

**LIFE
CYCLE
ASSET
MANAGEMENT**

Good Practice Guide
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Maintenance

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1. INTRODUCTION

This document was written by a team of Department of Energy (DOE) and contractor personnel to suggest elements to consider when developing maintenance programs for DOE facilities. It is not to be used as prescriptive guidance but, rather, to stimulate thought on such issues as identifying site maintenance needs, choosing performance measurements for those needs, and establishing maintenance program goals. DOE opposes any attempt by reviewers or auditors to characterize this Guide as requirements or prescription.

This guidance document suggests good practices associated with and supplementary to the maintenance requirements of DOE O 430.1, LIFE-CYCLE ASSET MANAGEMENT (LCAM). DOE philosophy is to define expectations and objectives, describe a set of business practices that meet the basic performance expectations of maintenance, and provide guidance on elements that should be considered for an effective maintenance program. DOE contractors may employ methods other than those defined in this Guide. Each contractor should evaluate the guidance provided in this document in light of its own knowledge, experience, and missions and develop a site-specific maintenance program.

The demands of each site or facility are different. The variety of assets, conditions, and missions within the DOE complex creates a diversity of needs for maintenance that necessitates careful analysis of site and program needs. Therefore, a Guide for conducting maintenance under DOE O 430.1 needs to focus on maintaining DOE physical assets at all facilities, whether they are high or low hazard, nuclear or non-nuclear, in the process of being decommissioned or expected to continue operation for decades. Table 1 illustrates how the various elements of a maintenance program are organized within this Guide.

This Guide contains six appendices. Appendix 1, Supplemental Information on Maintenance Program Management, provides a more detailed discussion of the elements that comprise a maintenance program. The redundancies in Appendix 1 and the Guide are intentional. To meet the needs of a diverse audience of both DOE and contractor personnel, the writers decided this was the best approach. Appendix 1 also identifies performance expectations for a DOE maintenance program and means that can be used to measure progress toward meeting those expectations.

Appendix 2, Definitions, defines terms that are unique to this Guide. Appendix 3, Assistance, is a list of the names and phone numbers of Program Managers who can provide additional information. Appendix 4, Suggested Reading, is a list of helpful materials pertaining to maintenance. Appendix 5, Related Training, is a list of sources for

maintenance-related training. Appendix 6, Suggestions for Additions or Revisions, is a form that can be used to submit suggestions for additions or revisions to the Guide.

1.1 Applicability

Consistent with DOE O 430.1, this Guide is applicable to the maintenance of physical assets at DOE sites. Some assets [structures, systems, and components (SSCs)] may be necessary to adequately protect worker and public health and safety and the environment during the phases of the facility life cycle. Additional requirements may apply for nuclear facilities, such as those in Chapter II of DOE 4330.4B, MAINTENANCE MANAGEMENT PROGRAM, or the draft Price-Anderson Amendments Act Maintenance Rule (10 CFR 830.340). Guidance pertaining to these additional requirements is outside the scope of this document.

1.2 Performance Expectations

The expectations and guidance included herein form a foundation from which DOE and its contractors can begin when developing performance measures. The performance expectations are:

- Exercise proper stewardship in maintaining property throughout its economic life.
- Maintain property in a manner that supports DOE missions.
- Maintain property in a manner that ensures operational safety, worker and public health, and environmental protection.
- Encourage partnership between DOE and its contractors.
- Incorporate industry standards.
- Manage maintenance programs in a cost-effective manner.
- Use a graded approach in the development and implementation of maintenance programs.
- Promote high-quality performance.

To manage the assets of any site, DOE and the contractor should arrive at a clear understanding of four basic premises: (1) the scope of the endeavor, (2) the resources

(i.e., both needed and available), (3) mutual expectations, and (4) measurements of progress toward the expectations. Expectations for a maintenance program should be expressed in terms of the results desired, not the methods or means to be used.

1.3 Graded Approach

The graded approach is an important concept that should be used in maintaining DOE physical assets. By suggesting the use of a graded approach to maintenance activities, DOE intends that Field Elements and contractors, when developing and implementing maintenance programs, ensure that the depth of detail required and the magnitude of resources expended for maintenance of a particular asset are commensurate with the asset's relative importance to safety, environmental protection, worker and public health, safeguards and security, and fulfillment of the asset's mission and economic value. Use of the graded approach may result in a decision to modify or omit certain maintenance activities for a particular asset. Application of an effective graded approach system is essential for a maintenance program to meet the goals described in DOE O 430.1.

