

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

Sponsor
Nuclear Power Engineering Committee
of the
IEEE Power and Energy Society

Approved 11 December 2013

IEEE-SA Standards Board

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.

Contents

1. Overview	1
1.1 Scope	2
1.2 Purpose	2
2. Normative references.....	2
3. Definitions, acronyms, and abbreviations	2
3.1 Definitions	2
3.2 Acronyms and abbreviations	6
4. Program elements	7
4.1 Performance monitoring	7
4.2 Performance evaluation	10
4.3 Problem prioritization.....	15
4.4 Problem analysis and corrective action recommendation.....	17
4.5 Corrective action implementation and feedback.....	21
5. Major programmatic resources	23
5.1 Operations.....	24
5.2 Maintenance	25
5.3 Engineering.....	25
5.4 Safety	26
5.5 Licensing	27
5.6 Quality assurance.....	27
5.7 Procurement.....	27
Annex A (informative) Reliability program management.....	28
A.1 Planning	28
A.2 Integration.....	29
A.3 Organization	29
A.4 Controlling.....	31
A.5 Leadership	31
Annex B (informative) Case study—Application of Excelsior Power Company’s reliability program plan to service water pumps	33
B.1 Overview.....	33
B.2 Service water pump performance.....	33
Annex C (informative) Sample RAM specification for replacement service water pumps.....	35
C.1 Section 1: General.....	37
C.2 Section 2: Scope.....	37
C.3 Section 3: Specific RAM requirements.....	37
C.4 Section 4: RAM tasks	38
C.5 Section 5: Availability demonstration.....	42
C.6 Section 6: Root cause analysis	43
Annex D (informative) Bibliography	44

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

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1. Overview

The need for reliable equipment performance at nuclear ~~power~~-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 information among the various elements. Clause 5 discusses the reliability program's interfaces with current ~~utility~~[operator](#) organizational structures. Resources within ~~a utility~~[the operating organization](#) that may supply both information and expertise to each program element are identified. Four informative annexes are included to further illustrate the ideas presented in this guide. Annex A discusses the management of a reliability program; Annex B provides a sample reliability program; Annex C provides a sample reliability, availability, and maintainability (RAM) specification; and Annex D provides an annotated bibliography to aid the user of this guide in selecting additional resources.

1.1 Scope

This document provides guidelines for the definition of a reliability program at nuclear ~~power~~ generating stations [and other nuclear facilities](#). The document emphasizes reliability programs during the operating phase of such ~~stations~~[facilities](#); 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) [of the facility](#).

1.2 Purpose

The purpose of this guide is to describe a basic framework (i.e., the program elements, guidelines on implementation, element interaction, and their scope of application) directed at improving nuclear ~~power~~ generating station [and other nuclear facility](#) performance through the effective implementation of reliability programs. It is oriented toward ~~station~~[facility](#) availability, encompassing balance-of-plant and safety-related equipment. Effective implementation of these guidelines should also improve ~~plant~~ [facility](#) safety by reducing challenges to safety systems in addition to enhancing reliable operation of the components of those safety systems.

2. References

Normative references

~~This guide should be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.~~ The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 352-~~1987 (Reaff 1999)~~,TM IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Stations Safety Systems.^{1,2}

IEEE Std 577-~~1976 (Reaff 1992)~~,TM IEEE Standard Requirements for Reliability Analysis in the Design and Operation of Safety Systems for Nuclear Power Generating Stations.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this ~~guide~~document, the following terms and definitions apply. ~~The IEEE Std 100-1996 Standards Dictionary Online~~ should be ~~referenced~~consulted for terms not defined in this clause.³

¹ IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, ~~P.O. Box 1331~~, Piscataway, NJ 08854-~~1331~~, USA (<http://standards.ieee.org/>).

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³ IEEE Standards Dictionary Online subscription is available at:
http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

~~3.1.1~~ acoustic monitoring: The detection of sound patterns emitted by equipment to determine its operating condition for predictive monitoring.

~~3.1.2~~ alert level: A probability value placed on equipment failure rates to identify when systems, trains, or components are not achieving their target availability or reliability values.

