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REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

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MONITORING THE EFFECTIVENESS OF MAINTENANCE AT NUCLEAR POWER PLANTS

A. INTRODUCTION

The NRC published the maintenance rule on July 10, 1991, as Section 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." The Commission's determination that a maintenance rule was needed arose from the conclusion that proper maintenance is essential to plant safety. As discussed in the regulatory analysis for this rule,[1] there is a clear link between effective maintenance and safety as it relates to such factors as the number of transients and challenges to safety systems and the associated need for operability, availability, and reliability of safety equipment. In addition, good maintenance is also important in providing assurance that failures of other than safety-related structures, systems, and components (SSCs) that could initiate or adversely affect a transient or accident are minimized. Minimizing challenges to safety systems is consistent with the Commission's defense-in-depth philosophy. Maintenance is also important to ensure that design assumptions and margins in the original design basis are maintained and are not unacceptably degraded. Therefore, nuclear power plant maintenance is clearly important in protecting the public health and safety.

Paragraph (a)(1) of 10 CFR 50.65 requires that power reactor licensees monitor the performance or condition of SSCs against licensee-established goals in a manner sufficient to provide reasonable assurance that such SSCs are capable of fulfilling their intended functions. Such goals are to be established commensurate with safety and, where practical, take into account industry-wide operating experience. When the performance or condition of an SSC does not meet established goals, appropriate corrective action must be taken.

Paragraph (a)(2) of 10 CFR 50.65 states that monitoring as specified in paragraph (a)(1) is not required where it has been demonstrated that the performance or condition of an SSC is being effectively controlled through the performance of appropriate preventive maintenance, such that the SSC remains capable of performing its intended function.

Paragraph (a)(3) of 10 CFR 50.65 requires that performance and condition monitoring activities and associated goals and preventive maintenance activities must be evaluated at least annually,[2] taking into

[1] NRC Memorandum to All Commissioners from J. Taylor on "Maintenance Rulemaking," June 27, 1991. Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL-6, Washington, DC 20555; phone (202) 634-3273; fax (202) 634-3343.

[2] As of the publication of this regulatory guide, a modification to the maintenance rule is in preparation that would change the evaluation interval to every refueling outage but not to exceed 2 years.

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This guide was issued after consideration of comments received from the public. Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience.

Written comments may be submitted to the Regulatory Publications Branch, DFIPS, ADM, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

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account, where practical, industry-wide operating experience. Adjustments must be made where necessary to ensure that the objective of preventing failures of SSCs through maintenance is appropriately balanced against the objective of minimizing unavailability of SSCs because of monitoring or preventive maintenance. In performing monitoring and preventive maintenance activities, an assessment of the total plant equipment that is out of service should be taken into account to determine the overall effect on performance of safety functions. Paragraph (b) of 10 CFR 50.65 states that the scope of the monitoring program specified in paragraph (a)(1) is to include safety-related and nonsafety-related SSCs, as follows:

(1) Safety-related structures, systems, or 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, and the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure comparable to the 10 CFR Part 100 guidelines.

(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.

Paragraph (c) of 10 CFR 50.65 states that the rule provisions are to be implemented by licensees no later than July 10, 1996.

Any information collection activities mentioned in this regulatory guide are contained as requirements in 10 CFR Part 50, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 50 have been approved by the Office of Management and Budget, Approval No. 3150-0011.

B. DISCUSSION

The objective of 10 CFR 50.65 (referred to hereafter as the maintenance rule or the rule) is to require monitoring of the overall continuing effectiveness of licensee maintenance programs to ensure that: (1) safety-related and certain nonsafety-related SSCs are capable of performing their intended functions and (2) for nonsafety-related equipment, failures will not occur that prevent the fulfillment of safety-related functions, and failures resulting in scrams and unnecessary actuations of safety-related systems are minimized.

The extent of monitoring may vary from system to system depending on the system's importance to risk. Some monitoring at the component level may be necessary; however, it is envisioned that most of the monitoring could be done at the plant, system, or train level. For example, for less risk-significant systems, indicators of system reliability (where sufficient performance data exist) and availability may be all that is necessary. For more risk-significant systems, some parameter trending, beyond that already required by NRC requirements to provide early warning of degradation, may also be necessary for critical components whose unavailability causes a system train to be unavailable or whose failure is otherwise unacceptable. Rather than monitoring the many SSCs that could cause plant scrams, the licensee may choose to establish a performance indicator for unplanned automatic scrams and, where scrams caused by equipment failures have been problematic or where such scrams are anticipated, the licensee may choose to monitor those initiators most likely to cause scrams.