Table 1. Maintenance Program Elements

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2. BUSINESS PRACTICES

Maintenance programs perform the cost-effective activities that preserve and restore the availability, operability, safety, and reliability of site assets so that they support the facility mission and fulfill their intended life cycles and purposes. Some of the following aspects of the maintenance process may be assigned to nonmaintenance personnel; this interface needs to be agreed upon and well understood.

2.1 Performance Measures

Paragraph 2 of DOE O 430.1 states that the Order "shall be implemented on a site-by-site basis through the establishment, by contract or financial assistance agreements, of site-specific performance criteria and a performance measurement system." Two key components of the new DOE approach to contractor relationships are evident in this quotation: (1) all performance criteria are to be negotiated and should depend on site-specific issues, such as condition, future plans, and budget; and (2) contractors should be judged on performance, not methodology. Therefore, the performance measures established should be tied to negotiated results, not to the manner in which those results are achieved.

The concept of performance measures is multi-tiered. For negotiated contracts, performance measures need to be established at a level high enough to allow evaluation of the overall maintenance program. Performance measures negotiated for contracts should be broad in scope.

DOE expects contractors and DOE personnel to establish site-specific, contractually based performance measures after analyzing site goals and resource availability. Because these factors differ so significantly across the complex, DOE is moving toward site-specific, performance-based criteria and away from generic and prescriptive measurements. In this environment, contractors and DOE personnel need to understand a site's current condition, long-range plans for its continued operations or final disposition, and resource availability. With this understanding, they can establish achievable, challenging, and mutually agreed-upon performance measures for their sites.

2.2 Identification, Inventory, and Periodic Assessment of the Maintenance Program's Physical Assets

A maintenance program should have a systematic method for identifying the physical assets that must be maintained. The method used will vary, depending on the significance of the facility being maintained. Approaches used to identify physical assets that need

maintenance can range from detailed inventories that include manufacturer specifications—which would be expected at higher-risk facilities—to less-detailed topical lists that include numbers of items. A maintenance program may decide to incorporate a prioritization with the identification method to facilitate the assignment of resources. Physical assets can be identified in a number of ways, ranging from bar coding items to listing assets within an area.

In keeping with good stewardship principles, periodic assessments of the identified assets will be needed. The frequency of these assessments should be determined by balancing industry standards and an asset's vulnerability and significance. The significance of the asset should be determined using the graded approach, with emphasis on environmental, safety, and health concerns; programmatic and mission risk concerns; and asset values. Assessments can be used to (1) ensure that the physical asset still exists; (2) evaluate the asset's condition and need for maintenance; (3) evaluate the asset's current usefulness and ability to perform safely, including assessing whether it is becoming technically obsolete or deteriorating because of age; and (4) estimate its remaining useful life. Data derived from these assessments may be used to justify replacement equipment, adjust maintenance practices and budgets, and strengthen the asset controls.

Asset identification, inventory, and assessment are basic to successful maintenance. Maintenance budgets and staffing may be identified and maintenance programs developed on the basis of asset inventory and condition evaluation. Each site should define the rigor and formality with which asset identification, inventory, and assessment should be implemented based on the status of operations at, and the condition of, their facilities.

2.3 Maintenance Program Requirements, Budgets, and Work Control Systems

To ensure that maintenance is conducted in a consistent, efficient fashion, maintenance managers should establish site-specific management systems and controls that define how work is to be done. These systems and controls should be based on a graded approach: for example, systems and controls for a shut-down, decommissioned, low-risk facility are likely to be minimal and general; systems and controls for an elevated-hazard facility are likely to be rigorous and precise. Various methods can be used to identify and develop maintenance systems and controls, but effective methods incorporate the graded approach.