~~3.1.3~~ analysis: A process of mathematical or other logical reasoning that leads from stated premises to the conclusion concerning specific capabilities of equipment and its adequacy for a particular application. ~~(IEEE Std 100-1996)~~

~~3.1.4~~ availability: The characteristic of an item expressed by the probability that it will be operational at a randomly selected future instant in time. ~~(IEEE Std 100-1996)~~

~~3.1.5~~ common-cause failure: Multiple failures attributable to a common cause. ~~(IEEE Std 100-1996)~~

~~3.1.6~~ complete (catastrophic) failure: Failure of equipment that is both sudden and total.

~~3.1.7~~ components: Items from which the system is assembled. ~~(IEEE Std 100-1996)~~

~~3.1.8~~ condition monitoring: Observation, measurement, or trending of condition or functional indicators with respect to some independent parameter (usually time or cycles) to indicate the current and future ability to function within acceptance criteria. ~~(IEEE Std 323-1983)~~

~~3.1.9~~ critical components: ~~Equipment whose failure will result in complete system or functional failure.~~

NOTE—See also Annex C of IEEE Std 1205 [B40].^{4, 5}

⁴ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

⁵ The numbers in brackets correspond to those of the bibliography in Annex D.

~~3.1.10 degraded~~**degradation**: A failure that is gradual, partial, or both; for example, the equipment ~~degrades~~deteriorates to a level that, in effect, is a termination of the ability to perform its required function.

~~3.1.28 nuclear plant reliability data system (NPRDS)~~**equipment performance & information exchange (EPIX)**: A reliability database maintained by the Institute of Nuclear Power Operations (INPO) that receives failures reports from utilities within the United States.

~~3.1.11 failure~~: The termination of the ability of an item to perform a required function. ~~(IEEE Std 100-1996)~~

~~3.1.12 failure modes and effects analysis (FMEA)~~: A systematic procedure for identifying the ~~modes~~types of failure and for evaluating their consequences. ~~(IEEE Std 352-1987)~~

~~3.1.13 failure rate~~: The expected number of failures of a given type, per item, in a given time interval. ~~(IEEE Std 100-1996)~~

~~3.1.14 fault tree analysis (FTA)~~: A technique by which failures that can contribute to an undesired event are organized deductively and represented pictorially. ~~(IEEE Std 352-1987)~~

~~3.1.15 generating availability data system (GADS)~~: Reliability information available from the North American Electric Reliability ~~Council~~Corporation.

~~3.1.16 GO~~: Availability analysis method similar to reliability block diagram with operators and event actions included.

hazard and operability study (HAZOP): A systematic qualitative technique to identify process hazards and potential operating problems using a series of guide words to identify and analyze process deviations. A HAZOP is used to question all portions of a process or system to identify potential deviations from the intention of the design, their causes, and consequences.

~~3.1.17 importance measures~~: A quantitative analysis to determine the importance of variations in equipment reliability to system risk and/or reliability.

3.1.18 incipient: An imperfection in the state or condition of equipment that could result in a degraded or immediate failure if corrective action is not taken.

3.1.19 inherent availability (IA): A measure of availability for a system operating in an ideal support environment in which scheduled maintenance, standby, and logistic time are ignored.
(IEEE Std 352-1987)

3.1.20 licensee event report (LER): Reports submitted by ~~the~~ a nuclear power plant licensee to the associated regulatory body [e.g., the Nuclear Regulatory Commission (NRC) under Regulatory Guide 1.16].

3.1.21 logistics time (LT): The downtime occasioned by the unavailability of spares, replacement parts, test equipment, maintenance facilities, or personnel.

3.1.22 mean logistics time (MLT): The mean downtime occasioned by the unavailability of spares, replacement parts, test equipment, maintenance facilities, or personnel.

3.1.23 mean time between failures (MTBF): The arithmetic average of operating times between failures of an item. (IEEE Std 100-1996)

3.1.24 mean time to repair (MTTR): The arithmetic average of time required to complete a repair activity. (IEEE Std 100-1996)

3.1.25 mission: The singular objective, task, or purpose of an item or system. (IEEE Std 352-1987)

3.1.26 mission time: The time during which the mission should be performed without interruption. (IEEE Std 352-1987)

3.1.27 NRC bulletins: Publications titled NRC Information Notice and published by the Office of Nuclear Reactor Regulation (NRR) of the Nuclear Regulatory Commission (NRC).

3.1.29 ~~nuisance failure~~: Intermittent or sustained failure of equipment secondary to system safety or reliability.