It is intended that activities currently being conducted by licensees, such as technical specification surveillance testing, can satisfy monitoring requirements. Such activities could be integrated with, and provide the basis for, the requisite level of monitoring. Consistent with the underlying purposes of the rule, maximum flexibility should be offered to licensees in establishing and modifying their monitoring activities.

Licensees are encouraged to consider the use of reliability-based methods for developing the preventive maintenance programs covered under paragraph (a)(2) of the rule; however, the use of such methods is not required.

With regard to the scope of the maintenance rule, as stated in paragraph (b) of the rule, it is understood that balance of plant (BOP) SSCs may have been designed and built with normal industrial quality and may not meet the standards in Appendix B to 10 CFR Part 50. It is not the intent to require licensees to generate paperwork to document the basis for the design, fabrication, and construction of BOP equipment.

Each licensee's maintenance efforts should minimize failures in both safety-related and BOP SSCs that affect safe operation of the plant. The effectiveness of maintenance programs should be maintained for the operational life of the facility.

As noted in the Regulatory Position, there may be a need to address maintenance activities that occur in the switchyards that could directly affect plant operations. Plant management should be aware of and have the ability to control these activities.

The regulatory guidance is intended to provide flexibility for a licensee to structure its maintenance program in accordance with the safety significance of those SSCs within the scope of the rule.

The nuclear industry has developed a document that provides guidance to licensees regarding implementation of the maintenance rule. This document has been prepared by NUMARC. A verification and validation (V&V) effort was conducted by NUMARC, with NRC staff observation, to test the guidance document on several representative systems. A number of changes were made to the NUMARC guidance document based on the results of the V&V effort. The NRC staff reviewed this document and found that it provides acceptable guidance to licensees.

Certain requirements for a renewed license under 10 CFR Part 54 may be satisfied by taking credit for activities required by the maintenance rule. However, the renewal rule requires (10 CFR 54.21(a)(6)(iii)), among other provisions, that an effective program must be implemented by the facility operating procedures and reviewed by the on-site review committee. The maintenance rule does not have these requirements.

Industry and NRC-sponsored probabilistic risk analyses (PRAs) have shown the risk significance of emergency ac power sources. The station blackout rule (10 CFR 50.63) required plant-specific coping analyses to ensure that a plant could withstand a total loss of ac power for a specified duration and to determine appropriate actions to mitigate the effects of a total loss of ac power. During the station blackout reviews, most licensees (1) made a commitment to implement an emergency diesel generator (EDG) reliability program in accordance with NRC regulatory guidance but reserved the option to later adopt the outcome of Generic Issue B-56 resolution, (2) stated that they had or will implement an equivalent program, or (3) endorsed the program embodied in NUMARC 87-00, Revision 1, August 1991, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors" (i.e., maintain the emergency diesel generator target reliability of 0.95 or 0.975). Subsequently, utilities docketed commitments to maintain their selected target reliability values. Those values could be used as a goal or as a performance criterion for emergency diesel generator reliability under the maintenance rule.

When utilities were performing their plant-specific coping analyses, they were allowed to use plant-specific data concerning unavailability due to maintenance. Therefore, emergency diesel generator unavailability due to maintenance, as assumed in a plant-specific individual plant examination (IPE) analysis, could also be used as the basis for a goal or performance criterion under the maintenance rule.

Section (a)(3) of the maintenance rule requires that adjustments be made where necessary to ensure that the objective of preventing failures of SSCs through maintenance is appropriately balanced against the objective of minimizing unavailability of SSCs due to monitoring or preventive maintenance. Therefore, plant-specific emergency diesel generator reliability and unavailability should be monitored as goals under 10 CFR 50.65(a)(1) or established as performance criteria under the plant's preventive maintenance program under 10 CFR 50.65(a)(2), taking into account the objectives of 10 CFR 50.65(a)(3).