Maintenance budget requests should be partially driven by the set of requirements for maintenance systems and controls developed for a specific program. Other potential budget drivers are the inventory, the site's programmatic mission, and the anticipated life-spans of the facilities. Staffing needs may be derived from these factors as well. Maintenance programs should define actual budget needs and be able to justify these needs

based on analytical processes. The degree to which each budget must be defined will vary depending on the site-specific budget process, the size of the budget, the complexity of the maintenance program, the facility mission, and unique site requirements.

Features of the actual work control systems for the range of maintenance programs associated with the DOE complex vary. Management systems and work controls should be used to (1) identify maintenance work that needs to be accomplished; (2) assign priority to the work using a graded approach; (3) plan the work to a level commensurate with its significance and complexity; (4) schedule and track the work to meet the site's needs; (5) perform the work in a manner that meets expectations for performance, schedule, safety, and cost; (6) perform any postmaintenance review or testing required, based on the significance and complexity of the task; and (7) provide data to manage maintenance functions.

Maintenance managers should assess the strengths and weaknesses of their programs and modify aspects of the system as necessary. The work control system should be flexible enough to allow managers of maintenance activities to control the work done under their authority to the extent required by the complexity and significance of the work activities.

2.4 Preventive, Predictive, and Corrective Maintenance

Successful maintenance is directly aligned with the programmatic missions of DOE, protects assets as national resources, and keeps them in condition to perform their individual purposes and fulfill their expected life cycles. Preventive, predictive, and corrective maintenance should be used to accomplish these goals. As with each of the maintenance considerations described in this Guide, preventive, predictive, and corrective maintenance should be implemented using the graded approach. A proper balance of these types of maintenance should be employed to provide a high degree of confidence that asset degradation is identified and corrected, equipment life is optimized, the maintenance program is cost-effective, and life-cycle costs are minimized.

2.5 Configuration Management

Configuration management at a site should be integrated with the maintenance program. Individual assets of high significance and vulnerability may have specific configuration management systems associated with them. The configuration management aspects of individual assets should be integrated with maintenance activities to ensure that the integrity of the assets is not compromised by maintenance activities.

2.6 Effective Use of Energy and Utilities

Maintenance plays an important role in the efficient and effective management of energy and utilities. Maintaining the utility systems is the primary contribution the maintenance program makes to the management of energy and utilities. By reducing the number and duration of unplanned outages, maintenance increases the reliability of the systems. Proper maintenance also allows utility system components to function until the end of their useful lives.

Proper operation and maintenance of physical assets may also contribute to effective management of energy and utilities. Equipment that is properly lubricated, adjusted, calibrated, and maintained uses less energy.

2.7 Maintenance Strategy

Maintenance programs should participate in site and facility planning to ensure that their abilities and needs are considered as plans are being developed and to ensure that site management understands such issues as needed facility maintenance, planned downsizings and shutdowns, planned outages, major projects and modifications, equipment replacement needs, and projected budgets.

Maintenance plans frequently affect other site program work loads and budgetary plans. Managers responsible for planning maintenance should ensure that potentially affected programs agree with, and are able to support, long-range or short-term plans. These potentially affected programs include construction, health and safety, environmental, and operations. Strategies should reflect how maintenance programs support the site mission and protect DOE assets.

2.8 Prioritization of Infrastructure Requirements

To participate effectively in site planning and budgeting activities, maintenance programs should prioritize the work that needs to be performed. Prioritization is important for two reasons: (1) justifying maintenance needs during planning and budgeting activities and (2) allocating resources.

Paragraphs 6d(4) and 6f(6) of DOE O 430.1 require that site infrastructure requirements be prioritized; however, each site may decide how to define "infrastructure requirements" and the level of detail that should be prioritized. With few exceptions, site maintenance programs support site infrastructure; therefore, maintenance activities should be prioritized. Because proper prioritization (i.e., incorporating a quality control method)

requires time and effort, managers should use a graded approach to decide what work activities should be prioritized. Within DOE, most corrective maintenance (repair) that requires construction funding is prioritized at the project or subproject level. Most costly repairs and preventive and predictive maintenance activities that use operating dollars should also be prioritized. At some point, it is not cost effective to prioritize at the unit level; sites may wish to prioritize groups of functions or activities, depending on what makes economic sense.

A site also may decide which prioritization methodology to employ. The four methodologies used most widely in DOE are discussed in *Project Management Prioritization Guide* (GPG-FM-030). A site can use one of these methodologies or select another. Whatever methodology is chosen should be technically credible and should be used consistently across the site.

