

Scoping Issues

Because the plant consists of many systems and components, some important and others with auxiliary functions, a process was needed by which the scope of the maintenance rule could be determined, that is which systems and components are to be included within the scope of the Rule. Consistent with the Rule, the guide provides for three basic categories of systems to be addressed. First, the most important safety systems and systems whose failure could trigger a plant shutdown and thereby challenging the safety systems, are considered risk significant. The second group is comprised of non-safety systems that mitigate accidents or whose failure could affect the performance of safety systems and systems used for emergency. The last category are systems that are not included in the first two categories and for which no performance monitoring is required, however, the normal plant maintenance program applies.

Determination of Risk Significance

The guide provides for a number of methods to determine risk significance, including an Individual Plant Evaluation (IPE), a Probabilistic Risk Assessment (PRA), Critical Safety Function Review (SFR) and Single Point Vulnerability (SPV). Of these methods, most plants chose to rely on their PRA as the principal tool to establish risk significance.

Risk Significance is measured by three separate parameters:

- Risk Reduction Worth (RRW)
- Risk Achievement Worth (RAW)
- Core Damage Frequency (CDF)

To determine the RRW, the PRA is modified to change the availability or reliability to 1.0 for each system, one at a time. This will simulate the system to be performing perfectly. The baseline PRA result is typically presented as the reactor core damage frequency (CDF). This number is then divided by the new result for each system to arrive at a number >1.0. Systems that produce more than a 5% decrease in risk are considered risk significant (RRW >1.05). The same process is repeated for RAW except that the system reliability or availability is set to zero (always fails). Systems that produce an RAW of >2.0 are considered risk significant.

For the last measure using CDF, the PRA is reviewed to identify the top 90% of the cut sets of the total CDF. After eliminating non-relevant cut sets, the remaining systems are presented to an expert panel for final determination.

Functional and Maintenance Preventable Functional Failures (MPFF)

System availability is influenced by planned and unplanned equipment outages. Planned outages can be managed, while unplanned outages are the result of equipment failures (random or non-random). Similarly, reliability is influenced by planned surveillance or functional tests and unplanned failures to run or failures to start. Because the planned unavailability and unreliability can be quantified, they represent the baseline of achievable performance, assuming no failures.

The NEI guide focuses on the system functional failures as the primary parameter to establish acceptable performance criteria on a systems basis. Because the Maintenance Rule requires monitoring of maintenance effectiveness, the term MPFF was created to single out only those failures that could have been prevented by proper maintenance. Specifically, this excludes failures associated with original design flaws and operational errors. Every system functional failure requires a root cause analysis at some level of detail to validate the MPFF designation.

Additionally, the NEI guide places significant emphasis on repetitive failures, component failures that occur in similar components (same design, function, vendor, material) for the identical cause. If a repetitive failure (RMPFF) occurs, it indicates that the original corrective action was not effective or comprehensive or that the diagnosis was incorrect. The root cause analysis is supposed to include a review of similar components and their susceptibility to the same failure cause. The acceptance criteria for all systems are therefore zero repetitive failures.

On-line Risk Management

To comply with paragraph A-4 of the rule, the industry adopted a unique strategy to assure that the risk associated with system maintenance outages is balanced over time. A 13-week calendar was developed, during which all the risk significant systems must be serviced. Each week was populated with one or more systems to be taken out-of-service for inspection, testing and maintenance. Only one highly ranked system could be serviced during any one week, while more than one lower ranked systems could be serviced during the same or in other weeks. For redundant safety systems, only one train can be taken out-of-service during any time. In this way, the on-line risk could be balanced for each of the 13 weeks to arrive at a fairly even distribution of risk over time. The 13-week schedule is then repeated four times in a year so that all systems are serviced every 90 days. Each 13-week on-line risk analysis includes the assumption that an additional system failure may occur. If further unplanned outages occur, the failed system impact on the on-line risk must be immediately assessed and compensatory measures must be taken (return the outage system to service or shut down the plant). It is noted that during any of the system(s) outage weeks, only maintenance work (corrective, preventive, testing, etc) associated with those system(s) is permitted, all other systems must remain operational.