3.1.30 ~~operational availability (A_O)~~: The measured characteristic of an item expressed by the probability that it will be operable when needed as determined by periodic test and resultant analysis.

3.1.31 ~~operational reliability~~: The assessed reliability of an item based on operational data.

3.1.32 ~~operations and maintenance~~: Plant staff organized to perform these functions.

3.1.33 ~~outage time~~: Mean time to repair plus time for logistics and approval.

3.1.34 ~~performance evaluation~~: The analysis, in terms of initial objectives and estimates, usually made on site to provide information on operating experience and to identify required corrective actions.

3.1.35 ~~performance monitoring~~: Determining whether equipment is operating or capable of operating within specific limits.

3.1.36 ~~preventive maintenance~~: A procedure in which the system is periodically checked and/or reconditioned to prevent or reduce the probability of failure or deterioration in subsequent service.

3.1.37 ~~probabilistic risk assessment (PRA)~~: A calculation of the probability and consequences of various known and postulated accidents.

3.1.38 ~~program evaluation review technique (PERT)~~: A diagrammatic method for establishing program goals and tracking.

3.1.39 ~~quality assurance (QA)~~: All planned and systematic actions necessary to provide adequate confidence that a system or component will perform satisfactorily in service. ~~(IEEE Std 100-1996)~~

regulatory communications: Publications issued by applicable regulatory authorities, such as Nuclear Regulatory Commission (NRC) Information Notices, Bulletins, etc.

3.1.40-reliability, availability, and maintainability (RAM): Elements that are considered as unified for reliability enhancement.

3.1.41-reliability-centered maintenance: A series of orderly steps for identifying system and subsystem functions, functional failures, and dominant failure modes, prioritizing them, and selecting applicable and effective preventive maintenance tasks to address the classified failure modes.

3.1.42-reliability monitoring: Direct monitoring of reliability parameters of a plant, system, or equipment (e.g., failure frequency, downtime due to the maintenance activities, outage rate).

3.1.43-reliability program: A description of activities and techniques associated with reliability technology, not necessarily a formalized program or entity unto itself, and may be integrated with design and operations.

3.1.44-reliability targets: The reliability goals to be achieved by the plant systems.

3.1.45-repair rate: The expected number of repair actions of a given type completed on a given item per unit of time. ~~(IEEE Std 100-1996)~~

3.1.46-risk: The expected detriment per unit time to a person or population from a given cause.

NOTE—In this document, risk is used in a broader context that includes the expected financial detriment per unit time to an organization (e.g., utility) from a given cause. ~~(IEEE Std 100-1996)~~

3.1.47-robustness: A statistical result that is not significantly affected by small changes in parameters, models, or assumptions.

3.1.48-root cause: The underlying or physical cause of problem/failure.

~~3.1.49~~ **SEE-IN:** The Significant Event Evaluation and Information Network, an information database maintained by the Institute of Nuclear Power Operations (INPO).

~~3.1.50~~ **single point failure analysis:** A reliability analysis that identifies single components or subsystems whose failure results in system failure.

~~3.1.51~~ **standby equipment:** Equipment not normally in operation that is available on demand to perform a specific function.

~~3.1.52~~ **statistical indicators:** Parameters based on past plant-specific or generic experience used to predict the failure of identical or similar equipment based on time or stress histories.

~~3.1.53~~ **surveillance test:** The test that can determine the state or condition of a system or subsystem. ~~(IEEE Std 352-1987)~~

~~3.1.54~~ **system reliability service (SRS):** A United Kingdom reliability information and database service.

~~3.1.55~~ **time to repair (TTR):** Time required to accomplish corrective maintenance or repair successfully. It includes all of the time required for diagnosis, set-up, replacement, reassembly, and test, but does not include logistics scheduling and approval.

~~3.1.56~~ **unavailability:** The numerical complement of availability. Unavailability may occur as a result of the item being repaired (that is, repair ~~unavailable~~unavailability) or as a result of undetected malfunctions (that is, unannounced unavailability). ~~(IEEE Std 352-1987)~~

~~3.1.57~~ **UNIRAM:** A modeling methodology and associated software package for the performance of reliability, availability, and maintainability (RAM) analysis of power production systems.