2.9 Backlog Management

A backlog of corrective maintenance work commonly exists at DOE sites. Backlog may be controlled by using a graded approach to assigning available resources. Backlog items should be reviewed periodically to ensure that the priorities that were assigned using the graded approach are being appropriately applied. The prioritization can then be used in a scheduling process to define whether work items are of immediate significance.

2.10 Roles and Responsibilities

Each maintenance program should be structured and defined so that accountability and organizational interfaces for the site and within the maintenance organization are clear. Clearly defined roles and responsibilities assist personnel in planning and effectively completing maintenance work activities. This definition of roles and responsibilities should extend throughout the maintenance organization so that personnel understand their roles in ensuring a successful maintenance program.

2.11 Maintenance Program Administration

The administration of maintenance programs should achieve a high level of performance by effectively implementing and controlling maintenance activities. The work control system is the basis for maintenance program administration.

Documentation should be an integral part of a maintenance program. Maintenance documentation may include, but is not limited to, formal policies, procedures, goals and objectives, and roles and responsibilities. These documents should encompass the quality

standards required, the methods used by maintenance personnel, and the goals and objectives of the program. Maintenance personnel and, where applicable, other personnel should work to these standards so the program can be applied uniformly throughout the facility. Each maintenance program should develop methods to ensure consistency, effective measurement, and improvement of maintenance performance.

2.12 Training and Qualification of Maintenance Personnel

Site-specific training and qualification programs should be developed to ensure that maintenance personnel are qualified to perform the tasks required of them. The training and qualification methods used can include on-the-job training, classroom instruction, computer-based training, or hire-in qualifications.

2.13 Maintenance Tools and Equipment

Maintenance programs should have an adequate supply of tools and equipment stored in a manner that limits degradation and loss. Measuring and test equipment are vital to predictive and preventive maintenance. Methods for their control and calibration should be developed and implemented. As with each program element described in this Guide, the graded approach is important to developing an effective method for equipment and tool control. Equipment should be evaluated as to risk and usage, and its maintenance and control should be in keeping with its ranking.

SUPPLEMENTAL INFORMATION ON MAINTENANCE PROGRAM MANAGEMENT

1. INTRODUCTION

The discussion in the body of this Guide focuses on the principles of maintenance. The content of this appendix is similar, but is organized to demonstrate the interrelationship between the elements of a maintenance program. It is intended to provide a common starting point for organizing maintenance elements and to provide those with less maintenance experience a topical model of what many consider to be the building blocks of a maintenance program. Each maintenance program is customized to a particular site or industry. This Guide is not intended to prescribe a site's organizational structure nor were existing organizational structures considered in its development. This guidance is based on industry and good business practices. These discussions are in no way requirements or prescription for a maintenance program and should not be the basis of an audit or review.

As explained in the body of this Guide, DOE intends that Field Elements and contractors apply the graded approach to ensure that the depth of detail required and the magnitude of resources expended for maintenance of a particular asset are commensurate with the asset's relative importance to safety, environmental protection, worker and public health, safeguards and security, and fulfillment of the asset's mission and economic value. Use of the graded approach may result in a decision to modify or omit certain maintenance activities for a particular asset. Application of an effective graded approach system is essential for a maintenance program to meet the goals described in DOE O 430.1.

2. ORGANIZATION AND ADMINISTRATION

2.1 Organization and Staffing

Performance Objective. A clearly defined maintenance organization with specific lines of authority, responsibility, and accountability should be established. Methods of communication and interface with other organizations should be defined. A sufficient number of properly trained management, supervision, and craft personnel should be used to perform maintenance activities.

2.2 Graded Approach

Performance Objective. The maintenance program should use a documented graded approach to ensure that the level of rigor employed and magnitude of resources expended are commensurate with the asset's relative importance to safety, environmental protection, worker and public health, safeguards and security, and fulfillment of the asset's mission and economic value. A site's use of the graded approach should be formally documented.

2.3 Administration

Performance Objective. The administration of maintenance should achieve a high level of performance by effectively implementing and controlling maintenance activities. This can be accomplished by using written performance standards, periodically observing and assessing the performance of maintenance personnel and systems, and holding personnel accountable for their performance.