System Performance Monitoring

System performance parameters and criteria are based on the system's functions. Systems, which are normally operating, can be monitored by trending their availability (planned and unplanned). Using the above 13-week outage schedule, a system is unavailable for a maximum of four weeks per year, or about 8%. The maximum baseline availability is therefore 92%. Note that high-risk electrical system trains are typically serviced within a very short time with an availability exceeding 99% (≤88 hours per year outage). The plant PRA is used to quantify the impact of unplanned failures, using historic generic or plant-specific component failure rates and to establish the final acceptance criteria for the system availability. Standby systems are those that are automatically or manually started in response to a pre-set value (i.e. sump/tank water level) or are initiated by an event (such as fire protection sprinkler system). Many of the standby systems are tested on a periodic basis (typically every 90 days) to assure functionality. The number of tests and actual demand starts are counted and the ratio of failed tests (failure to start, failure to run) per 100 attempts is defined as component or system reliability. Some systems, such as emergency power supplies require a very high reliability (i.e. 99%). Again, the acceptability of the reliability performance criteria must be confirmed with the PRA. The system performance parameters are typically trended over a two-year rolling period.

Corrective Actions and Goal Setting

When a system does not meet its performance criteria, such as when a functional failure of a component causes exceed the availability or reliability criteria for the system, a root cause must be established and a goal must be set and monitored until it is demonstrated that the corrective action was successful. If the system outage is relatively short and corrective action can be readily accomplished (such as resetting a tripped breaker or replacing the fuse for an MOV), the system maybe be able to tolerate two or three MPFFs over the two year period and thus avoids goal setting. If the failure cause is major or repetitive, a new performance goal needs to be selected to assure that the corrective measures can be quantified and monitored. A bearing failure of a pump may have been caused by an imbalanced impeller, so bearing temperature and pump shaft vibration could be monitored against a specified temperature goal and vibration goal to verify that the new bearing and rebalanced impeller was indeed an effective corrective action. At the same time, bearing temperature and pump vibration should be monitored for other similar pumps to avoid the same failure cause. Following successful verification, the system can return to its normal monitoring status.

Reporting and Data Collection

The system performance data must be monitored and trended to project the future behavior of the system. If the trend is negative, the point in time that the system would exceed its acceptance limits can be predicted, such that cause evaluations and corrective action planning can be initiated. Individual system performance is reported in the bi-annual periodic assessments that are subject to USNRC review and audit. In addition, the industry has setup a reporting database to capture all functional failures (MPFFs), giving system and component details, date, failure cause and detection and lost production, if any. This database called Equipment Performance and Information Exchange 4.0 (EPIX) is operated and managed by INPO since 1996. The information can be accessed and sorted in many ways (equipment type, component, vendor, plant, date) and EPIX has become the principal experience database for component failures. INPO periodically scans the data to look for generic industry problems and notifies power plants of specific issues that have emerged and that may need plant-specific attention.

Lessons Learned by the USNRC and Industry

It took the industry and the USNRC almost ten years to successfully implement the Maintenance Rule. Many changes and improvements had to be made to assure that the activities remain meaningful, add value, and meet the original objectives. The biggest benefit has been seen in improved plant performance and reductions in safety system challenges.

Another significant benefit to the industry has been the use of the Maintenance Rule systems performance monitoring in the life extension regulations. Because active systems and components are performance monitored, only passive components require aging management. The USNRC had established aging management requirements in a separate License Renewal Rule. By specifying the monitoring of active systems and components and requiring aging management programs for passive components the industry has realized significant cost and resource savings while ensuring that the plant systems, structures, and components continue to meet all safety requirements.

Many nuclear power plant utilities have combined the performance monitoring results with the system health reports, which must be generated each quarter year by the plant/system engineers. System unique problems can be identified early and be mitigated with corrective action.

Another important lesson learned has been the need to monitor failures on an industry wide scale. By having the plant operators report failures to the INPO EPIX database common cause failures can be identified and addressed. To date the EPIX database has more than 100,000 failure history entries for individual components. It can be said that anything that can go wrong with a particular component has been captured in the database. Performing data analysis of the failures has led to identification of failure detection methods that work and those that are not effective. Failure rates deduced from the data has led to optimization of spare parts inventories and focusing on those subcomponents and parts that are most likely to fail.

Lastly, power plant owners have been able to better allocate preventive and predictive maintenance budget to those systems and components that carry the highest safety and commercial risk and thereby improving plant performance, life expectancy and lowering insurance costs.

Oil Industry Applicability Assessment

In this section we attempt to supplement the discussions above with personal experience and professional judgment. Aging management is not unique to nuclear power plants. EPRI has used many of the component aging reports generated for the nuclear plants in applications to fossil and hydro power stations. Similarly, many of the nuclear power plant component aging data originates from other industries, including the concrete and steel aging effects and mechanisms.