Under 10 CFR 50.65(a)(2), the utility would establish performance criteria for both emergency diesel generator reliability and unavailability. Emergency diesel generator performance criteria for reliability would be met by the absence of a maintenance-preventable failure or the occurrence of a single maintenance-preventable failure followed by appropriate root cause determination and corrective action. Performance criteria for unavailability would be met by having fewer unavailable hours, on a rolling 1-year basis, than required by the established performance criteria.

If any performance criterion is not met, or a second emergency diesel generator maintenance-preventable failure occurs, it is expected that the licensee would establish goals and monitor subsequent emergency diesel generator performance under 10 CFR 50.65(a)(1), consistent with an appropriate balance between emergency diesel generator reliability and unavailability.

The emergency diesel generator reliability performance criteria or goals selected for implementing the intent of 10 CFR 50.63 for coping with station blackout could be monitored through the use of the triggers[3] and the monitoring methods described in Appendix D of NUMARC 87-00, Revision 1, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at LWRs," August 1991 (except for triggers and testing for "problem diesels" as described in paragraph D.2.4.4 of NUMARC 87-00, which will be addressed separately by the NRC). An acceptable unavailability goal could be to have fewer hours unavailable (on a rolling 1-year basis) than the number of hours established as acceptable by the licensee.

C. REGULATORY POSITION

The scope of monitoring efforts under the maintenance rule, as defined in 10 CFR 50.65(b), encompasses those SSCs that directly and significantly affect

[3]The triggers are intended to indicate when emergency diesel generator performance problems exist such that additional monitoring or corrective action is necessary. It is recognized that it is not practical to demonstrate by statistical analysis that conformance to the trigger values will ensure the attainment of high reliability, with a reasonable degree of confidence, of individual EDG units.

plant operations, regardless of what organization actually performs the maintenance activities. Maintenance activities that occur in the switchyard can directly affect plant operations, and as a result electrical distribution equipment out to the first inter-tie with the off-site distribution system (i.e., equipment in the switchyard) should be considered for comparison with 10 CFR 50.65(b) for inclusion under the scope of the maintenance rule.

NUMARC 93-01, dated May 1993, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,"[4] provides methods acceptable to the NRC staff for complying with the provisions of 10 CFR 50.65. NUMARC 93-01 references other documents, but NRC's endorsement of NUMARC 93-01 should not be considered as endorsement of the referenced documents.

The example in NUMARC 93-01, Section 12.2.4, which refers to optimizing emergency diesel generator reliability and availability, describes an acceptable method to establish emergency diesel generator performance criteria and/or goals and subsequently monitor emergency diesel generator performance.

[4]Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL-6, Washington, DC 20555; phone (202) 634-3273; fax (202) 634-3343.

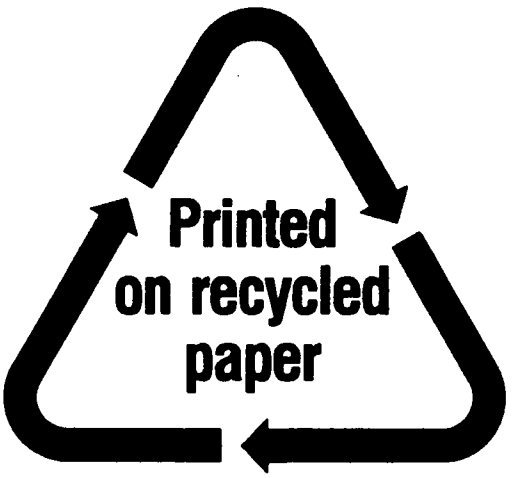
D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

Except in those cases in which the applicant or licensee proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the methods described in the guide will be used in the evaluation of submittals for construction permits and operating licenses (as appropriate) and will be used to evaluate the effectiveness of maintenance activities of licensees who are required to comply with 10 CFR 50.65. The guide will also be used to evaluate the effectiveness of emergency diesel generator maintenance activities associated with compliance with 10 CFR 50.63.

REGULATORY AND BACKFIT ANALYSES

Separate regulatory and backfit analyses were prepared for this Regulatory Guide 1.160. They are available, in the file for Regulatory Guide 1.160, for inspection or copying for a fee in the Commission's Public Document Room, 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL-6, Washington, DC 20555; phone (202)634-3273; fax (202)634-3343.



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