Suggested Criteria:

- Documented processes can be established for site maintenance activities.
- Maintenance and installation of equipment can be accomplished using established plant or industry standards.
- Maintenance resources (e.g., staffing, material, and space) can be controlled to ensure timely, efficient, and effective accomplishment of maintenance goals.
- Backlog should be controlled within established site goals.

2.4 Policies, Goals, and Objectives

Performance Objective. Maintenance policies, goals, and objectives should be documented and communicated to appropriate personnel. Maintenance activities should be conducted based on these goals and objectives.

Suggested Criteria:

- Maintenance program policies, goals, and objectives should support site strategic planning.

- Strategic planning may include consideration of planned equipment replacement, technical obsolescence, aging, facility condition, technology shifts, and emerging site and program issues.

2.5 Management Interfaces

Performance Objective. To ensure effective maintenance over an asset's life cycle, interfaces and coordination should be established between maintenance program activities and other activities such as: (1) design and construction activities, (2) startup or restart of new facilities, (3) operational readiness reviews, (4) operational phases, (5) stand-down or layup phases, (6) configuration management activities, and (7) decommissioning activities.

2.6 Training and Qualification

Performance Objective. Training and qualification programs should develop and maintain the knowledge and skills maintenance personnel need to perform maintenance activities.

Suggested Criteria:

- A training program may encompass (1) skills analysis and development; (2) technical skills, including maintenance processes, equipment-specific procedures, and personnel development; (3) on-the-job training, classroom presentation, and other training methods; and (4) training program review and enhancement. The training program should be provided for all personnel including managers, supervisors, crafts, and support personnel.
- Development of training and qualification programs may incorporate industry practices.
- Maintenance managers should ensure that the resources necessary to accomplish training goals and objectives are available.

3. CONDITION OF FACILITIES AND EQUIPMENT

3.1 Periodic Inspections

Performance Objective. Periodic inspections of equipment and facilities should be performed to maintain proper condition, cleanliness, and housekeeping to support safe and reliable facility operations.

3.2 Condition Assessment Surveys

Performance Objective. Physical assets should be inspected at predetermined frequencies to ensure that they are maintained in a condition consistent with assigned missions or long-range planning.

4. PERFORMANCE MEASURES

Performance Objective. Performance measures should be developed and used by managers to monitor and control maintenance activities. Performance measures used for external communications should be specified in the contract. Performance measures used internally should be established by management as needed for management control.

5. WORK CONTROL SYSTEM

Performance Objective. The work control system—by which maintenance activities are identified, initiated, planned, approved, scheduled, coordinated, performed, and reviewed for adequacy and completeness—should be provided to ensure that maintenance is accomplished in a timely manner, improves maintenance efficiency, and increases equipment availability.

Suggested Criteria:

- Work control methods that can be used to achieve a high level of performance include, but are not limited to, the following:
 - using written performance standards,
 - periodically observing and assessing the performance of maintenance personnel and systems, and
 - holding personnel accountable for their performance.

5.1 Work Order System

Performance Objective. A work order system should be in place to manage the work performed, regardless of whether the jobs are repetitive or one-time tasks. The work order system should be "user-friendly."

5.2 Job Planning and Estimating

Performance Objective. Jobs should be planned and estimated, using the graded approach, to identify the required support, permits, hold points, work procedures, and material requests that determine the scope of work and address task sequencing and steps to completion. Outages should be planned to promote optimum outage performance by integrating and coordinating work elements.

5.3 Work Performance (Time) Standards

Performance Objective. An estimate of the work-hours required to perform a planned job (determined by applying engineered standards, job slotting techniques, or other industry-recognized methods) should be used to determine cost estimates, establish reasonable schedules, and measure productivity.

5.4 Priority System

Performance Objective. A systematic method should be used to determine job priority or the importance of the work item to be performed.

5.5 Maintenance Procedures and Other Work-Related Documents

Performance Objective. Maintenance procedures and other work-related documents (e.g., drawings and instructions) should be available to provide appropriate work direction and ensure that maintenance is performed safely and efficiently.