The components typically covered in a nuclear plant can also be found in almost every other industrial facility. Table 1 provides a listing of typical passive and active components for which aging evaluations are performed in nuclear plants. Operating environments and service duty may differ, however, materials of construction and their degradation mechanisms are very uniform.

Table 1: *Typical Passive and Active Component Categories*

Item	Category	Structure, Component, or Commodity Group	Passive (P) Active (A)*
1	Structures	Concrete Structures, Inside, Outside	P
2	Structures	Underwater Concrete Structures	P
3	Structures	Underground Concrete Structures	P
4	Structures	Steel Structures, Inside, Outside	P
5	Structures	Underwater Steel Structures	P
6	Structures	Equipment Supports, Hangers and Foundations	P
7	Structures	Compressible Joints and Seals	P
8	Structures	Fire Barriers	P
9	Structures	Instrumentation Racks, Frames, Panels, and Enclosures	P
10	Structures	Electrical Panels, Racks, Cabinets, and Other Enclosures	P
11	Structures	Cable Trays, Conduit and Supports	P
12	Mechanical	High Pressure Piping	P
13	Mechanical	Low Pressure Piping	P
14	Mechanical	Underground Piping	P
15	Mechanical	Low Temperature Gas Transport Piping	P
16	Mechanical	Stainless Steel Tubing	P
17	Mechanical	Expansion Joints	P
18	Mechanical	Ductwork	P
19	Mechanical	Pumps, Horizontal, Vertical, Reciprocating	A, P (Casing)
20	Mechanical	Submersible Pumps	A, P (Casing)
21	Mechanical	Steam Turbines, Gas Turbines	A, P (Casing)
22	Mechanical	Emergency Diesel Generators, Fire Diesels	A
23	Mechanical	Heat Exchangers, Condensers, HVAC Coolers	P
24	Mechanical	Strainers	P
25	Mechanical	Air Compressors, Rotary, Reciprocating	A, P (Casings)
26	Mechanical	Valves, Manual, MOV, AOV, HOV, Check, Relief	A, P (Bodies)
27	Mechanical	Dampers, Butterfly Valves	A, P (Bodies)
28	Mechanical	Tanks, Air Accumulators, Reservoirs	P
29	Mechanical	Atmospheric Storage Tanks	P
30	Mechanical	Underground Storage Tanks (UST)	P
31	Mechanical	Blowers, Fans	A, P (casings)
32	Mechanical	Cranes, Rigs, Lifting Devices, Winches	A
33	Electrical	Batteries	A
34	Electrical	Cables, Terminations, Buses	P
35	Electrical	Chargers, Converters, Inverters, UPS	A
36	Electrical	Circuit Breakers, Switchgear	A
37	Electrical	Electric Heaters	A
38	Electrical	Fuses	A
39	Electrical	Generators, Motors, MG-Sets	A
40	Electrical	Transformers	A

* Passive structures and components are identified as those that perform their intended functions without moving parts or a change in configuration or properties. The description of “passive” may also be interpreted to include structures and components that do not display “a change in state.” Structures and components not fitting this definition are considered “Active”.

When a facility is originally designed, engineers do not always know the precise lifetime exposure of the equipment, or the actual maintenance programs to be applied. Nor are all potential degradation mechanisms considered. Similarly, mitigative or protective measures, such as coatings, corrosion allowance, cathodic protection, or chemical inerting, do not always perform as intended or are not effectively maintained. Design margins are established to account for these uncertainties, but sooner or later these design margins are exhausted and equipment failures are increasing. Preventive aging assessments therefore must consider the original design margins, equipment operating history, exposure and the current conditions to render a meaningful analysis and to establish an effective corrective action plan.

Attachment 1: The Maintenance Rule Text

US Code of Federal Regulations § 50.65
Requirements for monitoring the effectiveness of maintenance at nuclear power plants.

The requirements of this section are applicable during all conditions of plant operation, including normal shutdown operations.