~~3.1.58~~ **wearout:** The state of a component in which the failure rate increases with time as a result of a process characteristic of the population.

3.2 Acronyms [and abbreviations](#)

EPRI Electric Power Research Institute

[GADS](#) [Generating Availability Data System](#)

INPO Institute of Nuclear Power Operations

NERC North American Electric Reliability ~~Council~~ [Corporation](#)

NRC Nuclear Regulatory Commission

NRR Nuclear Reactor Regulation

[WANO](#) [World Association of Nuclear Operators](#)

4. Program elements

For a reliability program to be well constituted, it should provide a means for recognizing when a reliability problem exists, and conversely, when it does not, so resources are appropriately utilized. Also, the program should be capable of anticipating or predicting potential reliability problems that are likely to occur in the future based on historical performance or observed deterioration in equipment that has not yet failed and problems that have occurred elsewhere in the industry. If a problem is predicted or diagnosed, the reliability program should be able to prioritize its severity as compared to other reliability problems, so the most serious problems are corrected first. The program should be capable of determining the cause of the problem and devising corrective actions to rectify it. Finally, the reliability program should possess the means to monitor the efficacy of corrective actions to [help](#) ensure the adequacy of problem solution. A reliability program should possess the following elements to accomplish its objective of enhancing plant availability and safety:

- a) Performance monitoring
- b) Performance evaluation
- c) Problem prioritization
- d) Problem analysis and corrective action recommendation
- e) Corrective action implementation and feedback

These elements define a closed-loop process; once corrective actions are commenced to address detected reliability problems, the emphasis is directed back toward monitoring to [help](#) ensure the effectiveness of the corrective action. Figure 1 illustrates the closed-loop process of which reliability program plan elements are a part. Each of these elements is detailed in 4.1 through 4.5.

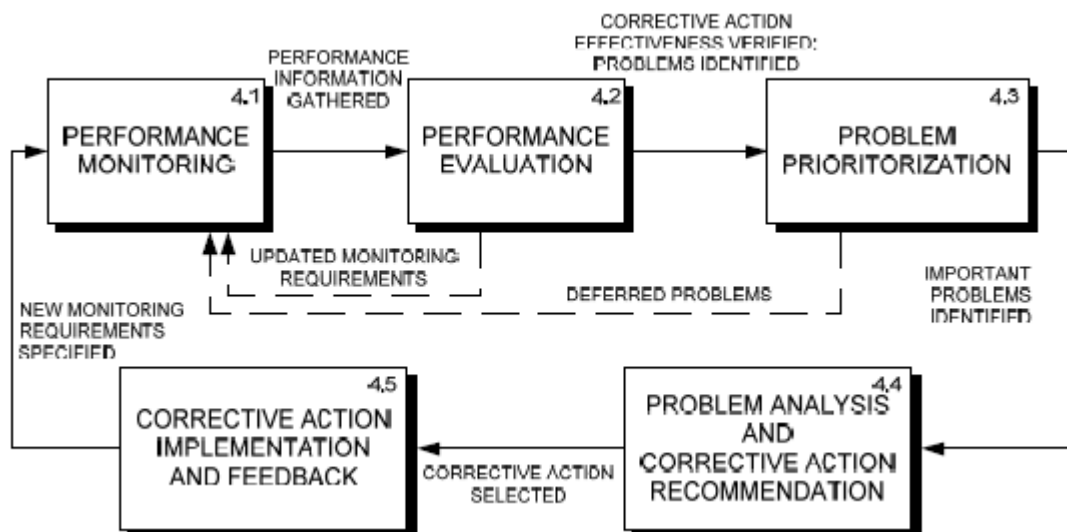


Figure 1 — Reliability program process: elements and interfaces

4.1 Performance monitoring

4.1.1 Explanation

Performance monitoring is the act of gathering pertinent failure detection and in-plant reliability information. Data include ~~both~~ [plant operating data \(e.g., pressure, temperature, voltage, flow rate, current, capacities from operator logs, surveillance test data files, etc.\)](#), reliability monitoring [data](#) (e.g., observation of failure frequency, outage rate, maintenance durations, outage times) and condition monitoring [data](#) (e.g., observation of conditions related to failure, such as degraded performance; changes in equipment parameters as measured by nondestructive tests, such as ultrasonic inspections, electrical continuity tests, and acoustic vibration monitoring). Data should include human errors, equipment failures, and maintenance actions and should be collected at a level consistent with the mission of the program (e.g., they may be collected at the component, system, and plant levels). As a minimum, data should be collected on complete failures; in addition, the practice of collecting data on both incipient and degraded failures may provide early indication of potential problems before they become serious [\(e.g., from preventive and predictive maintenance activities\)](#). Interfaces of this task to other elements of a reliability program are shown in Figure 2.