Suggested Criteria:

- A maintenance program should effectively prepare, verify, validate, approve, revise, and use procedures and other work-related documents.
- Procedures should be concise and contain the scope of work and other information personnel need to perform work safely and effectively.
- Procedures should establish the appropriate levels of diligence for maintenance activities.
- Procedures and other work-related documents should be reviewed periodically to ensure they are current and meet the program needs.

5.6 Scheduling System

Performance Objective. Maintenance activities should be scheduled and coordinated to ensure that they are conducted in the proper sequence, efficiently, and within prescribed time limits. An outage schedule should allow the completion and testing of work elements and should provide management with information necessary to control outage activities.

5.7 Postmaintenance Testing

Performance Objective. The maintenance program should use postmaintenance testing to verify that assets meet current operating requirements and to confirm the following: (1) the original deficiency has been corrected, (2) no new deficiencies have been created, and (3) the equipment is ready to return to service. The tests performed should be commensurate with the maintenance work performed and the importance of the asset to facility safety and reliability. Postmaintenance testing should be addressed in the work package.

5.8 Backlog Work Control

Performance Objective. Management should control backlog by using a graded approach to assign available resources. Managers may determine how much of the backlog to deal with as part of the planning process. Staffing levels, budgets, and availability of resources should be considered when making this determination. Backlog planning enables managers to know when the number of work items in the backlog is greater or less than anticipated and allows them to make management decisions based on data.

Backlog should consist of the entire available list of facility deficiencies for a site. Much of this list will be generated as a result of the site's facility inspection program. The backlog should not be judged on its size, rather, it should be judged by the level of implementation of the facility inspection program at the site. The size, composition, and importance of the corrective maintenance backlog is dynamic in the current environment of mission uncertainty and constrained resources. As a result, the backlog should be validated periodically through facility inspections, rather than simply assuming the cumulative effect of a growing backlog resulting from lack of resources. A large backlog should not create the assumption of a poorly maintained site, nor should a small backlog create the opposite assumption. The most significant portions of the maintenance backlog are those items that will affect the site mission if not corrected. It may be desirable to identify these deficiencies separately.

5.9 Equipment Repair History and Vendor Information

Performance Objective. The maintenance program should collect, maintain, and use vendor manuals and the history of maintenance activities to support analyses and planning of future activities, prevent and mitigate persistent or recurring failures or deficiencies, and ensure reliable use throughout the expected aging and life cycle of the asset.

6. MAINTENANCE FACILITIES, EQUIPMENT, AND TOOLS

6.1 Facility Maintenance and Training Support

Performance Objective. Maintenance facilities, equipment, and tools should be maintained and reviewed for adequacy in supporting facility maintenance and maintenance training.

6.2 Maintenance Materials Management

Performance Objective. The maintenance program should support maintenance activities with proper parts, materials, and services. The maintenance program should use industrial practices for materials management.

6.3 Control and Calibration of Measuring and Test Equipment

Performance Objective. A program for control and calibration of measuring and test equipment should be used to ensure the availability of tools and equipment necessary for maintenance, repair, and calibration of installed equipment and instruments.

Suggested Criteria:

- Maintenance programs should consider using industrial practices for measuring and test equipment, such as the following:
 - calibrations based on standards traceable to a national or recognized standard;
 - measuring and test equipment history; or
 - traceability of measuring and test equipment used to maintain critical or important assets.

6.4 Maintenance Tools and Equipment Control

Performance Objective. Maintenance programs should implement methods to store, issue, and maintain an adequate and readily available supply of tools and equipment.

7. IMPLEMENTATION OF MAINTENANCE ACTIVITIES

Performance Objective. A proper balance of corrective and preventive maintenance should be employed to provide a high degree of confidence that property degradation is identified and corrected, equipment life is optimized, and the maintenance program is cost effective. The assets to be included in the maintenance program should be identified and prioritized.

Suggested Criteria:

- The maintenance program should ensure appropriate equipment availability for all phases of equipment life (i.e., from commission through decommission). Examples include the following:
 - establishing planned maintenance levels and provisions with baseline data during construction and operational startup activities;
 - proactive changes to mission or technology changes;
 - layup-phase protective measures for systems and facilities in a standby mode; and
 - final maintenance activities during decommissioning.