(a)(1) Each holder of a license to operate a nuclear power plant under Secs. 50.21(b) or 50.22 shall monitor the performance or condition of structures, systems, or components, against licensee-established goals, in a manner sufficient to provide reasonable assurance that such structures, systems, and components, as defined in paragraph (b), are capable of fulfilling their intended functions. Such goals shall be established commensurate with safety and, where practical, take into account industry-wide operating experience. When the performance or condition of a structure, system, or component does not meet established goals, appropriate corrective action shall be taken. For a nuclear power plant for which the licensee has submitted the certifications specified in Sec. 50.82(a)(1), this section only shall apply to the extent that the licensee shall monitor the performance or condition of all structures, systems, or components associated with the storage, control, and maintenance of spent fuel in a safe condition, in a manner sufficient to provide reasonable assurance that such structures, systems, and components are capable of fulfilling their intended functions.

(2) Monitoring as specified in paragraph (a)(1) of this section is not required where it has been demonstrated that the performance or condition of a structure, system, or component is being effectively controlled through the performance of appropriate preventive maintenance, such that the structure, system, or component remains capable of performing its intended function.

(3) Performance and condition monitoring activities and associated goals and preventive maintenance activities shall be evaluated at least every refueling cycle provided the interval between evaluations does not exceed 24 months. The evaluations shall take into account, where practical, industry-wide operating experience. Adjustments shall be made where necessary to ensure that the objective of preventing failures of structures, systems, and components through maintenance is appropriately balanced against the objective of minimizing unavailability of structures, systems, and components due to monitoring or preventive maintenance.

(4) Before performing maintenance activities (including but not limited to surveillance, post-maintenance testing, and corrective and preventive maintenance), the licensee shall assess and manage the increase in risk that may result from the proposed maintenance activities. The scope of the assessment may be limited to structures, systems, and components that a risk-informed evaluation process has shown to be significant to public health and safety.

(b) The scope of the monitoring program specified in paragraph (a)(1) of this section shall include safety related and nonsafety related structures, systems, and components, as follows:

(1) Safety-related structures, systems and components that are relied upon to remain functional during and following design basis events to ensure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, or the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure comparable to the guidelines in Sec. 50.34(a)(1), Sec. 50.67(b)(2), or Sec. 100.11 of this chapter, as applicable.

(2) Nonsafety related structures, systems, or components:

(i) That are relied upon to mitigate accidents or transients or are used in plant emergency operating procedures (EOPs); or

(ii) Whose failure could prevent safety-related structures, systems, and components from fulfilling their safety-related function; or

(iii) Whose failure could cause a reactor scram or actuation of a safety-related system.

(c) The requirements of this section shall be implemented by each licensee no later than July 10, 1996.

Attachment 2: Abbreviations / Acronyms

Related to nuclear power plant aging management programs

Abbreviation or Acronym	Description
AMP	Aging Management Program
AMR	Aging Management Review
ANSI	American Nuclear Standards Institute
ASME	American Society of Mechanical Engineers
BOP	Balance of Plant
BWROG	Boiling Water Reactor Owners Group
CBA	Cost Benefit Analysis
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
CLB	Current Licensing Basis
CUF	Cumulative Usage Factor
DBD	Design Basis Document
DOE	U.S. Department of Energy
EPIX	Equipment Performance and Information Exchange
EPRI	Electrical Power Research Institute
EQ	Environmental Qualification
ER	Environmental Report
FHA	Fire Hazards Analysis and Fire Protection Program
FSAR	Final Safety Analysis Report
FSD	Functional System Description
GALL	Generic Aging Lessons Learned
IOE	Industry Operating Experience
INPO	Institute of Nuclear Power Operations
ISG	Interim Staff Guidance
ISI	In-Service Inspection
LRR	License Renewal Rule
MIC	Microbiological Influenced Corrosion
MPFF	Maintenance Preventable Functional Failure
NEI	Nuclear Energy Institute
NMAC	Nuclear Maintenance Assist Center
NPAR	Nuclear Plant Aging Reports
NRC	Nuclear Regulatory Commission (also USNRC)
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
PdM	Predictive (diagnostic) Maintenance
PM	Preventive Maintenance
PRA	Probabilistic Risk Analysis
RAW	Risk Achievement Worth
RMPFF	Repetitive Maintenance Preventable Functional Failure
RRW	Risk Reduction Worth
SER	Safety Evaluation Report
SOC	Statement of Considerations
SPV	Single Point Vulnerability

Abbreviation or Acronym	Description
SRP	Standard Review Plan
SRP-LR	Standard Review Plan for License Renewal
SSC	Systems, Structures and Components
TLAA	Time Limited Aging Analyses
USNRC	United States Nuclear Regulatory Commission
WANO	World Association of Nuclear Operators