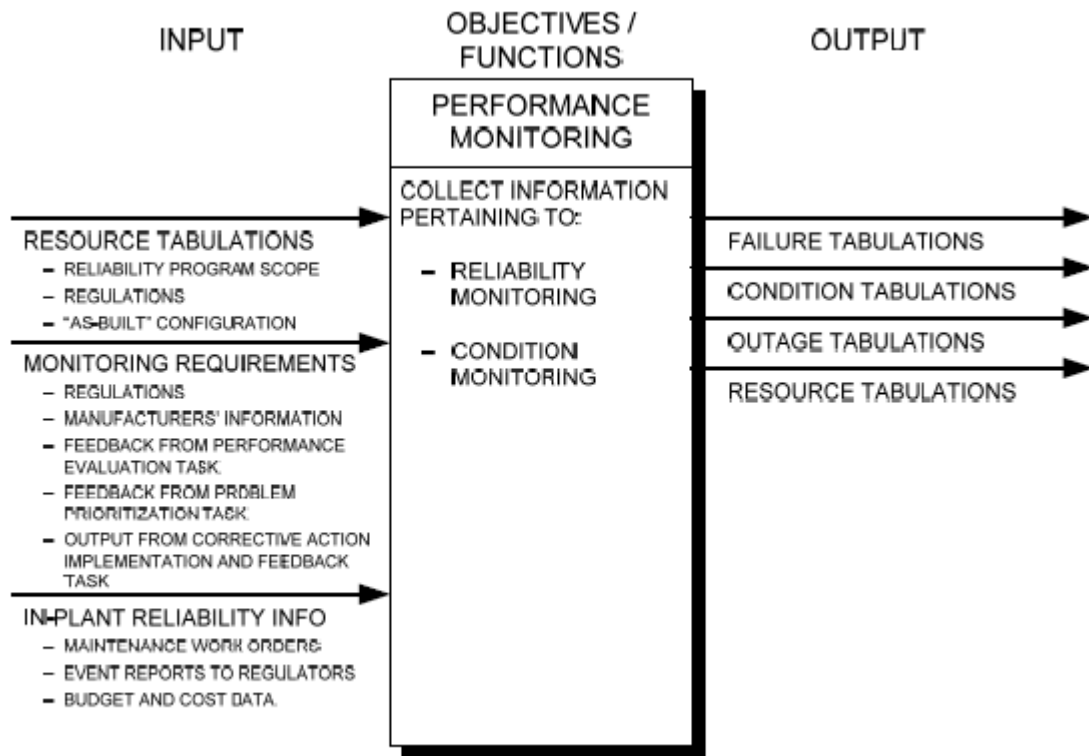


Figure 2 — Performance monitoring interfaces

4.1.2 Objective

The objective of performance monitoring is to provide basic data about actual in-plant reliability.

Sample uses are [as follows](#):

- a) To collect statistics on equipment failures to
 - 1) Detect the existence of a reliability problem
 - 2) Determine the severity of problems
 - 3) Verify the efficacy of corrective actions

- 4) Measure the efficiency of equipment surveillance
- b) To collect information relevant to poor equipment performance to aid in root cause determination
- c) To collect statistics and information that can be used to predict catastrophic failures (and, hence, to either prevent their occurrence or mitigate their effect)
- d) To identify equipment that is performing well
- e) To ~~relax~~[reallocate](#) resources where they are not being used most effectively
- f) To optimize inventory
- g) To optimize design
- h) To make procedure and training changes

4.1.3 Inputs

Inputs to performance monitoring include [the following](#):

- a) Definition of the scope of monitoring established by the reliability program or mandated by regulations (such as ~~technical specifications~~[the plant's Technical Specifications](#))
- b) Monitoring requirements mandated by regulations or established by equipment manufacturers
- c) Updated monitoring requirements based on the outputs of the performance evaluation task, the problem analysis and corrective action identification task, or the corrective action implementation and feedback task

