IEEE Guide for the Definition of Reliability Program Plans for Nuclear Generating Stations and Other Nuclear Facilities

IEEE Power and Energy Society

Sponsored by the

Nuclear Power Engineering Committee

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Abstract: Guidelines for the definition of a reliability program at nuclear generating stations and other nuclear facilities are provided. The document emphasizes reliability programs during the operating phase of such stations; however, the general approach applies to all phases of the nuclear power generating station life cycle (e.g., design, construction, start-up, operating, and decommissioning).

Keywords: IEEE 933™, problem analysis, reliability analysis, reliability program plan

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Introduction

This introduction is not part of IEEE Std 933-2013, IEEE Guide for the Definition of Reliability Program Plans for Nuclear Generating Stations and Other Nuclear Facilities.

The IEEE recognizes the importance of safe, reliable, and efficient nuclear power generation and seeks to provide guidance for constructing a reliability program to help achieve improved plant safety and performance. This guide is part of a continuing effort in which the IEEE and other industry groups have been engaged since the beginning of the commercial nuclear power industry. Related IEEE activities include the publication of the following guides and standards:

— IEEE Std 352™, IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Stations Safety Systems (a basic reliability tutorial)

— IEEE Std 577™, IEEE Standard Requirements for Reliability Analysis in the Design and Operation of Safety Systems for Nuclear Power Generating Stations

This guide's main objective, to provide a basic framework for operational reliability programs, has been adapted to nuclear generating stations and other nuclear facilities. However, principles contained in the guide are not limited to these stations or the power industry exclusively. Other station types and industries are encouraged to tailor the guide to meet their specific needs.

The guide has been developed to aid nuclear utilities in tailoring the principles of an effective reliability program to their own particular organization structure and approach. As an IEEE guide, it cannot establish specific reliability activities that might already be in place. Rather, the program elements discussed in the guide are provided for the review of, and possible inclusion into, either centralized or decentralized reliability program plans.

Other recent industry efforts include the activities of

— The Institute of Nuclear Power Operations (INPO), such as the Equipment Performance & Information Exchange (EPIX), the "Focus on Performance," the Significant Event Evaluation and Information Network (SEE-IN), and the Safety System Unavailability Monitoring Program

— The Nuclear Energy Institute (NEI)

— Reactor vendor owners' groups, such as the group on scram reduction

— The Electric Power Research Institute (EPRI)

Another important effort that correlates to effective reliability program planning is the Maintenance Rule enacted by the U.S. Nuclear Regulatory Commission (NRC), described in the following excerpts from Regulatory Guide 1.160, Revision 2, dated March 1997:

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 NRC'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, 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 NRC'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 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.

The NRC staff encourages licensees to use, to the maximum extent practicable, activities currently being conducted, such as technical specification surveillance testing, to 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 10 CFR 50.65(a); however, the use of such methods is not required.

These excerpts indicate that a natural tie exists between reliability program planning, the identification of preventive maintenance programs, and the extension of existing performance or condition monitoring programs to meet the scope and intent of the Maintenance Rule. Further, the concept of determining SSC equipment [through such tools as probabilistic risk assessment (PRA)] can act as a means for identifying the critical systems and components whose failure would severely affect the top level plant mission of availability and safety and, therefore, indicate a structure for the scope and detail of a reliability program. At this writing, however, specific links to the Maintenance Rule have not as yet been incorporated into this guide.

The members of the working group responsible for the development of the guide believe the guide to be a living document that should be revised regularly to include references to proposed and enacted rulemaking activities and to incorporate improvements as reliability programs mature (such as guidance for human reliability and software reliability). Therefore, both comments and participation in future activities related to the guide are encouraged, and input on this topic is hereby solicited from any interested, knowledgeable parties.

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IEEE Guide for the Definition of Reliability Program Plans for Nuclear Generating Stations and Other Nuclear Facilities

1. Overview

The need for reliable equipment performance at nuclear generating stations and other nuclear facilities has long been recognized. As a result, numerous methods to improve equipment performance have been developed. Some are empirical (such as determination of component availability based on maintenance records); some are predictive (such as condition monitoring and performance trending); while others are pragmatic (such as root cause analysis). This diversity among methods (empirical, predictive, and pragmatic) provides a comprehensive set of tools to engineers faced with equipment performance issues. However, this diversity can also be confusing to the novice reliability engineer. In addition, management may experience difficulty in coordinating the use of these methods and the interpretation of their results by various organizations.

This guide discusses the organization of reliability engineering techniques into a comprehensive program or plan. The purpose of the planned program is to help ensure reliable equipment performance. While the program described in this guide is comprehensive, it can be selectively applied to a component, system, plant, or entire utility grid; and it can be applied in a phased fashion. Clause 4 describes the technical elements of a reliability program and their integration into an effective technical approach. The applicability of various methods (empirical, predictive, and pragmatic) to each element is discussed. In addition, the information inputs and outputs of each element are detailed, along with the flow of