7.1 Surveillance and Preventive Maintenance

Performance Objective. Surveillance, inspecting, and testing activities should ensure that the equipment needed for safe and reliable facility operation performs within required limits and that preventive maintenance (defined as including periodic and planned maintenance) is used to maintain equipment within its operating requirements and to realize its maximum reasonable useful life.

7.2 Predictive Maintenance

Performance Objective. A predictive maintenance program should be used to monitor; determine trends; and analyze parameters, properties, and performance

characteristics or signatures of equipment to forecast equipment degradation so that maintenance can be performed prior to equipment failure.

7.3 Corrective Maintenance

Performance Objective. Corrective maintenance should be performed in a manner that restores equipment to safe and reliable service in a timely manner.

7.4 Nonmaintenance Work by Maintenance Personnel/Maintenance Work by Others

Performance Objective. The maintenance program should encompass both nonmaintenance work performed by maintenance personnel and maintenance work performed by nonmaintenance personnel.

Suggested Criteria:

- Maintenance may include modifications (including temporary modifications), improvements (including installation of new assets), and services performed by maintenance personnel. Modifications and temporary modification work performed by maintenance personnel should be accomplished in a manner that does not increase risk to the facility, equipment, environment, or personnel.
- Maintenance by others may include maintenance activities performed by:
 - site personnel who are not crafts personnel (e.g., armory activities by security personnel);
 - temporary personnel;
 - outside personnel (e.g., vendor or contract maintenance); or
- Maintenance by others may include additions or changes to site assets by construction, commissioning, or decommissioning activities.
- Work performed by plant personnel, contracted or temporary personnel, or other nonplant personnel (e.g., vendors, construction, contracted services) should satisfy the site standards.

7.5 Configuration Management

Performance Objective. Configuration management processes should be used for assets for which the maintenance program is accountable.

Suggested Criteria:

- A maintenance program should use controls and provide timely updates for changes and additions to assets.
- Planning and documentation of maintenance activities should include effective coordination with configuration management systems at a site.

8. MAINTENANCE EVALUATION AND ANALYSIS**8.1 Analysis of Root Causes of Problems**

Performance Objective. Systematic methods, such as root cause analysis, should be used to determine and correct root causes of problems, unplanned events, and occurrences related to maintenance.

Suggested Criteria:

- Maintenance managers should plan responses for potential unplanned occurrences to ensure that effective remedial actions can be taken in the event of an unplanned occurrence. Examples of management actions may include, but are not limited to, the following:
 - systematic analysis of unplanned occurrences related to maintenance to determine the root causes of failure;
 - failure tracking and trending; and
 - failure or corrective action performance measures.

8.2 Periodic Review and Analysis

Performance Objective. Ongoing measurement, analysis, and review of maintenance efficiency should be used to identify opportunities for improvement. Industrial practices, such as Total Productive Maintenance, may be applied.

Suggested Criteria:

- The use of management tools may include establishing or upgrading the preventive maintenance tasks and intervals, enhanced corrective maintenance methods, and enhanced methods for investigation or projection analyses.

- Maintenance program assessments may include: (1) periodic inspections of facilities, process equipment, and infrastructure to determine condition, operational status, aging, technological viability for mission execution, and housekeeping; (2) daily observations of conditions at maintenance job sites; (3) equipment deficiencies reported by others; and (4) needed work identified in the maintenance work control system.

8.3 Performance Measurement and Improvement

Performance Objective. Management and maintenance organizations should use quantitative means of measuring performance and effectiveness to improve the maintenance system. Industrial practices, such as Reliability Centered Maintenance, benchmarking, and work sampling, may be used to enhance maintenance performance.

8.4 Management Involvement

Performance Objective. To enhance the safety of facility operations, maintenance managers should be sufficiently involved with facility operations and maintenance to be technically informed and familiar with conditions at the operating facility.

8.5 Cost Identification and Control

Performance Objective. Cost accumulation and reporting systems should be used to evaluate maintenance performance.

8.6 Reviews and Lessons Learned

Performance Objective. External and internal reviews, such as self-assessments, lessons learned, and experience from other DOE sites and industry, should be evaluated and considered for program enhancement.

9. CUSTOMER SERVICE

Performance Objective. DOE and contractors should clearly define the goals for the maintenance program, the schedule, and the means of measuring progress toward those goals.

Suggested Criteria:

- Maintenance managers should use industrial practices for proactive management to meet or exceed customer expectations.
- Maintenance managers should actively support and foster partnering with DOE and program customers through an exchange of technical knowledge.
- Maintenance managers should establish daily, short-term, and strategic goals and objectives for management activities. Managers should use specific, measurable, achievable, reasonable, and timely performance indicators to measure progress toward maintenance goals and objectives.

DEFINITIONS

Attachment 1 to DOE O 430.1 is a list of definitions that pertain to life-cycle asset management. Unless defined otherwise in this appendix, all terms used in this Guide are consistent with the definitions provided in the Order.

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ASSISTANCE

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SUGGESTED READING

- DOE, 1996. *Project Management Prioritization Guide*, GPG-FM-030, Office of Field Management, Office of Project and Fixed Asset Management, MONTH?.
- DOE, 1995. *Requesting and Granting Exemptions to Nuclear Safety Rules*, DOE-STD-1083-95, February.
- DOE, 1994. *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE-STD-1020-94, April.
- DOE, 1994. *Natural Phenomena Hazards Site Characterization Criteria*, DOE-STD-1022-94, March.
- DOE, 1994. *Guideline to Good Practices for Seasonal Facility Preservation at DOE Nuclear Facilities*, DOE-STD-1064-94, June.
- DOE, 1994. *Guideline to Good Practices for Post Maintenance Testing at DOE Nuclear Facilities*, DOE-STD-1065-94, June.
- DOE, 1994. *Guideline to Good Practices for Maintenance Facilities, Equipment, and Tools at DOE Nuclear Facilities*, DOE-STD-1067-94, June.
- DOE, 1994. *Guideline to Good Practices for Maintenance History at DOE Nuclear Facilities*, DOE-STD-1068-94, June.
- DOE, 1994. *Guideline to Good Practices for Maintenance Tools and Equipment Control at DOE Nuclear Facilities*, DOE-STD-1069-94, June.
- DOE, 1994. *Guideline to Good Practices for Material Receipt, Inspection, Handling, Storage, Retrieval, and Issuance at DOE Nuclear Facilities*, DOE-STD-1071-94, June.
- DOE, 1994. *Guideline to Good Practices for Facility Condition Inspections at DOE Nuclear Facilities*, DOE-STD-1072-94, June.
- DOE, 1994. *Preparation, Review, and Approval of Implementation Plans for Nuclear Safety Requirements*, DOE-STD-1082-94, October.

- DOE, 1993. *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, DOE-STD-1021-93, July.
- DOE, 1993. *Guideline to Good Practices for Planning, Scheduling, and Coordination of Maintenance at DOE Nuclear Facilities*, DOE-STD-1050-93, March.
- DOE, 1993. *Guideline to Good Practices for Maintenance Organization and Administration at DOE Nuclear Facilities*, DOE-STD-1051-93, March.
- DOE, 1993. *Guideline to Good Practices for Types of Maintenance Activities at DOE Nuclear Facilities*, DOE-STD-1052-93, March.
- DOE, 1993. *Guideline to Good Practices for Control of Maintenance Activities at DOE Nuclear Facilities*, DOE-STD-1053-93, March.
- DOE, 1993. *Guideline to Good Practices for Control and Calibration of Measuring and Test Equipment (M&TE) at DOE Nuclear Facilities*, DOE-STD-1054-93, March.
- DOE, 1993. *Guideline to Good Practices for Maintenance Management Involvement at DOE Nuclear Facilities*, DOE-STD-1055-93, March.
- DOE, 1993. *Guide for Operational Configuration Management Program*, DOE-STD-1073-93-Part I, November.
- DOE, 1991. *Guide to Good Practices for Training and Qualification of Maintenance Personnel*, DOE-NE-STD-1003-1991, November.

RELATED TRAINING

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SUGGESTIONS FOR ADDITIONS OR REVISIONS

This Guide is a living document, open to periodic improvement. Readers are encouraged to record suggestions for additions or revisions.

Additional suggested reading: _____

Related training: _____

Examples of material covered in this document: _____