- d) ~~Utility and~~ Plant-specific information systems (e.g., maintenance work orders, licensee event reports, records of human errors, budget and cost data, plant and systems descriptions) that provide data for use in identifying, assessing, and prioritizing reliability problems and solutions

4.1.4 Outputs

The major output of the performance monitoring task is a tabulation of performance information on all equipment encompassed by the reliability program. Such a listing should include [the following](#):

- a) A complete identification of the affected equipment [i.e., tag number, serial number, ~~Nuclear Plant~~[equipment performance & information exchange \(EPIX\)](#) ~~Reliability Data System (NPRDS)~~ identification]
- b) The date and time of failure detection
- c) The type of failure (complete, degraded, or incipient)
- d) The method of failure discovery (e.g., during operation, maintenance, testing, or inspection)
- e) Conditions prior to failure (e.g., plant mode, power level, temperature) and the impact of the failure f) The date and time the equipment was restored to service
- g) A description of the nature and extent of damage and a preliminary assessment of the cause
- h) A description of how the affected equipment was repaired
- i) Referenced documents [i.e., work order number, quality assurance or quality control (QA/QC) inspection reports]

Specific performance monitoring requests should be consistent with the needs of the reliability program objective. For example, a condition monitoring program would include far more extensive physical parameter requests. Such data requests should be established by a needs analysis prior to data collection. The needs analysis describes all the activities, organizational units, and data flow in an organized manner, such as with flow diagrams.

4.1.5 Implementation

Many of the inputs to and outputs from the performance monitoring task already exist at nuclear ~~power~~-generating stations [and other nuclear facilities](#). It has been long recognized that benefits are to be gained by a careful assessment of equipment performance. Past efforts related to equipment reliability have mainly been directed toward components important to plant safety. The current industry and regulatory interest is broadening to include components whose failure results in ~~plant~~-[power](#) reduction or shutdown, spurred by the recognition of the fact that reduction of safety system challenges also reduces plant risk. Equipment with historical reliability problems and equipment whose failure is absolutely unacceptable (e.g., reactor shutdown systems) have been addressed by performance monitoring tasks. A recent development is the advent of reliability-based surveillance activities that systematically organize past and present practices. Reliability-based surveillance is based on the following concept: the unique reliability characteristics of a component, along with the component's importance for achieving an acceptable level of availability or risk and the practicality of implementation, should dictate the type and intensity of the surveillance for that component. (For one possible implementation of these concepts, see Lofgren [~~B12~~]²[B51](#).)

²~~The numbers in brackets correspond to those of the bibliography in Annex D.~~

Implementation of the performance monitoring task should focus on two concerns: utilization of existing information and expansion or tailoring information-gathering activities to suit the needs of the reliability program. However, first, it should be recognized that peculiar reliability requests may require collection of information not [otherwise](#) available. All performance monitoring data collection activities should be integrated into overall data collection activities to prevent double counting failures and overloading staff. Addressing these concerns should include consideration of the following items:

- a) Much [of the](#) existing information ~~may be stored in an electronically compatible medium~~ (in particular, maintenance records); ~~thus, the information for the performance monitoring task may be easily extracted. However, other types of information (such as the qualitative descriptions of failure or,~~ the results of tests conducted to measure equipment degradation like acoustic monitoring and other non-destructive methods) [may be stored electronically in a plant database from which the information for the performance monitoring tasks may be easily extracted. However, other types of information \(such as the qualitative descriptions of failure\) that](#) are not as easily recorded ~~and~~ [in a database may be stored electronically on a plant computer and linked to a component, so that data can be easily](#) extracted.
- b) The present and future needs of the reliability program should be carefully assessed when modifying existing information-gathering activities. First, it is desirable to use a single procedure to document component maintenance and testing, independent of whether the component is included within the scope of the reliability program. This practice simplifies the plant record-keeping effort and allows easy addition of equipment to the reliability program in the future. Second, the level of detail should be balanced so all pertinent information is gathered without collecting an excessive volume of information that will not be utilized (IEEE Std 352-1987³, IEEE Std 577-1976). Third, some highly desirable information (e.g., qualitative descriptions of events, subjective opinions about the causes of failures) is transitory; it should be quickly recorded to preserve its quality.

