National Nuclear Security Administration Self-Study Program

DOE O 433.1

MAINTENANCE MANAGEMENT PROGRAM FOR
DOE NUCLEAR FACILITIES

NNSA SERVICE CENTER

Change No: 0
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Date: 1/15/04

DOE O 433.1
MAINTENANCE MANAGEMENT PROGRAM FOR DOE NUCLEAR FACILITIES
FAMILIAR LEVEL

OBJECTIVES

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

1. State the purpose of implementing U. S. Department of Energy (DOE) O 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, 6/1/2001.
2. Define the following terms.
   - condition assessment survey
   - graded approach
   - predictive maintenance
   - preventive maintenance
   - reliability-centered maintenance
3. State the objective of the National Nuclear Security Administration (NNSA) maintenance management program.
4. Identify the types of NNSA facilities that require a maintenance implementation plan (MIP).
5. Describe the 18 maintenance management program elements important to a good maintenance program.

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.

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RESOURCES

DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, 6/1/2001.
DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*.
DOE M 411.1-1B, *Safety Management Functions, Responsibilities, and Authorities Manual*.

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INTRODUCTION

The familiar level of this module is divided into two sections. In the first section, we will discuss the purpose of DOE O 433.1, the overall objectives and requirements of the maintenance management program, and the responsibilities associated with the Order. In the second section, we will discuss DOE G 433.1-1 and the 18 maintenance management program elements important to a good maintenance program. We have provided examples throughout the module to help familiarize you with the material. The examples will also help prepare you for the practice at the end of this module and for the criterion test.

Before continuing, you should obtain a copy of the resources. Copies of the Order are available at http://www.directives.NNSA.gov/ or through the course manager. You may need to refer to these documents to complete the examples, practice, and criterion test.

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SECTION 1–OBJECTIVES AND GENERAL REQUIREMENTS

OBJECTIVES

To define the program for the management of cost-effective maintenance of NNSA nuclear facilities. Guidance for compliance with this Order is contained in DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for use with DOE O 433.1*, which references federal regulations, DOE Directives, and industry best practices using a graded approach to clarify requirements and guidance for maintaining DOE-owned government property.

CANCELLATION

This study guide replaces and cancels the study guide for DOE Order 4330.4B, *Maintenance Management Program.*

REQUIREMENTS

In addition to the maintenance program requirements of DOE O 430.1B, *Real Property Asset Management,* a nuclear facility maintenance management program must contain an NNSA-approved maintenance implementation plan (MIP) that addresses the following elements using a graded approach:

- structures, systems, and components (SSCs) included in the program;
- periodic inspections of SSCs and equipment required to determine if degradation or technical obsolescence threatens performance and/or safety;
- management systems used to control maintenance activities associated with the defined SSCs (these include work control, post-maintenance testing, material procurement and handling, and control and calibration of test equipment);
- assignment of roles and responsibilities and appropriate maintenance-related training and qualification requirements;
- interfaces between the maintenance organization and other organizations (e.g., operations, engineering, quality, training, industrial health);
- the configuration management process established to ensure the integrity of the identified SSCs using a graded approach;

- the prioritization process used to properly emphasize safety requirements, the maintenance backlog, system availability, and requirements for those infrastructure elements identified as part of the nuclear facility safety basis;
- the process for feedback and improvement established to provide relevant information regarding operations, maintenance, and assessment efforts;
- the systems engineer program established for the management of vital safety systems that is consistent with DOE O 420.1A, *Facility Safety,* and designates a system engineer with the requisite knowledge of the system safety design basis and operating limits from the safety analysis and the lead responsibility for the configuration management of design; and
- an accurate maintenance history that compiles maintenance, resource, and cost data in a system that is retrievable and capable of entering required-maintenance costs, actual maintenance costs, and availability data and failure rates for mission-critical and safety SSCs in the NNSA facility information management system.

The contractor maintenance management program should establish metrics to measure the performance of the program and incorporate appropriate voluntary consensus standards.

The contractor maintenance management program should address the following elements, as appropriate:

- Maintenance Organization and Administration. The organization and administration of the maintenance function must ensure a high level of maintenance performance through effective implementation and control of maintenance activities.
- Training and Qualification of Maintenance Personnel. A maintenance training and qualification program must be implemented to develop and maintain the knowledge and skills needed by maintenance personnel to effectively perform maintenance activities.
- Maintenance Facilities, Equipment, and Tools. Maintenance facilities, equipment, and tools should efficiently support nuclear facility maintenance and maintenance training.
- Types of Maintenance. Corrective and preventive maintenance should be balanced properly to provide a high degree of confidence that nuclear facility equipment degradation is identified and corrected, that equipment life is optimized, and that the maintenance program is cost-effective.

- Maintenance Procedures. Maintenance procedures and other work-related documents must be prepared and used to provide appropriate work direction and to ensure that maintenance is performed safely and efficiently.
- Planning, Scheduling, and Coordination of Maintenance. An effective system for planning, scheduling, and coordinating maintenance activities is implemented to ensure that maintenance, including surveillances associated with technical safety requirements (TSRs), is accomplished in a timely manner; improve maintenance efficiency; reduce chemical and physical hazard radiation exposure (ALARA); increase equipment availability; ensure worker safety through training and proper use of personal protective equipment; and ensure hazardous waste is properly segregated, treated, or disposed.
- Control of Maintenance Activities. Management involvement in control of maintenance activities should ensure that maintenance practices are effective in maintaining safe and reliable nuclear facility operation and are integrated with the work authorization and control requirements for conduct of operations requirements for NNSA facilities.
- Post-maintenance Testing. Post-maintenance testing should be performed to verify that components will fulfill their design function when returned to service after maintenance.
- Procurement of Parts, Materials, and Services. Parts, materials, and services required for maintenance activities should be available when needed.
- Receipt, Inspection, Handling, Storage, Retrieval, Issuance, and Disposal Turn In of Personal Property. All phases of receiving, inspecting, handling, storing, retrieving, issuing, and turning in for disposal of personal property used for maintenance should be covered by effectively implemented policies and procedures; suspect and counterfeit item control requirements; and, as appropriate, high-risk personal property management and control requirements from the time an item is received (for installation) in or maintenance of the nuclear facility until it is turned in for disposal.
- 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 ensure the accurate performance of nuclear facility instrumentation and equipment for testing, calibration, and repairs.
- Maintenance Tools and Equipment Control. Methods should be established to provide 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 and direct independent assessments of equipment and facilities to ensure safe nuclear facility condition and housekeeping and to meet the fire protection and natural hazard phenomena mitigation requirements of DOE O 420.1A, *Facility Safety*.
- Management Involvement. Contractor corporate and nuclear facility managers should be sufficiently involved with nuclear facility operations to be technically informed and personally familiar with conditions at the operating nuclear facility.
- 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 nuclear facility systems and components; all records and documentation should be maintained according to the approved site-specific records retention and disposition schedule.
- Analysis of Maintenance Problems. Systematic analysis should be used to determine and correct root causes of unplanned occurrences related to maintenance.
- Modification Work. Nuclear facility modification work, including temporary modifications, should be accomplished under the same basic administrative controls as those applied to nuclear facility maintenance activities so that risk to the facility, equipment, environment, or personnel does not increase because of the modification work.
- Seasonal Facility Preservation. A program should be in place to prevent equipment and building damage due to weather conditions.

Confirm that the nuclear facility maintenance management program established under DOE 4330.4B remains effective until it is updated to meet the requirements of DOE O 433.1.

The contractor will review and update the MIP every 2 years and submit any changes to NNSA for approval.

RESPONSIBILITIES

The responsibilities of all NNSA elements are delineated in Section 9 of DOE M 411.1-1B, *Safety Management Functions, Responsibilities, and Authorities Manual*. These responsibilities include the following:

- ensuring that sufficient resources are budgeted in a timely manner to accomplish the maintenance program's objective of providing NNSA with the highest confidence in the reliable performance of mission-critical, safety SSCs through proactive maintenance practices;
- ensuring that a cost-effective and efficient maintenance program is developed and implemented for all NNSA nuclear facilities consistent with NNSA's mission, safety and health, reliability, quality, and environmental protection objectives;
- ensuring that the responsibility, authority, and accountability for maintenance are clearly defined, appropriately assigned, and executed;
- ensuring that NNSA operational awareness review and analysis capability exists for evaluation of maintenance program performance and effectiveness;
- ensuring that where maintenance requirements or accepted maintenance standards cannot be met, such instances are appropriately documented and acknowledged by NNSA field elements, including the granting of exemptions by NNSA, as appropriate, when requested; and
- ensuring that the requirements and standards for maintenance of nuclear facilities are incorporated into contracts and subcontracts, including support services contracts, as appropriate.

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.

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EXAMPLE 1

Using the Familiar Level of this module and the resources, complete the following exercises.

1. State in your words what the NNSA hopes to achieve by implementing DOE O 433.1.

2. One of the objectives of the maintenance management program is to ensure that a graded approach is taken by the line management in the development and implementation of the maintenance program. Explain what that statement means.

3. Identify the position that is responsible for approving MIPs.

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.

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EXAMPLE 1 SELF-CHECK

1. State in your words what the NNSA hopes to achieve by implementing DOE O.433.1.
   To provide general policy and objectives for the establishment of programs for the management and performance of cost-effective maintenance and repair of NNSA property.

2. One of the objectives of the maintenance management program is to ensure that a graded approach is taken by the line management in the development and implementation of the maintenance program. Explain what that statement means. The maintenance management program should be developed in regard to:

   - the relative importance to safety, safeguards, and security;
   - the magnitude of any hazard involved;
   - the stage of the facility's life cycle;
   - the programmatic mission of the facility;
   - the particular characteristics of the facility; and
   - any other relevant factor.

3. Identify the position that is responsible for approving MIPs.
   Managers of field elements

SECTION 2–MAINTENANCE MANAGEMENT PROGRAM

In this section, we will describe the 18 maintenance management program elements important to a good maintenance program. The elements are

- maintenance organization and administration;
- training and qualification of maintenance personnel;
- maintenance facilities, equipment, and tools;
- types of maintenance;
- maintenance procedures;
- planning, scheduling, and coordination of maintenance;
- control of maintenance activities;
- post maintenance testing;
- procurement of parts, materials, and services;
- receipt, inspection, handling, storage, retrieval, issuance, and disposal turn in of personal property;
- control and calibration of M&TE;
- maintenance tools and equipment control;
- facility condition inspection;
- management involvement;
- maintenance history;
- analysis of maintenance problems;
- modification work; and
- seasonal facility preservation.

Each of these elements will be addressed in two segments. The first segment discusses the policy resources, goals and objectives, and accountability needed in facility maintenance. The second segment provides implementation guidelines.

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. NNSA operations office, contractor, and facility policies

should strive for excellence in facility maintenance and operation. Effective implementation and control of maintenance activities are achieved by management establishing and enforcing written policies, procedures, and standards for maintenance; periodically observing and assessing performance; and holding personnel accountable for their performance.

Policy

Sufficient staff, equipment, and funding should be allocated to the maintenance organization so that its functions can be effectively performed. Resources can be allocated on a case-by-case basis, depending on the organization used. One indication that sufficient resources have been allocated is how well the maintenance goals are met.

Contractors should establish maintenance standards, considering input from maintenance staff and crafts workers. These standards should establish expected performance levels and define maintenance objectives, responsibilities, and accountabilities. Operations office personnel and facility managers should monitor performance in maintenance through direct observation and development of maintenance reports. Maintenance personnel should be held accountable for their performance through supervisor counseling, performance appraisals, and, when necessary, disciplinary measures. Remedial training should be provided when appropriate.

The maintenance organization and administration should ensure effective implementation and control of maintenance activities and include the following objectives.

- Organizational structure is clearly defined.
- Staffing and resources are sufficient to accomplish assigned tasks.
- Responsibilities and authority for each management, supervisory, professional and craft position are clearly defined and understood.
- Interfaces with supporting groups are clearly defined and understood.
- Administrative controls are used in the conduct of maintenance activities that effect safe and reliable plant operation.
- Performance appraisals are effectively used to enhance individual performance.
- Temporary and other non-facility personnel use the same (or equivalent) facility-approved policies, procedures, and controls and the same workmanship standards as plant maintenance personnel.

- Personnel are actively encouraged to develop methods to improve safety, reliability, quality, and productivity.
- Performance indicators are reviewed and used to improve maintenance performance.

Guidelines

Maintenance Organization Policies

It is a primary responsibility of the maintenance manager to ensure implementation of contractor management and facility policies that affect the maintenance organization. Maintenance organization procedures should support contractor management and facility maintenance policies.

Each facility should develop an integrated approach to maintenance that encourages working relationships among all organizational units that support the maintenance function.

Maintenance Strategy

Effective management of the maintenance program requires long-range planning. Establishing a scope of long-range major activities shows how funding and staff resources can be managed to meet the needs of the maintenance program. Issues such as the following should be part of long-range planning:

- recurring major maintenance items such as component overhaul, inspections, and rebuilds;
- timing of planned maintenance and facility or equipment outages;
- major projects and modifications requiring maintenance organization involvement;
- future organizational structure and staffing changes aimed at continuing improvements in the maintenance program and the plant as a whole;
- planning for equipment replacement as components reach the ends of their service lives;
- timing of outages for other plants in the system when reliance on them for resources is part of the maintenance plan;
- periodic conduct of value-impact assessments of maintenance methods, processes, and approaches/alternatives to performing work;
- government and industry issues and events that will impact the maintenance program;
- budget changes or projects that may divert large amounts of money from maintenance activities; and

- contractor and corporate long-range support.

Staffing Resources

The maintenance manager is responsible for helping to select high-quality personnel, for effectively using available resources, for assessing resource adequacy, and for making recommendations to the appropriate manager regarding needed change. The maintenance manager should be involved in defining entry-level criteria and in screening new personnel. High-quality personnel should be selected to establish a staff of supervisory, engineering, planning, technical, warehousing, and other personnel that are needed to support the maintenance program. Entry-level criteria should ensure that maintenance personnel have the requisite background and experience to be trainable for work in nuclear facilities. A written or practical test could be used to demonstrate this minimum level of competence.

Goals and Objectives

Maintenance goals should be used as a management tool for involving facility groups in improving maintenance performance and for measuring maintenance effectiveness. To establish goals, it is necessary to determine the current value and estimate the expected value of the parameter for which a goal will be established. Based on this, a challenging but achievable goal should be established.

Quantitative Indicators

A program should be in place to provide management with information regarding maintenance performance indicators. Quantitative indicators should be presented in a way that shows a significant period, such as 12 to 36 months, to support a more meaningful analysis of performance trends. Where data are subject to wide variations over time, averaging techniques may be used to smooth the data and identify trends.

Status Reports to Managers

Managers should receive periodic reports on the status of various programs and on the status of action items.

Using Operating Experience

Programs should be in place to ensure the timely review of operating experience to incorporate lessons learned into maintenance programs and practices. Reviews should include in-house and external industry events. Management should use industry operating experience and in-house events as mechanisms for assessing performance to determine the root causes of problems. Mechanisms should also be in place to ensure that significant in-house events are promptly provided to the industry for use by other facilities.

Management Control of Plant Configuration

Management should ensure that plant configuration, including how the facility is maintained, conforms to the established design basis requirements. Many routine activities, if carried out improperly, can have an adverse effect on facility configuration and can cause eventual equipment damage or increase the probability or consequences of a significant event.

Document Control Administration

A document control system should provide for the timely receipt, processing, distribution, retention, storage, and retrieval of documents originating within and outside the maintenance organization.

Procedures

Controls should be established for the preparation, review, approval, distribution, and revision of maintenance procedures. A systematic program should be used to ensure the review and updating of maintenance procedures at regular intervals that are not to exceed a specified period (normally 2 years).

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.

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Policy

The training organization should maintain maintenance training programs that meet the intent of established industrial guidelines and that address specific company and facility needs.
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 education, training, experience, and skill level;
- providing instructors and trainers;
- establishing qualification criteria, with emphasis on successful performance in the field;
- coordinating on-the-job training (OJT);
- qualifying individuals as they complete their training programs; and
- providing training-effectiveness feedback to the training organization to enhance and, where necessary, adjust course teaching methods, content, and emphasis

Maintenance personnel knowledge and performance should support safe and reliable facility operation and include the following objectives.

- Maintenance is performed by or under the direct supervision of personnel who have completed applicable formal qualification associated with the tasks to be performed.
- Maintenance personnel are capable of troubleshooting equipment problems efficiently.
- Maintenance personnel, including temporary and non-facility personnel, are knowledgeable of changes to plant policies, procedures, systems, and equipment that affect their activities.
- Maintenance personnel are knowledgeable of appropriate lessons learned from industry and in-house operating experiences that are applicable to their craft.

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Maintenance Training Programs

OJT is a formal part of the maintenance-training program. This aspect of an individual's training is normally conducted in the facility as part of his/her day-to-day work activities. Accordingly, maintenance department supervisors and selected experienced craft personnel are directly involved in OJT. Key elements of OJT include the following.

- OJT should be conducted according to formally defined training programs that specifically identify items the trainee must accomplish.
- OJT should be conducted by personnel who are qualified as OJT trainers.
- When trainees perform maintenance on installed equipment, a qualified OJT instructor should observe the work so that the trainee properly accomplishes the activity and understands how to avoid errors that could affect personnel safety or adversely affect the station.
- To determine the number of trainees allowed to participate simultaneously in any particular training evolution, the trainer should consider training effectiveness and the effect on the equipment being maintained. Limiting the trainee/trainer ratio will help each trainee receive the most effective instruction and will help ensure that the trainer is not overwhelmed by having too many trainees at once.
- The maintenance manager should establish a policy that allows trainees to perform independent maintenance only on equipment for which they are qualified.
- In addition to being trained in technical maintenance functions, a select group or team should be schooled in principles and methods of root-cause analysis.

Training Program Approval

The maintenance manager should be directly involved in approving and periodically reviewing the maintenance training program. The performance of maintenance personnel should be monitored to identify enhancements and emphases for the initial- and continuing-training program.

Management and Supervisory Training

There should be a formalized training program that develops and maintains managerial and supervisory skills. The program's training should include managerial and supervisory skills, accountability, assessment, and observation of routine activities, communication skills, teamwork, and company management styles and philosophies. It should also include position-specific technical areas that enable these individuals to communicate properly with their workers and to carry out their responsibilities.

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.

Policy

A program for evaluating the adequacy of maintenance facilities is needed to help ensure that maintenance activities can be accomplished effectively. 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.

A program for evaluating the adequacy of tools and equipment to support maintenance activities is also needed. The use of maintenance facilities, tools, and equipment should be periodically reviewed and adjustments should be made to support effective maintenance.

Maintenance should develop and implement comprehensive seasonal transition, freeze protection, and energy conservation plans developed to address the specific needs and action schedules to sustain critical areas, buildings, and individual items, as appropriate.

Facilities and equipment should effectively support the performance of maintenance activities and include the following objectives.

- Maintenance facilities size and arrangement promote the safe and effective completion of work.
- Facilities should be provided for work on contaminated components.
- Work area lighting and other environmental conditions promote safe and effective working conditions.
- Work areas are maintained in a clean and orderly condition.
- Proper tools, equipment, and consumable supplies are available to support work requirements.
- Suitable storage is provided for tools, supplies, and equipment. Special tools, jigs, and fixtures are identified and stored to permit retrieval when needed.
- Contaminated tools are segregated from clean tools to prevent cross-contamination. Reuse is stressed, when feasible.
- Scaffolding and rigging equipment is identified, tested, and properly stored.
- Facilities, equipment, and tools are maintained in good repair.
- Measurement and test equipment is calibrated and controlled to provide accuracy and traceability. Out-of-tolerance test equipment is removed from service. Plant equipment calibrated with out-of-tolerance test equipment is evaluated in a timely manner for operability and is recalibrated as necessary.
- Fixed local area hosts and work platforms are provided to facilitate maintenance access to facility equipment.

Guidelines

Shop and Satellite Work Areas

The layout of shop and satellite work areas should be designed with a high priority on industrial safety and efficiency. Location and type of work performed should be considered in determining the types and level of environmental controls and services to be included in each maintenance shop and satellite work area.

Examples of some environmental controls and services include:

- 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

Each shop and satellite work area should have storage that is convenient and that encourages craft personnel to keep the area neat and clean. Shelves, cabinets, lockers, and toolboxes are examples of storage facilities that could be provided for items such as tools, parts, reference materials, and personal effects.

Laydown and Staging Areas

A plan for identification and use of maintenance laydown and staging areas should be developed and kept current. Planned outages should have assigned staging and laydown areas for equipment, special tools, rigs, and parts. Personnel movement into and out of areas should be planned and understood by all concerned.

Temporary Facilities

Temporary facilities are required for activities involving contractor support during outages and control of airborne radioactivity and contamination. Planning and coordinating temporary facilities with other groups such as radiological protection and operations result in more efficient use of space. Such necessary services as electric power, compressed air, water, environmental controls, and lighting should be provided at temporary-outage support facilities. ALARA should be considered when designing and locating temporary facilities. Glove boxes or temporary containments should be considered for work on contaminated equipment to prevent spread of contamination. Design of major temporary facilities should be controlled through the plant's design change programs to ensure that additional building services (such as electricity, compressed air, and water) do not overload plant systems.

TYPES OF MAINTENANCE

A proper balance of corrective maintenance and preventive maintenance 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.

Policy

Many factors should be considered in establishing an effective and efficient balance of the various types of maintenance. On important systems and equipment, a thorough technical analysis using methods such as reliability-centered maintenance will be needed to establish this balance. On less important systems, the amount of preventive maintenance to be performed may be determined through use of a more basic judgmental engineering analysis.

A proper balance of the types of maintenance may include, at one extreme, no preventive maintenance for equipment that is allowed to run until it fails, if the failure would not adversely affect facility operations. At the other extreme, for equipment whose failure can limit safe or reliable operation or result in unplanned outages, extensive preventive maintenance may be required.

The elements needed to successfully implement the maintenance program include:

- a method that determines how each of the different types of maintenance is to be used to maintain each system and piece of equipment;
- a master equipment list (MEL) to help I selecting and scheduling preventive maintenance and in evaluating the effectiveness of the maintenance program;
- scheduling each preventive maintenance action to allow consideration for performing related maintenance at the same time;
- review and approval by the maintenance manager of preventive maintenance actions that are deferred past a grace period or are missed entirely;
- periodic review of the maintenance program to determine its effectiveness on overall facility reliability.

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Maintenance should be conducted in a safe and efficient manner to support facility operation and include the following objectives.

- Personnel exhibit professionalism and competency in performing assigned tasks that results in quality workmanship.
- Maintenance personnel are attentive to identifying and are responsive to correcting facility deficiencies with a goal of maintaining equipment/systems in an optimum material condition.
- Managers and supervisors routinely observe maintenance activities to identify and correct problems and to ensure adherence to facility policies and procedures including industrial safety and radiation protection.
- Maintenance managers, supervisors, and craftsmen actively use ALARA concepts to minimize personnel exposure.
- Support groups such as operations, engineering, quality control (QC), and radiological protection are appropriately involved in maintenance activities. Participation of these groups is coordinated to effectively support the maintenance effort.
- Maintenance work is properly authorized, controlled, and documented.
- Pre-job and post-job briefings are effectively used.
- Work activities are performed according to controlled procedures, instructions, and drawings as required by facility policy. Crafts persons and other maintenance personnel identify and provide feedback to correct procedural problems.
- Good maintenance practices such as those listed below are followed:
    - Proper tools and equipment are used.
    - Good industrial safety radiological protection and ALARA practices are followed.
    - Foreign materials and contaminants are excluded from open systems and equipment.
    - Work sites are clean and orderly.
- Appropriate personnel (e.g., operations, engineering, and maintenance) are aware of and perform post-maintenance testing, review results, and take corrective action, as necessary.
- Maintenance rework is identified and documented. Corrective actions, including periodic reviews for generic implications, are taken to minimize rework.

- Temporary and other non-facility personnel are properly supervised and work under the same controls, procedures, and standards as plant maintenance personnel.

Guidelines

Master Equipment List

A detailed master list of both safety and non-safety equipment, components, and structures to be included in the maintenance program should be developed. Special tools and equipment should be included in this master list.

Preventive Maintenance

Preventive maintenance consists of all those systematically planned and scheduled actions performed to prevent equipment failure. The preventive maintenance program should define the required activities and the frequency with which they should be performed. Selection of required preventive maintenance actions should be based on the manufacturers' recommendations, plant experience, and good engineering practice. Preventive maintenance frequency should be based on adequately implementing the entire program, considering such elements as predictive maintenance results, vendor recommendations, ALARA considerations, and monitoring performance. A documented basis for the planned actions should be provided. Any deferral of planned actions should have a technical basis. The preventive maintenance program enhancement method provides two analytical processes, problem components analysis and system analysis. Each process is followed by preventive maintenance task selection and implementation. The final element of the enhancement method is establishment of a living preventive maintenance program that is continually updated, based on actual equipment performance, to maintain its effectiveness.

Preventive Maintenance Program Enhancement

Problem component analysis focuses on improving reliability of problem components by determining failure modes and implementing any needed preventive maintenance tasks or design changes.

System analysis focuses on improving overall reliability of facility systems by determining failure modes and implementing preventive maintenance tasks or design changes. This analysis improves the use of resources by identifying existing preventive maintenance tasks and TSRs that may be redundant or unnecessary. Additionally, this analysis identifies non-critical components that may be evaluated to determine whether assigned preventive

maintenance tasks are cost-effective with respect to resources and radiation exposure or consequences of failure. The review of non-critical components often provides the greatest opportunity to optimize the use of available resources.

Logic Tree Analysis

A decision tree analysis or logic tree analysis (LTA) process may be used to determine the importance of each significant failure mode and aid in the selection of applicable and effective preventive maintenance tasks. The LTA requires that the analyst answer "yes" or "no" to a series of questions. These answers should determine the decision path. The analyst starts by evaluating whether the failure mode is visible or evident to the operating crew. The analyst then determines the consequence and importance of the component functional failure. After determining the consequences and importance of the failure, an applicable and effective preventive maintenance task is selected or a design change may be necessary. Using LTA, each failure mode is categorized according to its consequence and importance to the operation of the facility. The categories are described below.

- Class A (Safety). Failure modes that affect personnel and/or facility safety. Scheduled maintenance is required and should reduce the likelihood and severity of the failure to an acceptable level; otherwise, the component/system should be redesigned.
- Class Bl (Shutdown Initiators). Failure modes that may cause facility shutdowns. Scheduled maintenance or a design modification is required to reduce operational costs and limit challenges to safety systems.
- Class B2 (Operational Impact). Failure modes that result in forced outages, production losses less than 10 percent, or other operational impacts. Scheduled maintenance or a design modification is necessary to reduce operational and corrective maintenance cost.
- Class C (Economics). Failure modes that affect support functions and do not cause production losses greater than 20 percent. Scheduled maintenance or a design modification is necessary to reduce the corrective maintenance cost.
- Class D (Hidden Failures). Failure modes of standby or infrequently used components that do not affect personnel and/or facility safety and are not evident to the operating crew. Scheduled maintenance is necessary to reduce the likelihood of multiple failures to an acceptable level. Hidden failures are reclassified using LTA as B1, B2, or C to establish priority of task selection.

Predictive Maintenance

Predictive maintenance should be integrated into the overall preventive maintenance program so that "proactive repair" planned maintenance may be performed before equipment failure. Not all equipment conditions and failure modes can be monitored. Therefore, predictive maintenance should be selectively applied. Reliable predictive maintenance is normally preferable to periodic internal inspection or equipment overhauls. Additionally, corrective maintenance efficiency may be improved by directing repair efforts at problems detected using predictive maintenance techniques. Predictive maintenance should be limited to components and systems that are significantly important to the safe and reliable operation of the facility. The program should collect, trend, and analyze data and initiate planned actions for degrading equipment. The effectiveness of the program is dependent on the accuracy of equipment degradation rate and time to failure assessment.

The following steps should be used to evaluate new methods or techniques for the predictive maintenance program.

- Provide a brief, general description of the proposed technique. Include acceptance criteria, alarm points, frequency, and any other appropriate information.
- Determine the systems or equipment types that would be monitored by the proposed method.
- If the proposed method hasbeen used at the facility before, describe the application where it was used.
- List any additional special test equipment required (not already available). Include a cost estimate, if possible.
- Determine whether any special skills or training is required to implement the proposed method.
- Determine whether other facilities are known to be using or have used the proposed method, and, if so, whether reviews of their experiences are available.
- Determine whether there are other test or inspection methods to monitor the same parameters, and compare them to the proposed method or technique.
- Determine what information would be provided by the proposed technique that is not provided by test or inspection methods already in effect.
- Determine whether past equipment failures might have been prevented if the proposed technique had been in effect (be as specific as possible).

- Provide any additional information that might be helpful in evaluating the benefits to be derived from implementing the proposed method or possible consequences of not implementing it.

Corrective Maintenance

Corrective maintenance consists of all those actions performed to restore failed or malfunctioning equipment to service per the current authorization basis. Corrective maintenance activities should ensure that the condition that caused the failure is identified, corrected, and documented. Analysis should be performed to determine the root cause of failure and the corrective action that should be taken, including feedback into the preventive and predictive maintenance programs and maintenance training and qualification programs. The establishment of priorities for corrective maintenance should be based on plant objectives and the relative importance of the equipment.

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 work-site supervision is required to achieve the quality work essential to safe and reliable facility operation.

Policy

Maintenance procedures should provide technical guidance to craft personnel to help ensure that 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. Guidance should be provided for the issuance of maintenance procedures, including development and writing, verification and validation, approval, use, change control, periodic review, and revision. Other factors, such as control of reference material, procedure identification and storage, and the requirement to maintain accurate procedures, must also be considered.

Maintenance procedures and other work-related documents should provide appropriate directions for work, should be used to ensure that maintenance is performed safely and efficiently, and include the following objectives.

- The preparation, review, approval, and revision of procedures and other work-related documents are properly controlled.
- Documents used in lieu of procedures (such as excerpts from vendor manuals) receive the same review and approval as procedures.
- Procedures and other work-related documents such as vendor manuals, drawings, reference materials, and posted job performance aids used in support of maintenance are technically accurate and up-to-date.
- Procedures are readily available and clearly identified.
- New and revised procedures are reviewed for technical accuracy before use and are checked to ensure usability before or during initial use.
- Procedures are clear, concise, and contain adequate information for users to understand and perform their activities effectively.
- Portions or steps of other documents that are used or referred to when performing a procedure are specifically identified in the procedure.
- Technical details such as set points, control logic, and equipment numbers are consistent among procedures, drawings, valve lineup sheets, and system descriptions.
- Human factors considerations are incorporated into procedures to promote error-free performance.
- Hold points, such as quality and radiological protection checks, are included in procedures, as needed.
- A policy governing the use of procedures is implemented.
- Temporary changes to procedures, if used, are effectively controlled, including ensuring appropriate review and authorization before use and ensuring user awareness of applicable temporary changes.
- A formal program exists to periodically review procedures for technical accuracy, human factors considerations, and the inclusion of in-house and industry operating experience.

Guidelines

Procedure Develop and Writing

Procedures should be written for and used in all work that could result in a significant process transient, a condition of degraded facility reliability, or a personnel or equipment hazard. Work complexity is also an indicator of the need for a procedure. Procedures should be written for each preventive maintenance action or written generically for similar preventive maintenance actions.

Information provided in procedures should be clear and concise, minimizing the need for interpretation and the possibility of misinterpretation. Experienced craft personnel and engineers can be trained to write maintenance procedures, or procedure writers can be used, with craft personnel or engineers providing technical input. Maintenance procedures must be written with the users (crafts workers) in mind and should include the following:

- procedure identification and status (titling or numbering, location, and page and revision identification);
- procedure purpose and scope;
- consistent organization, presentation and designation of instruction steps, caution and note style, and page style;
- clearly understood text, using correct grammar and punctuation; appropriate level of detail; concise instruction steps in logical sequence; specific nomenclature; quantitative and compatible values; referencing and branching methods; coordination of multiple actions; warning and caution location; effective formatting; and clear table, graph, and data sheet layout;
- consistent presentation of illustrations;
- clear indication of steps that could initiate an equipment trip or transient or the initiation or interruption of any process action;
- clear indication of hold points, independent verification requirements, or data to be recorded;
- systematic nuclear facility and system prerequisites, precautions and limitations, required special tools and materials, and required personnel;
- clear indication of acceptance criteria, follow-on steps, and restoration instructions;
- steps that inform operations personnel of expected alarms or equipment operations;

- guidance to craft personnel to notify the operations organization of maintenance that cannot be completed as originally planned or that will be delayed and extended past the anticipated due date and/or across shift changes; and
- development and preparation using personal computer, desktop-publishing, and computer-aided writing programs.

Procedure Verification

Procedures should be verified to determine if they are technically accurate and properly arranged. This review should ensure that the procedure incorporates human factor principles and appropriate administrative policies. The technical accuracy review should also include a review of the procedure against the design requirement for the system or component it concerns. This may be accomplished by comparing the vendor manual and design specifications to the procedures.

Verification should be conducted by one or more reviewers from the facility producing the procedure who were not involved in writing the procedure. Reviewers from other disciplines, such as health physics, engineering, and operations, should also be considered for involvement in the process.

Procedure Validation

Procedures should be validated to determine its usability and correctness. This review evaluates whether the procedure provides sufficient and understandable guidance and direction to the craft personnel and that it is compatible with the equipment or system being maintained. Validation may be conducted in a shop, in a training environment, or on a mockup or simulator.

Procedure Change Control, Periodic Review, and Revision

Responsibilities for procedure program administration should be clearly defined. Procedures should be controlled according to facility administrative requirements. All procedures should be periodically reviewed for changes affecting content and for philosophy and format enhancements and human factor considerations. Reviewers should use checklists to ensure that the scope and depth of the review are consistent and adequate. A method should exist to ensure that technical safety requirements and other commitments are not inadvertently changed or deleted in the process of revising procedures.

Controls are needed to allow for procedure changes (temporary alterations so that work can be safely continued) and revisions (permanent alterations that incorporate outstanding temporary changes and other needed updates). Changes and revisions are necessary to correct errors and to ensure that procedures reflect current maintenance practices and requirements.

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.

Policy

Planning for work is an important part of the maintenance process. In-depth work planning identifies the required support and detailed scoping necessary to schedule daily maintenance accurately. Defining the work to be performed and providing appropriate procedures or instructions can reduce maintenance errors and risk of injury to personnel. Assigning work priorities that reflect the relative importance of each job to facility operation maximizes the effect of maintenance in upgrading safety and reliability. Planning also reduces delays in accomplishing work by ensuring support items such as special tools, personnel protection equipment, and other equipment and repair parts and materials required to accomplish the work are available when needed. This in turn results in increased efficiency and contributes to maintaining a higher level of facility condition as well as assuring worker safety.

Scheduling corrective and preventive maintenance and planned and unplanned outage work is necessary to ensure that maintenance is conducted efficiently and within prescribed time limits. Scheduling daily activities based on accurate planning estimates will improve use of time on the job and help reduce radiological exposure. Scheduling planned outages is important to support the return of the facility to service on schedule (and within the approved budget) and results in improved availability and capacity factors. A contingency work schedule (shutdown file) should be maintained so that if an unplanned outage occurs, the

duration is minimized and effectively used and so that needed maintenance is performed before restart.

Guidelines

Planning Group Organization

Planning maintenance activities can be accomplished by a dedicated planning staff or by maintenance supervisors at facilities with smaller staffs. If a dedicated group is used, it may be established as a central planning group or it may be decentralized, with planners for each discipline working within their respective groups.

A centralized planning group offers the benefit of improving the coordination among the various facility groups and providing a central point to supply planning and scheduling information. A decentralized planning group facilitates a closer working relationship between each planner and the individual shop craft personnel and can lead to increased planner credibility. However, this approach can diminish coordination among the planners.

Planning Group Responsibilities

All work requests (WRs) or work packages should be reviewed by a planner. Different levels of planning attention should be applied to different jobs. The review should address the following items:

- definition of the problem and identification of the work scope;
- identification of personnel hazards expected to be encountered during the maintenance activity, and safe work practices to be used to mitigate and eliminate such hazards;
- identification and review of necessary procedures, drawings, vendor manuals, and maintenance history;
- identification of needed and available data for use in analysis of maintenance problems;
- procurement of necessary repair parts, materials, tools, and equipment;
- assessment of labor and skill requirements for nuclear facility, non-nuclear facility, and subcontractor personnel;
- identification and review of resources, including other tasks scheduled to occur in the immediate area during the same period;
- prejob ALARA planning;

- identification of initial conditions and prerequisites, including applicable TSRs and limiting conditions for operations (LCOs);
- identification of QC inspection requirements, code requirements, and TSRs;
- establishment of equipment restoration and post-maintenance inspection or testing requirements; and
- review of work instructions or work packages for completeness

Planning System

A system of planning, scheduling, and coordinating maintenance work activities should be clearly defined based on the maintenance operations model, which consists of five interrelated processes applicable to each maintenance job. The processes are as follows:

1. Plan Maintenance Job. Identify the scope of a needed maintenance job. Produce a maintenance job plan. Determine the maintenance job planning category, priority, and safety concerns. Identify and procure materials, and identify other maintenance task resources. Prepare the maintenance job package.
2. Schedule Maintenance Job. Calculate the estimated start date and project resources for the maintenance job. Schedule and commit required resources and special tools/equipment items to allow performance of all maintenance tasks within the maintenance job.
3. Execute Maintenance Job. Initiate and perform a maintenance job and collect job information as defined in the maintenance job package.
4. Execute Post-maintenance Test (PMT). Verify that facilities and equipment items fulfill their design functions when returned to service after execution of a maintenance job.
5. Complete Maintenance Job. Perform maintenance job closeout, including completion of all documentation contained in the maintenance job package to ensure historical information is captured.

Work Control Program

A work-control program based on the requirements of DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities,* should be integrated with the planning system. The implementation of this program should ensure that the maintenance activities in nuclear facilities are conducted in a manner that preserves and restores the availability and operability of the SSCs important to safe and reliable facility operation.

Control of Work Backlog

A computerized work-control system should be used to provide the maintenance manager and his/her supervisors with the means for identifying, recording, and tracking the status of all valid WRs. Computerized systems offer the following features that could be helpful in managing the work backlog:

- the ability to sort WRs by deficiency tag, priority, WR date, facility conditions required, and systems affected;
- the ability to indicate the status of all WRs on hold for planning, parts, material, or other constraints;
- the ability to track the status of in progress WRs; and
- the ability to track post-maintenance testing to ensure that all required PMTs are accomplished before a piece of equipment or a system is returned to service.

Work Priority

Each WR related to repairs of production equipment should be reviewed by the operations department to determine its impact on facility operations. Meaningful priorities that determine how soon a WR needs to be worked should be set based on operational and industrial safety and reliability. Communication among cognizant groups should be established to enable proper priorities to be set. A method should be established that avoids congesting the work-control system with jobs that are not important to safe and reliable operation.

The priority system should be kept simple to enhance its use and accuracy; typically, it is limited to about six categories. Corrective maintenance should be assigned a priority based on the maximum time allowed before corrective action must be taken, as well as on the importance of the system or equipment.

Items that should be considered when priorities are assigned to WRs include the following:

- personnel and radiological safety
- equipment repair urgency
- operability of redundant equipment
- operating approval commitments (e.g., TSR, LCO)
- facility conditions required for equipment repair

- status of repair or replacement parts
- ALARA considerations such as exposure and contamination control
- personnel availability
- minimization of the spread of contamination from leaks

Planning, Scheduling, and Coordinating Maintenance Performance Monitoring

Facility management should develop performance measures to monitor the progress toward meeting facility maintenance goals. Progress toward meeting these goals should be evaluated frequently and reported to facility management. The following are typical performance measures:

- rate of activity completion
- percent compliance to the daily schedule
- progress against the schedule
- amount and rate of bulk work (nonscheduled or listed work) completed
- expended worker hours by craft or work group versus planned worker hours
- number of accidental occurrences
- expended man-rem versus planned man-rem
- amount of radwaste generated
- number of skin and clothing contaminations

The performance measures should be monitored frequently to ensure they are valid measures of facility maintenance status. Examples of areas that may be checked to ensure that the progress reported actually reflects real status include the following.

- The rate of activity completion is checked against the projected activity completion, the number of activities remaining, and the time remaining on the schedule to ensure that the current rate supports the scheduled completion date.
- Compliance to the daily schedule is maintained at a high level to ensure that scheduled work is being completed to support the overall facility maintenance goals.
- Progress against the overall schedule is tracked to identify areas where work completion does not support the schedule.
- Bulk work completions should be tracked against remaining resources and time to ensure that bulk work is being completed at a rate that supports the schedule.

- Actual expended worker hours are tracked against the earned value (original estimates) of completed jobs, planned worker hours, remaining scheduled work, and remaining time to ensure that sufficient resources and time exist to complete the maintenance activities as scheduled.
- Other performance measures, such as accidental occurrences, skin and clothing contaminations, and overall exposure, should be tracked to identify areas of concern where actual values are exceeding projections.

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 safety, 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.

Policy

A work-control program is an administrative method by which maintenance activities are identified, initiated, planned, approved, scheduled, coordinated, performed, and reviewed for adequacy and completeness. The program should address the following areas.

- Developing administrative procedures to describe the control of work from identification and planning through completion, review, and storage of historical data. Personnel involved in the conduct and support of maintenance should be trained in using these procedures.

- Identifying the individuals/job titles responsible for performing various types of work (such as packing adjustments, equipment lubrication, and maintenance of health physics portable instrumentation).
- Using WR forms to control maintenance activities. A WR form (and/or work package) should be prepared and used to direct and document maintenance activities. This form should provide for documented review at the appropriate level. WR forms control maintenance activities by ensuring correct equipment energy isolation (e.g., personal locking devices in addition to operational control of lockout/tagout procedures), personnel safety, and the proper conduct of maintenance and PMTs.
- Controlling troubleshooting to prevent unplanned repairs and unauthorized modifications.
- Reviewing requested work to ensure unauthorized modifications are not accomplished by the maintenance request.
- Setting goals for high-quality workmanship, safe work practices, and improved radiological protection and obtaining the support for them from maintenance personnel. A key factor in achieving these goals is work-site guidance and overview provided by maintenance supervisors. Monitoring to identify rework (maintenance that has to be repeated) can be effectively used to identify programmatic or qualification deficiencies.
- Documenting work accomplished and the results of PMTs, including the satisfactory return to service of the equipment or system.
- Reviewing WRs after the completion of maintenance to verify that the activity was satisfactorily completed according to facility procedures and standards and to capture maintenance history data.
- Performing temporary repairs under the facility's temporary modification program to provide engineering review of the adequacy of the temporary repair and a means for identifying required permanent repairs.
- Establishing and maintaining the same policies and procedures for non-facility contractor and subcontractor personnel conducting maintenance on the site as facility personnel.

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Level: Familiar
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The control of maintenance work should support the completion of tasks in a safe, timely, and efficient manner such that safe and reliable facility operation is optimized, and should include the following objectives.

- The work-control system provides management with an accurate status of maintenance planning and outstanding maintenance work.
- Control of work is accomplished through the effective use of a priority system. The backlog of work is effectively managed.
- Work planning includes considerations such as material, tool, and manpower requirements; interdepartmental coordination; safety considerations; radiological protection requirements; and QC requirements. Maintenance history records are considered where appropriate.
- The work to be accomplished is clearly defined by a work document that identifies or includes applicable procedures and/or instructions. Troubleshooting activities are controlled by applicable work documents.
- Advance planning is performed and routinely updated for scheduled and unscheduled outages. Considerations such as work priority, work procedures and instructions, facility/system conditions, length of outage required, pre-staging of documents and material, and coordination of support activities are included.
- ALARA concepts are used in work planning to minimize man-rem exposure.
- Scheduling and coordination of maintenance activities avoids unnecessary removal of equipment and systems from service and uses manpower effectively.
- Post-maintenance testing requirements are clearly defined and include the following: clearly written test instructions,
    - test scope sufficient to verify the adequacy of work accomplished,
    - test acceptance criteria.
- PMT results are documented and reviewed to ensure proper system/equipment performance before returning the system to service.
- Completed work-control documents are reviewed in a timely manner to check proper completion of maintenance work and to verify that corrective action resolved the problem.

Guidelines

Work Control Procedure

Each facility or group of facilities should have an administrative procedure describing the work-control system. Administrative requirements may be contained in separate documents covering individual areas or in one overall procedure that describes the administrative control of maintenance activities. The work-control procedure helps all personnel understand the requirements and controls required for performing work. The basic intent of the work-control system is to identify all facility deficiencies and work needed, avoid redundant identification of deficiencies, and guide the safe accomplishment of work and subsequent post-maintenance activities. If the work-control system does not include modifications, in-service tests, and surveillance actions, the systems controlling these activities should interface with the work control system.

The work-control procedures should describe the WR form, including applicable attachments, and should, at a minimum, address the following:

- personnel responsibilities for identifying and tagging deficiencies and initiating WRs that adequately describe the symptoms or problems;
- supervisory responsibility for controlling the safe conduct of maintenance activities and processing WRs;
- descriptions of the process for initiating and processing WRs, including the pre-job review, approval cycle, and post-job review;
- descriptions of the priorities used to schedule work;
- determinations of the impact of maintenance activities on facility operations;
- work planning and scheduling;
- conduct of routine maintenance planning meetings;
- requirements for personnel and equipment safety and radiological protection (e.g., confined-space entry permits, welding and burning permits, lockouts/tagouts, RWPs, and personal safety equipment);
- post-maintenance testing; and
- collecting data for maintenance history files.

Work Request/Work Order

Maintenance performed on nuclear facility systems should be controlled by the facility WR or by another approved work-control document. The document should clearly define the work to be performed and should include the following items:

- equipment identification;
- name of the person initiating the WR;
- date WR was initiated;
- description of the symptom, problem, or work requested;
- location of equipment and deficiency tag;
- job priority;
- personnel safety and radiation protection requirements or permits (e.g., confined-space entry permit, welding and burning permit, lockout/tagout, isolation, draining, depressurization of the component, and RWPs);
- applicable TSR, time constraints, and associated LCOs;
- qualification requirements (such as environmental and seismic qualifications);
- applicable work instructions and references;
- inspection, safety, or ALARA hold points associated with the work;
- required post-maintenance testing, inspections, and acceptance criteria;
- authorization by the appropriate operations shift supervisor and maintenance supervisor to commence work;
- narrative description of conditions found by the craft personnel;
- documentation of actual work performed with post-maintenance testing and inspection results;
- acceptance of the equipment by operation; and
- final reviews and signoffs by maintenance, QC, and other groups in the WR review cycle

Supervision of Maintenance Activities

First-line supervisors should spend the majority of their time in the field. They should routinely monitor work in progress to help ensure that maintenance activities are conducted safely according to NNSA and facility policies and procedures. Good work practices should be recognized and encouraged; poor work practices should be corrected on the spot. Causes of poor work practices should be identified and corrected, and generic corrective actions should be initiated as needed. Work-site supervisors and good industrial safety practices are

interrelated. Success in safety is achieved by the consistency of policies and procedures applied by supervisors. This is an integral part of the supervisor's total responsibility.

Equipment

Equipment should be selected for special attention under this program based on the criteria below. The selection of certain equipment for special attention under this program does not imply that other equipment is to be ignored; normal care and application of sound technical and management controls are needed for all equipment, as well as for all activities associated with the equipment.

Equipment with a record of frequent operational failures that either have caused or have significant potential for causing loss of production capacity or negative impact on safety (failure information considered should include in-house records as well as information on other facilities available through vendor technical information) should be given special attention.

Equipment whose failure to operate as designed would likely cause significant loss of production capacity because of its importance to the facility should be given special attention.

Equipment with a record of frequent maintenance or rework that has caused inordinate use of maintenance resources or that has caused significant loss of production capacity or actuation of nuclear safety systems should be given special attention.

Equipment that maintains environmental conditions for important operating components should be given special attention.

In addition to regular monitoring by operators, equipment performance should be regularly evaluated by performance tests and analysis of operating and maintenance data.

The following are examples of performance tests that may be included:

- pump speed control system performance
- flow instrument loop calibration
- pump performance
- lube oil system performance
- trip valve performance
- control building air conditioning system performance
- instrument air compressor performance
- instrument air dryer performance
- voltage control system test
- air ejector/vacuum pump performance
- rotating equipment vibration tests
- valve leakage tests

Configuration Management

Configuration management is a discipline that applies technical and administrative direction and surveillance to identify and document the physical characteristics of a facility. It is a method of doing business that maintains consistency among design requirements, physical configuration, and facility documentation. It audits to verify conformance to specifications and related documentation. Such a program can be broken down into five basic programmatic elements:

- program management
- design requirements
- document control
- change control
- assessments

An important aspect of a configuration management program is the assurance that the design basis of an NNSA nuclear facility is established, documented, and maintained. The facility SSCs, and computer software should conform to approved design requirements, and any changes to them must be minimized through an integrated management review process, with established approval criteria.

Integrated Safety Management System

An integrated safety management system (ISMS) is based on the concept that safety requires the involvement of the workers and hands-on contractor line managers. They should determine safe work practices and other hazard-mitigating requirements. The goal of ISMS is to make safety planning an integral part of overall site strategic planning. It uses the concept that safety management should not be an add-on to strategic planning, but a central part of that planning. It is a high-level program that endeavors to integrate environment, safety, and health considerations with the programmatic requirement setting, resource allocation, and budgeting process. It aims to incorporate safety into management and work practices at all levels, addressing all types of work and all types of hazards to ensure the safety of workers, the public, and the environment. ISMS should be the foundation of the budget formulation and allocation process and a primary factor in establishing expectations and accountability.

Human Factors Engineering

Human beings are quite inventive in the kinds of mistakes they can make in any simple or complex system. They may err and cause a chain of events in a system to be broken through failure to perceive a stimulus, failure to discriminate among various stimuli, failure to respond in the correct sequence, misinterpretation of the meaning of stimuli, or physical inability to make a required response. To an equal extent, a given system task is also influenced by hardware performance. Hardware system performance depends on original design intent and industrial engineering reliability that is established by empirical data and failure probabilities.

Human activities in the workplace range from strictly mental to predominantly physical and can vary in type and level of effort or intensity. The output from human activity in the workplace can produce the desired result. However, an individual's response to work or personal relationships, to training or the lack of it, or to physical or mental impediments can produce shortcomings in an entire industrial process. For example, sleep experts recommend 8 hours of sleep per night for good health, safety, and optimum performance. Even if this basic human need is ignored because of the demands of work or an individual's personal life, the human body retains the need for sleep. Lack of sleep can cause workers to fail to complete assigned tasks properly.

To prevent human failures from occurring in maintenance activities at NNSA nuclear facilities, human factors engineering concepts should be incorporated either as part of

original design or as required design modifications are made. Human reactions to unforeseen events are extremely difficult to assess before the events take place. A thorough review of lessons learned from previous events and necessary corrective measures lays a foundation for such an assessment. Some workers become frustrated or excited by the circumstances of events, and they may ignore strict control measures or consider them not applicable to the situation. Posing hypothetical situations provides insights on how people may respond (confidently without hesitation) under normal conditions. However, when procedures, lighting, communications, physical limitations, physiological or psychological demands, stressful mental activity, unreasonable expectations, physical arrangement of displays and controls, or other regular/irregular environmental conditions frustrate or strain them, people, seeking relief, become innovative in ways that can have extremely negative impacts. For example, under the stress of deadlines, maintenance workers might be tempted to disable or override important safety features or interlocks to speed repair work. Situations such as this should be anticipated and specifically controlled through SSC design, training, and procedure compliance. Measures should also be implemented to overcome worker's ambivalence to training and failure to adhere to procedures.

Human factors should be accounted for in the design and operation of NNSA nuclear facilities to ensure that SSCs contribute to their maintainability by accommodating proactive preventive maintenance and reactive corrective maintenance. These maintenance actions include inspecting, checking, troubleshooting, adjusting, replacing, repairing, and service activities.

Other factors that influence maintainability include repair and maintenance support facilities, hot shops, maintenance information, and various aspects of the environment. Human factors efforts are oriented toward improving maintenance activities by:

- reducing the need for and frequency of design-dictated maintenance,
- reducing system/equipment downtime,
- reducing design-dictated maintenance support costs,
- limiting maintenance personnel requirements, and
- reducing the potential for maintenance error.

POST-MAINTENANCE TESTING

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 post-maintenance testing 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 post-maintenance testing 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.

- The responsibilities of each group are clearly defined.
- The scope of equipment tested includes all facility equipment.
- Appropriate tests include 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 a PMT.
- Post-test system restoration is formally controlled (restoring system to normal and/or standby modes following completion of post-maintenance testing).

Policy

Post-maintenance testing is used to determine whether maintenance was performed properly and the equipment operates correctly, and performs its desired functions. A PMT should be

per-formed after corrective maintenance and after some PM activities. The test should be commensurate with the maintenance work performed and the importance of the equipment to facility safety and reliability. In some cases, this may include testing additional equipment to verify system performance. A post-maintenance testing program should include the following elements:

- assigning responsibility for determining PMT requirements using functional groups such as operations, maintenance, and technical support;
- determining the scope of the post-maintenance testing program to help ensure that appropriate levels of testing are applied to facility equipment and that redundant testing is minimized;
- tracking the status of equipment that has undergone maintenance to ensure that all testing is completed before work closeout; and
- conducting proper PMTs, documenting the results, and verifying that the resulting data meet acceptance criteria

Guidelines

Post-Maintenance Requirements

A program should be established to control and document post-maintenance testing. It may be a part of the facility work-control system and may use the facility WR or work package to specify testing, assign responsibility, and document acceptance of all PMTs. The WR should provide specific instructions or cross-reference a test procedure and should provide traceability to PMT data. This may be accomplished by recording the data directly on the WR or by referencing data recorded on PMT data sheets or documents.

Post-Maintenance Program Scope

Because corrective maintenance is performed to correct a deficient condition, most corrective maintenance should have a retest associated with it to verify that the equipment functions properly. Some PM activities also require post-maintenance testing. The rigorousness of the testing performed should be based on the work done and the importance of the component to safe and reliable facility operation.

Post-maintenance testing should be accomplished on safety and non-safety equipment, systems, or activities such as the following:

- maintenance that affects integrity or operation of a liquid or gas system;
- maintenance that affects mechanical strength of components or fittings;
- equipment that is included in special programs, such as the environmental qualification programs;
- maintenance that affects or removes design-approved radiation shielding;
- electric distribution equipment, such as breakers, bus work, or high-voltage connections;
- electric control circuitry, such as protection relays, limit switches, or permissive relays;
- electronic components, such as controllers, circuit cards, and transmitters;
- instrumentation and instrument loops;
- health physics and chemistry instrumentation;
- M&TE; and
- temporary systems that have been installed as substitutes for systems or portions of systems that are normally operational.

If a test is unsatisfactory, the SSC should be tagged to indicate that a deficiency still exists. The owner/operator may tag the component out of service; declare it inoperable; or, depending on the test results and significance of the existing deficiency, return it to service with the documented deficiency.

Equipment that is important to safe and reliable facility operation should be tested according to approved procedures. PMT procedures should contain acceptance criteria that aid in measuring the performance of repaired equipment. Baseline data should be provided, if applicable.

Post-Maintenance Test Control

A program should be established to control post-maintenance testing. When more than one group is involved in the PMT or when the test must be delayed until conditions permit, one organization, such as the operations department, should be responsible for coordinating test performance. The designated organization should review the total work scope to minimize redundant testing. The department performing or having the lead for performing the PMT

should assign an individual with overall responsibility for conducting the test and an individual with responsibility for reviewing test data and determining the acceptability of equipment.

Post-Maintenance Test Performance, Documentation, and Acceptance

The operations department should be assigned responsibility for the operational acceptability of all equipment and systems. Accordingly, operators should normally perform or be closely involved in post-maintenance testing. Maintenance, technical support, QC, and other personnel may also be involved in or called on to perform post-maintenance testing. For tests involving participation of more than one group, an individual in the lead group should be assigned to coordinate testing activities. Post-maintenance testing of minor equipment may be performed by the operator returning the equipment to service, by the craft personnel performing the maintenance, by the engineer after maintenance, or by a combination of these and other needed individuals. The organization responsible for specifying the PMT should review the work performed to ensure that the test is appropriate. Any questions should be resolved with the organization that determined the post-maintenance testing requirements. Operational acceptability of the equipment, based on satisfactory completion of PMTs, should be verified by the operations organization obtaining an appropriate signature on the WR or other reference document. This verification should be made from objective evidence, such as conducting or witnessing the PMT and reviewing completed procedures and documented test results. PMT data and their acceptability should be entered or cross-referenced to maintenance history with the WR.

Deficiencies identified during post-maintenance testing should be documented and corrected on the original WR and on a new WR or on another reporting system before the original WR is accepted as complete by operations. The original WR should reference any new WRs or other documents written to resolve these deficiencies.

If a PMT fails and the equipment or system cannot be repaired and tested satisfactorily in a short time (normally, before the next shift change), the degraded or inoperative status of the equipment should be documented such that operators understand its limitations. The TSR should be consulted for safety equipment, and appropriate actions should be taken until the equipment is properly tested and returned to service.

PROCUREMENT OF PARTS, MATERIALS, 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 (QA) requirements to ensure that parts, materials, and services are available when needed.

Policy

Having the correct part, material, or service available when needed to complete a maintenance activity should be the fundamental objective of an effective procurement program. This is accomplished by establishing clearly defined policies and procedures and by implementing them. Controls on, and assessments of, procurement activities are used to help ensure that proper parts, materials, and services are purchased to support maintenance activities and to meet the requirements for safe and reliable facility operation.

Guidelines

Procurement Policy and Procedures

Policies should be established for the procurement of parts, material, and services. These policies must be understood by stores and purchasing personnel and other personnel who interface with them, such as maintenance supervisors, planning personnel, and scheduling personnel.

Procedures should be prepared that describe the specific responsibilities of personnel involved in the procurement function. Specific procurement actions should be included in these procedures.

Procedures should be prepared to describe specific procurement actions and the specific responsibilities of personnel involved in the procurement of:

- safety-class items,
- safety-significant SSCs,
- critical spare parts,
- major project purchases,
- routine procurement purchases,
- contracted work and services, and
- hazardous materials.

Procurement Initiation

Timely procurement of parts, materials, and services for maintenance activities can be enhanced by considering items such as the following:

- identifying long-lead-time items early;
- selecting procurement sources based on approved vendors and past vendor performance;
- justifying single-source items;
- selecting vendors on the basis of performance, approved listings, and/or design mandate;
- identifying special receiving inspection needs and criteria;
- specifying vendor technical documentation and material safety data sheets, as applicable, as a deliverable;
- identifying appropriate quality, engineering, environmental, shelf life, preventive maintenance, and vendor technical manual requirements;
- updating the spare parts inventory after design modifications; and
- participating in a spare parts system pooled with other facilities that share common or nearby sites.

Procurement Control

Controls should be developed and maintained throughout the procurement process to help obtain parts, materials, and services promptly. Controls such as the following should be provided:

- segregation and status resolution of damaged, nonconforming, or otherwise deficient items.;
- special receiving inspection documentation to support future procurement;
- confidence that initial deliverable quantities and spare part stocking levels are adequate;
- emergency procurement process and practices that ensure that acquired items support safe and reliable application;
- the ability to track procurement status by the requester;
- the ability to track procurement status from receiving through delivery to issue-for-use;
- assurance that procurement documents and controls prevent the delivery or use of suspect/counterfeit parts;
- verification of the reliability of supplier performance;
- prompt and effective resolution of deficiency or nonconformance of items;
- control and maintenance of QA records to provide documentation for qualified parts and materials and to ensure traceability of parts and materials;
- a means of qualifying nonqualified material;
- a method for acceptable substitution to obtain parts that are no longer available from the original supplier, that have new identification numbers, or that have different material specifications;
- review of design requirements by appropriate personnel to ensure that upgraded or substitute parts are consistent with the application of the part and component;
- development of emergency procurement policies and an expediting process to obtain parts, materials, and services that are needed immediately to support safe and reliable facility operation;
- establishment of a parts and materials reorder system that ensures material availability for anticipated usage while minimizing unnecessary inventory;
- identification of multiple applications of requested parts or materials; and

- the ability of the procurement organization to track procurement progress and take necessary measures to meet maintenance and outage schedules.

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.

Policy

Many personnel at a facility are involved in some portion of the stores operation. They should be aware of the correct process to receive, inspect, handle, and store facility material and equipment so that it is easily retrievable and usable when issued. Therefore, policies should be established that address these functions. These policies must be understood by stores personnel and other organizations that interface with them, such as purchasing, QA/QC, engineering, radiological protection, operations, safety, and maintenance. Procedures should be prepared that specifically describe the responsibilities and the techniques for receiving, inspecting, handling, storing, retrieving, and issuing material from stores. QA/QC aspects of the stores function should be incorporated into these procedures.

Materials management should ensure that necessary parts and materials meeting quality and/or design requirements are available when needed and the materials management program should include the following objectives.

- Programs are implemented to order, receive, and issue proper parts and materials for work activities. Stock levels are adjusted, as necessary, to meet facility needs.
- Procurement documents provide clear and adequate technical and QA requirements consistent with design specifications. Areas such as storage, PM, and shelf-life requirements are addressed. Proper engineering control and approval are obtained on any deviation from design specifications for parts or materials.
- Mechanisms are in place to provide for the expeditious procurement of parts and material on a high-priority basis when needed.
- Methods are established to acquire replacement parts not available from the original supplier.

- Material is inspected to ensure conformance to purchasing requirements before release for use and storage. Documentation for received material is accounted for and retrievable. Nonconforming items are identified and controlled to prevent unauthorized use.
- Effective material procurement status is provided, including accurate stock records, tracking of purchase orders, and maintaining traceability of safety-related parts and material.
- Materials are stored and identified in a manner that results in timely retrieval.
- Safety-related parts and components are properly controlled, segregated, and identified in all material storage areas.
- The quality of stored equipment, parts, and materials is maintained by appropriate means such as environmental and shelf-life controls, and preventive maintenance.
- Parts and materials issued for installation are properly controlled. Unused parts and materials are promptly returned to a controlled storage area. Safety-related parts are readily traceable from purchase to installation.
- Flammable and hazardous materials are identified, segregated, and properly controlled during receipt inspection, storage, and issue.
- Equipment and materials used by non-facility personnel are subject to inspection, storage, and issuance controls equivalent to items received through normal facility processes.
- Lessons learned from experience, such as lead times, parts usage, and supplier reliability, are factored into materials management.

Guidelines

When parts, materials, and equipment are received, stores personnel should inspect them before they are accepted for storage or are used. This inspection is conducted to verify that the items delivered agree with the approved purchase documentation, are packaged according to purchase order specifications, have necessary product control requirements furnished by the vendor (such as special storage or shelf-life information), and appear to be in good condition. In the case of safety items and designated critical items important to reliable facility operations, stores personnel should inspect them to ensure that the vendor has supplied what was ordered, that the necessary formal documentation has accompanied the shipment or is otherwise on hand, and that items have been received in an acceptable condition. Technical staff and maintenance personnel may be needed to assist in the inspection of more complicated parts, materials, and equipment.

Technical staff and QC personnel should approve any deviation from design specifications of material or equipment received before the item is accepted into the stores system. They should also approve any upgrade of material or equipment from a non-safety to a safety category. An acceptance tag or label placed on the received material may be used to signify that the receiving inspection was performed and that the applicable requirements have been met.

A separate receiving and inspection area and a separate holding area should be provided. The latter area is used to hold material and equipment that has not been officially received into the stores system because of nonconformance.

Nonconforming material must also be clearly tagged or labeled to prevent its issuance. A tracking or follow-up method should be established to ensure that problems with nonconforming items are promptly resolved.

During receipt inspection, the designated organization should ensure that special storage instructions have been addressed. Before final acceptance of an item, the designated organization should ensure that the necessary purchase order instructions and requirements are completed such as the following.

- The tickler file has been updated as required.
- Appropriate items have been added to the preventive maintenance program.
- Appropriate inspection instructions are clearly defined.

Inspection and test activities should be selectively and judiciously applied to new, repaired, and replacement items on the basis of risk to safety and/or importance to reliable capacity to ensure items will perform as expected.

Handling

A procedure should be prepared for items requiring special handling. It should include information such as weight, size, chemical reactivity, radioactivity, and susceptibility to physical shock, damage, or electrostatic sensitivity. Sling location balance points, method of attachment to the load, and other pertinent factors in handling loads should be clearly identified. Sound handling practices should be followed whether a specific procedure is used or not.

Hoisting and lifting equipment should be certified by the manufacturer, indicating maximum loads to be handled, and the information marked on the equipment. The maximum load capability, as marked on the equipment, should not be violated when handling or moving items. Hoisting and lifting equipment should be regularly tested, inspected, and acceptance tagged to ensure integrity. The facility inspection program for hoisting and lifting equipment and rigging should be applied to items used in the stores operation. Personnel who operate cranes, forklifts, and other lifting equipment should receive performance-based training and be licensed to verify their qualifications.

Clearly defined instructions or job plans, including unusual, unique, or deceptive weight, balance, or lift points and other critical information, should be communicated to the handler for items to be lifted or otherwise handled. Likewise, clearly defined instructions/job plans should be developed and communicated for items that require special handling such as vibration isolation, protection from the environment, specific orientation, etc., to ensure integrity. Calibrated/certified items should be handled in a manner that ensures their integrity is not jeopardized.

Storing Material and Equipment

Material and equipment should be stored in a manner that provides maximum protection and ready availability. Material and equipment should also be stored with due consideration for environmental conditions. For example, preventive maintenance should be performed on large pumps and motors (those having more than 25 horsepower) that are in storage. This includes periodically checking energized heaters, periodically changing desiccant, meggering motors, rotating shafts on pumps and motors, changing oil on rotating equipment, and performing other maintenance specified by the vendor.

A shelf-life control program should be provided for items in stores that are important to safe and reliable facility operation. Various items with finite storage lifetimes (such as paints, recorder paper, adhesives, sealants, valve diaphragms, and gasket material) should be tracked so that stock that has exceeded its shelf life is not issued. Any material reaching the end of its shelf life should receive proper engineering analysis with appropriate vendor input to extend its storage life. If storage life cannot be extended, the material should be disposed of and new material ordered. Reordering/restocking programs should incorporate appropriate lead times to ensure sufficient material with good shelf life is available for issuance.

Safety material and equipment should be segregated from non-safety-related material and equipment to prevent inadvertent use of the wrong category of item. If segregation is not practical, marking and tagging techniques should be developed to preclude use of the wrong material or equipment.

CONTROL AND CALIBRATION OF M&TE

The program for control and calibration of M&TE should be consistent with QA requirements of 10 CFR 830, Subpart A, "Quality Assurance," and should ensure the accurate performance of facility instrumentation and equipment for testing, calibration, and repair. M&TE 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. M&TE devices do not include permanently installed facility process or control instrumentation, nor does the category include test equipment used for preliminary checks where data obtained will not be used to determine acceptability or verify conformance to established criteria.

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 non-nuclear facility contractor or subcontractor groups that are engaged in maintenance activities.

Policy

The control and calibration of M&TE used on safety-class items, safety-related SSCs, or SSCs that affect critical facility performance and reliability play an important role in maintenance and the safe operation of NNSA nuclear facilities. Ensuring that properly

calibrated measuring, tooling and test equipment performs as intended is essential to a comprehensive maintenance program, and is an important factor in enabling facilities to move from corrective maintenance to effective preventive maintenance. A computer-based system should be considered as necessary for the establishment of an M&TE program to allow for frequent updates of M&TE status and permit personnel access to current information as quickly as possible.

Operators depend on installed facility instrumentation for accurate indications, process control actions, and trip functions to operate the facility safely and reliably. The accuracy of the installed instrumentation is established and maintained through the M&TE control and calibration program. Such a comprehensive M&TE program should include the following elements:

- Unique identification numbers on all M&TE that accurately identify the specific devices and provide traceability.
- A current MEL identifying all M&TE.
- Calibration standards that are traceable to a national standard or that themselves are recognized as standards.
- Procedures for calibrating M&TE to help control the performance of calibration and to provide repeatable calibrations and acceptance criteria.
- Establishment of a calibration frequency that helps maintain M&TE accuracy and availability.
- Provision for checking the function of M&TE, when applicable.
- Provision of facilities to control storage, issue, and calibration of M&TE.
- Segregation and marking of M&TE devices with suspected or actual deficiencies to prohibit their use.
- Clear marking to indicate limitations of M&TE devices that are not fully calibrated or usable.
- Records for accountability and traceability of use. A recall system should be developed for recalibrations.
- A maintenance policy that minimizes contamination of M&TE.
- Timely evaluations of M&TE devices found out of calibration or defective to determine the validity of all measurements and/or calibrations for which they were used.

- Trending of M&TE reliability problems to determine if any corrective actions are needed.
- Periodic reviews to determine whether the control of M&TE is effective.

Guidelines

Procurement

Copies of technical manuals with full schematics, troubleshooting sections, spare parts lists, tables of specifications, and calibration procedures should be obtained with each type of equipment. A certificate of calibration and tolerance should be included. Distribution of these manuals should be according to document control procedures.

Identification

Each piece of M&TE should be assigned a unique identification number that is permanently marked on or attached to it (the identification number may consist of the manufacturer's serial number). These numbers assist in identifying, tracing, and controlling M&TE. An MEL of all controlled M&TE should be maintained. If separate organizations control their M&TE, each should maintain or have access to a list of its own equipment.

Calibration Standards

Only calibration standards traceable to NIST or other nationally recognized standards organizations should be used for calibration of M&TE. M&TE should be calibrated using reference standards (secondary or working) whose calibration has a known valid relationship to nationally recognized standards or accepted values of natural physical constants. If national standards do not exist, the basis for calibration should be documented. The reference standard used should have accuracy at least four times greater than the device under test. If this accuracy ratio cannot be met, analysis of the errors should be estimated to provide a valid uncertainty of the calibration process. If repair or calibration of a standard is necessary, the recalibration must be traceable to NIST or to the standard of record for the M&TE. Calibration standards maintained at the facility should be kept in calibration facilities in designated storage locations. If calibration standards are issued for field use, the supervisor responsible for them should authorize and minimize the period of issuance. Issuance of laboratory standards for field use should be discouraged. Standards should be calibrated on a frequency consistent with vendor recommendations and facility experience. Calibration records for standards should be consistent with those of all other M&TE.

Calibration Procedures

Calibration of equipment should be performed by qualified technicians using approved procedures. These procedures should be written and should contain the following.

- Precautions or limitations.
- Calibration standards to be used and their accuracy.
- Calibration instructions and data sheets for as-found and as-left data.
- Acceptance criteria for each scale, expressed as a range and in the units that are being measured (e.g., represent 9.75 volts as 9.726-9.774 volts rather than as 9.75 volts ± 0.25 percent). Acceptance criteria should be rounded up on the - side and down on the + side to be within the range of accuracy of the instrument being read.

Calibration Frequency

Frequency of calibration should be determined based on the manufacturers' recommendations, M&TE usage, and M&TE historical reliability. Consideration should be given to the amount and type of M&TE available for use compared with that needed to support periods of peak activity such as outages. This information can help determine calibration frequency and schedule requirements that result in adequate M&TE support for facility needs.

Measuring and Test Equipment Repairs/Out of Calibration

M&TE found to exceed required calibration tolerance or that has been subjected to possible damage should be identified as rejected. When repairs are required to standards or other M&TE, they should be recalibrated to the original requirements before being returned to normal service. When calibration/certification is performed, the as-found condition and/or minor adjustments to the M&TE should be noted as part of the equipment history information.

When M&TE is suspected or actually found to be inoperable, unreliable, defective, or out of calibration, all data recorded since the previous calibration by affected equipment should be identified through the usage record. A prompt evaluation should be performed to determine the need for corrective action. This evaluation should be documented on a gross-error report. The appropriate owner/operator of the affected equipment should evaluate the validity of all applications and data derived since the previous calibration, determine their disposition, and establish the nature and timing of corrective actions, if necessary.

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Date: 1/15/04

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 for the development of special tools and equipment needed in the maintenance program.

Policy

A program for storing, issuing, and maintaining tools and equipment is needed to accomplish maintenance activities effectively and efficiently. The process of providing tools and equipment should include proper storage and issuance controls. Crafts persons should be readily able to obtain the tools and equipment they need to perform maintenance and then return them as soon as practicable after completing the work. Tools and equipment should be kept in a state of readiness, some by inclusion in the preventive maintenance program. Proper preventive maintenance can also result in improved personnel safety and extended life of tools and equipment.

A system should exist which provides for tool and equipment control in the maintenance organization. This system should include unique identification of controlled items and documentation of their issue and return. Additionally, the system should provide for storing, issuing, and maintaining tools and equipment to enhance efficient and effective maintenance activities.

Crafts persons should be provided an initial issue of tools of the trade for day-to-day use. Based on need, special tools should be drawn from controlled storage and returned as soon as reasonable after completion of the task.

All worn or damaged tools should be repaired or replaced. Tools should be regularly inspected and serviced, on the basis of recall program controls, to ensure they:

- remain safe to use,
- are in a high state of readiness for use, and
- do not prematurely require replacement.

The process should provide the supervisor with opportunities to exercise an active role in encouraging individual innovation when new and/or special tool and equipment needs exist.

Guidelines

Storage and Issuance

Special tools and equipment are sometimes obtained temporarily from other sources, such as a vendor or contractor. A method should exist to identify availability of, and sources for, these special tools and equipment so that they can be obtained and made ready for use when needed. When these special tools and equipment are at the facility, they should be controlled in the same manner as other tools and equipment.

Policies governing the control of tools and equipment should be clearly established. Policies and procedures should emphasize personnel accountability and item traceability. These policies should address all aspects of tool control, including inventory, issue, tracking, use, and return.

An inventory system should be established for tools and equipment. This inventory should be computer-based, compatible with existing facility inventory systems, and adaptable to daily supply changes.

A computer-based issuance and tracking system should be established, using a bar-code identification attached to tools or to containers of equipment. Permanent laser-affixed codes should be used where possible to prevent inadvertent loss of identification. Items should be marked where possible with a unique identification number, to provide a specific tracking mechanism. Pre-inventoried containers of tools and equipment may be identified as single units if the contents are inventoried and restored after use.

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Perform an inventory of all maintenance tools and equipment at least annually and after major planned outages. The quantities of tools and equipment should be compared to previous inventories and significant changes investigated. The inventory list should include equipment items such as chain falls, lifting rigs, and scaffolding, as well as all tools. This inventory should be maintained by a single organization that is also responsible for the storage, issuance, and control of tools and equipment. The following items, as a minimum, should be addressed in the storage-and-issuance process:

- Potentially contaminated and contaminated items should remain within the radiation area (RA) until verified by the appropriate authority to be clean and safe to remove.
- A job-planning process goal should be to ensure that the proper items are available in the quantities required to support scheduled maintenance requirements.
- Instrument/motor/pump pools should maintain a supply of critical items for designated applications.
- Reuse of repaired items should be encouraged to keep them in a high state of clean, safe, and reliable readiness.
- Specialty tools should be identified and stored for ready retrieval.
- Unusable items should be segregated from normal items for dispositioning and to prevent inadvertent issue for use.
- Instructions should be developed to define responsibility and accountability for the proper storage and issuance of controlled items.
- The system should provide for storage areas that segregate items to prevent cross-contamination or wrong selection for issue.
- The system should provide for designating and controlling storage, laydown, and staging areas.
- A method should be established that provides for inventory listings of specialty and controlled tools and equipment and that may be used to communicate applicable information to potential users.

Tool and Equipment Maintenance

The following items, as a minimum, should be included in the tool and equipment maintenance process.

- Regular-issue hand tools should be checked by the user to ensure safe, reliable use.
- A recall system should be established for the periodic inspection of welding, lifting, hoisting, and rigging equipment, and for safety devices and personnel safety equipment. The recall system should also provide for scheduled equipment and tool inspection (including some portable hand tools such as electrical drill motors) based on the risk to safety and the importance to reliable use.
- When worn or defective items are identified, a method should be established to remove them from service and to segregate them from normal items to prevent unsafe use.
- Unrepairable tools and equipment should be disposed of as soon as practical.
- The system should provide for repair/replace decisions based upon established guidelines for worn/damaged/defective tools and equipment.
- Instructions should be developed which define responsibilities regarding deficiency-tagged equipment.

Tools and Equipment in Radiation Areas

An adequate supply of tools and equipment dedicated for exclusive use in RAs should minimize the number of unnecessarily contaminated tools used to perform work in the RA. The control of these tools, including issuance, decontamination, inventory, and repair, should be assigned to a single facility department manager, such as the maintenance or radioactive materials controls department manager.

A sufficient supply of RA tools and equipment should be established for routine maintenance needs to prevent introduction of additional non-contaminated items. The input and the cooperation of all maintenance work groups are required during maintenance planning to determine the types and numbers of tools and equipment needed.

Control all RA tools and equipment as radioactive material. Controlling these items as radioactive material makes workers aware of the potential hazard associated with the use of these tools and assists the facility in properly retaining each item in the RA. The following controls should be incorporated.

- Handle potentially contaminated tools and equipment according to applicable facility procedures.
- Mark or label each potentially contaminated item as radioactive material.
- Label or mark all containers of temporarily stored RA tools and equipment such as barrels, toolboxes, "gang" boxes, crates, etc., as radioactive material, along with the identity of the contents, the levels of radioactive contamination, and the radiation dose rates, according to applicable facility procedures.
- Designate storage areas for highly radioactive tools and equipment that may cause high-radiation areas. These areas may need to be shielded and locked and should be as remote as possible from traffic areas. High-radiation areas should be controlled according to applicable facility procedures.

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.

Policy

The appearance and proper functioning of facility systems and equipment are key indicators of a well-maintained and -operated facility. Good facility condition, cleanliness, and housekeeping can be established and maintained by knowledgeable individuals who are alert to onsite deficiencies and who take prompt corrective action. Additionally, there should be a periodic, focused inspection effort, by thoroughly trained personnel, to assist in effective identification and correction of facility deficiencies. The maintenance of systems and equipment within design conditions produces such benefits as minimizing fluid leakage, minimizing control room alarms caused by malfunctioning equipment, and maintaining environmental integrity of equipment. Providing easier access for operations and maintenance activities by reducing the sources and spread of radioactive contamination constitutes another benefit of good facility condition and housekeeping.

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Properly used, a facility condition and housekeeping inspection program is an effective means for identifying and correcting deficiencies. The following elements should be included in the inspection program.

- Facility managers should set high facility condition and housekeeping standards and communicate them to all personnel to promote a clear understanding of these standards.
- Appropriate personnel should receive training in inspection techniques.
- Facility managers and supervisors should personally participate in inspections.
- Inspection areas should be assigned to ensure that the entire facility is periodically inspected, including areas with difficult access (e.g., high-radiation areas and locked areas).
- An inspection coordinator should be assigned to implement, schedule, and monitor the effectiveness of the inspection program.
- Deficiencies identified should be reported and corrected promptly, thus allowing personnel to see the positive results of the inspection program.
- A condition assessment survey with assigned risk assessment code could be used to prioritize schedules for repair.
- Instructions could be prepared to establish the program and define responsibilities for conducting inspections, correcting deficiencies, and accomplishing other tasks associated with the program, such as on-the-spot correction of minor deficiencies. What are considered minor deficiencies, who is allowed to correct them, and the limitations and documentation associated with this type of work should be clearly defined.
- Inspection guidelines and criteria could be prepared to assist the assigned inspectors in performing their inspections.

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The material condition of the facility is maintained to support safe and reliable plant operation and should include the following objectives.

- Systems and equipment are in good working order; examples of this include the following.
  - Fluid system leaks are minimized.
  - Equipment is appropriately protected from adverse environmental conditions.
  - Instruments, controls, and associated indicators are calibrated, as required.
  - Good lubrication practices are evident.
  - Fasteners, supports, and safety systems are properly installed.
  - Equipment and SSCs are properly preserved and insulated.
- Material deficiencies are identified and are in the work-control system.
- Temporary repairs are minimized and permanent repairs are made when conditions permit.
- Temporary environmental protection (e.g., dust, humidity, freeze, shock) is provided for facility equipment when needed to support construction, outage, or maintenance activities.
- Newly installed or modified systems/equipment are verified to be in good working order before operational acceptance by the facility staff.

Guidelines

Setting standards involves management establishing an atmosphere of proper work ethics; positive attitudes; and specific expectations that are realistic, that are within the capabilities of the staff, and that are consistent with sound engineering judgment and good economic practice. Standards must be communicated effectively to all personnel so that they are clearly understood. Facility managers and supervisors should conduct routine inspections to assess adherence to these standards. Indicators of good facility condition and housekeeping standards include the following.

- Rotating equipment operates according to design specifications.
- Equipment is properly serviced.
- Fluid system integrity is maintained.
- Temporary repairs are recorded and controlled by the facility temporary modification program. Permanent repairs are scheduled when facility conditions permit.

- Instruments and gauges are operational, calibrated, on scale, and indicate values representative of the existing system and equipment conditions.
- Energized electrical and electronic equipment is operative, supplied from normal power sources, and protected from adverse environmental effects such as leaks and overheating.
- Protective cabinet doors and electrical enclosure covers are installed to maintain design integrity.
- Equipment and systems are insulated to control heat transfer to or from the environment, to control ambient noise levels, and to promote personnel safety.
- Facility equipment and systems subject to corrosion are protected with a preservative to minimize corrosion.
- Temporary environmental protection is provided, where appropriate.
- Industrial safety and radiological hazards are minimized.
- Walkway and equipment access is maintained.
- Equipment is clean.
- Station areas, rooms, and grounds, including the storage areas for needed tools and materials, are maintained in a clean and orderly condition.
- Coatings or coverings used to seal walls and floors in potentially contaminated areas are in good condition and assist in controlling contamination.
- No unauthorized modifications or changes to the facility exist.
- Illumination of areas, rooms, and grounds is maintained to provide sufficient light to perform inspections and minor maintenance.

Conducting Inspections

The following process applies to the conduct of inspections.
Each department manager or his/her designated representative should conduct an inspection of his/her assigned inspection zone during the week scheduled. The inspection may be conducted as one evolution or as a series of smaller inspections during the week.

Each inspection should include detailed walk downs of the inspection zone. Key areas to consider are out-of-the-way and limited-access areas. The inspection should not only identify deficiencies; it should also identify corrective actions being taken to improve facility conditions. In this manner, the program serves as a positive feedback mechanism.

Subordinates should be included on inspections-periodically. This should provide a method

to teach inspection techniques and convey high standards.

The owner/operator should accompany each department manager periodically to ensure his/her (owner/operator's) standards are adequately understood by other department managers.

MANAGEMENT INVOLVEMENT

To ensure the safety of NNSA facility operations, NNSA, contractor, corporate, and facility managers should be technically informed and personally familiar with conditions at the operating facility. Responsible NNSA 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, NNSA, contractor, corporate, and facility managers should periodically review the maintenance programs to verify that the programs are accomplishing their objectives and are upgraded as needed.

Policy

Maintenance performance should be checked by observing people at work; by inspecting, monitoring, and checking equipment; and by following up promptly on corrective actions. Key assistants and selected supervisors should also be trained to perform these types of activities.

A high profile by management during frequent, nonscheduled, individual tours of work areas on- and off-shift provides first-hand observation of actual conditions and an opportunity to communicate expected performance standards through appropriate and timely recognition/feedback directly to individuals regarding either positive or negative observations. It also provides an opportunity to seek involvement in and to establish ownership of approved actions at the level closest to and directly involved in performance improvement.

The following objectives should be used to improve facility maintenance performance.

- Specific objectives for maintenance organizations are published and kept current.
- Objectives address areas where improvement is needed. Objectives are challenging and set at the level of performance desired by management. Objectives are stated in measurable terms.
- Where appropriate, action plans with specific milestones are used to help achieve objectives and improve the level of performance.
- Maintenance division objectives are consistent and complement contracting organization and facility objectives.
- Responsibilities are assigned for achievement of specific objectives. Assignments reflect actions needed by each contributing department to achieve common objectives.
- Personnel understand the actions necessary, within the scope of their duties and responsibilities, to achieve the objectives.
- Managers and supervisors are held accountable for the achievement of assigned objectives.
- Management reviews are periodically conducted to assess progress toward achieving objectives and to determine changes in planned actions necessary to achieve them.

Guidelines

Managers should include time in their schedules for walking through the facility. This time should be directed at improving face-to-face communications and feedback at all levels of the maintenance organization. Maintenance management should establish the percentage of time that first-line supervisors are expected to spend supervising fieldwork. The workload of first-line supervisors should be monitored and adjusted to allow them sufficient time monitoring work in the field. Facility tours and personnel contacts should also be planned for irregular hours (including selected weekend or back shift inspections) and should cover selected facility areas and personnel activities. The results and observations of these tours should be documented and reviewed for action.

Rules, responsibilities, and accountability between NNSA and contractor and facility managers should be clearly delineated and communicated to all levels of the maintenance organization. NNSA managers should be responsible and accountable for the management and maintenance of NNSA assets according to federal regulations, DOE directives, and

contractual agreements. NNSA contractors should be responsible for the operation, management, and maintenance of NNSA nuclear facilities according to commitments and agreements for satisfactory deliverables under the contract.

Performance Indicators, Goals, and Objectives

The results of maintenance performance indicators, goals, and objectives and other related information should be developed, trended, and reported to provide feedback. This feedback should be used by senior management in the progress and feedback reviews.

A well-structured, formal quality management program should be developed in the maintenance organization. Various councils, task analysis teams, and engineering and technical support groups should continually review.

- significant program elements to determine and recommend opportunities for maintenance program improvement,
- critical work in progress,
- system and procedure applicability,
- real-time and historical data,
- root-cause resolution,
- activity intervals and acceptance criteria,
- value-added new technology for acquisition potential,
- project status,
- non-facility maintenance personnel performance, and
- site planning.

Problem Analysis

Root-cause analyses of unplanned, recurring, and persistent maintenance problems, incidents, and outages that impact safe and reliable operations, although historically performed, have only recently adopted formal methodologies to systematically and clearly lead to their effective resolution. The root cause is seldom a single factor.

The criteria for acceptable root-cause resolution are as follows.

- Implementation should prevent recurrence of the problem.
- The proposed action is feasible.
- Implementation should not adversely impact safety, reliability, or operational goals.
- The proposed action results in long-term improvement and generic applicability.

A plan defining the acceptable root-cause corrective action should be developed, documented, approved by applicable managers, implemented, and tracked to validated completion. Analyses and corrective action plans should include generic applicability to similar items, training and qualification programs, documentation revision, maintenance activities, and tool availability.

Program Reviews

Inspections, audits, reviews, investigations, and self-assessments are necessary parts of an effective maintenance program. Senior managers should periodically review and assess elements of the maintenance program. These assessments can assist line managers and supervisors in the identification and correction of program deficiencies. An evaluation of each maintenance program element should be conducted at least every other year and should include inputs from maintenance managers and supervisors and other groups, such as operations, technical staff, and appropriate corporate departments. This evaluation should address the overall effectiveness of the program element. It should also address interorganizational and intraorganizational coordination problems that create work delays and reduce productivity. Areas needing improvements should be assigned for corrective action and follow-up.

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.

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Policy

One objective of a good equipment maintenance history program is the ability to readily retrieve equipment maintenance, performance, and reference information to improve facility reliability. The work-control system may be useful as a maintenance history data collection tool. The maintenance history program should provide a system to document component identification and description, vendor reference information and correspondence, diagnostic monitoring data, corrective and preventive maintenance or modification information, and spare parts information. This system may be maintained centrally or locally by the group responsible for collecting the data. In either case, easy access should be provided to all groups needing the information. The historical data, combined with operating experience at similar facilities, operating logs and records, and facility performance monitoring data, can be effective in analyzing trends and failures in equipment performance and adjusting the maintenance program. The maintenance history program should clearly define systems and equipment to be included, data to be collected, methods for recording data, and uses for the data.

Maintenance history should be used to support maintenance activities, upgrade maintenance programs, optimize equipment performance, and improve equipment reliability and should include the following objectives.

- Maintenance history records are computerized and maintained for SSCs and equipment that affect safe and reliable facility operations.
- Maintenance work and inspection/test results are effectively documented.
- Maintenance history records are appropriately considered in planning for corrective maintenance, modifications, and preventive maintenance.
- Maintenance history records are readily available for use.
- Maintenance history is periodically reviewed to identify equipment trends and persistent maintenance problems and to assess their impact on facility reliability. Maintenance program adjustments are made or other corrective actions are taken as needed.

Guidelines

Program Development

The maintenance history program should clearly define the safety systems and equipment that require documentation and retention of historical data according to the MEL for which maintenance provides support. In addition, non-safety equipment requiring repeated maintenance should be considered for inclusion. The MEL could provide much of the information for the system. Alternatively, if the MEL is computerized, the history files could be cross-referenced to it.

Normally, components are grouped by system; however, in cases of like components such as valves, circuit breakers, and controllers, it may be more appropriate to group components by type.

The maintenance history file for each component should include the following four sections:

- component identification and description
- maintenance records
- diagnostic monitoring data
- vendor correspondence

ANALYSIS OF MAINTENANCE PROBLEMS

Systematic analysis should be used to determine and correct root causes of unplanned occurrences related to maintenance. 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.

Policy

An analysis program should be established to investigate unplanned occurrences that have an impact on safety or reliability or that are of a recurring nature, indicating that corrective actions have not been effective in solving their root causes. The symptom(s) of an unplanned occurrence should be addressed. However, for long-term corrective action, it is necessary that the root cause of the problem be determined and corrected.

An analysis program should include the methodical collection of facts describing the unplanned occurrence. These facts should then be reviewed from the standpoint of management controls and engineering and human performance perspectives to pinpoint probable causes for the unplanned occurrence.

Guidelines

Information Collection

When all initial information related to the unplanned occurrence is collected, additional information pertinent to the investigation should be identified and obtained. This may include diagnostic information, operating procedures, vendor-recommended maintenance requirements, maintenance schedules, recommended maintenance that was not accomplished, information related to personnel training and qualifications and adequacy of communications, maintenance procedures, and relevant information obtained from documentation of maintenance history.

Event Analysis

The purpose of the analysis phase is to reconstruct the event. A detailed sequence of facts and activities is developed and the event's apparent causal factors are identified and categorized into human performance or equipment performance problems.

Cause Determination

The possible causes of a problem should be evaluated by one or more techniques or methodologies to establish a root cause. The root cause should meet three criteria: (1) its correction should prevent recurrence of the unplanned occurrence; (2) its correction should be feasible; and (3) its correction should not adversely impact safety, reliability, or operational goals.

Corrective Action

When all the causes involved have been determined, a corrective action plan should be developed, executed, and tracked to completion. The plan may be as simple as initiating a maintenance request for repair, changing a preventive maintenance frequency, counseling personnel, or modifying the training program slightly. It may also be extensive, such as developing and installing a major modification, procuring long-lead-time parts and materials, contracting for specialized services, revising procedures, and training personnel for continued operation and maintenance of the installation.

Quality Assurance

Contractors responsible for a nuclear facility are required to implement an NNSA-approved quality assurance program (QAP) according to 10 CFR 830, Subpart A, "Quality Assurance." Consequently, a QAP that applies to the maintenance management program should already be in place at each NNSA nuclear facility. The QAP should include ten criteria for the management, performance, and assessment of work so that it meets requirements. One of the criteria explicitly requires that items be maintained to prevent their damage, loss, or deterioration. A maintenance management program established using the QAP will satisfy that explicit criterion and address the other QA criteria in an integrated fashion.

MODIFICATION WORK

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.

Policy

Modifications to SSCs may impact many aspects of the maintenance program. These modification-required changes should be recognized at an early enough date that they may be incorporated into the maintenance program before maintenance work begins on the modified SSC.

Temporary modifications should be controlled to ensure necessary personnel are aware of all changes and the expected duration of temporary modifications and that temporary alterations made to facility SSCs do not unacceptably alter or degrade the original design, facility safety, or reliability. The number and duration of temporary modifications should be minimized. Use of this guideline should control temporary modifications by requiring them to be adequately identified, reviewed, approved, documented, and periodically reassessed for continued applicability.

A temporary modification is any short-term alteration made to facility SSCs that does not conform with approved drawings or other design documents.

Guidelines

Maintenance Program Interface with Modifications

A modification is a planned and controlled change to a permanent facility SSC that is accomplished according to the requirements and limitations of applicable procedures, codes, standards, specifications, licenses, and predetermined safety restrictions identical to or commensurate with those of the item being modified.

Facility maintenance personnel should be cognizant of the effects of modifications on structures, systems, and equipment. After modifications, the required changes to documents such as drawings, procedures, spare parts lists, and vendor information should be accomplished before the structure, system, or equipment is operated and any subsequent maintenance activities are conducted.

The maintenance program should require that all plant modifications be reviewed under a change control program to identify future required maintenance activities and should specify that these activities be added to the maintenance programs, as applicable.

Temporary Repairs or Temporary Modifications

Temporary repairs are temporary modifications to the plant that allow equipment to remain in or be returned to service in a condition that is not the same as the original design specification. Before implementation, temporary repairs should receive a safety review according to the facility temporary modification program to ensure the adequacy of the repair and its effect on personnel and equipment safety and reliability.

Temporary repairs should be tracked after their completion for consideration of permanent repairs. Permanent corrective action should be taken as soon as practicable.

Reviews and Audits

All operations personnel on shift should review the temporary modification log every shift as part of their shift turnover process to ensure that they are aware of all existing temporary modifications. They should also review the log before each mode change to ensure that no temporary modifications need be removed or have further evaluations completed.

The owner/operator should perform a monthly review and audit of the log for administrative errors. This review also should identify those temporary modifications no longer needed,

past their expected duration, or installed for more than 3 months. The number and duration of temporary modifications should be minimized.

SEASONAL/SEVERE WEATHER AND ADVERSE ENVIRONMENTAL CONDITIONS MAINTENANCE

Seasonal facility preservation includes developing and implementing a plan to address severe weather and environmental and wildfire conditions, referred to as "severe conditions," for the safe operation and preservation of NNSA nuclear facilities.

Policy

The fundamental objective of an effective severe conditions facility preservation plan should be to ensure continued safe facility operations. This objective requires that appropriate controls be established for inspections and self-assessments of severe conditions facility preservation plans to ensure correction of deficiencies or preparation of other compensatory measures to protect NNSA nuclear facilities.

The plan should clearly define responsibilities, accountabilities, and interfaces for each functional organization supporting each step in the plan. A severe conditions facility preservation plan, as a minimum, should include steps to address.

- cold weather, including freezing conditions, hail, snow, and ice;
- flash floods and mud slides;
- hurricane watches and warnings;
- tornado watches and warnings (high winds);
- extreme hot/dry weather; and
- wildfires.

Guidelines

Plans should be developed, implemented, and documented to prevent equipment and building damage at NNSA facilities because of severe seasonal and environmental conditions. A task team should be established to develop and implement policies, goals, and objectives for severe conditions protection plans. Buildings and equipment with the potential for damage from seasonal weather conditions should be identified, and a risk assessment based on the graded approach should be conducted. The plan should include contingencies for the critical facilities or equipment that are likely to sustain damage when severe conditions are expected.

The plan should ensure that the preparatory actions and requirements imposed to provide severe conditions protection are reviewed by facility operations and safety personnel before implementation to ensure that the facility is maintained in a safe condition to protect the health and safety of the public.

As a minimum, this plan should address the following.

- a checklist for building managers to ensure the implementation of actions to provide protection for their assigned areas of responsibility before severe conditions;
- identification of items requiring major modifications or redesign to mitigate/prevent equipment damage;
- specific responsibilities for the operations staff and building managers for monitoring the temperatures in facilities on and off shifts, including weekends and holidays;
- provisions for alerting personnel and providing increased surveillance in periods of extreme, unusual, or extended severe conditions;
- adequate foul weather and fire protection gear, tools, and equipment are available for use for emergency and operations personnel;
- the recalibration of exposed instrument loops when instrument lines or transmitters are subjected to severe conditions;
- a review of the status of safety related equipment during severe conditions and assurance inoperable equipment is available for return to service, if possible;
- a review of surveillance schedules and considerations given to performing surveillances early, if possible, or delaying them until after the severe condition passes, if permitted, to minimize equipment out of service;
- inspection of outside areas for loose materials and debris, which may become missiles in a strong wind, and securing to the maximum extent possible;
- the availability of adequate lumber and other supplies for wind protection or damage control;
- verification of operability and availability of communications equipment;
- identification of plant vehicles needed for emergency use and ensuring vehicles have a full tank of fuel and are in good repair;
- the availability of equipment for making emergency repairs;
- ensuring materials susceptible to severe conditions damage are properly stored and protected;

- ensuring the protection of accumulation site waste containers and bulk chemicals from potential damage as a result of seasonal hazard;
- ensuring all building doors and windows can be properly secured; and
- provisions to remove seasonal weather protection features after the weather season is over with appropriate verification and documentation of return to normal service through the facilities configuration management system

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 the practice.

Change No: 0
DOE: O 433.1
Level: Familiar
Date: 1/15/04

EXAMPLE 2

1. List the elements that may be included in the program implementation and baseline activities portion of the site maintenance plan.

2. List the items that are considered when assigning priorities to maintenance jobs.

3. Describe the elements that should be included in a post-maintenance testing program.

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 the practice.

Change No: 0
DOE: O 433.1
Level: Familiar
Date: 1/15/04

EXAMPLE 2 SELF-CHECK

1. List the elements that may be included in the program implementation and baseline activities portion of the site maintenance plan.
   - site maintenance policy
   - a description of the contractor's application of the graded approach
   - a brief description of the contractor's management and coordination of maintenance-related activities
   - description of the implementation of Chapter I elements for real property maintenance
   - a description of the site's personal property maintenance program

2. List the items that are considered when assigning priorities to maintenance jobs.
   - personnel safety
   - mission impact
   - operability of redundant equipment
   - critical path equipment
   - potential for environmental release and damage

3. Describe the elements that should be included in a post-maintenance testing program.
   - Test requirements are identified by the appropriate technical authority.
   - The scope of the post-maintenance testing program is determined.
   - The status of equipment that has undergone maintenance is tracked.
   - Proper post-maintenance tests are conducted, the results documented, and the resulting data verified to have met acceptance criteria and appropriate sign off obtained.

Change No: 0
DOE: O 433.1
Level: Familiar
Date: 1/15/04

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 general level. You will need to refer to the Orders 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. Discuss the use of quantitative indicators in maintenance management.

2. Discuss the types and level of environmental controls and services to be included in a maintenance shop or satellite work area.

3. Discuss the purpose of procedure validation.

4. Discuss the purpose of a work-control program.

5. State the types of items or purchases that require procurement procedures.

6. Discuss the guidelines for tagging measurement and test equipment.

7. Discuss the elements that should be included in a facility condition inspection.

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8. State the objective of a good equipment maintenance history program.

9. Define the term "temporary modification."

10. Discuss the conditions that should be addressed in a severe conditions facility preservation plan.

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.

Change No: 0
DOE O 433.1
Level: General
Date: 1/15/04

DOE O 433.1
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 perform the following:

1. List the key elements you would look for in the contractor's action plan to correct the situation described in the scenario; and

2. State which requirements, sections, or elements of U. S. Department of Energy (DOE) O 433.1 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 433.1, Familiar Level, 12/15/03.
DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, 6/1/2001.
DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*.
DOE M 411.1-1B, *Safety Management Functions, Responsibilities, and Authorities Manual*.
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Change No: 0
DOE O 433.1
Level: General
Date: 1/15/04

INTRODUCTION

The familiar level of this module introduced the purpose and scope of DOE O 433.1. 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. You are not required to complete the example. However, doing so will help prepare you for the practice and criterion test.

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 these questions.

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.

SCENARIO
On November 18, 2002, a security police officer (SPO) was attempting to operate a roll-up door in the Building 12-98 straddle ramp area 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 assure 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 walk down 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, 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, 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.

Take some time to review the example scenario and the contractor actions taken to correct the situation. Then decide if all the correct actions were considered and if the appropriate DOE

Directive(s) requirements (from those included in this module) were selected. Write your answer below, and then compare your answer to the one 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 following questions.

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.

SCENARIO

On November 1, 2002, the fire-water sprinkler system for the office annex froze, and a pipe tee broke and discharged firewater into the annex, which resulted in considerable water damage before the fire water 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 of the outside are 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 that 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 dead 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.
- Clean up 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.

Take some time to review the scenario and the actions the contractor took or did not take to correct the situation. Then decide if the contractor's actions were complete and correct. Finally, determine if the requirements, sections, or elements of the DOE Directives cited in the scenario were correct.

Write your answer 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.