U.S. Department of Energy Orders Self-Study Program

DOE O 433.1B

MAINTENANCE MANAGEMENT PROGRAM FOR DOE NUCLEAR FACILITIES

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FAMILIAR LEVEL

OBJECTIVES

Given the familiar level of this module and the resources, you will be able to answer the following questions:

1. What is the objective of DOE O 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*?
2. What is the purpose for quantitative indicators in maintenance management?
3. What are three types of environmental controls included in a maintenance shop?
4. What is the relationship between DOE G 433.1-1 and DOE O 433.1A?
5. What is the purpose for post-maintenance testing?
6. What is the objective of a good equipment maintenance history program?
7. What are three conditions that should be addressed in a severe conditions facility preservation plan?
8. What are the five programmatic elements of a configuration management program?
9. What are the definitions for the following maintenance-related terms?
    - Corrective
    - Preventive
    - Reliability-centered

Note: If you think that you can complete the practice at the end of this level without working through the instructional material and/or examples, complete the practice now. The course manager will check your work. You will need to complete the practice at this level successfully before taking the criterion test.

RESOURCES

10 CFR 830, "Nuclear Safety Management." January 1, 2011.
10 CFR 830.3, "Unreviewed Safety Question Process." January 1, 2011.
10 CFR 830.4, "Documented Safety Analysis." January 1, 2011.
DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*. 4/25/11
DOE O 251.1C, *Departmental Directives Program*. 1/15/09.
DOE O 420.1B, chg. 1, *Facility Safety*. 12/22/05.
DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*. 4/21/10.
DOE O 430.1B, chg. 2, *Real Property and Asset Management*. 9/24/03.
DOE O 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*. 4/21/2010.
DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*. 9/5/01.
DOE-STD-1027-92, chg. 1, *DOE Standard: Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. September 1997.

INTRODUCTION

The familiar level of this module is designed to summarize the basic information in DOE O 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*. This Order canceled DOE O 433.1A. This module is divided into three sections. Section one contains the objective, general requirements, and the responsibilities assigned to field element managers. Section two includes the requirements in attachment 2 of the Order, *Maintenance Management Program Requirements for DOE Nuclear Facilities.* Section three is a summary of the guidance provided in DOE G 433.1-1, *Facility Maintenance Management Program Guide for Use with DOE O 433.1*.The information provided will meet the relevant requirements in the following DOE functional area qualification standards:

- DOE-STD-1170-2007, *Electrical Safety and Systems Oversight*
- DOE-STD-1181-2004, *Facility Maintenance Management*
- DOE-STD-1151-2010, *Facility Representative*
- DOE-STD-1146-2007, *General Technical Base*
- DOE-STD-1161-2008, *Mechanical Systems*
- DOE-STD-1150-2002, *Quality Assurance*
- DOE-STD-1175-2006, *Senior Technical Safety Manager*
- DOE-STD-1159-2003, *Waste Management*

Completion of this module also meets certain requirements associated with the DOE facility representative (FR) program and the DOE intern program. The information contained in this module addresses specific requirements and as such does not include the entire text of the source document. Before continuing, you should obtain a copy of the Order and its accompanying manuals. Copies of the DOE directives are available at http://www.directives.doe.gov/ or through the course manager.

SECTION 1—OBJECTIVES, GENERAL REQUIREMENTS, AND RESPONSIBILITIES

Objectives

To define the safety management program required by 10 CFR 830.204, "Documented Safety Analyses," for maintenance and the reliable performance of structures, systems, and components (SSCs) that are part of the safety basis required by 10 CFR 830.202, "Safety Basis," at hazard category 1, 2 and 3 DOE nuclear facilities.

Requirements

DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*, provides acceptable approaches for meeting the requirements of DOE O 433.1B. DOE G 433.1-1 references Federal regulations, DOE directives, and industry best practices using a graded approach regarding implementation of requirements for maintaining DOE-owned government property. Graded approach is defined in 10 CFR 830.3, "Definitions," and guidance for applying it is provided in DOE G 433.1-1.

All hazard category 1, 2, or 3 nuclear facilities, as defined in DOE-STD-1027-92, chg. 1, *DOE Standard: Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, must conduct all maintenance of SSCs that are part of the safety basis in compliance with an approved nuclear maintenance management program (NMMP).

Nuclear maintenance management programs for government-owned, government-operated (GOGO) facilities must demonstrate compliance with the requirements contained in attachment 2 of DOE O 433.1B and must be approved by the respective secretarial officer (SO) or designee; approval consists of reviewing NMMP description documentation and evaluating its compliance with attachment 2.

Approval of NMMP description documentation is required prior to startup of new hazard category 1, 2, and 3 nuclear facilities and at least every three years for all hazard category 1, 2, and 3 nuclear facilities.

Changes to NMMPs must be reviewed under the unreviewed safety question (USQ) process to ensure that SSCs are maintained and operated within the approved safety basis, as required by 10 CFR 830, "Nuclear Safety Management." Changes which would result in an USQ must be approved prior to the change taking effect.

Assessments of NMMP implementation must be conducted, at least every three years or less frequently if directed by the SO in accordance with DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, to evaluate whether all requirements are appropriately implemented.

Periodic self assessments in accordance with DOE O 226.1B must be conducted to evaluate the effectiveness of oversight of NMMPs.

A single maintenance program may be used to address the requirements of DOE O 433.1B and the requirements of DOE O 430.1B, *Real Property Asset Management*.

Full implementation of the requirements in DOE O 433.1B must be accomplished within one year of its issuance, unless a different implementation schedule is approved by the SO with concurrence of the central technical authorities (CTA).

Responsibilities

The following responsibilities are assigned to field element managers. Please refer to the Order for responsibilities that are assigned to other DOE positions.

- Ensure that maintenance activities and programs at hazard category 1, 2, and 3 nuclear facilities under their purview are conducted in compliance with the requirements of DOE O 433.1B.
- Ensure that sufficient resources are requested to meet the requirements of DOE O 433.1B and to ensure that safety SSCs are sufficiently maintained to perform their assigned safety function.
- Ensure that cost-effective NMMPs are developed and implemented for all hazard category 1, 2, and 3 DOE nuclear facilities.
- Ensure that the requirements of DOE O 433.1B are incorporated into contracts, subcontracts, and support services contracts for hazard category 1, 2, and 3 nuclear facilities as appropriate.
- Notify contracting officers when contracts are affected by DOE O 433.1B.
- Review and approve NMMP program description documentation that demonstrates compliance with the specific requirements.
- Conduct comprehensive self assessments and assessments of contractor maintenance management programs.

Note: You do not have to do example 1 on the following page, but it is a good time to check your skill or knowledge of the information covered. You may do example 1 or go to section 2.

EXAMPLE 1

Using the familiar level of this module and the resources, answer the following questions.

1. What is the objective of DOE O 433.1B?

2. What is the relationship between DOE G 433.1-1 and DOE O 433.1B?

3. When must NMMP descriptions be approved for hazard category 1, 2, and 3 nuclear facilities?

Note: When you have finished, compare your answers to those contained in the example 1 self-check. When you are satisfied with your answers, go to section 2.

EXAMPLE 1 SELF-CHECK

1. What is the objective of DOE O.433.1B?
   To define the safety management program required by 10 CFR 830.204, for maintenance and the reliable performance of SSCs that are part of the safety basis required by 10 CFR 830.202, at hazard category 1, 2 and 3 DOE nuclear facilities.

2. What is the relationship between DOE G 433.1-1 and DOE O 433.1B?
   Guidance for compliance with DOE O 433.1B is available in DOE G 433.1-1.

3. When must NMMP descriptions be approved for hazard category 1, 2, and 3 nuclear facilities?
   Approval of NMMP description documentation is required prior to startup of new hazard category 1, 2, and 3 nuclear facilities and at least every three years for all hazard category 1, 2, and 3 nuclear facilities.

SECTION 2—ATTACHMENT 2, MAINTENANCE MANAGEMENT PROGRAM FOR DOE NUCLEAR FACILITIES

General Requirements

Federal and contractor organizations responsible for hazard category 1, 2, or 3 nuclear facilities, as defined by DOE-STD-1027-92, must perform the following:

- Develop and implement an NMMP through tailored application of the specific requirements in attachment 2 of DOE O 433.1B. The NMMP must describe the safety management program for maintenance and the reliable performance of SSCs that are part of the safety basis at hazard category 1, 2 and 3 DOE nuclear facilities. Guidance on applying the specific requirements is provided in DOE G 433.1-1.
- Conduct all maintenance of SSCs that are part of the safety basis in compliance with an approved NMMP.
- Ensure that equivalencies and exemptions from the maintenance management program elements of this attachment are identified, formally documented with supporting justification, and approved in accordance with DOE O 251.1C, *Departmental Directives Program*. Central technical authority or designee concurrence is required for exemptions and equivalencies to DOE O 433.1B.
- Implement the NMMP through Federal or contractor-approved documents, respectively. This is normally accomplished with a manual or a set of implementing procedures.
- Submit NMMP description documentation to DOE/NNSA for review and approval prior to the startup of new hazard category 1, 2, and 3 nuclear facilities and at least every three years for all nuclear facilities. NMMP description documentation must be, at a minimum, an applicability matrix or a combination of multiple documents. The following elements must be covered:
  - Correlation of the requirements in this attachment to the applicable facilities
  - Correlation of the implementing documents to the specific requirements in this attachment
  - Documentation of the basis for applying a graded approach, if applicable
- Submit either an addendum or page changes to the program documentation to reflect the changes made as a result of the implementation of requirements in this attachment. If no changes are needed, a memorandum to that effect may be submitted as the addendum. Changes must be submitted to DOE/NNSA for approval within 90 days from the date of inclusion of the requirements in this attachment in the contract.
- Conduct assessments of NMMP implementation, at least every three years or less frequently if directed by the DOE/NNSA SO in accordance with DOE O 226.1B and 10 CFR 830 subpart A. DOE G 433.1-1 provides acceptable approaches for conducting NMMP assessments.
- Ensure that NMMPs are identified in the applicable documented safety analysis (DSA) in accordance with 10 CFR 830.204.
- Review proposed changes to the NMMP, which could affect the performance of safety SSCs, as part of the ongoing USQ process. This review is intended to evaluate whether safety SSCs are maintained and operated within the approved safety basis, as required by

10 CFR 830.203. Changes which would result in a positive USQ must be submitted to DOE/NNSA for approval prior to the change taking effect.

- These requirements will be fully implemented within one year of its issuance, unless a different implementation schedule is approved by the SO with concurrence of the CTA.

Specific Requirements

The NMMP must clearly address the following:

- Integration with regulations and DOE Orders and manuals.
- The NMMP must be integrated with applicable programs and requirements identified by Federal regulations and other DOE Orders and manuals.
- Maintenance organization and administration. The management structure that applies sufficient resources necessary to support the requirements and ensures integration with other programs.
- Master equipment list. The process for developing, implementing, managing, and maintaining the master equipment list at a level that clearly identifies the SSCs that are part of the safety basis.
- Planning, scheduling, and coordination of maintenance. The process for planning, scheduling, coordination, and control of maintenance activities, and properly emphasizing equipment availability. The process must describe the application of a system engineer program in accordance with DOE O 420.1B, *Facility Safety*, in the planning and execution of maintenance activities.
- Types of maintenance. The process for utilization of appropriate types of maintenance to provide for safe, efficient, and reliable operation of safety SSCs.
- Maintenance procedures. The process for developing and implementing documented and approved work instructions for work on safety SSCs.
- Training and qualification. The training and qualification program for maintenance positions specified in DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*.
- Configuration management. The incorporation of the configuration management program to control approved modifications and to prevent unauthorized modifications to safety SSCs.
- Procurement. The appropriate integration of the procurement process with the NMMP to ensure the availability of parts, materials and services for maintenance activities.
- Maintenance tool and equipment control. The process for control of maintenance tools including calibration of measuring and test equipment.
- Suspect and counterfeit items. The incorporation of the process to prevent the use of suspect and counterfeit items into maintenance procedures and work instructions.
- Maintenance history. The process for developing and maintaining documented and retrievable maintenance history to support work planning, performance trending, analysis of problems to determine root causes of unplanned occurrences related to maintenance, and continuous program improvement.

- Aging degradation and Technical Obsolescence. The process for conducting inspections to evaluate aging-related degradation and technical obsolescence to determine whether the performance of SSCs is threatened.
- Seasonal facility Preservation. The process for ensuring the prevention of damage to safety SSCs from adverse weather conditions.
- Performance measures. The process for developing, maintaining, and communicating performance measures to identify maintenance issues requiring corrective action and lessons learned.
- Facility condition Inspection. The process for conducting and implementing routine assessment of facilities to identify issues related to operability, reliability, housekeeping, and general condition.
- Post-maintenance testing. The process for conducting post-maintenance testing to verify that safety SSCs can perform their intended function when returned to service.

Note: You do not have to do example 2 on the following page, but it is a good time to check your skill or knowledge of the information covered. You may do the example or go to section 3

EXAMPLE 2

1. What three elements must be covered in an NMMP description?

2. What is the required frequency for NMMP implementation assessments?

3. Which of the following specific requirements in DOE O 433.1B helps to control approved modifications and to prevent unauthorized modifications to safety SSCs?
   - Configuration management
   - Maintenance history
   - Maintenance procedures
   - Suspect counterfeit items

Note: When you are finished, compare your answers to those contained in the example 2 self-check. When you are satisfied with your answers, go on to section 3.

EXAMPLE 2 SELF-CHECK

1. What three elements must be covered in an NMMP description?
   The following elements must be covered:
   - Correlation of the requirements in attachment 2 of DOE O 433.1B to the applicable facilities
   - Correlation of the implementing documents to the specific requirements in attachment 2 of DOE O 433.1B
   - Documentation of the basis for applying a graded approach, if applicable

2. What is the required frequency for NMMP implementation assessments?
   At least every three years.

3. Which of the following specific requirements in DOE O 433.1B helps to control approved modifications and to prevent unauthorized modifications to safety SSCs?
   a. Configuration management

SECTION 3—DOE G 433.1-1

DOE contractors should develop a maintenance implementation plan (MIP) for each nuclear facility under their cognizance. DOE contractors may include facility-related, nonsafety equipment within the MIP. The MIP should clearly identify and define the following minimum elements:

- All SSCs included in the maintenance program; SSCs that are critical to mission objectives or facility operations; or SSCs that may be desirable for inclusion in the maintenance program for other reasons. Contractors should develop a detailed master list of equipment/SSCs to be included in the maintenance program to help in selecting and scheduling preventative maintenance (PM) and to evaluate the effectiveness of the maintenance program. The list normally is developed and controlled by or with assistance from engineering support organizations and can be used for other purposes, such as determining the safety or code classification of components. The MIP should include safety-related and non-safety-related SSCs in the maintenance program.
- Management systems used to control maintenance activities associated with the defined SSCs.
- Assignment of organizational roles and responsibilities and appropriate maintenance-related training and qualification requirements.
- Interfaces between the maintenance organization and other organizations.
- Facility/site mission.
- System for assessing maintenance status.
- Planned major activities.
- Summary of maintenance backlog.
- Performance indicators.
- Self-assessment program.
- Schedule for periodic inspection of SSCs, and equipment to determine whether deterioration or technical obsolescence that threatens performance and/or safety is taking place.

The MIP should establish maintenance priorities based on mission needs, and the priorities should be tracked directly to maintenance budget requests. This provides a forum on maintenance priorities between DOE and the contractor operating a nuclear facility. The maintenance priorities should be derived from or based on the safety basis documentation to preserve the facility's safety envelope so that the SSCs covered by the MIP are maintained in a condition suitable for their intended use.

The MIP should describe in detail the integration of the MIP with the quality assurance program and the safety management system.

The MIP should establish a configuration management process to ensure the integrity of the identified nuclear facility SSCs using a graded approach.

The MIP should establish how an accurately documented, computerized maintenance history engineering database will be maintained locally and how certain data fields will be incorporated into the DOE corporate facility information management system. The MIP will facilitate DOE

maintenance planning, performance evaluation, and prioritizing in a way that balances safety requirements, the maintenance backlog, and facility availability so that resources can be effectively allocated to address safety, programmatic, and operational considerations.

The MIP should establish how performance requirements for those infrastructure elements identified as part of the nuclear safety basis will be enforced.

The following provides a brief introduction to each of the specific requirements listed in DOE O 433.1B. Refer to DOE O 433.1-1 for a detailed discussion and the criteria associated with each specific requirement. You may need this information to answer questions in the practice and the criterion test.

Maintenance Organization and Administration

The organization and administration of the maintenance function should ensure that a high level of performance in maintenance is achieved through effective implementation and control of maintenance activities. DOE operations office, contractor, and facility policies should reflect a striving for excellence in facility maintenance and operation. Effective implementation and control of maintenance activities are achieved primarily by management establishing and enforcing written policies, procedures, and standards for maintenance; periodically observing and assessing performance; and holding personnel accountable for their performance.

Senior management can achieve a high level of performance in facility maintenance by establishing high standards, by communicating these standards to personnel who perform maintenance; by selecting and training high-quality personnel; by providing sufficient resources to the maintenance organization; by setting goals and objectives; by closely observing and assessing performance; by effectively coordinating maintenance activities with operations and other facility organizations; and by holding workers and their supervisors accountable for their performance. Another key to obtaining and maintaining high-quality maintenance performance is the establishment of an organization to provide time for and emphasize long-range planning.

Training and Qualification of Maintenance Personnel

A maintenance training and qualification program should be implemented to develop and maintain the knowledge and skills needed by maintenance personnel to perform maintenance activities effectively. The program should be designed so that the maximum potential of maintenance personnel is fulfilled.

This section describes the implementation of training and qualification programs for maintenance personnel. Guidance is also provided for training program evaluation and recordkeeping. Maintenance managers and supervisors should be directly involved in training maintenance personnel. Their involvement should, at a minimum, include close coordination with the contractor’s training organization to establish and maintain course content and emphasis, determine and support training schedules, accomplish on-the-job training (OJT), and provide feedback to adjust course content and emphasis, as necessary.

The training organization should maintain maintenance training programs that meet the intent of established industrial guidelines and that address specific company and facility needs. These training programs are supported and guided by the maintenance organization. This support and guidance normally includes all or a portion of the following tasks:

- Defining the jobs, tasks, skill levels, and responsibilities of individuals in maintenance positions
- Defining training programs for each position
- Determining the content and emphasis of the training needed
- Determining and supporting training schedules
- Determining the training needs of and tailoring the training program for each individual, based on his/her previous education, training, experience, and skill level
- Providing instructors and trainers
- Establishing qualification criteria, with emphasis on successful performance in the field
- Coordinating the conduct and instruction of OJT
- Qualifying individuals as they complete their training programs
- Providing training-effectiveness feedback to the training organization to enhance and, where necessary, adjust course teaching methods, content, and emphasis

Maintenance Facilities, Equipment, and Tools

Maintenance facilities, equipment, and tools should efficiently support the facility maintenance and maintenance training functions. Maintenance facilities directly affect the training of maintenance personnel and the ability to maintain the facility in an optimum state of readiness.

Maintenance facilities include storage areas for equipment, tools, supplies, and parts. This section provides guidance in determining needs for the facilities, tools, and equipment necessary to support maintenance.

A program for evaluating the adequacy of maintenance facilities is needed to help ensure that maintenance activities can be effectively accomplished. Industrial safety, location, access, communication, environmental controls, radiological controls, power sources, and the type of activity to be performed are examples of items to be considered in providing adequate maintenance facilities. Maintenance training facilities, shops, satellite work areas, laydown and staging areas, storage facilities, mockups, temporary facilities, decontamination facilities, shower and toilet facilities, lunch areas, conference areas, and offices are examples of maintenance facilities that need evaluation. In addition, adequate office equipment should be provided to support efficient and effective work. The objective is to create and maintain a safe and productive workplace where high-quality work can be performed.

Types of Maintenance

A proper balance of corrective maintenance and PM should be used to provide a high degree of confidence that degradation of facility equipment is identified and corrected, that life of equipment is optimized, and that the maintenance program is cost-effective. The maintenance program includes preventive, predictive, and corrective maintenance.

Preventive Maintenance
Includes all those planned, systematic, periodic, and seasonal maintenance actions taken to prevent SSC or facility failures, to maintain designed-in operating conditions, and to extend operating life. The PM process takes into account the inevitability of failures in any simple or complex piece of equipment, although the consequences of failures can be controlled by careful design and effective maintenance. The reason for the failure incident can be apparent if basic differences between expected behaviors and the actual behaviors of SSCs are considered. These differences can be translated into possible failure modes. Preventative maintenance identifies any differences between actual and expected behavior of SSCs. Generally, regulatory and code requirements, DOE technical safety requirements for surveillances, in-service inspection and testing, vendor recommendations, and other forms of maintenance action and frequency selection based on engineering judgment or analytical methods are the pursuit of proactive planned maintenance.

Predictive Maintenance
The actions necessary to monitor; find trends; and analyze parameters, properties, and performance characteristics or signatures associated with SSCs, facilities, or pieces of equipment to discern whether a state or condition may be approaching that is indicative of deteriorating performance or impending failure, where the intended function of the SSCs, facilities, or pieces of equipment may be compromised. Predictive maintenance activities involve continuous or periodic monitoring and diagnosis to forecast component degradation so that "as-needed" planned maintenance can be initiated before failure. Not all SSC, facility, or equipment conditions and failure modes can be monitored and diagnosed in advance; therefore, PM should be selectively applied. To the extent that predictive maintenance can be relied on without large uncertainties, it is normally preferable to activities such as periodic internal inspection or equipment overhauls.

Corrective Maintenance
The repair of failed or malfunctioning equipment, system, or facilities to restore the intended function or design condition. This maintenance does not result in a significant extension of the expected useful life.

Reliability-Centered Maintenance
A proactive systematic decision logic tree approach to identify or revise PM tasks or plans to preserve or promptly restore operability, reliability and availability of facility SSCs; or to prevent failures and reduce risk through types of maintenance action and frequency selection to ensure high performance.

Reliability-centered maintenance is the performance of scheduled maintenance for complex equipment, quantified by the relationship of PM to reliability and the benefits of reliability to safety and cost reduction through the optimization of maintenance task/frequency intervals. The concept relies on empirical maintenance task/frequency intervals to make determinations about real applicable data suggesting an effective interval for task accomplishment. The approach taken to establish a logical path for each functional failure is that each functional failure, failure effect, and failure cause be processed through the logic so that a judgment can be made as to the necessity of

the task, and includes: 1) reporting PM activities, plans, and schedules; 2) optimizing/calculating the PM interval by balancing availability, reliability, and cost; 3) ranking PM tasks; 4) accessing PM information from piping and instrumentation drawings; 5) accessing PM and other maintenance data; 6) listing recurring failure modes/parts, including failure to start and failure to run; 7) calculating and monitoring SSC availability; 8) accessing PM procedures, and 9) keeping track of PM cost.

Maintenance Procedures

Maintenance procedures and other work-related documents should be prepared and used to provide appropriate work direction and to ensure that maintenance is performed safely and efficiently. A key element in performing maintenance in a safe, efficient, and consistent manner is the proper use of written procedures. A balanced combination of written guidance, skilled employees, and worksite supervision is required to achieve the quality work essential to safe and reliable facility operation. This section describes important concepts for preparation, verification, validation, approval, control, use, and periodic review and revision of maintenance procedures.

Maintenance procedures should provide technical guidance to craft personnel to help ensure they accomplish their work in a systematic, correct manner. This guidance must be technically accurate, complete, up-to-date, and presented in a clear, concise, and consistent manner that minimizes human error. Experience has shown that deficient procedures and failure to follow procedures are major contributors to many significant, undesirable events. The probability of craft personnel error increases with the use of poorly written procedures.

Planning, Scheduling, and Coordinating Maintenance

An effective system for planning, scheduling, and coordinating maintenance activities should be implemented to ensure maintenance is accomplished in a timely manner, ensure worker safety, improve maintenance efficiency, reduce radiation exposure, and increase equipment availability.

Planning and scheduling involves assigning priorities that reflect the importance of maintenance work relative to safe and reliable facility operation; personnel safety; identification of logistics; personnel support; and other preparation; and minimizing any adverse impact that the maintenance activity has on facility operation. Coordination of work ensures needed support is available.

The processes of planning, scheduling, and coordinating work are discrete tasks that are closely related and that are usually delegated to one of several functional groups. Planning, scheduling, and coordinating work usually involves a planning group, a scheduling system (work-control system), a scheduling group (which may be a part of the planning group), and a coordination group (which may also be a part of the planning group). Outage planning, scheduling, and coordination are usually managed by a dedicated group of individuals in order to control this significant effort.

Control of Maintenance Activities

Management involvement in control of maintenance activities should ensure that maintenance practices are effective in maintaining safe and reliable facility operation. This control should extend

to all facility, contractor, and subcontractor personnel involved in maintenance activities. Rigorous control of maintenance activities should be directed toward achieving high-quality work performance, personnel, equipment and system protection, and facility safety and reliability.

The work-control program should be based on administrative procedures that address identification of needed work, planning and preparation for work, establishment of conditions to perform work, conduct of work activities, documentation of completed work, post-maintenance acceptance of work, return-to-service procedures, review of completed work records, control of temporary repairs, and control of non-facility contractor and subcontractor personnel working in the facility. The program should also make provisions for collecting and storing equipment maintenance data.

Post-Maintenance Testing (PMT)

Post-maintenance testing should be performed to verify that components will fulfill their current, authorized design function when returned to service after maintenance.

Post-maintenance testing includes all testing performed after maintenance activities. An effective PMT program should apply to all maintenance activities and should address each organization's responsibilities, equipment to be included, degree and type of testing, procedure needs, acceptance requirements, testing control, and results documentation.

Post-maintenance testing could be as simple as checking a manual valve for leaks at normal operating pressure after packing adjustment or as detailed as an in-depth diesel generator performance test.

The objective of PMT is to verify that SSCs are capable of performing their intended function when returned to service following maintenance and to ensure that the original deficiency is corrected. Post-maintenance testing requires close coordination among various facility groups and contract personnel. Post-maintenance testing integrates with the work-control system and the health and safety permit system. An effective PMT may be directly related to facility reliability.

Post-maintenance testing involves the following key elements:

- Responsibilities of each group are clearly defined.
- Scope of equipment tested includes all facility equipment.
- Specifying appropriate tests includes inputs from maintenance, owner/operator, and technical support groups.
- Guidance is available to planners for identifying appropriate tests.
- Testing is conducted with owner/operator's authorization, uses approved procedures or instructions, and is performed and reviewed by qualified personnel.
- Tests are conducted under the appropriate system operating parameters.
- A form is used to authorize, document, and review the results of PMT.
- Post-test system restoration is formally controlled.

Procurement of Parts, Material, and Services

Proper parts, materials, and services required for maintenance activities should be available when needed. Proper parts and materials in good condition are necessary to maintain design requirements for maintenance activities during normal facility operation and to support unplanned and planned outages. Services are periodically needed to provide unique or supplementary maintenance support. An effective procurement process should be developed in conjunction with quality assurance requirements to ensure that parts, materials, and services are available when needed.

Material Receipt, Inspection, Handling, Storage, Retrieval, and Issuance

All phases of receiving, inspecting, handling, storing, retrieving, and issuing equipment, parts, and materials for maintenance should be covered by effectively implemented policies and procedures from the time an item is received until it is installed in the facility.

Control and Calibration of Measuring and Test Equipment (M&TE)

The program for control and calibration of M&TE should be consistent with quality assurance requirements, and should ensure the accurate performance of facility instrumentation and equipment for testing, calibration, and repair. Measuring and test equipment devices include all tools, gauges, instruments, devices, or systems used to inspect, test, calibrate, measure, or troubleshoot to control or acquire data for verifying the conformance of an instrument or piece of equipment to specified requirements.

The M&TE selected for use should have the precision necessary to ensure that facility instrumentation and equipment will operate within design accuracy requirements and be durable enough for their intended applications. Control and calibration requirements for M&TE apply to onsite and offsite calibration facilities and nonnuclear facility contractor or subcontractor groups that are engaged in maintenance activities.

Maintenance Tools and Equipment Control

Methods should be provided for storage, issuance, and maintenance of an adequate and readily available supply of tools and equipment and also for the development of special tools and equipment needed in the maintenance program.

Facility Condition Inspection

Management should conduct periodic inspections of safety equipment and facilities to ensure excellent facility condition and housekeeping. The condition of a facility depends on many factors, including design, fabrication, modifications, ongoing maintenance, facility work-control programs, and day-to-day operation. After initial facility construction, ongoing maintenance and the control of modifications are prime contributors to keeping systems and equipment in optimum condition to support safe and reliable operation. The involvement of facility managers and supervisors in periodic walkdowns and inspections clearly displays management standards to all personnel and can significantly improve the condition of the facility. Establishing a program for identification and dispositioning of condition deficiencies and housekeeping discrepancies is an important step in

maintaining facilities and equipment in a condition of maximum safety, reliability, and availability.

Management Involvement

To ensure the safety of DOE facility operations, DOE and contractor corporate and facility managers should be technically informed and personally familiar with conditions at the operating facility. Responsible DOE and contractor corporate managers should visit the facility, including visiting at irregular hours; assess selected activities and portions of the facility; and leave a written record of their observations. Additionally, DOE, contractor corporate, and facility managers should periodically review the maintenance programs to verify that they are effectively accomplishing their intended objectives and are upgraded as needed. Key features of programs that support maintenance management are described in DOE G 433.1-1, which if implemented should enhance safe, reliable, and efficient maintenance operations. They include

- management involvement;
- performance indicators, goals, and objectives results;
- problem analysis;
- feedback; and
- program reviews.

Maintenance History

A maintenance history and trending program should be maintained to document data, provide historical information for maintenance planning, and support maintenance and performance trending of facility systems and components. The documentation of complete, detailed, and usable history will be increasingly important as plant-life extension becomes an issue. Trending should be directed toward identifying improvements for the maintenance program and needed equipment modifications.

The maintenance history program should document SSC maintenance and performance data as a basis for improving facility reliability. This history should assist in ensuring that root causes of failures are determined, corrected, and used in future work planning. This may be accomplished by a thorough review and analysis of maintenance performed, diagnostic monitoring data, and industry experience reports.

Maintenance history files should include component identification numbers and descriptions; complete maintenance records for all components/facilities in the system; diagnostic monitoring data; and relevant correspondence, including correspondence with vendors. To be an effective method for maintenance history control, the files should be computerized, with individual groups responsible for collecting data and populating the system. Provisions should be made for engineering review and analysis of both the history files and the overall program.

Analysis of Maintenance Problems

Systematic analysis should be used to determine and correct root causes of unplanned occurrences related to maintenance. DOE G 433.1-1 provides guidance for collecting and trending maintenance

history to reduce recurring or persistent equipment failures that should be reviewed by the analysis program. Incident reports, post-trip reviews, and other similar operating experience review documents and methods supplement the maintenance history program and provide data, including human error data, which should be reviewed by the analysis program.

Modification Work

This section is concerned with temporary modifications, permanent or minor modifications. Facility modification work, including minor modifications and temporary modifications, should be accomplished under the same basic administrative controls as those applied to facility maintenance activities so that there are no increases in risk to facility equipment, environment, or personnel because of the modification work. Changes to the maintenance program to incorporate facility modifications should be commensurate with the complexity of the task, the extent of the modification, and the importance of the equipment.

Seasonal Severe Weather and Adverse Environmental Conditions Maintenance

Seasonal facility preservation includes developing and implementing a plan to address severe weather, environmental, and wildfire conditions, referred to as severe conditions, for the safe operation and preservation of DOE nuclear facilities. This section describes examples of proactive measures that should be taken by maintenance organizations to adapt the facilities to changing external weather/environmental conditions.

Note: You do not have to do example 3 on the following page, but it is a good time to check your skill or knowledge of the information covered. You may do the example or go to the practice.

EXAMPLE 3

1. What are three methods that management can use to achieve effective implementation and control of maintenance activities?

2. What are three tasks that are normally included in a maintenance training program?

3. What are three types of environmental controls that should be used in a maintenance shop?

Note: When you are finished, compare your answers to those contained in the example 3 self-check. When you are satisfied with your answers, go on to the practice.

EXAMPLE 3 SELF-CHECK

1. What are three methods that management can use to achieve effective implementation and control of maintenance activities?
   Effective implementation and control of maintenance activities are achieved primarily by management establishing and enforcing written policies, procedures, and standards for maintenance; periodically observing and assessing performance; and holding personnel accountable for their performance.

2. What are three tasks that are normally included in a maintenance training program?
   Note: Any three of the following comprise a complete answer.

   Maintenance training programs include all or a portion of the following tasks:
   - Defining the jobs, tasks, skill levels, and responsibilities of individuals in maintenance positions
   - Defining training programs for each position
   - Determining the content and emphasis of the training needed
   - Determining and supporting training schedules
   - Determining the training needs of and tailoring the training program for each individual, based on his/her previous education, training, experience, and skill level
   - Providing instructors and trainers
   - Establishing qualification criteria, with emphasis on successful performance in the field

3. What are three types of environmental controls that should be used in a maintenance shop?
   Note: Any three of the following comprise a complete answer.

   Examples of some environmental controls and services include the following.
   - Fume removal
   - Temperature, humidity, and dust control
   - Equipment space considerations
   - Lighting
   - Demineralized water
   - Noise control
   - Facility service and instrument air
   - Electric power supplies
   - Radiological controls

PRACTICE

This practice is required if your proficiency is to be verified at the familiar or general level. This practice will prepare you for the criterion test that will be required if your proficiency is to be verified at the familiar level. You will need to refer to the DOE directives to answer the questions in the practice correctly. The practice and criterion test will also challenge additional skills that you have acquired in other formal and on-the-job training.

1. What is the purpose of DOE O 433.1B?

2. What is the purpose for quantitative indicators in maintenance management?

3. What are three types of environmental controls included in a maintenance shop?

4. What is the relationship between DOE G 433.1-1 and DOE O 433.1B?

5. What is the purpose for post-maintenance testing?

6. What is the objective of a good equipment maintenance history program?

7. What are three conditions that should be addressed in a severe conditions facility preservation plan?

8. What are the five programmatic elements of a configuration management program?

9. What is the definition for reliability-centered maintenance?

10. What is the definition for predictive maintenance?

Note: The course manager will check your practice and verify your success at the familiar level. When you have successfully completed this practice, go to the general level.

DOE O 433.1B
MAINTENANCE MANAGEMENT PROGRAM FOR DOE NUCLEAR FACILITIES
GENERAL LEVEL

OBJECTIVES

Given the familiar level of this module, and a scenario, you will be able to answer the following questions:

1. What are the key elements you would look for in the contractor's action plan to correct the situation described in the scenario?
2. Which requirements, sections, or elements of U.S. DOE O 433.1B, *Maintenance Management Program for DOE Nuclear Facilities* apply to the situation described in the scenario?

Note: If you think that you can complete the practice at the end of this level without working through the instructional material and/or the examples, complete the practice now. The course manager will check your work. You will need to complete the practice in this level successfully before taking the criterion test.

RESOURCES

DOE Orders Self-Study Program, DOE O 433.1B, Familiar Level. August 2011.
DOE O 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*. 4/21/10.
DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433*. 9/5/01.

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INTRODUCTION

The familiar level of this module introduced the purpose and scope of DOE O 433.1B. Several definitions and the requirements associated with the Order were discussed. In the general level of this module, students are asked to apply the information contained in the familiar level and the Order to a scenario related to the Order. Please refer to the resources listed on the previous page to make your analysis and answer the questions.

Note: You do not have to do the example on the following page, but it is a good time to check your skill and knowledge of the information covered. You may do the example or go on to the practice.

EXAMPLE SCENARIO

Please review the following scenario, and then answer the questions that follow.

Scenario

On November 18, 2002, a security police officer (SPO) was attempting to operate a roll-up door when the chain sprocket came loose from the door drum drive shaft and fell to the floor. The sprocket landed approximately one foot from the SPO.

An investigation of the situation revealed the following.

The sprocket fell because the main shaft shifted in the assembly over time, forcing the sprocket off the end of the shaft. Qualified maintenance personnel performed an inspection of all of these types of doors, looking for abnormalities. The sprocket was correctly reinstalled on the door.

The lack of preventive maintenance (PM) on this door precluded maintenance personnel from discovering the problem before the sprocket came off the shaft. At the time the door was installed there was no system in place to ensure the equipment was placed in the PM system.

Maintenance history shows this type of roll-up door to have a moderate failure rate, usually related to mechanical components such as limit switches and door curtain guide parts. This is the first case of a sprocket falling off that could be found in the maintenance history. This particular door has a high cycle rate because it is in a high-traffic area. It is also the only door of its type that was not in the PM system. It was determined to have been omitted from the PM system because at the time of original installation, there were no means to ensure equipment had been placed in the system. The original installation was found to be inadequate because there was no machined area on the drive shaft for the setscrews, and the key only covered half the area in the keyway. The PM, as written, would not have found this.

Immediate actions:

- The SPO pushed the stop button for the roll-up door and reported the event through his chain of command to the operations center.
- Maintenance was notified and locked and tagged the roll-up door out of service.
- Maintenance initiated a walkdown of all roll-up doors to verify proper installation and operation of the door sprockets.

Additional corrective actions:

- The roll-up door was added to the PM system.
- The life-cycle asset management manual was revised to ensure installed equipment is evaluated for placement in the PM system.
- A lessons learned will be developed and published stressing the need to notify the appropriate authorities when equipment is malfunctioning or is nonresponsive and to stop trying to operate equipment when it is malfunctioning or nonresponsive.

Requirements applicable to this scenario:
DOE G 433.1-1, section 4.4.3.3.3, "Component History Review"

When reviewing the history of the components, the analyst should attempt to identify the following:

- Failure modes
- Failure causes and mechanisms
- Failure rates compared to the industry failure rates, if easily retrievable and available

DOE G 433.1-1, section 4.4.3.4.11, "Analysis Strategy for Critical and Non Critical Components"

A minimum review of noncritical components should consist of a review of the maintenance history, total PM tasks, and vendor information for the component. This review should identify recurring or highly probable failure modes. If the failure rate of the noncritical component is high and its repeated failures are not cost-effective, then effective PM tasks or design changes may be used to control the failure rate.

1. Is the contractor's action plan correct? If not, state what should have been done.

2. Were the correct DOE documents or requirements cited? If not, state the correct documents or requirements.

When you are satisfied with your answers compare them to the ones contained in the example self-check.

EXAMPLE SELF-CHECK

Your answer does not have to match the following exactly. You may have added more corrective actions or cited other requirements from the Order that apply. To be considered correct, your answer must include at least the following.

The actions and the requirements listed are correct.

PRACTICE

This practice is required if your proficiency is to be verified at the general level. The practice will prepare you for the criterion test. You will need to refer to the Order to answer the questions in the practice correctly. The practice and criterion test will also challenge additional analytical skills that you have acquired in other formal and on-the-job training.

Please review the following scenario and answer the questions that follow.

Scenario

On November 1, 2002, the fire-water sprinkler system for the office annex froze, and a pipe tee broke discharging firewater into the annex, resulting in considerable water damage before the firewater could be shut off.

An investigation of the situation revealed the following.

The annex is heated by a steam system. The steam system and the annex had undergone numerous repairs starting in March of 2002. Management considered the steam repairs to be a low-priority issue. Therefore, repairs to the steam system were worked when resources were available. Repairs were finally completed on October 31, 2002. The startup of the steam system was scheduled for November 4, 2002.

On October 31, 2002, at 1235, an operator discovered water leaking onto the floor that appeared to be coming from two duct-mounted, chilled-water cooling coils located in the supply air duct in the heating, ventilation, and air conditioning (HVAC) system. The operator notified the on-duty technical lead and the facility system engineer of the leaking cooling coils. The operator successfully directed the remaining water leaking from the cooling coils to a nearby floor drain, and the cooling coils were isolated from the system. It was determined that the cooling coils froze and broke because the temperature outside coming into the building was below 32 degrees and no steam was available to pre-heat the incoming air. The chilled-water system was out of service as part of the project to replace the existing water chiller, so the amount of water available to leak was only what was present in the pipe. Management was notified of the broken coils and action was taken to isolate the cooling coil.

Management directed the HVAC system be operated on a single exhaust fan since outside temperatures at night had been dropping into the 20's, and the weather forecast for the weekend predicted temperatures in the low 20's. This configuration of the HVAC minimizes direct intake of outside air and preserves heat within the facility. Management decided that startup of steam to the facility would begin on November 1, 2002.

On November 1, 2002, at 0625, commercial power was lost, and power was provided by standby generators. The annex is not supplied by standby power. Outside air temperature at the time commercial power was lost was approximately 5 degrees. According to the freeze protection surveillance readings, the temperature in the annex at 0600, prior to losing commercial power, was

between 30 and 38 degrees. The data readings are considered below the required parameter (>40 degrees), so the operator stated in the comment section of the freeze protection surveillance sheet "outside temperature at 5 degrees, with no steam for heating." There was no amplifying information provided on the form to assist operations personnel in directing or initiating actions to correct an out-of-parameter reading. Therefore, no action was taken to mitigate the out-of-parameter readings. The technical lead reviewed the freeze protection readings and failed to recognize that no mitigating action had been taken with regard to the abnormal reading.

On November 1, 2002, at 1020, commercial power was fully restored to the annex. At 1030 the facility operator conducted freeze protection surveillance checks, and the annex temperature was between 30 and 42 degrees. Again, no mitigating action was taken to address the out-of-parameter readings. At 1330 water was discovered by operations personnel dripping from three fire-water sprinkler heads located in the annex conference room. Action was immediately taken to contain the water and minimize electrical hazards posed by the water in the conference room. The operator immediately notified the on-duty technical lead concerning the situation. The technical lead told the operator to send utilities personnel to the annex to isolate the fire water from the facility since this is not a task facility operators are trained to do. The operator returned to the annex conference room to check on the water dripping from the sprinkler heads to find the sprinkler system discharging full flow (approximately 350 gallons per minute) from a broken fire-water line.

Utilities personnel arrived at 1338 and isolated fire water to the annex by closing the fire-water valve. The annex was cleared of personnel, and entry points into the annex were posted to prohibit entry. At 1400, the technical lead notified the facility manager of the event and was instructed to put scheduled fuel inventories on hold and use operators to assist in bringing steam online to the facility. At 1700, the fire-water valve that supplies fire water to the annex was closed.

On November 4, 2002, management, safety, and fire protection personnel walked down the annex area to assess the damage. There was considerable water damage to personnel offices, and many of the false-ceiling tiles had collapsed to the floor due to the water they absorbed. The management, safety, and fire protection personnel also found that a pipe tee from the fire sprinkler system in the conference room had split in half, causing the discharge of water. The pipe tee broke from the frozen water in the line. Efforts to restore the annex area to an operational status commenced.

Immediate actions taken:

- Management and DOE were notified.
- Fire-water and electrical systems were isolated in the annex.
- Entryways to the annex were posted to prohibit entry.
- Cleanup of damage in the annex was initiated.

Applicable DOE directives:
DOE G 433.1-1, section 4.18.3.2, *Cold Weather Preparation*

The following should be included to minimize equipment and building damage from cold weather conditions and temperatures less than or equal to 35 degrees.

- Identify areas where portable heating may be required and obtain portable heating equipment, approved by the fire protection engineering group.
- Monitor the conditions surrounding fire protection sprinkler systems to ensure a temperature of above 40 degrees is maintained.
- Ensure that systems requiring or deserving special protection due to hazards or costs associated with freeze damage have temperature alarms and/or automatic backup.
- Review wet-pipe sprinkler systems for areas susceptible to freezing and take appropriate actions such as making provisions for auxiliary heat, draining, and/or posting a fire watch.

1. Was the situation handled correctly? If not, what should have been done?
2. Was the list of requirements, sections, and elements complete and correct? If not, state the correct or omitted requirements.

Write your answers below and then bring the completed practice to the course manager for review.

Note: The course manager will check your practice and verify your success at the general level. When you have successfully completed this practice, the course manager will give you the criterion test.