³~~For information on references, see Clause 2.~~

4.2 Performance evaluation

4.2.1 Explanation

Performance evaluation is the qualitative or quantitative analysis that compares selected event and physical parameter data to plant performance targets, improvement goals, or alert levels to identify deviations from expected performance. This task includes setting both qualitative objectives and quantitative targets, goals, alert levels, or action levels in the start-up phase of a reliability program and routinely conducting both diagnostic and prognostic work to identify current reliability problems and to predict likely future problems. Included in this effort is the specific consideration of the validity of any collected historical data set in light of programmatic or design changes that have occurred in the interim. For example, if a previous analysis has indicated a need to change a surveillance interval, the data set collection process should reflect the potential for significant change in the failure rate as a result of this new interval. Detailed inputs and outputs are illustrated in Figure 3.

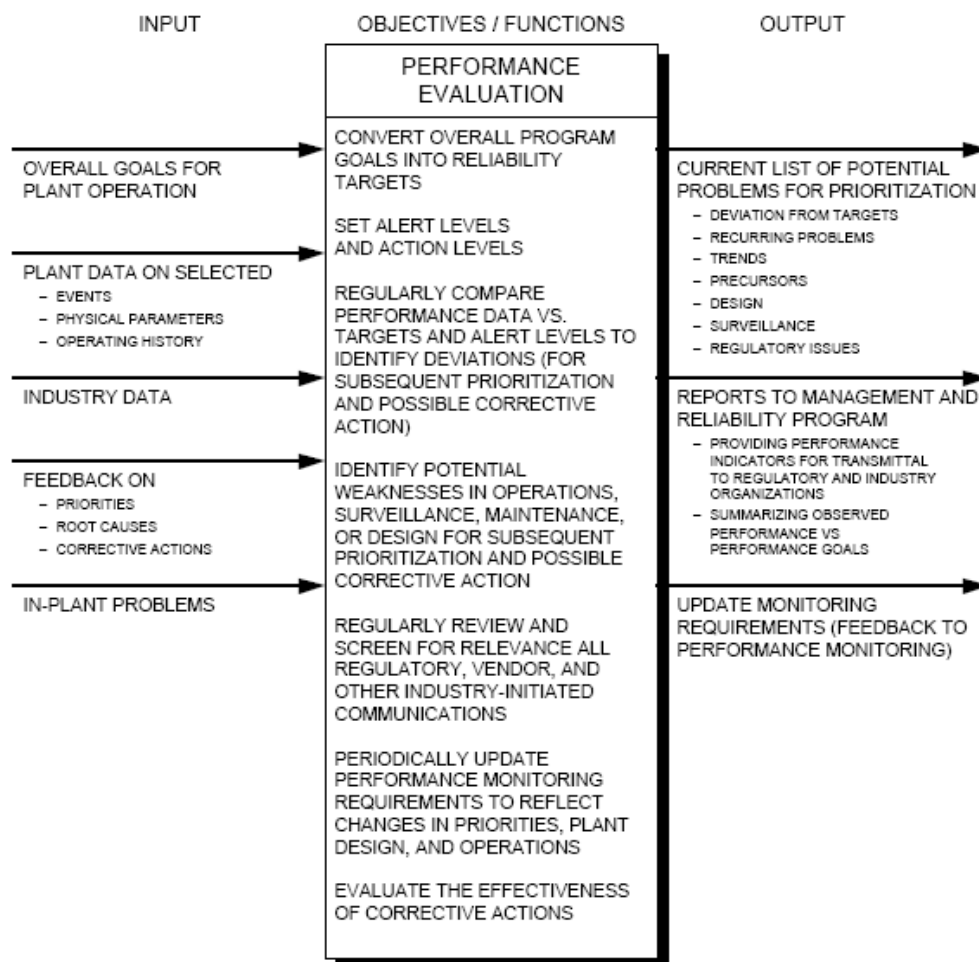


Figure 3— Performance evaluation interfaces

4.2.2 Objective

The objectives of performance evaluation are to identify problems or potential problems related to reliability in operations, surveillance, and maintenance; to indicate where requirements might be relaxed without significantly affecting performance (or optimized to [help](#) ensure overall performance) adequacy; and to indicate where requirements might be relaxed in design without serious problems occurring. Accomplishing these objectives requires performing the following tasks: