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Chg 1: 6-14-13

Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1B

U.S. Department of Energy
Washington, D.C. 20585

FOREWORD

This Implementation Guide is approved for use by all Department of Energy (DOE) and National Nuclear Security Administration (NNSA) organizations and contractors. Throughout this Guide the use of the term DOE includes DOE and NNSA.

DOE Guides are part of the DOE Directives System and are issued, as described in DOE Order (O) 251.1C, *Departmental Directives Program*, to provide acceptable, but not mandatory means for complying with requirements of an Order or Rule. Alternate methods that satisfy the requirements of an order are also acceptable. DOE O 251.1C requires justification of any implementation selected "to ensure that an adequate level of safety commensurate with the identified hazards is achieved." DOE Implementation Guides cannot be made mandatory by reference in an Order, Notice, or a Technical Standard.

This Guide is recognized by DOE as providing acceptable approaches for implementing requirements for Nuclear Maintenance Management Programs (NMMPs) set forth in DOE O 433.1B Admin Chg 1, *Maintenance Management Program for DOE Nuclear Facilities*. As such, application of this Guide should facilitate the efficient use of time and resources in developing NMMPs, and result in the favorable review and approval of programs, processes, and Nuclear Maintenance Management Program Description Documentation (NMMP-DD) for implementing and demonstrating compliance with DOE O 433.1B requirements.

DOE review and approval authorities should be familiar with the implementation guidance contained in guides when reviewing and approving programs for implementing and demonstrating compliance with requirements of an Order or Rule. Accordingly, this Guide is appropriate for use by review and approval authorities as a benchmark for determining if alternate methods used in whole or part are justified and demonstrate compliance with DOE O 433.1B requirements for NMMPs.

Beneficial comments (recommendations, additions, deletions, and any pertinent data) that may improve this document should be sent to:

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I. INTRODUCTION

A. PURPOSE

This implementation Guide has been prepared to assist Maintenance Managers in understanding and meeting the requirements of U.S. Department of Energy Order (DOE O) 433.1B Admin Chg 1, *Maintenance Management Program for DOE Nuclear Facilities*, referred to as DOE O 433.1B hereafter. The Guide also helps DOE employees in the approval and oversight of DOE nuclear maintenance management programs (NMMPs). It is especially useful for review and approval authorities as a benchmark for determining if alternate methods used are justified and demonstrate compliance with DOE O 433.1B requirements.

DOE O 433.1B requires DOE facility operators to develop and implement an NMMP for Hazard Category 1, 2, and 3 nuclear facilities under DOE cognizance. An acceptable NMMP consists of processes to ensure that structures, systems, and components (SSCs) are capable of fulfilling their intended function as identified in the facility safety basis. This Guide provides guidance for implementing program NMMP elements in a manner that would be acceptable to DOE for meeting the requirements of the Order.

To further clarify the scope of the Order, the term **"Structures, Systems, and Components (SSCs) that are part of the safety basis"** includes "Safety-Class and Safety-Significant SSCs; other systems that perform important defense-in-depth functions; and equipment relied on for the safe operation and safe shutdown of the nuclear facility, and for maintaining the facility in a safe shutdown condition as documented in the safety basis (e.g., DSA). Support systems to Safety SSCs that are required for the safety functions are also included." .

This Guide may also be used for development of the maintenance program required in DOE O 430.1B Chg 2, *Real Property Asset Management*, for facilities not covered by DOE O 433.1B. The requirements of DOE O 430.1B also apply to nuclear facilities. The NMMP may serve as the single program to satisfy the requirements of both Orders. The Nuclear Maintenance Management Program Description Documentation (NMMP-DD) can be utilized to document the implementation of maintenance requirements in DOE O 430.1B and the implementation of maintenance for SSCs that are not part of the safety basis of a nuclear facility.

The Order requires both DOE and contractor personnel to perform assessments. Guidance is provided for the various types of assessments and associated scopes. This guidance may also be used for contractor assurance systems. The approved NMMP-DD provides a description of the locally implemented maintenance program and should be the basis for assessing program execution.

Examples in this Guide are for illustration, to aid in understanding the guidelines. The examples should not be construed as the only methods for meeting the intent of the Order.

B. APPLICABILITY

This guidance applies to all DOE elements involved in the maintenance of DOE hazard category 1, 2, and 3 nuclear facilities, and automatically applies to DOE elements created after it is issued. This includes both Government-owned and Government-operated (GOGO) and Government-owned and Contractor-operated (GOCO) nuclear facilities. The applicability of this Guide is the same as the applicability of DOE O 433.1B.

This Guide provides acceptable, but not mandatory methods for meeting the Order's requirements. Alternative methods that satisfy the Order's requirements are also acceptable. (DOE O 251.1C par. 5.d.(1)) However, any implementation selected must be justified to ensure achievement of an adequate level of safety (commensurate with the hazards).

C. OVERVIEW OF THIS GUIDE

The remainder of this Guide is divided into two sections (Section II and Section III) to provide guidance on general requirements and maintenance program elements of the Order. These sections are followed by three Appendices.

Section II of this Guide covers the general requirements and includes guidance for the Application of Graded Approach, one especially important element of the General Requirements of DOE O 433.1B. General requirements are also covered within Section I of this Guide.

Section III provides guidance on each of the 17 maintenance program elements, which are identified as *Specific Requirements* in Attachment 2 of the Order. The topics are organized and numbered in the Guide following the same structure outlined in the Order:

A. Integration with Regulations and DOE Orders and Manuals (and their CRDs);
B. Maintenance Organization and Administration;
C. Master Equipment List;
D. Planning, Scheduling, and Coordination of Maintenance;
E. Types of Maintenance;
F. Maintenance Procedures;
G. Training and Qualification;
H. Configuration Management;
I. Procurement;
J. Maintenance Tool and Equipment Control;
K. Suspect and Counterfeit Items;
L. Maintenance History;
M. Aging Degradation and Technical Obsolescence;
N. Seasonal Facility Preservation;
O. Performance Measures;
P. Facility Condition Inspection;
Q. Post Maintenance Testing.

Each Sub-Section for the 17 maintenance program elements includes:

- Order Implementation Guidance: a statement of the Order requirements followed by guidance for the items that the NMMP should address.
- Additional Background/Guidance Supporting Implementation and Procedure Development: more detailed guidance useful in supporting development of the NMMP.
- Some sections also include example forms and checklists.

In addition, the Guide includes three appendices:

Appendix A: NMMP-DD Options and Examples

Appendix B: NMMP Assessment Guidance

Appendix C: Definitions, Acronyms, and References

II. NUCLEAR MAINTENANCE MANAGEMENT GENERAL REQUIREMENTS

This section provides implementation guidance regarding the NMMP and the NMMP-DD, application of the graded approach, and two additional elements of the general requirements part of DOE O 433.1B (i.e., incorporation in the Documented Safety Analysis (DSA) and review of the NMMP as part of the Unreviewed Safety Question (USQ) process). Not all general requirements of the Order are explained in this Guide, as some general requirements are self explanatory in the Order and do not need further guidance. Subsection II.A addresses the NMMP; subsection II.B addresses the NMMP-DD; subsection II.C addresses the application of the graded approach' and subsection II.D addresses NMMP changes.

A. NUCLEAR MAINTENANCE MANAGEMENT PROGRAM

DOE O 433.1B requires DOE facility operators develop and implement an NMMP for Hazard Category 1, 2, and 3 nuclear facilities under DOE cognizance. In accordance with DOE O 433.1B, the NMMP must describe the safety management program for maintenance and the reliable performance of structures, systems and components (SSCs) that are part of the safety basis at hazard category 1, 2 and 3 DOE nuclear facilities. In accordance with DOE O 433.1B, the NMMP must clearly address the 17 elements of maintenance identified in Section 2 of Attachment 2 of DOE O 433.1B (Section III of this Guide provides implementation guidance on these).

Beyond the administrative requirements regarding (1) the scope of and areas to be addressed by the NMPP and (2) the timeframes for implementation and review, the Order provides broad latitude for operating organizations in defining their NMMP to best suit their mission and organizational environment.

B. NUCLEAR MAINTENANCE MANAGEMENT PROGRAM DESCRIPTION DOCUMENTATION

DOE O 433.1B requires NMMP description documentation be, at a minimum, an applicability matrix or a combination of multiple documents that covers: (1) Correlation of the requirements to the applicable facilities; (2) Correlation of the implementing documents (i.e., procedures, work instructions, etc.) to the specific requirements; and (3) Documentation of the basis for applying a graded approach, if applicable.

DOE O 433.1B requires each organization to develop a NMMP-DD that addresses the topics listed in the Order and that the NMMP-DD be submitted to DOE for review and approval. Re-submission for review and approval is required at least every three years.

Sites with more than one nuclear facility and/or contractor may develop a consolidated NMMP that can accommodate the facility differences without losing effectiveness.

The Order states that the NMMP-DD can be anything from "a manual" to "a combination of multiple documents," to "an applicability matrix, as a minimum." The Maintenance Implementation Plan (MIP) that was required by the previous revision of DOE O 433 served a similar purpose to the NMMP-DD. In practice, MIPs varied from a very thick manual with much detail to an applicability matrix that simply lists the procedure documents associated with

each element of maintenance. Most MIPs included an applicability matrix; some MIPs also included a description of the overall maintenance program.

MIPs can be converted into NMMP-DD and compliance with the current Order can be achieved with a NMMP-DD that is only an applicability matrix so long as it identifies the document(s) that document: (1) the basis for applying the graded approach and (2) the implemented (or planned) site-specific methods for satisfying the Order's requirements for each of the 17 elements of maintenance (based on a graded approach, if applicable).

An "applicability matrix", as used in context of this Guide, is a table listing a set of applicable procedures and other associated documents and sometimes listing the applicable paragraph numbers of sections of the documents. An applicability matrix does not contain any narratives or explanations of the listed documents.

It is recommended that the applicability matrix include/list a single document that provides an overall summary of the NMMP. This summary should be written at a level that comprehensively describes the big picture of the implemented (or planned) site-specific methods for satisfying the Order's requirements for each of the 17 elements of maintenance (based on a graded approach, if applicable). An appropriate title for this document is "NMMP Summary-Level Description" or "NMMP Summary". A recommended practice is for this NMMP Summary to contain an assessment of strengths and weaknesses along with a listing and explanation of the planned continuous improvements (if any).

C. APPLICATION OF GRADED APPROACH

Attachment 2, paragraph 1.e. (3) of DOE O 433.1B requires federal and contractor organizations to submit NMMP-DD that provides "Documentation of the basis for applying a graded approach, if applicable." The graded approach methodology ensures the level of rigor for implementing the Order's 17 maintenance management elements is based on their importance/significance and associated consequences.

Graded approach, as defined in 10 Code of Federal Regulation (CFR) Part 830, *Nuclear Safety Management*, means the process of ensuring that the level of analysis, documentation, and actions used to comply with a requirement are commensurate with:

a. The safety, safeguards, and security function provided;

b. The magnitude of any hazard involved;

c. The life-cycle stage of a facility;

d. Programmatic mission of a facility;

e. Particular characteristics of a facility;

f. The relative importance of radiological and non-radiological hazards; and

g. Any other relevant factor.

DOE contractors should use knowledge of their nuclear facilities and sound engineering judgment to determine the depth of detail and magnitude of resources required for implementing each of the Order's 17 maintenance management elements.

The method of and basis for applying the graded approach should be documented and address:

- How the graded approach defined in 10 CFR Part 830 was used;
- Where it was applied (e.g., for a specific SSC, or a group of SSCs); and
- Why it was used and how it ensures an adequate level of safety for this SSC (or group of SSCs).

Appendix A provides additional guidance for applying the graded approach.

D. NMMP Changes

General Requirement 1.h requires that NMMPs are identified in the applicable Documented Safety Analysis (DSA). When combined with General Requirement 1.a, there is an expectation that the newly approved NMMP will be the Safety Management Program (SMP) for maintenance and reliable performance of SSCs that are part of the safety basis. This change should take effect upon approval of the NMMP-DD by DOE and review(s) under the Unreviewed Safety Question (USQ) process. The next annual DSA update should reflect this change. 10 CFR Part 830, Subpart B, Appendix A, Table 4 expects that the Administrative Controls section of the Technical Safety Requirements provide information on the commitments to SMPs.

The NMMP-DD should be incorporated into the facility safety basis maintenance safety management program as specified in the applicable 10 CFR Part 830 safe harbor. Changes to the NMMP-DD should be evaluated within the facility's USQ process. The implementation period should be addressed in the DOE approval letter for the NMMP. .

General Requirement 1.i requires review of proposed changes to an approved NMMP, under the USQ process, if the proposed changes could affect the performance of Safety SSCs. However, as an SMP for a nuclear facility 10 CFR 830.203(d) requires all changes to the NMMP, which is incorporated into the DSA to be reviewed pursuant to a DOE-approved USQ procedure. Title 10 CFR 830.203(e) requires DOE approval prior to taking any action to implement the change. The Functions, Requirements, and Authorities (FRA) documents generally identify the Approval Authority for changes affecting the safety basis.

The Order does not define whether changes to the NMMP that are not USQs require DOE approval, other than the three-year review cycle. The NMMP-DD should indicate what other types of changes, if any, must be submitted to DOE for approval, and at what level such changes can be approved.

III. NUCLEAR MAINTENANCE MANAGEMENT PROGRAM ELEMENTS

In each of the following sub-sections, the Order requirement is identified and followed by implementation guidance which is the essential guidance that provides an acceptable, but not mandatory means for complying with requirements of an Order or Rule, (in accordance with DOE O 251.1C). Additional good practices/background guidance as well as detailed guidance useful in supporting development of maintenance program implementation documents and some examples then follows, where appropriate.

To support ease of finding the guidance for each of the Order specific requirements, a new page of this guide starts each of these sub-sections.

A. INTEGRATION WITH REGULATIONS AND DOE ORDERS AND MANUALS (AND THEIR CRDs)

A.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B and using a graded approach as applicable, the NMMP must be integrated with applicable programs (e.g., Safety Management Programs) and requirements identified by Federal regulations and other DOE Orders and Manuals (and their CRDs) to include:

Orders and Manuals:

1. DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*
2. DOE O 414.1D, *Quality Assurance*
3. DOE O 420.1C, *Facility Safety*
4. DOE O 430.1B, Chg. 2, *Real Property Asset Management*
5. DOE O 440.1B Admin Chg 1, *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees*
6. DOE O 422.1, *Conduct of Operations* (formerly DOE O 5480.19)
7. DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities* (formerly DOE O 5480.20A)
8. DOE O 436.1, *Departmental Sustainability*
9. DOE O 458.1, Admin Chg 3, *Radiation Protection of the Public and the Environment* (formerly DOE O 5400.5)
10. DOE O 450.2, *Integrated Safety Management*

Code of Federal Regulations (CFRs):

1. 10 CFR Part 830, *Nuclear Safety Management*; Subpart A, *Quality Assurance Requirements*
2. 10 CFR Part 830, *Nuclear Safety Management*; Subpart B, *Safety Basis Requirements*

3. Integrated Safety Management System (ISMS) provisions contained in 48 CFR Part 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution*
4. 10 CFR Part 835, *Occupational Radiation Protection*
5. 10 CFR Part 850, *Chronic Beryllium Disease Prevention Program*
6. 10 CFR Part 851, *Worker Safety and Health Program*

The NMMP should address the following:

- Implementation of the requirements, policies, processes, and procedures contained in each of the above directives and regulations; including integration with the processes and procedures that implement the requirements of DOE O 433.1B; and
- How the NMMP is the safety management system for defining the maintenance of SSCs consistent with expectations outlined in the DSA.

The description document should address such items as how maintenance supports the safe operation and is integrated with the following safety basis related elements: Documented Safety Analysis (DSA); including Technical Safety Requirements (TSR), the Unreviewed Safety Question (USQ) process, Quality Assurance (QA) Program, Configuration Management (CM), and Integrated Safety Management (ISM).

NMMP implementing documents should integrate or reference related requirements from the associated DOE directives and federal regulations listed in the Order. Personnel knowledgeable of these related requirements should be involved in the development and review of these procedures and instructions.

A.2 ADDITIONAL BACKGROUND/GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

Subject matter experts in areas such as oversight and self-assessment, quality assurance, nuclear safety, radiological controls, and training developed the requirements in the above directives and regulations. Rather than repeat all these requirements and associate guidance here, and potentially create conflict between governance, these requirements and appropriate implementation guidance are left in their own source documents, guides, and standards. Local implementing governance can be organized as best suits the local organization to refer to or integrate such requirements.

A.3 EXAMPLE DOCUMENTS

The example Applicability Matrix included in Appendix A includes all the above directives and regulations to show the corresponding local procedures or other related documents.

B. MAINTENANCE ORGANIZATION AND ADMINISTRATION

B.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must clearly address the management structure that applies sufficient resources (e.g., oversight and independent assessment, management involvement, funding, assignment of personnel roles and responsibilities, facilities, tools, and equipment) necessary to support the requirements described in this attachment and ensures integration with other programs.

The NMMP should address the following:

- The organizational structure, including roles and responsibilities of key positions in the organization;
- Staffing levels and resources, including a description of how these levels and resources were determined to be adequate to accomplish assigned tasks;
- Interfaces with supporting groups, such as Quality Assurance, Materials Management, and Radiological Controls;
- Processes in place to actively encourage personnel to provide feedback and develop methods to improve safety, reliability, quality, and productivity;
- Performance objectives and indicators that are used to improve maintenance performance;
- How management and supervisory personnel will monitor and assess facility maintenance activities to improve all aspects of maintenance performance. This should include a description of how:
    - Line managers and supervisors will personally take part in monitoring and assessing maintenance activities;
    - Frequently tours of the plant and observations of ongoing work are expected;
    - Observations are documented and effective corrective actions are taken for noted problems;
    - Senior managers will monitor the assessment activities of their subordinate managers and supervisors;
    - Management and supervisory assessments, and improvement efforts will be performance-oriented;
    - Assessments by other independent groups, such as QA, will be used by line managers and supervisors as a management tool to assist them in assessing maintenance performance; and
    - Selected maintenance data reflecting facility performance are analyzed and trended, and the results are forwarded to appropriate levels of management.
- The process for determining root causes for problems identified during monitoring of maintenance activities and by analysis of trends, and how corrective actions are initiated and tracked to completion.

B.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

The maintenance management structure should ensure sufficient resources (e.g., oversight and independent assessment, management involvement, funding, assignment of personnel roles and responsibilities, facilities, tools, and equipment) to support the NMMP meeting the requirements of DOE O 433.1B and the expectations described in this Guide. The maintenance management structure should provide for integration with other programs.

To achieve a high level of performance in facility maintenance senior management should: establish high standards; communicate these standards to personnel who perform maintenance; select and train high-quality personnel; provide sufficient resources to the maintenance organization; set goals and objectives; closely observe and assess performance; effectively coordinate maintenance activities with operations and other facility organizations; and hold workers and their supervisors accountable for their performance. In addition, senior management should provide time for and emphasize long-range planning, as discussed in Section III.D, *Planning, Scheduling, and Coordination of Maintenance.*

Contractors should establish maintenance processes (including procedures and programs), considering input from maintenance staff and craft workers, as well as from operations, health physics, industrial safety and engineering (including the Cognizant System Engineer, CSE). These processes should clearly define maintenance objectives, responsibilities, and accountabilities. They should also be communicated to the workers by training them in good work practices and by making sure that supervisors observe and guide work activities. Supervisors and managers through direct observation and development of maintenance reports should closely monitor performance in maintenance. Progress toward achieving goals should be examined to measure the effectiveness of the maintenance organization performance. Remedial training should be provided when appropriate.

To ensure the safety of DOE facility operations, DOE and contractor corporate and facility managers should be technically informed and personally familiar with conditions at the operating facility. These responsible managers should visit the facility, assess selected activities and portions of the facility; and leave a written record of their observations.

Additionally, these managers should periodically review the maintenance programs to verify that they are effectively accomplishing their intended objectives and are upgraded as needed. Section B.2.2 addresses management involvement, performance indicators, goals and objectives, results, progress and feedback reviews, and maintenance program reviews needed for a safe, reliable, effective, and efficient maintenance program.

B.2.1 Guidelines - Maintenance Organization and Administration

B.2.1.1 Maintenance Organization Policies

Maintenance management has the primary responsibility to ensure implementation of contractor management and facility policies that affect the maintenance organization. Maintenance organization procedures should support these policies and clearly identify the responsibilities for their implementation. Maintenance personnel should clearly understand their authority, responsibility, accountability, and interfaces with other groups. Based on these policies, procedures, and other definitive documentation should be developed to guide maintenance

organization activities. These documents should specify the types of controls necessary to implement maintenance policies. See Section III.F. Maintenance Procedures.

B.2.1.2 Maintenance Strategy

Working Relationships Each facility should develop an integrated approach to maintenance that encourages effective working relationships among all organizational units that support the maintenance function [e.g., operations, health physics, stores, Quality Control (QC), engineering, procurement, and modifications]. The working relationship strategy should include the following:

- Supporting group responsibilities;
- Lead responsibilities; and
- Mechanisms for issue resolution.

Nuclear facilities and their responsible organization should have Memorandums of Agreement (MOAs) or Understanding (MOUs), or other formal documentation that is reviewed annually and updated as necessary to succinctly communicate what each supporting department is to provide (i.e. critical spare parts, fully trained skill of the craft staffing, tools, equipment, WO and PM record keeping, Master Equipment List, etc.). The management of both organizations should approve documentation.

Maintenance Planning Effective management of the maintenance program involves establishing a scope of major activities that shows how funding and staff resources can be managed to meet the needs of the maintenance program. Maintenance planning should consider issues such as the following:

- Recurring major maintenance items such as restoration or renovation of systems or facilities;
- Timing of planned major 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 methods, processes, and approaches/alternatives to performing work;
- Government and industry issues, events, and lessons learned that may impact the maintenance program;
- Budget guidance that may affect maintenance funding; and
- Contractor and corporate long-range support.

B.2.1.3 Staffing Resources

The Maintenance Manager is responsible for selecting high-quality personnel, for effectively using available resources, for assessing resource adequacy, and for making recommendations to the appropriate manager regarding needed change. The manager should be involved in defining entry-level criteria and in screening new personnel. Entry-level criteria should ensure that maintenance personnel have the requisite background and experience to be trainable for work in nuclear facilities. High quality personnel should be selected to establish a staff of supervisory,

Subject Matter Experts, engineering, planning, technical (craft workers), warehousing, and other personnel needed to support the maintenance program. Adequate engineering support should be available (e.g., CSEs who are actively involved with such daily maintenance activities as troubleshooting and evaluating unusual conditions).

The maintenance staff should have sufficient personnel and time to conduct training activities. A training and qualification program should be developed for maintenance supervisors, planners, craft workers, and warehouse personnel, to ensure that high-quality performance is achieved and maintained. See Section III.G. Training and Qualification

B.2.1.4 Goals and Objectives

Maintenance goals should be established and used as a management tool for involving cognizant facility groups in improving maintenance performance and for measuring maintenance effectiveness. The current value and the expected value of the parameter should be considered to ensure the goal established is challenging but achievable. The responsible maintenance manager should develop action plans for meeting the goals, with input from personnel involved in conducting maintenance activities. Through this process, maintenance effectiveness can be monitored and improvements achieved. See Section III.O, *Performance Measures*, for the selection and use of performance indicators.

B.2.1.5 Accountability

Managers, supervisors, engineers, planners, craft workers, warehouse personnel, and other personnel who support maintenance should be recognized for their performance. Rewards and other forms of positive recognition should be given for superior performance. Personnel involved in significant or frequent violations of maintenance requirements should be encouraged to improve through counseling, remedial training, or disciplinary measures, as appropriate. Performance feedback should be provided by performance appraisals and managerial or supervisory discussions and feedback to each individual. Each employee should be aware of their responsibility to report problems or unanticipated conditions to their supervisor. Each employee should understand they are accountable for performance of their activities and the areas in which they need to improve.

B.2.1.6 Status Reports to Managers

Managers identify what is important to them by what they monitor. Managers should receive periodic reports on the status of various programs and on the status of action items. Managers should monitor items that are nearing the completion date to verify that due dates will be met. Managers should deal with overdue items, ensure appropriate action is taken, and the item is resolved. See Section B.3, *Management Involvement*.

Undesirable performance trends should be assessed to determine the contributing and root causes. Corrective actions should be developed and implemented to correct undesirable conditions.

Follow-up on the effectiveness of corrective actions for deficient conditions should be scheduled as part of the management-monitoring program to determine whether the immediate condition has been corrected and the root causes eliminated. Some cases will require monitoring of the immediate corrective actions and, after sufficient time for completion of all corrective actions,

subsequent monitoring to determine whether recurrence of the condition is minimized. Based on the results of the follow-up monitoring, the item can be closed or a new corrective action may be required. Closeout methods should be streamlined to prevent a backlog of completed items.

B.2.1.7 Causal Analysis and Event Prevention

Problems, whether identified by management assessment, outside organizations, or events should be analyzed to determine underlying causes so effective corrective actions can be developed and implemented. The causal analysis should be graded to an appropriate level depending on factors such as safety, complexity, mission significance, and cost. Particular emphasis should be placed on deficiencies or causal factors identified as having generic implications, i.e. where there may be a broader extent of the condition.

Causal analysis methods should be applied to event investigations, undesirable trends in quantitative indicators, and performance deficiencies noted in monitoring reports. For example, if a deficient condition exists because of personnel performance, the underlying cause(s) may be one or more of the following:

- Erroneous, incomplete, or unusable procedures;
- Insufficient or incorrect training;
- Insufficient supervision caused by lack of monitoring, accountability, or improper standards; and/or
- System or equipment design deficiencies.

Corrective Actions Corrective actions should address the analyzed causes rather than the symptoms of the problem. The objective of causal analysis should be to identify failures at an appropriate level. Where possible, corrective actions should prevent not merely a reoccurrence of the specific problem, but also prevent other problems, which may result from that same cause. Corrective actions should be developed with input from appropriate facility and staff members, including those tasked with implementing the actions, to achieve ownership of the corrective actions. Facility line management should approve corrective actions and ensure the actions are implemented in a timely manner. Input from organizations such as quality assurance (QA) or corporate support/oversight groups should be considered when determining actions in response to deficient conditions they identified. Management should track corrective actions' completion and effectiveness.

Responsible managers and supervisors should be held accountable for the timely and effective implementation of corrective actions. Delays in the completion of approved corrective actions should be brought to the attention of the responsible manager who assigned the corrective actions. An escalation process should provide higher levels of management attention to problem areas where corrective action continues to be incomplete or ineffective.

Use of Operating Experience Programs should be in place to ensure the timely review of in-house and external industry operating experience to incorporate lessons learned into maintenance programs and practices. Management should use this operating experience in assessing performance and in performing causal analyses of problems. Management should have mechanisms in place to ensure that significant in-house events are promptly provided to the industry for use by other facilities.

Another aspect of operating experience involves visits to or communications with other facilities (benchmarking). Maintenance division managers, supervisors, and workers should take opportunities to visit and communicate with other facilities both to help solve specific problems and to learn different approaches to the routine business of operating facilities.

B.2.1.8 Management Control of Plant Configuration

Management should ensure that plant configuration, including the manner in which the facility is maintained, conforms to the established design basis requirements. Many routine activities, if carried out improperly, can have an adverse impact on facility configuration and cause eventual equipment damage or increase the probability or consequences of a significant event. Effective control of facility configuration requires rigorous attention to detail as well as the understanding and commitment of every member of the maintenance organization to observe and report/record material condition and status. See Section III.H, *Configuration Management*, for more details.

B.2.1.9 Document Control Administration

Workers should ensure documents are the current, approved versions before use. The maintenance document control program should ensure technically correct and readily accessible information is provided to support maintenance activities. Technically accurate and approved information written in a clear and concise format is needed to support safe and reliable maintenance operations. The document control system should ensure that only authorized technical information is available for the performance of maintenance activities. Controlled information should include maintenance procedures, maintenance plans, maintenance policy manuals, maintenance records and documentation, drawings, vendor technical manuals, and maintenance correspondence.

The document control system should provide for the timely receipt, processing, distribution, retention, storage, and retrieval of documents originating both within and outside the maintenance organization. More than one department may share the responsibility for document control. For example, one department may be responsible for the control, updating, and distribution of drawings and another responsible for maintaining maintenance procedures and retention and storage of maintenance documents including technical manuals. Controls should be established outlining the responsibilities and authorities of individuals or groups associated with document control. A master control file of maintenance documents should be maintained, with access to change documents limited to designated personnel. Satellite files of controlled maintenance documents should be established as necessary to support maintenance operations. Responsibility for maintaining satellite files should be clearly defined.

B.2.1.10 Procedures

A formal systematic program should be established for the preparation, review, approval, distribution, and revision of maintenance procedures to ensure continued accuracy and usability. The program should ensure the review and updating of maintenance procedures at regular intervals.

All maintenance procedures should use a uniform procedure format. An administrative procedure should be developed that provides the prescribed methods of formatting, content

determination, and numbering maintenance procedures. See Section III.F, *Maintenance Procedures*, for details.

B.2.1.11 Vendor Information

The receipt, processing, and distribution of vendor technical information relating to the systems or components installed at the facility should be controlled to the same level as facility documentation applicable to the same SSC. The proper performance of maintenance activities is strongly dependent upon the availability and use of accurate, up-to-date vendor technical information.

The application of controls on vendor manuals depends on the intended use of the manual. If detailed procedures have been developed for use in the conduct of maintenance, then vendor manuals should be used only as reference source material and so marked. If vendor manuals are intended as replacements, substitutes, or supplements for maintenance procedures, then their use should be controlled in the same manner as maintenance procedures. Vendor manuals should be reviewed for completeness, accuracy, and applicability before initial use. Vendor manuals should be treated as maintenance documents, with maintenance management/document control retaining responsibility for maintaining the manuals current. See Section III.F, *Maintenance Procedures*, for more details.

B.2.2 Guidelines - Management Involvement

B.2.2.1 Management Involvement

DOE and contractor corporate and facility managers should be involved and know what is going on in their facility by touring it frequently. The high profile by management conducting frequent nonscheduled individual tours of work areas both 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 involve and establish ownership in approved actions at the level most directly involved in improving performance.

This encourages individuals at all levels to take pride in their accomplishments and motivates first-line supervisors and craft workers to accept responsibility for the early detection of opportunities for improvement. This degree of management involvement promotes timely escalation of significant problems/concerns to the level of management having resolution authority. Maintenance management should also establish the expectation for first-line supervisors to spend a percentage of their time supervising fieldwork, and should monitor and adjust their workload accordingly. These tours by management and first line supervision may be selectively based on concerns resulting from program reviews or other feedback. The results and observations of these tours should be documented and reviewed for action. Fewer errors, higher standards, and improved morale can result.

In addition to first-hand observations, Maintenance Managers ensure effective knowledge-based decisions using factual information from a variety of sources. These sources include key performance indicator trend review, critical self assessments, exception reports, problem and corrective action status tracking, lessons learned and alert system reviews, daily and weekly

review of staff activities, customer feedback, craft worker input, historical data, and regulatory requirements.

Rules, responsibilities and accountability between DOE and contractor and facility managers should be clearly delineated and communicated to all levels of the maintenance organization. DOE managers should be responsible and accountable for the management and maintenance of DOE assets in accordance with federal regulations, DOE directives, and contractual agreements. DOE contractors should be responsible for the operation, management, and maintenance of DOE nuclear facilities in accordance with commitments and agreements under the contract. The contractor managers should ensure that environmental, safety, and health (ES&H) functions and activities become an integral part of their work planning and execution process.

DOE involvement in the oversight of nuclear facility maintenance programs should include reviews by the DOE facility representative, field and area offices, and Headquarters. Inspections, audits, reviews, investigations and continuous self-assessment are necessary ingredients to achieving excellence in maintenance activities. Whether DOE or contractor, senior managers should periodically review and assess elements of the maintenance program for effectiveness and to identify areas of needed improvement. A comprehensive assessment of maintenance program elements should be conducted periodically and should include input from managers and supervisors from maintenance and other groups such as operations, technical staff, and appropriate corporate departments. See Sections III.M and P for facility inspection techniques and Appendix B for assessment guidance.

B.2.2.2 Management Monitors Performance

The results of maintenance performance indicators, goals and objectives, and other related information should be developed, trended, and reported to provide feedback to senior management for use in the progress and feedback reviews discussed below. See Section III.O, *Performance Measures*, for the development and use of performance indicators, goals, and objectives.

Management should ensure there is an effective process for identifying and analyzing problems. The process should include collecting relevant data, conducting a causal analysis to identify the root cause and appropriate corrective action(s), and follow up to determine the effectiveness of the corrective actions and whether it has generic implications.

Inspections, audits, reviews, investigations, and self-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 periodically and should include inputs from maintenance managers, supervisors, and other groups, such as operations, technical staff, and appropriate corporate departments. The evaluation should address the overall effectiveness of the program element and any inter- or intra-organizational coordination problems that create work delays or reduce productivity. Areas needing improvements should be assigned for corrective action and follow-up. The program elements to be considered in this evaluation are those identified in the Order and this Guide as Elements III.B-Q**.**

B.2.2.3 Problem Analysis

Problem analysis is addressed in Section III.O, *Performance Measures*.

B.2.2.4 Information Collection

Problems should be coded and clearly defined to permit status tracking and trending. In addition to maintenance history files, information pertinent to the most recent occurrence is valuable during problem analysis and may be obtained from:

- WRs/WOs;
- Shop floor activity logs;
- Strip-chart and other recording devices;
- Operator statements (facts and symptoms);
- Troubleshooting results;
- Craft worker statements; and/or
- Industry experience.

Information and data gathered from the most recent occurrence should be recorded as maintenance history.

B.2.2.5 Feedback

Management should set aside time to actively solicit and encourage written or verbal feedback regarding concerns or suggestions for improvement from all affected individuals and organizations including line, staff, support (craft workers, planners, engineers, etc.), and customers regarding performance concerns and opportunities for improvement at all levels of the maintenance organization. Feedback should be evaluated and actions that result in improved maintenance services implemented. The individual providing the feedback should receive a timely response from management that explains the rationale for either no action or alternate action, and indicates status of the suggested action.

Concerns that involve broad areas of responsibility should be addressed by project teams consisting of representatives from all affected crafts and organizations. These project teams should be given the necessary time to provide effective action.

Application of lessons learned from in-house maintenance experiences (and the experiences of other facilities) is essential for long-term success. Management should use information about problems encountered during maintenance activities to improve performance.

B. 2.2.6 Program Reviews

Management should periodically review and assess the maintenance program in accordance with the facility self-assessment program as addressed in DOE O 226.1B.

C. MASTER EQUIPMENT LIST

C.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include a process for developing, implementing, managing, and maintaining the Master Equipment List (MEL) at a level that clearly identifies the Structures, Systems, and Components (SSCs) that are part of the safety basis.

The NMMP should address the following:

- Development and maintaining up-to-date of a comprehensive listing of SSCs that are a part of the safety basis; and
- How the MEL will be used by maintenance and support personnel to identify and apply appropriate controls to maintenance.

C.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

10 CFR 830 Subpart B, Nuclear *Safety Management*, and DOE O 420.1C, *Facility Safety*, require formal definition of minimum acceptable performance of Safety Structures, Systems, and Components (SSCs) in the Documented Safety Analysis (DSA). This is accomplished by first defining a safety function, then describing the SSCs, placing functional requirements on those portions of the SSCs required for the safety function, and identifying performance criteria that will ensure functional requirements are met.

A product of initial safety basis development and updates should be a listing of these SSCs, which is then used to develop and maintain the MEL. The MEL clearly identifies all SSCs that are part of the safety basis, thus requiring controls that are more rigorous. The organization may include in the MEL and the nuclear maintenance program those non-safety SSCs to which they chose to apply rigorous controls.

Within the design change and/or configuration management process, the facility should evaluate changes/modifications to identify any necessary updates to the MEL. The work planning process should include checking equipment, which will be effected in the MEL to determine if special controls are required in the maintenance package.

While an approved hard-copy list of all SSCs that are part of the safety basis is acceptable, typically the MEL is maintained electronically in the facility's computerized maintenance management system and includes all facility equipment, with the safety basis items coded for identification. Thus, the MEL can be an index with many uses, including periodic maintenance, spare parts inventories, and equipment history. Each MEL item should be identified uniquely. An engineering group typically develops and maintains the MEL. Additional information, such as the following, may be included or linked/referenced to the MEL items:

- Equipment name/type;
- Equipment tag in field (location);
- Safety category;
- Reference to safety basis source;

- Any applicable TSRs/LCOs;
- Installed make and model;
- Spare Parts; and/or
- Status (active, retired, inactive).

D. PLANNING, SCHEDULING, AND COORDINATION OF MAINTENANCE

D.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include the process for planning, scheduling, coordination, and control of maintenance activities, and properly emphasizing equipment availability. The process must include the application of a Cognizant System Engineer Program in accordance with DOE O 420.1C in the planning and execution of maintenance activities.

The NMMP should address the following:

- Planning group organization and responsibilities;
- Expectations for management commitment, overview, and support of the program;
- The process for ensuring the appropriate level of detailed work instruction so that workers, schedulers, and other affected organizations can carry out the activities as planned;
- The process for coordination of integrated discipline of work packages to ensure involvement of the appropriate persons and the proper sequence of carrying out the work;
- Expectations for experience or qualification of individuals performing work planning;
- How feedback from maintenance personnel is used to facilitate improved future planning activities;
- The use of job history for establishing standard job duration, parts, and consumables for repetitive jobs;
- The manner in which the planning system addresses the following:
    - Identification and control of the hazards associated with the work activity and area;
    - Reduction of the impact of planned outages by planning, coordinating, and completing maintenance activities in a timely manner;
    - Reducing facility and equipment downtime;
    - Reducing human errors;
    - Reducing radiological and toxicological exposure to workers;
    - Controlling and reducing the number of contaminated areas;
    - Completing scheduled surveillances and PM activities in a timely manner;
    - Establishing appropriate post-maintenance/post-modification testing and acceptance criteria;
    - Managing the corrective maintenance backlog to minimize the backlog and completion time of outstanding deficiencies;
    - Controlling overtime;
    - Completing outage and non-outage work on schedule; and

- The process for reviewing completed work packages for proper documentation, post-maintenance testing, safety hazards encountered, feedback, possible changes to the PM program, and equipment history update.

The NMMP should further address how:

- 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 and the backlog of work is effectively managed;
- Work planning considerations such as material, tool, and manpower requirements; interdepartmental coordination; safety considerations; radiological protection requirements; and QC requirements are included; and 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 materials, 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; and
  - Test acceptance criteria.
- Post-maintenance testing results are documented and reviewed to ensure proper system/equipment performance before returning the system to service; and
- 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.

In accordance with DOE O 420.1C, the CSE must maintain integrity of a facility's safety basis as well as maintain overall cognizance of the system and be responsible for system engineering support for operations and maintenance. The CSE must provide technical assistance in support of line management safety responsibilities and ensure continued system operational readiness. In accordance with DOE O 433.1B, the NMMP must describe the application of a CSE to the maintenance activities.

The NMPP should address how System Engineering is involved in the following activities:

- Remaining apprised of operational status and ongoing modification activities;
- Assisting in review of key system parameters and evaluate system performance;
- Identifying trends from operations and maintenance, and providing assistance in determining operability, correcting out-of-specification conditions, and evaluating questionable data;
- Remaining cognizant of system-specific maintenance and operations history and industry operating experience, as well as manufacturer and vendor recommendations and any product warnings regarding safety SSCs in their assigned systems in order to advise the maintenance organization;
- Initiating actions to correct problems;
- Reviewing and concurring with design changes and maintenance modifications;
- Providing input to the development of special maintenance and test procedures; and
- Ensuring that system configuration is being managed effectively, including reviewing and concurring with post-maintenance/post-modification testing and acceptance criteria for assigned systems.

D.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

Effective work planning is necessary to identify the required support and detailed scoping to successfully schedule, coordinate, and control maintenance activities. Accurately defining the work to be performed and providing qualified workers and appropriate procedures or instructions can reduce maintenance errors and the risk of injury to personnel. Planning also reduces work delays and improves efficiency by ensuring required support items such as special tools, personal protective equipment, other equipment, repair parts, and materials are available when needed.

Coordinating maintenance activities is necessary to help ensure work can be effectively accomplished. Coordination should ensure the availability of necessary safe work permits; equipment lockouts/tagouts; and QC verifications. Coordination should include the CSE when the maintenance activities involve safety class and safety significant SSCs as defined in the facility's DOE approved safety basis, as well as to other systems that perform important defense-in-depth functions, as designated by facility line management (DOE O 420.1C). Coordination is needed where various groups (e.g., mechanical, electrical, instrumentation and control, and contractor) are involved in a work activity or are concurrently working in the same area. A knowledgeable individual responsible for the major portion of the work activity should be assigned the lead in identifying and coordinating needed support.

D.2.1 Guideline – Control of Maintenance

A maintenance work-control program should be integrated with the planning system and with ISMS. The work-control program should ensure work activities are consistent with the facility safety basis and effectively identified, initiated, planned, approved, scheduled, coordinated, performed, and reviewed for adequacy and completeness. The program should ensure the availability and operability of the SSCs that are a part of the safety basis. The work-control

program should apply the same policies and procedures for non-facility contractor and subcontractor personnel conducting maintenance on the site as facility personnel.

The work-control system should provide the data necessary to properly plan and schedule maintenance activities, as well as to support failure analysis (see Section III.O, *Performance Measures*) and maintenance history (see Section III.L, *Maintenance History*).

The maintenance organization should establish high standards for all maintenance personnel supervising and performing maintenance activities (see Section III.B, *Maintenance Organization and Administration*). Maintenance management should be involved and oversee work to ensure these standards are met and work is conducted in accordance with DOE, contractor, and facility policies and procedures.

Configuration control is maintained by ensuring that systems and equipment are restored to their original condition following maintenance. (See Section III.H, *Configuration Management*)

This section describes a system for effectively planning, scheduling, and coordinating routine maintenance activities as well as unplanned and planned outages, and for effectively controlling maintenance activities.

D.2.2 Guideline - Planning

D.2.2.1 Planning for Maintenance Activities

The primary objective of work planning is to identify all technical and administrative requirements to complete a work activity and to provide the materials, tools, and support activities needed to perform the work safely and correctly. Effective planning, scheduling, and coordination will help minimize delays.

Work planning should be periodically assessed through field observation of work being performed and direct feedback from maintenance personnel to maintenance planners. An effective planning program should contain the following:

- Management commitment, overview, and support of the program;
- The appropriate level of detailed work instruction so that workers, schedulers, and other affected organizations can carry out the activities as planned;
- Proper coordination of integrated discipline review to ensure involvement of the appropriate persons and the proper sequence of carrying out the work;
- Involvement of experienced individuals in work planning;
- Feedback from maintenance personnel to facilitate improved future planning activities; and
- Use of job history for establishing standard job duration, parts, and consumables for repetitive jobs.

The planning system should address the following:

- Identifying and controlling the hazards associated with the work activity and area;
- Reducing the impact of planned outages by planning, coordinating, and completing maintenance activities in a timely manner;

- Reducing the number of forced outages;
- Minimizing challenges to SSCs that are a part of the safety basis;
- Reducing worker lost-time accident rate;
- Reducing facility and equipment downtime;
- Reducing human errors;
- Reducing radiological and toxicological exposure to workers;
- Controlling and reducing the number of contaminated areas;
- Completing scheduled surveillances and PM activities in a timely manner;
- Establishing appropriate post-maintenance/post-modification testing and acceptance criteria;
- Reducing repeat maintenance WRs (rework);
- Managing the corrective maintenance backlog to minimize the backlog and completion time of outstanding deficiencies;
- Controlling overtime;
- Staffing and training the maintenance organization; and
- Completing outage and non-outage work on schedule.

D.2.2.2 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 centralized or decentralized, with planners for each discipline working within their respective groups.

The planning process should involve knowledgeable maintenance personnel and experienced personnel from such other disciplines as safety, operations, QC, and radiological protection. A small facility may function well with maintenance supervisors being responsible for all planning. A larger facility may gain by having a dedicated planning group to relieve the first-line supervisor of most planning duties to allow adequate time for other supervisory duties, such as observing and directing activities at the work sites.

D.2.2.3 Planning-Group Responsibilities

A planner should review all Ready-to-Work Work Requests /Packages. 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 (e.g., by work-site inspection, by review of other maintenance that should or could be performed within the lockout/tagout boundary for the equipment);
- 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;
- Procurement of necessary repair parts, materials, tools, and equipment;
- Assessment of labor and skill requirements for nuclear facility, non-nuclear facility, and subcontractor personnel and their availability;
- Identification and review of possible conflicts, including other tasks scheduled to occur in the immediate area during the same period;
- Pre-job ALARA planning;
- Identification of initial conditions and prerequisites, including applicable TSR and LCOs;
- Identification of QC inspection requirements and code requirements;
- Establishment of equipment restoration and post-maintenance inspection or testing requirements; and
- Review of work instructions or work packages for completeness.

Once the work is completed, the completed work packages should be reviewed for proper documentation, post-maintenance testing, industrial safety hazards encountered, feedback, possible changes to the PM program, and equipment history update.

D.2.2.4 CSE Responsibilities

In accordance with DOE O 420.1C, the CSE is required to maintain integrity of a facility's safety basis as well as maintain overall cognizance of the system and the CSE is responsible for system engineering support for operations and maintenance. In accordance with DOE O 420.1C, the CSE is required to provide technical assistance in support of line management safety responsibilities and ensure continued system operational readiness.

The CSE supports the planning and performance of maintenance activities by:

- Ensuring that system configuration is being managed effectively, including reviewing and concurring with post-maintenance/post-modification testing and acceptance criteria for assigned systems;
- Remaining apprised of operational status and ongoing modification activities;
- Assisting in review of key system parameters and evaluate system performance;
- Initiating actions to correct problems;
- Remaining cognizant of system-specific maintenance and operations history and industry operating experience, as well as manufacturer and vendor recommendations and any product warnings regarding safety SSCs in their assigned systems in order to advise the maintenance organization;
- Identifying trends from operations and maintenance;
- Providing assistance in determining operability, correcting out-of-specification conditions, and evaluating questionable data;

- Providing or supporting analysis when the system is suspected of inoperability or degradation;
- Reviewing and concurring with design changes and maintenance modifications; and
- Providing input to the development of special maintenance and test procedures.

D.2.2.5 Worker Skills

To perform the planning function correctly and efficiently, the maintenance activity should be evaluated to determine the necessary worker skills along with the necessary level of detail in procedures to support the activity. The requirements to provide procedures to maintain SSCs important to facility safety are defined in DOE O 433.1, *Maintenance Management Program for Nuclear Facilities*, DOE O 422.1 (formerly DOE O 5480.19), *Conduct of Operations*, 10 CFR Part 830 and the facility TSR.

The training and qualification program should provide a foundation for the basic skills and knowledge a worker (contractor and permanent staff) needs to possess to perform the job. (See Section III.G, *Training and Qualification*)

The use of mock-ups and run-throughs should be used as needed to facilitate the workers performance of complex or very sensitive tasks.

D.2.2.6 Supervisor and Worker Responsibilities

The first-line supervisor/team leader is accountable to senior management for the quality of work performed in the following areas:

- Understanding and ensuring the correct use of the approved NMMP;
- Selecting qualified people to perform work;
- Ensuring experienced workers assigned to perform work activities are appropriately qualified;
- Identifying and controlling job hazards;
- Following an integrated work schedule to manage time and resources effectively;
- Periodically observing work-in-progress, while providing job-site coordination and supervision;
- Ensuring proper return to service of equipment, including job-site cleanliness and post-maintenance testing; and
- Maintaining the quality of the completed work packages to record the work actions performed adequately.

Craft workers provide specialized hands-on skills. At the direction of first-line supervisors/team leaders, the workers perform those tasks necessary to preserve or restore the equipment. Craft worker responsibilities are in these general areas:

- Maintaining appropriate skill levels;
- Using and following procedures and work instructions properly;
- Recording information accurately;
- Performing work using good quality and ES&H work practices;
- Identifying and controlling job hazards; and
- Stopping work if an unanticipated or unsafe condition is identified.

A balanced combination of written guidance, craft skills, and work-site supervisory observation is required to achieve the appropriate rigor and quality workmanship essential to safe, efficient, and reliable facility operation. Rigor is the amount of supervision and written direction based on the risk and complexity of the task and the known skills of the craft worker. The relationship of all three elements should be considered during task planning and personnel assignment.

Once the work is completed, the completed work packages should be reviewed for proper documentation, post-maintenance testing, industrial safety hazards encountered, feedback, possible changes to the PM program, and equipment history update.

D.2.2.7 Ranking Hazards in Planning Work

When developing controls for a maintenance work activity, consideration should be given to the probability and significance of negative consequences due to the identified hazards associated with the work activity and area.1 The complexity of the work activity will also impact the probability of an undesirable outcome. A simple matrix (such as shown below) would show hazard consequence measured on one axis and probability measured on the other. The worse the potential consequence and the greater the probability of an undesirable outcome, the more robust the controls or the defense-in-depth should be. The purpose of the matrix is to gage the appropriate effort to expend on control development and implementation, graded from the least to the most hazardous work activities. The level of hazards analysis and controls is graded based upon the likelihood and severity of the consequences to the worker, the public, and the environment.

Depending on the particular maintenance work activity, the individual planning the work should use a team approach in evaluating the hazard(s). The team may include environmental, health, and safety professionals, the CSE, the facility owner, and worker representation in determining whether the consequence and the probability of the hazard(s) are at the high, medium, or low level.

[1] For a comprehensive look at this subject, see “the red book”, Guidelines for Hazard Evaluation Procedures, Second Edition with Worked Examples Center for Chemical Process Safety.

The information gained from the matrix should be used in planning the work to determine the proper degree of rigor needed to ensure the safe and effective performance of the work activity. Controls to be considered include:

- Mix of worker skills and qualifications (apprentice, master, special qualifications);
- Degree of worker preparations (Pre-Job Briefing, Mockup Training);
- Detail of work instructions (minor maintenance, comprehensive work package); and
- Level of supervisory oversight (routine, frequent, continuous).

HAZARD RANKING MATRIX			
	CONSEQUENCE		
PROBABILITY	H	M	L
H	HH	HM	HL
M	MH	MM	ML
L	LH	LM	LL

D.2.2.8 Planning System

A system of planning, scheduling, and coordinating maintenance work activities should consist of five interrelated processes applicable to each maintenance job. The processes are as follows.

- Plan Maintenance Job Identify the scope of a needed maintenance job. Produce a maintenance job plan. Determine maintenance job planning category, priority, and safety concerns. Identify and procure materials, and identify other maintenance task resources. Prepare the maintenance job package.
- Schedule Maintenance Job Calculate 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.
- Execute Maintenance Job Initiate and perform a maintenance job and collect job information as defined in the maintenance job package.
- Execute Post-Maintenance Test (PMT) Verify facilities and equipment items fulfill their design functions when returned to service after execution of a maintenance job.
- Complete Maintenance Job Perform maintenance job closeout including completion of all documentation contained in the maintenance job package to ensure historical information is captured and feedback on opportunities for improvement.

D.2.2.9 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:

- Equipment identification;
- Name of the person initiating the WR;
- Date WR was initiated;
- Description of the symptom, problem, or work requested;
- Location of equipment;
- 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 management to perform work;
- Narrative description of conditions found by the experienced workers;
- Documentation of actual work performed with post-maintenance testing and inspection results;
- Acceptance of the equipment by operations; and
- Final reviews and signoffs by maintenance, QC, and other groups in the WR or other approved work-control document review cycle.

The WR or other approved work-control document should be reviewed by affected groups or their representatives (such as maintenance, operations, technical support, CSEs, QC, safety, and radiation protection personnel) during the planning process to ensure it is current and accurate.

D.2.2.10 Maintenance Work Request/Work Order Processing

A maintenance WR/WO should be initiated and a maintenance deficiency tag/sticker attached or applicable status indicator/tracking system updated as soon as practical after discovery of a facility equipment deficiency.

All WR/WOs for facility equipment should be delivered to the equipment owner/operator or designated representative for review and appropriate action to minimize further equipment damage. The owner/operator review should ensure the following:

- The WR/WO is not a duplicate of an existing WR/WO;
- Equipment name, identification number, and location are properly entered;
- Originator information is included on the form and is legible;
- Deficiency tag number and location are documented, if applicable;
- Failure/problem description is accurate and clearly stated;
- Special conditions necessary to remove equipment from service such as an LCO, a system outage, or a major facility outage are clearly identified; and
- Priority is assigned, TSRs are identified, and time limits for action are specified, if applicable.

After review, the owner/operator representative should forward WR/WOs to the maintenance-planning department. The planning supervisor or designated individual should review the WR/WO to determine whether it should be performed as a minor maintenance task and assign it to the responsible craft planner. The craft planner should review the WR/WO and perform the following.

1. Verify that the WR/WO is not a duplicate of an existing WR/WO.
2. Walk down the identified deficiency using the walk down checklist, as necessary, to assist with job planning.
3. Verify the identified deficiency accurately describes the equipment problem. For example, “waste disposal pump leaks”, does not communicate the urgency of needed repairs or provide accurate direction or performing repairs. A more useful description would be, “The casing flange on the waste disposal pump leaks 10 drops per minute during pump operation at full load. The pump design does not permit any leakage from the casing flange. Continuation of the leakage will damage the pump and result in its inoperability.”
4. Identify special equipment/conditions to be considered in planning the work such as scaffolding requirements, special tools, interference removal, special radiological considerations, etc.
5. If the activity should be performed as minor maintenance, forward the WR/WO to the appropriate craft supervisor or scheduler for accomplishment.

D.2.2.11 Maintenance Work Request/Work Order Planning

The planner should perform the following steps using a walk down checklist.

1. Identify any other pending and/or appropriate maintenance tasks, such as PM, surveillance tests, or related corrective maintenance, that may be performed concurrently with the work being planned. Discussion with operations, scheduling, and the system engineer/engineering, may be necessary to coordinate all associated work. (PMs that might affect the results of surveillance testing should be scheduled to occur following the completion of surveillance testing to avoid pre-conditioning the surveillance testing results.)
2. Identify and initiate appropriate requests as necessary for additional task and/or support needs such as scaffolding erection, electrical disconnection, piping removal, etc.
3. Review component history to determine when and what actions were previously taken for similar repairs. Consider repairs to similar equipment in other locations. Repetitive maintenance trends for problem equipment, components, and structures should be brought to the attention of the system engineer/engineering for resolution.
4. Obtain applicable detailed drawings of the components and associated systems to be repaired or affected by the repair.
5. Review vendor information for special requirements for component repair and parts that may be needed to perform repairs.
6. Provide a list of required special tools and parts for the job in the job package. If like-for-like replacement parts are not available, contact the system engineer/engineering for resolution.
7. Check for parts availability. Order/reserve parts as necessary to perform repair.
8. Determine procedure requirements based on equipment classification, ALARA considerations, and/or extent of repair needed to restore the equipment to operating condition (see DOE-STD-1029, Chg 1, *Writer's Guide for Technical Procedures*). Where pre-approved procedures are available, work should be performed using these procedures. Review and consider feedback from previous performance of the maintenance procedure.
9. If an approved procedure is not required as determined in Step D.2.3, provide work instructions to the craft worker in sufficient detail to correct the equipment deficiency. Vendor recommendations, engineering requirements, craft training/skills (skill-of-the-craft), special tool needs, and hazards involved in performing the task should be considered when preparing these instructions. System engineer/engineering review of new work instructions should be performed to ensure adequacy. Work instructions to control troubleshooting should also be developed.
10. Working with craft supervision, review maintenance history records to determine time and coordination requirements to accomplish the task.
11. Initiate special permits necessary to perform the maintenance task. Flame permits, confined space permits, tagging requests, RWP requests, etc., should be included in the work package, if available.

12. When ALARA work planning is performed, special consideration should be given to providing adequate detail to assist the craft worker in performing the task and reducing radiation exposure. Examples of items that should be considered include the following:
    - Reviewing previous work packages for lessons learned and effective methods of performing the task;
    - Reviewing area photographs, if available, to identify problems that may delay work;
    - Providing detailed tool lists;
    - Providing rigging and handling sketches;
    - Performing mockups or practice runs in non-radiation areas;
    - Using portable shielding to reduce radiation levels;
    - Dividing work into distinct tasks to be performed by different individuals;
    - Holding an in-depth pre-job briefing to ensure craft workers have a clear understanding of the tasks to be performed;
    - Improving access to the work through portable scaffolding or work platforms;
    - Posting work areas to control access;
    - Including ALARA personnel in the planning process; and
    - Designing special tools that may reduce time to complete repair.
13. Work with the Operations Manager and the System Engineer/engineering to determine the following:
    - Operational impacts such as alarms, possible actuation, special system alignment, or operator actions; and
    - PMTs that should be performed to check the maintenance performed and to return the component to operation (see Section III.Q, *Post Maintenance Testing*).
14. Assemble the work package. The craft worker in performing the maintenance uses facility document control procedures should be followed to ensure the most recent revision of a procedure.
15. Place the work package in the appropriate file or forward it to scheduling for accomplishment. Files should indicate the following:
    - Ready to Work - All requirements are met; parts are available; support needs, such as scaffolding, are identified;
    - Hold for Parts - Repair parts are on order but have not been received or are not available;
    - Hold for Facility Conditions - All requirements have been met; however, special facility conditions, such as a component outage/LCO, are needed to perform the work; and
    - Outage Item - Facility outage or major system outage is needed to perform task.

Consider maintaining a library of routine, recurring maintenance instructions to minimize planning time. Previous job histories should be reviewed to establish standard job durations, typical parts and consumables needed, and other job requirements.

D.2.3 Guideline – Scheduling Maintenance Activities

D.2.3.1 Control of Work Backlog

Work requests (WRs) should be entered and retained in the system from the time the work is identified until all work actions are complete, including post-maintenance testing and administrative reviews. The system should provide a serialized list of WRs with a brief description of work required, priority assigned, date initiated, and plant conditions required for performing the work.

Work should be scheduled and combined with other maintenance activities on the same equipment, or with other maintenance on similar equipment in proximity. For example, corrective maintenance could be scheduled simultaneously with an upcoming PM action that requires the same or a similar lockout/tagout, or PM routes could be established that allow craft workers to lubricate all equipment on a particular elevation, or quarterly and annual PM could be scheduled simultaneously.

Delays beyond the scheduled due dates for PM actions should be approved by the facility manager.

D.2.3.2 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.

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; and
- Minimization of the spread of contamination from leaks.

The following list illustrates a priority system.

1. Non-outage work.
    a. Priority 1 - Emergency or severe adverse impact on personnel safety; limits facility operation (top priority: work today and provide special coverage if necessary).
    b. Priority 2 - Urgent; hinders facility operation (schedule within 24 hours).
    c. Priority 3 - Necessary; has potential to degrade or hinder facility operation (schedule within seven days).
    d. Priority 4 - As time permits.
2. Outage work (subcategories for Priority 5 and 6 work as part of outage planning are also useful).
    a. Priority 5 - Hot shutdown or hot standby.
    b. Priority 6 - Cold shutdown.

Scheduling corrective and preventive maintenance as well as planned and forced outage work is necessary to ensure that maintenance is conducted efficiently (e.g., within prescribed time limits). Scheduling daily activities based on accurate planning estimates improves facility production capacity through effective use of time on the job and helps to reduce hazardous worker exposures. 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. In addition to the integrated maintenance schedule, a contingency schedule should be maintained so that if a forced outage occurs, the forced outage time is minimized and effectively used and so that all needed maintenance is performed before an anticipated facility restart.

Sufficient detail should be included in the integrated maintenance schedule to coordinate activities and track progress. By grouping individual work items and integrating major tasks, more efficient use of technical support and scarce resources should be achieved. The integrated maintenance schedule should form the basis for progress reporting.

Effective daily schedules are needed to implement the maintenance activity plans represented by the integrated schedule. Management should track and periodically assess performance to the daily schedule.

D.2.3.3 Schedule Requirements

The schedule should be a management tool (particularly for first-line supervisors) to control and direct maintenance activities. Management should use it to determine the critical path and explore alternatives when needed. The schedule should be a concise method for tracking completion of maintenance tasks, particularly critical path activities. The following are some of the attributes that should be included in the schedule.

- The schedule should be an accurate, living document. Workers should understand the relationship of their tasks to the schedule as a whole;

- The schedule report format should be appropriate for the user. The level of detail in the schedule needed by the facility manager may be different from the level of detail needed by a craft supervisor;
- The schedule should be proactive, predicting and leading activities. The schedule should be credible and up to date. It should be based on the best information available and reviewed and accepted by those actually responsible for doing the work;
- The schedule should be flexible, within the overall goals of the facility, to deal with unanticipated events and produce optimum results; and/or
- There should be one overall schedule developed such that a hierarchy of schedules of varying detail may be obtained from a common database.

D.2.3.4 Schedule Methods

To be responsive to the needs of management, a computerized scheduling system should be used.

Computerized scheduling offers the following advantages:

- Rapid update capability;
- Ease in exploring alternatives;
- Supports resource determination and leveling capability;
- Supports identification of work-site congestion; and
- Reports tailored to users.

All supervisory personnel should have a basic understanding of the schedule program appropriate to their needs and uses.

D.2.3.5 Schedule Detail

The detail included in the overall schedule should be that required to ensure coordination of work and permit assessment of progress. It is particularly important to include details of tasks that have interfaces among the various craft and support personnel. The following are some examples of the detail that may be required.

- The operations manager should be able to anticipate tagout needs;
- Radiological protection personnel should be able to anticipate the schedule and need for RWPs, technician support, and major radiological protection actions, such as installation of temporary shielding;
- QC personnel and other inspection groups should be able to anticipate the need for their presence at the job site; and
- Critical resource needs, such as overhead cranes and scaffolding, should be described in sufficient detail to avoid interference, conflicts, and work delays.

A sufficient number of activities should be scheduled to ensure the short-term visibility needed for work coordination and progress tracking. Use of these intermediate milestones may provide an overall measure of the progress of maintenance activities and identify tasks significantly behind schedule.

D.2.3.6 Daily Schedules

Daily schedules are important to ensure that work is properly coordinated even when there may be last-minute schedule changes. A daily schedule is generally used as the basis for discussions at daily meetings (e.g., Plan-of-the-Day).

A 3-day outlook schedule, updated and issued daily, has proven useful at many facilities. This schedule provides the detail necessary to control the present day's work and provides an opportunity for craft planning for the next few days without an unreasonable amount of data. Extending the outlook period further than about 5 days and/or not issuing the schedule on a daily basis increases the risk that data may not be current when needed.

A detailed review of the daily schedule should be an integral part of shift turnover activities to ensure that the oncoming shift is familiar with any short-term adjustments made to the schedule. This is particularly important for operator turnovers to ensure that operators know the status of the facility and are familiar with upcoming maintenance activities including tagging needs.

D.2.3.7 Schedule Preparation

The following items should be considered during the schedule preparation process.

- Work items should be coded to identify their discrete locations in the facility and reviewed together to assess the degree of area congestion and to minimize duplication of support work such as scaffolding and insulation removal;
- The schedule should be craft loaded and the sequence and timing of activities adjusted to ensure that resource requirements are consistent with resource availability;
- Tests, inspections, or other tasks that may identify additional work should be scheduled as early as possible to permit time for completion of the additional work within the established time frame; and
- Significant as-found, post-maintenance, and post-modification testing should be explicitly scheduled. Time should be allotted for testing, line up, and other activities required for returning systems to service. System interactions and operator resources should be considered when scheduling system and facility start-up.

D.2.3.8 Schedule Integration

Integration of major tasks is a key to successful schedule development. There should be one overarching schedule that includes work to be done by both non-facility contractors contributing support to the schedule and site personnel. The planning organization should involve non-facility contractors as early as possible in the planning process to ensure their work is integrated and scheduled properly.

Those responsible for the tasks should provide details for specific tasks. The planning organization should integrate these details into the overall schedule.

D.2.3.9 Schedule Review

Schedules should be periodically reviewed. Opportunities for schedule improvements should be explored during the review process. This should include review of TSR and other regulatory

requirements to determine whether changes that may result in work efficiency or schedule improvements are possible without sacrificing safety.

The overall intent of the schedule review process, coupled with obtaining user input to the planning process, should be to provide a sense of ownership of the schedule to those who are expected to implement it.

D.2.3.10 Format, Progress Reporting, Updating, and Distributing

The schedule information provided to users should be concise and understandable.

Detailed information should be limited to the needs of the recipient.

The fundamental principles of a schedule progress reporting system should be simplicity, accuracy, and timeliness. The individuals responsible for the work should be responsible for progress reporting.

The individuals responsible for progress reporting should be identified and trained in the process. Vendors and contractors should be included in the progress reporting system.

Progress may be reported in a number of ways depending on the facility needs and on the particular scheduling system used.

D.2.4 Guideline – Coordinating Maintenance Activities

Facility personnel should be apprised of scheduled maintenance activities that affect them to ensure proper activity coordination. This may be accomplished by publishing and updating a short duration rolling schedule covering about 3 days.

The responsible maintenance supervisor should be provided with work packages soon enough for adequate shop level preparation and pre-job instructions before starting the job. Each supervisor should have sufficient fill-in work assigned to maintain crew productivity. If fill-in work has facility conditions requirements associated with it, then it should be identified on the rolling schedule so that all cognizant groups are aware of the jobs.

The schedule should allow for unexpected or emergency work requirements. Facility management should identify and approve WRs that could be postponed or stopped to allow the work force to accomplish emergency work.

After jobs have been scheduled and assigned on the rolling schedule, the lead group, the group responsible for the most significant portion of the job, should assume the responsibility for support coordination. The lead group should then be responsible for coordinating such activities as verifying that lockouts/tagouts are available as required, that QC inspectors are available as required, and that parts are available at the job site.

Daily meetings with affected individuals should be conducted to focus on the progress of key jobs and to provide short-range coordination of scheduled activities. Meetings should be managed to use the time of the managers and supervisors efficiently, to minimize redirection of work in progress, and to prevent delays to oncoming work shifts.

Many items, particularly material needed for modifications and repair parts for older equipment, may be long lead-time items. They should be identified and ordered well in advance and tracked to delivery to ensure that they will be available at the job site when needed.

Extensive involvement of managers and supervisors in maintenance activities promotes timely completion of work, quality of completed work, and safety of personnel and equipment. Supervisors should focus on:

- Monitoring on-going work to control quality and progress;
- Providing accurate and timely status reports;
- Coordinating support and interface work activities;
- Ensuring the timely availability of tools, supplies, and parts; and
- Understanding schedule interpretation and use.

Supervisory oversight should include independent verification of such activities as tagouts before opening piping, valves, or mechanical equipment or before working on electrical equipment.

D.2.4.1 Pre-job Coordination

Line supervisors should consider specific coordination and integration activities in preparing for work include the following:

- Effective integration of facility system operation and maintenance activities to ensure proper facility conditions, timely equipment or system tagouts, initiation and completion of maintenance or modifications, and timely performance of inspections;
- ALARA actions, including shielding installation and pre-job briefings on ALARA precautions;
- Support of maintenance activities by health physics and decontamination personnel, including support during the performance of tasks, identifying and posting work areas, and timely decontamination of tools, floors, and equipment;
- Allocation of space and crane use;
- Inspection of maintenance activities by QC personnel, including completion of associated documents; and
- Continuous document processing, issuing, and closeout throughout the job.

D.2.4.2 Material Staging and Availability

Convenient staging of the proper materials for scheduled maintenance is one key to success. Responsibilities regarding procurement of material required for maintenance and modifications should be specified. Having one organization responsible for coordinating material needs and a single point of contact for expediting material has proven successful at other facilities and should be considered.

Parts and material required for maintenance activities should be identified and purchased in time to allow for receipt and inspection well before they are needed. After processing, these parts and material should be identified for specific work packages and segregated from other stock inventory. Standard stock items and consumables required for planned work should be allocated to ensure their availability.

Adequate storage and protection of parts and materials segregated for planned maintenance activities should be provided. This is particularly important for material staged at the job site and not within normal storage areas.

Periodic reports highlighting any material or parts problems should be distributed to appropriate management personnel. Problems with material availability should be identified early to permit contingency planning.

D.2.4.3 Daily Meetings

Well managed planning and scheduling meetings are necessary to keep facility personnel aware of significant maintenance activities that are in progress and to make corrections to schedules. Meetings should be effectively managed to limit the time personnel spend in the meetings. Participation in meetings should be limited to those personnel affected. Three types of meetings, discussed below, have been shown to be effective in improving communications among work groups and in enhancing job coordination.

A **daily directional meeting** may be held after the start of the primary work shift. Management and representatives should attend this meeting from major work groups. It should focus on major jobs and evolutions planned for the next 48 hours and identify any redirection necessary due to significant problems. Results of the directional meeting affecting activities should be factored into the schedule at the daily planning meeting.

A **planning meeting** should be held each day following the directional meeting to review the near-term (next 3 to 5 days) schedule and verify that jobs may be worked as scheduled. Planners and representatives of the operations manager, radiological protection, and other support departments should attend. The participants should ensure the information contained in the next updated schedule is consistent with current plans and resource availability. The schedule should be updated by incorporating information from the directional meeting and the planning meeting.

A **shift work coordination meeting** should be held shortly before the start of each shift. This meeting should be attended by oncoming shift supervision for each of the groups supporting the maintenance schedule, including maintenance, health physics, technical staff, system engineer/engineering, area coordinators, and task coordinators, for jobs requiring significant support. The operations supervisor for the oncoming shift should also attend. This meeting should address all schedule problems for work to be performed by the upcoming shift and should modify the schedule as necessary to reflect last-minute changes. Groups supporting the maintenance should be notified. Each attendee should leave the meeting with a clear understanding of what their work group should do on the upcoming shift. The meeting should end in time for supervisors to return to their work groups before the shift starts.

Assignments for problem resolution should be made at meetings, but resolution should not be attempted during the meeting. The meetings should not be used as the primary method to determine the status of maintenance activities.

D.2.5 Guideline – Planning, Scheduling And Coordinating Outages

Assign responsibility for the overall control of planned and unplanned long-term outages (typically three or more days) and for adherence to the outage schedule. Revise the schedule as required ensuring that the schedule reflects achievable goals and real-time progress. Monitor

activities on the critical path and near critical paths at least once per shift during the outage. Structure the outage management system so that individuals responsible for areas of outage work present status reports directly to outage management staff as well as to their line managers.

Schedules of past outages (planned and unplanned) should be retained for reference in planning for future outages, particularly for unplanned outages.

D.2.5.1 Planned Outages

Preparation for and scheduling of major maintenance activities and modifications may have to begin several years in advance, depending on the complexity of the effort. Assign a designated outage manager or coordinator to direct preparations for and management of the outage.

Complete engineering work as early as possible. Allow adequate time for review of work packages, resolution of comments, budgeting, contracting, procurement, and other long lead-time planning functions.

Maintain a current list of proposed outage activities. It should include all demands for resources (such as non-nuclear facility contractor and subcontractor resources) and activities (such as corrective maintenance, PM, surveillance, in-service tests and inspections, and modifications). Periodically hold outage-planning meetings to refine and update this list.

An initial milestone list that identifies cutoff dates for major activities required to support outage planning should be prepared. This list should include items such as the following:

- Identification of major jobs;
- Letting of bids for contracts and materials;
- Identification of corrective maintenance, PM, surveillance, and in-service test requirements;
- Identification of major modifications and dates for design work, work package preparation, and procurement of materials, parts, and services;
- Identification of pre-outage work that can and should be performed to reduce the demand for resources during the outage (such as pipe prefabrication, cable pulling, conduit runs, raceway installation, fabrication of supports, and scaffold erection);
- Identification of facilities required for outage support and milestones for their construction;
- Identification of temporary services that may be required by experienced workers when lockout/tagout of equipment related to the maintenance activity disrupts normal services (e.g., electricity, lighting, air, and water);
- Staging of special tools and equipment and preparation of work areas; and
- Development of schedules.

Develop an overall outage schedule as soon as all major outage activities are identified. Periodic revisions to this schedule should be issued throughout the outage planning process. The schedule should identify and allocate such critical resources as labor, shop facilities, cranes, equipment accessibility, personnel radiation dosage, and availability and scheduling of outside subcontractors and non-facility contractor groups.

Based on the overall schedule, a detailed outage schedule committing all affected groups should be issued before the scheduled outage start date. Addition of unanticipated work to the outage schedule should require a formal review and approval process.

D.2.5.2 Unplanned Outages or Other Limitations to Facility Operations

Management of unplanned outages and other facility operating limitations is necessary to minimize the duration of these conditions and to use available time effectively. Facility management or the maintenance supervisors should maintain a prioritized list of corrective maintenance, modifications, surveillance, PM, special items, or commitments that need to be performed under a system or facility outage. Resource requirements, industrial safety considerations, and task completion time for each of the identified jobs should be estimated to aid in planning, scheduling, and coordination. To the extent possible, an up-to-date list of prioritized outage tasks and assembled work packages, including procedures, repair parts and materials, lockout/tagout requests, special tools, and personnel entry forms (such as RWPs or confined-space entry permits) should be prepared.

Potential short outage work should be grouped by the required facility condition and approximate duration. Activities should be grouped to accomplish as much work as possible. Other maintenance activities, such as surveillance or PM, should be reviewed to determine whether they should be performed while equipment or systems are out of service.

An unplanned outage work list should be prepared, and outage activities should be coordinated. Facility management should periodically update the list. Copies of the updated proposed outage list, reflecting current planning, should be sent to all affected facility organizations. If an unplanned outage or other major limitation occurs, appropriate facility managers should initiate selected work from the outage list based on the estimated duration of the outage and resources available.

Facility management should conduct coordination meetings to determine the critical path and major milestones and to accept or reject any new or significant work to be accomplished. Support requirements should be verified and coordinated among cognizant departments. During the outage, a status should be obtained during each shift to measure progress and to make required adjustments. After completion of each outage, facility management should conduct a critique to determine how outage improvements could be made and designate personnel to implement these improvements.

D.2.6 Guideline - Planning, Scheduling, and Coordinating Maintenance Performance Monitoring

Facility management should develop performance measures to periodically monitor and report the progress toward meeting facility maintenance goals. The following are typical performance measures:

- Rate of activity completion (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);
- Percent compliance to the daily schedule (maintained at a high level to ensure that scheduled work is being completed to support the overall facility maintenance goals);

- Progress against the schedule (is tracked to identify areas where work completion does not support the schedule);
- Amount and rate of bulk work (nonscheduled or listed work) completed (completions should be tracked against remaining resources and time to ensure that bulk work is being completed at a rate that supports the schedule);
- Expended worker hours by craft or work group versus planned worker hours (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);
- Number of accidental occurrences;
- Expended man-rem versus planned man-rem (should be tracked to identify areas of concern where actual values are exceeding projections);
- Amount of rad waste generated (should be tracked to identify areas of concern where actual values are exceeding projections); and
- Number of skin and clothing contaminations (should be tracked to identify areas of concern where actual values are exceeding projections).

The performance measures should be reviewed periodically to ensure they are valid measures of facility maintenance status.

Deviations in the expected results identified in reviews of the performance measures should be analyzed to identify their root causes and should be reported to facility management for appropriate corrective action.

D.2.7 Guideline -Work Control

D.2.7.1 Work-Control Procedure

The work-control procedures 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;
- The process for initiating and processing WRs, including the pre-job review, approval cycle, and post-job review;
- 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;
- Post-maintenance testing (see Section III.Q, Post Maintenance Testing); and

- Collecting data for maintenance history files (see Section III.L, Maintenance History).

The work-control procedure may cross-reference or include outage scheduling and control procedures (see Section III.F, *Maintenance Procedures*).

D.2.7.2 Supervision of Maintenance Activities

First-line supervisors should spend the majority of their time in the field. They should monitor work in progress to ensure that maintenance activities are conducted safely in accordance with DOE 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. Success in safety is achieved by the consistency of policies and procedures applied by supervisors. Examples of work practices that should be checked include the following:

- Pre-job briefings and applicable training (e.g., mockup training);
- Industrial safety and radiological protection practices (e.g., appropriate use of safety equipment, adherence to lockout/tagout requirements, proper handling of hazardous chemicals, proper use of ALARA concepts, and minimizing spread of contamination);
- Worker awareness of their responsibility to immediately notify their supervisor and stop work on any activity that they believe to be unsafe or out of scope, and are to prevent others from performing the activity until appropriate reviews are completed; (For less significant work related issues or questions that may be corrected with minimum effort and time issues a graded approach should be used. Some sites may establish the grading within their stop work process, while others establish a separate time-out/safety pause process for addressing less significant work related issues.);
- Quality of workmanship, materials, and parts;
- Procedure use, including adherence to step-by-step requirements, signoffs, and work hold points;
- Open system and component protection;
- Accountability of tools, chemicals, and materials;
- Correct tool use for the job (e.g., short, non-sparking tools for batteries and test instruments used on correct ranges);
- Clean and orderly work sites;
- Work progress and time required to perform the job, especially if an LCO exists;
- Work being performed on the correct component, system, or unit;
- Adequate documentation of actual work performed; and
- Proper use of post-job reporting and, when applicable, post-job critiques.

D.2.7.3 Review of Completed Work Requests

The equipment owner/operator should compare the work accomplished to the post-maintenance testing or inspection performed to determine that all work is acceptable before returning the equipment or system to normal service.

Maintenance supervisors should review completed WRs for adequacy of repair, complete documentation, notation of generic corrective actions, and identification of rework. A post-job review/discussion should be held with the workers involved to determine whether any unexpected problems or unsafe conditions occurred and/or how the activity can be accomplished more efficiently and safely the next time. Where appropriate and in accordance with facility instructions, other reviews should be accomplished by technical support, QC, safety, radiation protection, and other organizations. Feedback should be provided to planning, scheduling, and maintenance personnel to highlight areas that were exemplary and areas that needed improvement.

D.2.7.4 Temporary Repairs

For temporary repairs or modifications to the facility, see Section III.H, *Configuration Management*.

D.2.7.5 Control of Non-facility Contractor and Subcontractor Personnel

Non-facility contractor and subcontractor personnel (workers not directly employed by the facility operating contractor) who perform maintenance or modifications on facility systems should be trained and qualified for the work they are to perform. This should include general employee training and specific training in appropriate facility administration, safety, QC, and radiation protection procedures and practices. The training required should recognize the individual's previous training and experience. Qualified personnel should continuously supervise non-facility contractor and subcontractor personnel who are not fully trained and qualified for the job to be performed.

Non-facility contractor and subcontractor personnel should perform maintenance under the same controls as and the same high work standards as facility maintenance personnel. Non-facility contractor and subcontractor managers and supervisors should be held accountable for the work performance of their personnel. Facility supervisors should review the work of these personnel during preparation for work, at the job site, and during post-maintenance testing and acceptance inspections to the extent needed to enforce these requirements.

D.2.7.6 Integrated Safety Management System (ISMS)

An 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. Safety management should not be an add-on to strategic planning, but a central part of that planning. ES&H considerations should be integrated with the programmatic requirement setting, resource allocation, and budgeting process. Safety should be incorporated into management and work practices at all levels, addressing all types of work and all types of hazards to ensure 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. The seven ISMS management principles are as follows:

1. Line management responsibility for safety;
2. Clear roles and responsibilities;
3. Competence commensurate with responsibilities;
4. Balanced priorities;
5. Identification of safety standards and requirements;
6. Hazard controls tailored to the work being performed; and
7. Operations authorization.

Under ISMS, contractor safety responsibilities and accountability should be clearly established. The ISMS functions are:

1. Define the scope of work;
2. Analyze the hazards;
3. Develop and implement hazard controls;
4. Define performance of work within controls; and
5. Provide feedback and continuous improvement.

The Safety Analysis Report (SAR) and TSR are part of a nuclear facility's authorization basis. The SAR describes the hazard analysis and accident consequence analysis that was conducted to define the conditions under which the facility can be safely operated, and specifies safe operating conditions and parameters. The TSR contains individual operational requirements that need to be met to ensure safe operation. Effective "Control of Maintenance Activities" is essential in ensuring the safe operating conditions and maintaining the facility safety basis.

The dependence of a facility's authorization basis on periodic maintenance of safety-related systems can be a strong justification for maintenance budget requests (see DOE P 450.4A, *Integrated Safety Management Policy*; and 10 CFR Part 830, *Nuclear Safety Management*).

D.2.7.7 Human Performance in Maintenance

Errors during the performance of maintenance are more prevalent than during typical operations for some of the following reasons:

- It involves removal and replacement of a large numbers of varied components;
- Performance is usually under severe time pressure;
- Work locations are often cramped and poorly lit spaces;
- Can involve the use of unusual or unavailable tools;
- Vendor manuals and procedures rarely reflect tasks under real life conditions;
- Often those who start the job are not the ones required to finish it;
- A number of different groups may work on the same item of equipment; and/or
- Equipment troubleshooting requires the use of system knowledge and may require actions beyond routine maintenance instructions.

Most maintenance errors have been judged by experience workers as having happened before and likely to happen again. The fact that the same errors keep on happening to different people in different organizations strongly suggests that we should focus our remedial attention more upon the task and the workplace, than upon the presumed psychological inadequacies of those making the errors.

Maintenance supervisors, work planners, and workers should anticipate the likelihood of human error as a hazard to maintenance. DOE-HDBK-1028-2009, *Human Performance Improvement Handbook* discusses numerous factors that impact error-free performance and provide tools that may be utilized to improve maintenance.

Examples of Mechanical Minor Maintenance

A. The following are examples of work that may qualify as minor maintenance.
   1. Manual Valve: Adjust packing on manual valves not subject to testing, repair or replace handwheel, lubricate valve stem.
   2. Pumps: Adjust packing; adjust cooling water flow.
   3. Flanges: Tighten to stop leakage (not to exceed recommended torque values).
   4. Diaphragms: Seal against in-leakage.
   5. Brackets/Hangers: Replace missing bolts (except safety-related/seismically qualified or material substitution).
   6. Doors: Repair or replace knobs, hinges, bars, or closures.
   7. Plumbing: Repair or replace commodes, water fountains, sinks.
   8. Structures: Patch walls, roofs, etc. (except fire barrier seals).
   9. Grating/Stair: Treads: Repair or replace grating, clips, or treads.

B. The following are examples of work that does not qualify as minor maintenance.
   1. Manual Valves: Adjust packing on valves that require testing.
   2. Motor-operated Valves: Adjust or replace packing.
   3. Pumps: Replace packing or seals, replace casing bolts, replace gasket.
   4. Flanges: Replace gasket or fasteners; install or remove blank flange.

Examples of Electrical Minor Maintenance

A. The following are examples of work that may qualify as minor maintenance.
   1. Lamps or Bulbs: Replace.
   2. Fuses: Replace where fuse is not required to be safety-related.
   3. Junction Boxes (non-environmentally qualified): Replace covers or screws.
   4. Conduit: Replace covers, screws, brackets.
   5. Motors: Replace air filters, replace cover screws, and replace screens.
   6. Facility Paging System: Repair or replace handles, knobs, etc.
   7. Portable Sump Pumps: Repair or replace motor or wiring.
   8. Door Locks or Latches: Repair or replace (except fire and security doors).
   9. Telephone Equipment: Install, replace, or repair.

B. The following are examples of work that does not qualify as minor maintenance.
   1. Light Fixture: Repair or replace where tagout is required.
   2. Fuses: Replace where fuse is safety-related.
   3. Fire Alarm Panel: Repair.
   4. Protection Relay Test Switches: Repair or replace.

Table III.D-1 Examples of Minor Maintenance

Examples of Instrument Minor Maintenance
A. The following are examples of work that may qualify as minor maintenance. 1. Lamps or Bulbs: Replace. 2. Fuses: Replace where they do not perform a safety function. 3. Pressure Gauges: Replace gauge or glass. 4. Instrument tubing: Tighten. 5. Air Filters: Replace. 6. Knobs: Tighten, repair, or replace. B. The following are examples of work that does not qualify as minor maintenance. 1. Electro-pneumatic Equipment and Positioners: Clean or adjust. 2. Pneumatic Controllers: Clean, adjust, or calibrate. 3. Fuses: Replace when the fuse performs a safety function. 4. Transmitters: Vent or fill.

Table III.D-1(continued) Examples of Minor Maintenance

Example Troubleshooting Guide
For work that requires troubleshooting for unknown conditions on energized, pressurized, or operating equipment, perform the following. 1. Use the following sources to develop the troubleshooting methodology: • System engineers • Owner/operator personnel (organization responsible for the equipment) • Training • Technical Safety Requirements • Final safety analysis report • Equipment vendor manuals • Equipment manufacturers • Applicable procedures • Applicable system/circuit drawings • Vendor drawings
2. Include the following, as applicable, in the work instructions. • Notes, precautions, and prerequisites for the specific task (e.g., "System contains live steam; do not vent"; "Do not exceed three motor starts in any one-hour period"; "Do not remove input/output signal cable before de-energizing power supply"). • Steps to record and observe as-found/as-left conditions of the affected equipment. • Steps to record any abnormalities observed during equipment operation (e.g., bearing noise, smoke, vibration) • Steps to prevent further damage if any abnormal conditions are observed. • Specific instructions for craft workers/technicians to stop work when problems or conditions encountered were not anticipated or are not understood. They should be directed to consult with their supervisors or planners before taking action. • Steps to record and verify lifted/landed leads. Lifted lead forms should be included in the work package as required. • Steps to record the identification numbers and calibration due dates of measuring and test equipment used • Steps to tag and retain all parts removed during the troubleshooting process. These parts will be retained as appropriate for further investigation/analysis by maintenance or system engineer.

Table III.D-2 Example Troubleshooting Guide

3. For troubleshooting equipment important to safe and reliable facility operation, a troubleshooting impact statement should be included as part of the planning package. Include the following information on the statement:
   a. scope of the troubleshooting,
   b. required equipment status,
   c. work boundaries for the activity,
   d. potential facility upsets that may occur, and
   e. approval of owner/operator supervision before beginning troubleshooting activities.
4. Any follow-up corrective maintenance deemed necessary as a result of troubleshooting should be performed under a separate corrective maintenance work order or under an approved revision to the work plan.

Table III.D-2 (continued) Example Troubleshooting Guide

E. TYPES OF MAINTENANCE

E.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include a process for utilization of appropriate types of maintenance (e.g., preventive maintenance, predictive maintenance, corrective maintenance) to provide for safe, efficient, and reliable operation of SSCs that are part of the safety basis.

Types of maintenance generally fall into two categories: Periodic (or Proactive) – scheduled by calendar period, operating hours, or other situational event (e.g. prior to startup) and Corrective (or Reactive) – repairs, alignments, etc. needed when equipment fails or does not perform its intended purpose. Periodic Maintenance includes Preventive Maintenance (PM), Surveillances, and Predictive Maintenance (PdM).

The NMMP should address the following:

- The types of maintenance used by the facility, their definitions, and applicability;
- The methodology for developing balanced maintenance strategies which result in safety basis compliance; high production reliability and quality; and worker, public, and environmental safety;
- How PMs and PdMs are selected and assigned appropriate periodicity. Considerations such as operational experience, consensus standards, vendor recommendations, engineering analysis, and cost/benefit analysis are used as a basis to establish optimum periodic maintenance tasks and intervals;
- How maintenance activities are scheduled and performed within established intervals; PMs are waived or deferred only with appropriate approval related to SSC significance and amount of delay;
- Recording PM activities performed; data collected; and, where appropriate, the “as-found” and “as-left” condition of the equipment;
- How using PM techniques and results to assess equipment performance, program adjustments are made and other corrective actions are taken where needed;
- How PdM is appropriately used to limit unnecessary PMs;
- Expectations for managers and supervisors to routinely observe maintenance activities to identify and correct problems, and to ensure adherence to facility policies and procedures;
- Maintaining and reviewing tracking and trending compliance with periodic maintenance intervals, equipment availability, and maintenance rework and backlog; and
- Analyzing missed goals and unsatisfactory trends to identify causes, generic implications, and corrective actions to minimize cost and maximize reliability.

E.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

An effective maintenance program provides a high degree of equipment and facility predictability, reliability, and cost-effectiveness. Individual equipment maintenance plans may vary, but should be optimized for the equipment. This maintenance approach may range from: "Run-to-Failure" – for non-safety related, low cost, easily replaceable equipment; to a very proactive plan of ongoing maintenance – for equipment whose failure can impact safe operation, product quality, and facility mission. Many factors should be considered in establishing an effective and efficient balance of the various types of maintenance. For safety related systems and equipment, a thorough technical analysis using a method such as Reliability-Centered Maintenance (RCM) should be used to establish this balance. RCM provides a systematic method for analyzing functions, failure modes, and periodic maintenance to monitor and maintain equipment to ensure it continues to meet its functional requirements. For other equipment, the amount of periodic maintenance may be determined through industry experience, consensus standards, and good engineering judgment; then adjusted based upon results during the operating cycle.

The Federal Energy Management Program (FEMP) - *Operations & Maintenance (O&M) Best Practices Guide*, Chapter 5 provides a good description of various techniques for effective maintenance, including RCM and predictive maintenance options. Follow the linked reference for more information.

Elements needed to implement this maintenance program successfully include the following:

- The Master Equipment List (MEL) of Section III.C, which includes a listing of all SSCs that are part of the safety basis. The MEL may also include other SSCs that are not part of the safety basis. The MEL should be used as the listing for development of system and component maintenance plans.
- A System Engineering Program per DOE O 420.1C, which should take the lead in developing, monitoring, and revising maintenance plans in conjunction with maintenance and operations. The effectiveness of these maintenance plans should be periodically reviewed.
- Work control planners should develop standard work procedures for this periodic (recurring) maintenance and ensure it is scheduled at its required periodicity.
- Maintenance management should monitor compliance with periodic maintenance schedules and provide input to improve the efficiency of the program. Performance of this maintenance should be evaluated in their self-assessment program.

E.2.1 Preventive Maintenance (PM) and Surveillance

PMs consist of all those systematically planned and scheduled actions performed to prevent equipment failure. The PM program should define the required activities and the frequency with which they should be performed. Selection of required PM actions should be based on manufacturers' recommendations, plant experience, and good engineering practice. PM frequency should be based on adequately implementing the entire program, considering such elements as regulatory requirements, consensus standards (e.g. NFPA), vendor recommendations, ALARA considerations, and performance monitoring. A documented basis

for the planned actions should be provided. Further, any deferral of planned tasks should have a technical basis. A Subject Matter Expert (SME) should lead or be directly involved in the establishment of the PM Program and individual PM activities. Effectiveness should be monitored and the program revised if necessary.

Surveillance is the term normally used to denote preventive maintenance, inspections, or tests on safety SSCs required by the facility safety basis. These surveillances are important as they help to maintain the safety basis valid and maintain compliance with the TSR, where applicable. Normally, Operations tracks the scheduling and performance of surveillances, in addition to the general work control process, because of their safety basis relationship.

E.2.1.1 Determining PM Intervals

The initial interval for PM tasks should be established to maximize equipment reliability. The objective of a maintenance program is to increase the availability of SSCs by eliminating hidden faults before equipment fails. Unfortunately, maintenance actions sometimes introduce new failures because of factors such as human error. Therefore, there is a need to establish an effective interval (or frequency of maintenance) that yields the maximum achievable availability.

Optimization of maintenance intervals involves the following general activities:

- Ranking PM tasks;
- Monitoring PM activities, plans, and schedules;
- Accessing PM and other maintenance data;
- Listing recurring failure modes/parts;
- Calculating and monitoring SSC availability;
- Keeping track of PM cost; and
- Calculating the PM interval by balancing availability, reliability, and cost.

E.2.1.2 Scheduling PMs

The management of PM scheduling should incorporate the following concepts:

1. A master resource-loaded schedule should be prepared for all PMs.
2. PM work-control documents should be prepared for each task. Since they are recurring and may be used on more than one piece of equipment, they should be designed for easy replication.
3. PM tasks are capable of being quickly sorted and listed by system and required operational condition. This can aid in planning work items during forced outages or unplanned changes in operating conditions.
4. PMs should be scheduled at their nominal intervals and, where practical, with corrective and other related maintenance or testing on the same equipment.
5. PMs that might affect the results of surveillance testing such as lubrication, venting, and equipment exercising should be scheduled to occur following the completion of surveillance testing to avoid pre-conditioning the equipment and affecting the results.

6. PMs are intended to be performed at their nominal periodicity (e.g. weekly, monthly, quarterly), using a graded approach. To allow some flexibility for workload and other unforeseeable conditions, the maintenance program documents should define what is meant by each technically based nominal period. Generally, this allowance should not be more than 25% of the PM interval (e.g. monthly equals three to five weeks) not to exceed one quarter regardless of the interval, and should be approved as part of the interval determination. PMs should be scheduled at their nominal intervals under normal circumstances.
7. Delays in the performance of scheduled PMs beyond their defined period should require escalating approval. For example, approval should be obtained from system engineers, maintenance supervisors, operations managers, maintenance managers, and the facility manager, depending on the length of time that the task is to be delayed and the potential risk involved.
8. Maintenance and operations personnel should be encouraged to recommend changes in PM interval based on real-time observations and conditions. System engineers should evaluate and the operations and maintenance management should approve these proposals. Figure III.E-1 provides a sample form.
9. The Maintenance Manager should report periodically to the Operations Manager any associated problems with performing PM tasks, including the number overdue.

E.2.1.3 Performing PMs

PMs should be performed using the normal work control processes for recurring maintenance. All involved parties should be coordinated (e.g., operations, radiological protection, QA/QC). Good work practices; such as pre-job briefings, data recordings, cleanliness, correct tool use, supervision, and history update; are essential to the PM task.

E.2.1.4 Evaluation of the PM Program

PM program assessments should include the overall effectiveness of the program in improving facility and equipment availability, as well as reducing the cost of maintenance. This evaluation should consider PMs that are being performed unnecessarily or excessively, thereby consuming valuable and limited resources that may otherwise be used to upgrade other maintenance programs. Additionally, excessive PMs may increase item deterioration, radiation exposures, maintenance errors, and rework.

Items to be considered in the evaluation should include:

- Adequacy of PM procedures as deemed by worker feedback;
- Applicable QA audit reports and self-assessment findings;
- Failure trend reports for facility and industry equipment;
- Applicable occurrence, nonconformance, and material deficiency reports; and/or
- Deferral statistics and causes.

Using the results of these evaluations, the following items should be addressed and implemented as appropriate:

- Adjustment of PM task intervals;
- Redefinition of PM activities;
- Addition or deletion of PM activities;
- Adjustment of spare parts stocking levels;
- Replacement of cost/labor intensive items;
- The need for personal protective equipment in performing PM tasks;
- Propose design changes;
- Identification of special tools; and/or
- Revised PM program and/or PM task procedures.

E.2.2 Predictive Maintenance (PdM)

PdM consists of measurements or tests performed to detect equipment or system conditions. These activities should be less invasive, time consuming, and costly than preventive or corrective maintenance. The results of PdM can be analyzed to determine what degree of maintenance is required and when it is needed. This provides benefits similar to preventive maintenance without performing unneeded maintenance with its cost and potential for human error. Corrective maintenance efficiency may be improved by directing repair efforts (manpower, tooling, parts) at problems detected using PdM techniques. Industry studies have shown significant savings and improved reliability using PdM. PdM should be integrated into the overall maintenance program so that "proactive repair" planned maintenance may be performed before equipment failure.

Not all equipment conditions and failure modes can be reliably monitored; therefore, PdM should be selectively applied. It is normally limited to components and systems that are important to the safe and reliable operation of the facility. The effectiveness of the program is dependent on the accuracy of equipment degradation rate and time to failure assessment.

Many different predictive maintenance techniques are used throughout industry. The following paragraphs describe some of the common predictive maintenance techniques. Although the key elements of the program are applicable to all facilities, some of the details may need to be modified to reflect individual facility conditions and needs.

Bearing temperature monitoring is a technique used to measure and trend temperatures of critical machinery bearings to predict failure. Changes in bearing temperature may indicate wear due to loss of lubrication, excessive vibration, or intrusion of foreign material into the rotating assemblies. Bearing temperature analysis is often performed in conjunction with the vibration monitoring and lubricating oil analysis/ferrography programs.

Infrared thermography is a technique based on the fact that the infrared radiation emitted by a source varies with its surface temperature. Infrared surveys may be performed on heat-producing equipment such as motors, circuit breakers, batteries, load centers, and insulated areas

to monitor for high resistance, loose connections, or insulation breakdown. Additionally, this technique may be applied to pinpoint condenser air in-leakage locations and valve leaks.

Lubricating oil analysis, ferrography, and grease analysis are techniques used for the early detection of lubricant breakdown and abnormal wear.

- Lubricating oil analysis monitors the actual condition of the oil itself. Parameters measured include viscosity, moisture, additive package, and the presence of other contaminants.
- Ferrography is a technique used to analyze oil for metal wear products and other particulates. Trending and analyzing the amount and type of wear particles in a machine's lubrication system may pinpoint where degradation is occurring.
- Grease analyses are techniques used to detect changes in the lubricating properties of grease. Sensory tests such as color, odor, and consistency are most often applied to greases. A penetration test is sometimes used to quantify grease consistency. Grease analyses are often performed on samples obtained from motor-operated valves.

Vibration monitoring is a technique used for monitoring and analyzing facility rotating equipment. This technique is used to analyze displacement, velocity, and acceleration parameters to predict the need to correct problems such as bad bearings, poor alignments, or improper balance.

In addition to the predictive maintenance techniques already described, various other methods, including the following, may be used as a predictive approach to monitoring facility performance.

- Eddy current testing is used to monitor heat exchanger tube wall thickness.
- Temperature differential is used as a means of monitoring heat exchanger performance.
- Flow measurement is used to monitor heat exchanger and pump performance.
- Unit heat rate is used to measure facility steam cycle efficiency.

Acoustic testing is in many cases one of the few techniques that can locate leaks in buried lines. Acoustic testing utilizes various devices that amplify the sound produced by leaking fluids to aid in the detection and location of leaks in buried pipelines. Acoustic testing can be used for leak detection in water, steam, gas and air lines.

The Federal Energy Management Program (FEMP) - *Operations & Maintenance (O&M) Best Practices Guide*, Chapter 6 provides additional discussion and references regarding Predictive Maintenance Technologies.

E.2.3 Corrective Maintenance

Corrective Maintenance is performed in response to failed or malfunctioning equipment, systems, or facilities in order to restore their intended function and design capabilities. Analysis should be performed to determine the causes of unexpected failure and the corrective action that should be taken, including feedback into the preventive and predictive maintenance programs, and training and qualification programs. The establishment of priorities for corrective maintenance should be based on plant objectives and the relative importance of the equipment. Section D of this Guide provides information on planned and unplanned maintenance

scheduling. Emergency management procedures should manage equipment failures leading to emergency conditions. This is not to be confused with urgent maintenance, failure of equipment important to safety and/or mission performance. Urgent maintenance may have accelerated processes, but should continue to follow the ISM model for work scope definition, hazard identification and control, and work authorization.

A program for identification and timely repair of deficient SSCs should be established. There should be established criteria and responsibilities established for timely review and approval of deficiency reports and work requests. A reliable method should be in place to confirm that all material deficiencies are identified and entered into the work-control system. Inspection criteria, including a process to measure the degradation of standby and passive safety-related systems should be in place, and inspection tours should be periodically conducted to identify any exceptions or deviations. The criteria should include:

- Mechanical systems and equipment are in good working order;
- Good equipment lubrication practices are being followed;
- Fluid system leaks are minimized, monitored, appropriately corrected or controlled, and assessed for impact on safe operations;
- Instrumentation, controls, and associated indicators are operable and calibrated as required;
- Electrical and electronic equipment are operable and appropriately protected from adverse environmental conditions;
- Mechanical operators, fasteners, and supports are in place and operable;
- Components, systems, and structures are preserved and insulated; and
- Housekeeping is adequate to support reliable system operations.

E.2.4 Maintenance of Facilities in Transition

Many DOE nuclear facilities are in transition rather than an operational or standby mode. Some of these facilities are large and complex, geographically widespread, and contain potentially hazardous chemical, nuclear, or radiological materials. Their transition includes deactivation, decommissioning, surveillance and maintenance (S&M), demolition, and site remediation. A review should be conducted to provide the safety basis, and physical and administrative characteristics of the facilities following cessation of operations, but before the disposition begins. The objective of the review should be to identify and evaluate the boundaries of the facility being transferred; its physical condition; the extent, nature, and level of contamination; inventories/estimates of types and quantities of special nuclear, fissionable, toxic, hazardous, and/or radioactive materials; and the appropriate S&M requirements. DOE G 430.1-2, *Implementation Guide for Surveillance and Maintenance during Facility Transition and Disposition,* provides guidance pertaining to S&M activities.

Throughout a facility's transition phase, S&M activities should be performed to monitor and document the presence, status, and/or condition of SSCs and hazards associated with the facility. S&M should be adjusted as needed following deactivation, decommissioning, and demolition activities. Continuing S&M should ensure adequate containment of contamination, and potential

hazards to workers, the public, and the environment are minimized.

As remediation occurs at a facility in transition and the hazard profile changes, the authorization basis and associated S&M requirements should also change to be commensurate with the hazards and impacts to workers, the public and the environment. DOE-STD-1120-2005, *Integration of Environment, Safety, And Health into Facility Disposition Activities*, provides guidance for integrating ES&H into facility disposition activities. It also provides guidance that addresses authorization basis and its changes during facility disposition.

Preventive Maintenance (PM) Document Validation and Feedback Form

PM Task Number: _____ Work Order No.: _____

PM Description/Title: _____

Component Tag Number: _____

Component Description: _____

Performers/Discipline:

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

Evaluation Factors	YES	NO	NA	Comment
1. Materials and tools equipment list complete and adequate?				
2. Can PM task be performed as written?				
3. Procedure reflects current as-built facility configuration?				
4. Referenced parts/equipment correctly identified and easily located?				
5. Graphic illustrations accurate, legible, and easy to understand?				
5. Indicate enough illustrative detail to perform the PM task adequately?				
6. Data sheets follow sequentially with the procedure book?				
7. Prerequisites, precautions, and limitations clearly identified?				
8. Tag numbers, nomenclature, and units/symbols identical to those on the components or instruments?				
9. PM frequency adequate?				
10. Step, Caution, and Note statements easily understandable?				
11. Changes to Work Order required?				

Evaluation Factors	YES	NO	NA	Comment
12. Personnel allocations/ requirements adequate?				
13. Concurrent maintenance correctly identified?				
14. Editorial/grammatical errors identified?				
Recommended changes to format, flow, or technical content:				
Additional Comments:				
Resolution/Justification:				
Resolved by: _____ Signature				Date: _____

Figure III.E-1 Sample Preventive Maintenance Document Validation and Feedback Form

F. MAINTENANCE PROCEDURES

F.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include the process for developing and implementing documented and approved work instructions for work on safety SSCs (i.e., work packages, procedures, work instructions, and drawings).

In meeting this requirement, maintenance procedures should be prepared and used to provide appropriate work direction and to ensure that maintenance is performed in a safe, efficient, and consistent manner. Maintenance procedures should be technically accurate, complete, up to date, and presented in a clear, concise, and consistent manner to minimize human error. DOE-STD-1029-92, Chg 1, provides information on maintenance procedures.

Guidance should be provided for the development, writing, verification, validation, approval, and use of maintenance procedures as required. The guidance should also include such factors as procedure: issuance, periodic review, revision, reference material control, identification, and storage

The NMMP should address the following:

- A process governing the development of procedures which includes:
  - Ensuring procedures are clear, concise, and contain adequate information for users to understand and perform their activities effectively;
  - Verifying technical details such as set points, control logic, and equipment numbers are consistent among procedures, drawings, valve lineup sheets, and system descriptions;
  - Including hold-points such as quality and radiological protection checks in procedures, as needed;
  - Incorporating human performance factors into procedures to promote error-free performance;
  - Documenting post-maintenance/modification testing requirements and acceptance criteria, follow-on steps, and restoration instructions, where appropriate; and
  - Checking new, changed, or revised procedures to ensure usability before or during initial use.
- Control of the review, approval, and revision of procedures and other work-related documents;
- How documents used in lieu of or in support of procedures (such as excerpts from vendor manuals) receive the same review and approval as procedures, and are maintained technically accurate and up-to-date;
- How effective procedures are clearly identified and maintained readily available for workers;
- Management’s expectations for procedure use;
- Identifying actions to be taken when procedures conflict, are inadequate for the intended tasks, or when unexpected results occur; and

- Periodic procedure reviews for technical accuracy, human performance factors, and the inclusion of in-house and industry operating experience.

F.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

As addressed in DOE O 433.1B, the term 'maintenance procedures' is a generic term for documents providing maintenance directions (e.g., work packages, procedures, work instructions, and drawings). Maintenance procedures should be prepared and used to provide appropriate work direction and to ensure that maintenance is performed in a safe, efficient, and consistent manner. Maintenance procedures should be technically accurate, complete, up to date, and presented in a clear, concise, and consistent manner to minimize human error. DOE-STD-1029-92, Chg 1, provide information on maintenance procedures.

Guidance should be provided for the development, writing, verification, validation, approval, and use of maintenance procedures as required. The guidance should also include such factors as procedure: issuance, periodic review, revision, reference material control, identification, and storage

A balanced combination of written direction, skilled workers, and work-site supervision is required to achieve the quality work essential to safe and reliable facility operation.

F.2.1 Guidelines - Maintenance Procedure Development and Writing

Maintenance procedures should be written for and used in all maintenance of SSCs that are part of the safety basis in Hazard Category 1, 2, and 3 nuclear facilities. Maintenance procedures should be developed following ISM and the five core functions: define the scope of work, analyze the hazards, establish the controls, perform the work safely, and obtain feedback. Maintenance procedures should extend the five core functions into the planning and performance of work. Using the graded approach, the procedures may include information such as special skill levels required; materials and special tools needed; facility or system conditions and permits needed; and other safety requirements and precautions needed to perform the maintenance. Workers should be involved in procedure development and verification whenever possible. In addition, the procedures should identify system interactions and interconnectivities that could result in equipment/systems undergoing maintenance adversely affecting other SSCs.

The maintenance procedures should be clear and concise with the user in mind, to ensure accurate understanding. Experienced workers and engineers can be trained to write maintenance procedures, or procedure writers can be used, with experienced workers or engineers providing technical input. Maintenance procedures should include the following:

- Procedure identification and approval status;
- Procedure purpose and scope;
- Consistent organization, presentation and format;
- Clearly understandable text, using correct grammar and punctuation; appropriate level of detail; concise instruction steps in logical sequence; flags to identify instructions steps that need to be performed in a prescribed sequence; specific nomenclature; quantitative and compatible values; referencing methods; coordination of multiple actions; effective formatting; and clear table, graph, and data sheet layout;

- Clear indication of hold points, warnings, caution statements, independent verification requirements, or data to be recorded;
- Nuclear facility and system prerequisites, precautions and limitations, required special tools and materials, and required personnel;
- Clear indication of post-maintenance/post-modification testing and acceptance criteria, follow-on steps, and restoration instructions where appropriate;
- Applicable operating experience information;
- Direction to workers to stop work and notify management of maintenance that cannot be completed as originally planned; and/or
- Reference to source information.

F.2.2 Guidelines - Procedure Verification

Verification is review of a new or revised procedure to determine whether it is technically accurate and in the proper format. The review should ensure the work activity is adequately described, all hazards are analyzed and controls are established, and that human factors principles and appropriate administrative policies are incorporated. The technical accuracy review should review 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 procedure.

Verification should be conducted by one or more reviewers who were not involved in writing the procedure but are representative of the intended users. Reviewers from other disciplines, such as health physics, engineering, and operations, should be considered for involvement in the process.

F.2.3 Guidelines - Procedure Validation

Validation is review of a procedure to determine its usability and correctness. This review evaluates whether the procedure provides sufficient and understandable direction to the worker and is compatible with the equipment or system being maintained. Validation may be conducted in a shop, in a training environment, on a mockup or simulator, or by the worker and supervisor walking through the procedure prior to its approval. In general the walk through of the procedure should be done at the location where the work will be performed to identify any issues with equipment, the procedure, access, unanticipated hazards, controls, etc. In certain hazardous circumstances, such as a high radiation area, it may be necessary to identify any issues without performing the walk through at the work location.

F.2.4 Guidelines - Procedure Approval

Proposed procedures and changes to procedures, which could affect the performance of safety SSCs, should be reviewed as part of the USQ process. In accordance with administrative procedures, management should approve maintenance procedures.

F.2.5 Guidelines - Procedure Use

A process should be in place to ensure the worker has the most current procedure prior to performing work.

Management should establish and reinforce clear expectations and requirements for the use of procedures to perform maintenance activities. Management should ensure procedure use requirements are understood and met by the workers. Normally, three levels of procedure use are defined:

- Continuous use of procedures for activities having direct impact on nuclear safety and reliability or difficult, complex tasks independent of the frequency performed (generally the worker will have the procedure in-hand or immediately available for use in executing tasks);
- Reference use for tasks easily accomplished from memory or for tasks for which improper actions pose no immediate consequences to workers or equipment (generally the worker will have the procedure available in the work area for referral as needed); and
- Information use for tasks that can be performed without referring to the procedure (generally the worker will cover these procedures in training or preparing to perform work, separate from the work area).

Procedures should clearly identify and distinguish between steps or groups of steps that may be performed out of sequence and those that need to be performed in a prescribed sequence. Procedure users should understand the need to use procedures with forethought and good judgment, even when step-by-step compliance is not required. Workers should not proceed with work and should seek supervisory assistance with any situation that is unclear or unexpected. (See definition of **stop work** and **time out/safety pause**.) Supervisors or managers should resolve such inquiries promptly

F.2.6 Guidelines - Procedure Change Control, Periodic Review, and Revision

Responsibilities for procedure program administration should be clearly defined. Procedure changes (i.e., redlines) and revisions should be controlled in accordance with facility administrative requirements. All procedures should be periodically reviewed to ensure their continued applicability and accuracy. Redline changes and revisions of procedures should receive the same review, approval, and distribution as new procedures with the extent of these reviews varying depending on the extent of the revision. The implementation impacts need to be evaluated and communicated to affected parties (e.g., training and other procedures/forms/processes).

Vendor manuals or the portions of a vendor manual and other reference materials used in support of maintenance should be technically accurate, up to date, and controlled. Reference material (e.g., an instruction section of a vendor manual and vendor or contractor drawings) used in lieu of facility-prepared maintenance procedures should receive the same review and approval as facility maintenance procedures.

G. TRAINING AND QUALIFICATION

G.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B and using a graded approach as applicable, the NMMP must include a training and qualification program for maintenance positions specified in DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities* (formerly DOE O 5480.20A).

The NMMP should address the following:

- That a maintenance training and qualification program should establish and maintain the knowledge and skills needed by maintenance personnel to perform maintenance on all SSCs that are part of the safety basis for Hazard Category 1, 2, and 3 nuclear facilities;
- Maintenance is performed by or under the direct supervision of personnel who are qualified on the tasks to be performed;
- Maintenance personnel, including temporary and non-facility personnel, are knowledgeable of the following (as applicable to their activities) or escorted by an individual who is:
    - General plant layout;
    - Purpose and importance of facility/systems and equipment;
    - Maintenance policies, processes, and procedures;
    - Effect of work on facility systems;
    - Industrial safety, including hazards associated with work on specific; equipment/systems;
    - Radiological protection and ALARA principles;
    - Job-specific work practices;
    - Principles to be used in the identification of potential suspect/counterfeit items; and
    - Cleanliness and housekeeping practices.
- On-The-Job Training activities being evaluated for qualification sign-off are evaluated by personnel qualified as OJT instructors/evaluators;
- Maintenance personnel are knowledgeable of appropriate lessons learned from industry and in-house operating experiences (including actual events) applicable to their craft;
- Maintenance personnel are capable of troubleshooting equipment problems in a safe and efficient manner;
- Continuing Training is performed to maintain and enhance worker proficiencies and qualifications;
- Maintenance training is reviewed as part of the facility’s Self-Assessment Program; and
- Periodic systematic evaluations of maintenance training and qualification (not to exceed three years) in accordance with DOE-STD-1070-94 "Guidelines for Evaluation of Nuclear Facility Training Programs” are performed (This may be done as a portion of the periodic evaluation of the overall facility/organization training program).

G.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

A balanced combination of written guidance, worker skills, and work-site supervision is required to achieve the quality workmanship essential to safe and reliable facility operation. This section discusses maintenance training program guidance (i.e., worker skills). Many organizations find that applying the same principles from DOE O 426.2 to all levels of maintenance promotes safe and efficient worker performance.

Many facilities rely heavily on what is known as "skill-of-the-craft", but have not assessed the actual skill levels of their personnel. For example, it is commonly accepted that an electrician possesses the necessary skills to install wiring and terminal lugs; however, certain electrical products require specialized training and skills to install electrical wires, cables, and conduits (e.g., termination and sealing of various types of medium voltage (5–15 kV) cables; environmental sealing of connections of cables to bus bars rated up to 15 kV in accordance with ANSI C37.20; and sealing connections to medium voltage motors). While work instructions should take credit for the skill-of-the-craft, to reduce the potential for inadequate instructions to personnel, maintenance managers should establish minimum levels of craft proficiency and implement training programs to ensure that the expected craft skill levels are developed and maintained. This baseline skill-of-the-craft training may be coordinated with or conducted by bargaining unit organizations that provide maintenance workers. Specialized and facility-specific training is normally provided by the facility training organization.

Some examples of maintenance skills-of-the-craft may include:

- Lubricating equipment;
- Cutting fasteners to length;
- Installing tubing;
- Tightening or replacing fittings;
- Replacing gaskets, bolting, valve packing, and stationary seals;
- Taking electrical readings, such as insulation resistance and voltage;
- Replacing fuses and lamps;
- Insulating cables (except on printed circuit boards);
- Soldering (except on printed circuit boards); and/or
- Crimping lugs and splices (non-EQ).

Maintenance management should be directly involved in this training program, which should establish and maintain the knowledge and skills needed by personnel to perform maintenance. This involvement should include coordination with the training organization to establish and maintain individualized training and qualification programs, course objectives and content, required reading, On-The-Job Training (OJT) exercises, and schedules. Additionally, maintenance management should routinely provide feedback to improve training program content and emphasis based upon observation of maintenance activities.

G.2.1 Responsibilities

Responsibilities for establishing, implementing, and maintaining the Maintenance Training Program should be clearly defined and understood. The key element for success is coordination between the management of the maintenance and training organizations. Maintenance Managers should ensure:

- Nuclear maintenance is only performed by qualified individuals, or trainees under direct supervision of a qualified worker;
- Training Programs are defined and developed for jobs associated with the maintenance of SSCs related to the safety basis of nuclear facilities with emphasis on successful performance in the field;
- Individual training plans are assigned to individuals based upon their prospective job assignments and their previous education, training, experience, and skill level;
- Required training, including OJT, is appropriately scheduled and attended by maintenance personnel; and
- Training-effectiveness feedback is provided to enhance and adjust course teaching methods, content, and emphasis.

G.2.2 Training Program Development

DOE O 426.2 states:

"All technicians and maintenance personnel must be qualified to perform the tasks associated with their specialty, or work under the direct supervision of personnel qualified to perform the activity or task."

"Personnel who perform work on engineered safety features as identified in the facility Documented Safety Analysis must be trained on those systems/components. Included in this category are systems having a direct impact on the safe operation of the facility. System training must, at a minimum, include the following elements:

1 Purpose of the system;
2 General description of the system including major components, relationship to other systems, and all safety implications associated with working on the system; and
3 Related industry and facility-specific experience."

The training program should be established utilizing the Systematic Approach to Training (SAT) Process. The basic SAT elements include: job analysis; performance objectives; training design, development, and implementation; trainee evaluation; and improvement of the training based on the performance of trained personnel in the job setting.

DOE-HDBK-1078-94, *Training Program Handbook*: *A Systematic Approach to Training*, and DOE-HDBK-1074-95, *Alternative Systematic Approaches to Training*, should be used to implement a graded SAT approach. Additional implementation guidance (e.g., analysis, learning objective development, developing examinations) can be found on the DOE Technical Standards web site http://www.standards.doe.gov/.

Each trainee's previous education, experience, and skill level should be reviewed to determine if they can be credited with satisfying any portions of the training program. One method to

accomplish this is to administer a written examination to prospective employees. Based on the exam results, a training program and milestones for the individual could be established.

Training should be defined and developed or obtained to include managerial, supervisory, planning, craft, and other positions, as deemed necessary.

G.2.3 On-the-Job Training

OJT is practical, hands-on training by which employees learn skills through training conducted within the job environment. OJT is a formal part of maintenance training. This aspect of an individual's training is normally conducted in the facility as part of their day-to-day work activities. Accordingly, maintenance department supervisors and selected experienced workers should be directly involved in OJT. Key elements of OJT include the following.

- Program Adherence. OJT should be conducted in accordance with formally defined training programs that specifically identify items the trainee needs to accomplish. Knowledge requirements for each item, as well as the action a trainee is required to do (perform, simulate, observe, or discuss), should be defined. Both the trainer and the trainee should understand what is required for each training item.
- Trainer Qualification. OJT evaluations should be performed by personnel who are qualified as OJT instructors/evaluators. Personnel in the training department who have maintenance experience, as well as personnel in the maintenance department itself, may be used as OJT instructors/evaluators. They should have good verbal communication skills and technical knowledge, and should have the ability to provide trainees with effective hands-on experience.
- Trainee Supervision and Control. Non-qualified personnel should work under the direct supervision of personnel qualified to perform the activity or task. The trainee should understand how to avoid errors that could affect personnel safety or adversely impact the station. Before performing maintenance on equipment, trainees should discuss the procedure with the qualified worker and talk through required actions by pointing to the control switch, valve breaker, or other component that will be manipulated. Incorrect actions should be discussed, particularly if they could result in a plant transient such as an equipment trip. The trainee should also demonstrate industrial safety and radiological protection aspects of the job (e.g., the equipment to be maintained is properly tagged and isolated, and an RWP is used). When trainees perform maintenance for qualification purposes, a qualified OJT instructor should observe the work so that the trainee properly accomplishes the activity in accordance with OJT evaluation guidance.
- Logs and Reports. The qualified worker should review any information recorded by the trainee on official work and data sheets, and should stress to the trainee the importance of maintaining accurate training and nuclear facility records. In addition, they should discuss with the trainee out-of-specification values and their consequences, and the required reporting of such issues.
- Number of Trainees. Consideration should be given to the training effectiveness and the effect on the equipment being maintained when a number of trainees are involved in an activity. Limiting the number will help each trainee receive the most effective instruction and will help ensure that the qualified worker is not overwhelmed by having too many

trainees at once. An individual may be able to handle several trainees for disassembly and assembly of a pump. However, it may be prudent to have only one trainee at a time for work involving a live, high voltage circuit or for conducting safety system surveillances.

- Qualified to Conduct Maintenance. The Maintenance Manager should establish a process that only allows individuals to perform independent maintenance on equipment for which they are qualified. This process should specify how supervisors determine that an individual is qualified before they are independently assigned to perform a task.

G.2.4 Qualification

Maintenance management should review an individual's training accomplishments before qualifying them for a given task. Similarly, qualifications of contractor personnel should be reviewed. This review should include the following:

- Verifying completion of all required prerequisite training;
- Conducting or evaluating the results of a final written, oral, or practical examination, if required;
- Evaluating the recommendations of the individual's supervisors; and
- Formally approving and documenting qualification.

G.2.5 Management and Supervisory Training

There should be a formalized training program that provides the necessary training to develop and maintain managerial and supervisory skills. The program's training should include, but not be limited to 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. This is especially important to aid first-line supervisors in managing maintenance activities. Career progression planning should be used to help customize the training program for personnel being considered for specific supervisory and managerial positions.

G.2.6 Continuing Training

Continuing training programs should be established to maintain and enhance the knowledge and skills of personnel who perform functions associated with engineered safety features as identified in the facility safety basis. Process and administrative changes that affect the workers should be included. The guidance in DOE-HDBK-1118-99, *Guide to Good Practices for Continuing Training*, should be used to develop continuing training programs. Satisfactory participation in this program and work performance, and completion of any periodic prerequisite training (e.g. GET) should maintain worker qualifications following initial qualification.

G.2.7 Training Program Approval, Effectiveness, and Feedback

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

elements as part of the facility's self-assessment process.

Any performance trends indicating maintenance knowledge or skills that need improvement should be considered during review of the maintenance training. Trainee feedback on their perceptions and suggestions for improving the training program should be obtained. The training organization should address recommendations from the Maintenance Manager for changes to training programs.

H. CONFIGURATION MANAGEMENT

H.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include incorporation of the configuration management program to control approved modifications and to prevent unauthorized modifications to Safety SSCs. Implementation of Configuration Management (CM) programs shall be in accordance with requirements of DOE O 420.1C.

The NMMP should address the following:

- The process to document and maintain plant configuration and handle desired changes, while maintaining the facility safety basis and without increasing risk to personnel, facility equipment, or the environment;
- The process to authorize the use of equivalent repair parts, and a method for workers to verify this approval;
- The role of the CSE in CM according to DOE O 420.1C; and
- A method to ensure that planners and workers are familiar with the need for engineering review and approval if maintenance will not result in returning SSCs to their design configuration;

H.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

Proper CM is integral to the ongoing integrity of the safety basis. Baseline configurations of SSCs that are part of the safety basis should be maintained or changes controlled to ensure they continue to support their safety function with no increase in risk to personnel, facility equipment, or the environment.

Nuclear facility maintenance is integral to configuration management in the following ways:

- Proper maintenance helps maintain consistency among design requirements, documentation, and the physical equipment;
- Proactive maintenance (PM/PdM) staves off degradation and keeps equipment operating within design requirements;
- Corrective maintenance returns SSCs to their designed/documented configuration and function;
- Work controls ensure intended changes are made and unintended changes are not introduced;
- Post-Maintenance Tests ensure SSCs conform to design requirements after maintenance or planned modification; and
- Surveillance & Testing verify continuing SSC functionality to design/safety basis requirements.

H.2.1 Maintenance Program Interface with Modifications

A modification is a planned and controlled change to a facility SSC that is accomplished in accordance with 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. DOE-STD-1073-2003, *Configuration Management*, provides detailed guidance for the overall CM Program and will not be repeated here. Generally, the engineering group has cognizance of the CM Program. The maintenance process should address installation and verification of facility modifications based on the complexity of the task, the extent of the modification, and the importance of the equipment, just as is done for normal maintenance activities. Typically, maintenance packages, which implement a design change, have additional commissioning and/or post-installation testing requirements specified by the design change package to validate the operability of the installation.

Normal maintenance practices are intended to closeout work with the affected equipment in its original baseline configuration. Replacement parts should be identical to the installed parts unless item equivalency has been reviewed and approved by engineering. The modification process addresses control of activities, which can change SSC configuration.

H.2.2 Temporary Modifications

Temporary modifications allow equipment to remain in or be returned to service in a condition that is not the same as the currently approved design. They may also result in short-term alterations to facility SSCs such that they do not conform to permanent drawings or other design documents. Temporary modifications should be reviewed (including reviewing for Unreviewed Safety Questions), approved, documented, and periodically reassessed. This ensures that temporary alterations made to facility SSCs do not unacceptably alter or degrade the original design, facility safety (including the safety basis), or reliability. The number and duration of temporary modifications should be minimized. Temporary and non-standard repairs should be approved and tracked as temporary modifications. Temporary modification control is discussed further in DOE-STD-1039-93, “Guide to Good Practices for Control of Equipment and System Status”.

The following are examples of conditions that may be temporary modifications to in-service equipment:

- Lifted electrical leads or jumpers;
- Mechanical bypasses, jumpers, or blank flanges;
- Temporary set point changes or disabled annunciators/alarms;
- Disabled relief or safety valves;
- Temporary equipment or pipe supports; and
- Disabled floor drains.

I. PROCUREMENT

I.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include appropriate integration of the procurement process with the NMMP to ensure the availability of parts, materials and services for maintenance activities. Overall, procurement normally falls under the responsibility of the Materials Management/Supply/Procurement organization. However, as a customer of the procurement process, maintenance should be involved in the aspects of procurement, which impact the parts, materials, and services received; and how they effectively integrate into those processes. Additionally, 10 CFR Part 830.120, DOE O 414.1D, *Quality Assurance*, and its associated Guide provide the requirements and implementing guidance for the quality aspects of materials management.

The NMMP should address the following:

- The process to identify, order, receive, store, and install proper parts and materials for work activities while meeting all quality requirements;
- Mechanisms to provide for the expeditious procurement of parts and material on a high priority basis when needed;
- How materials are stored and identified in ways that result in timely retrieval;
- How safety-related parts and components are properly controlled, segregated, and identified in all material storage areas;
- Identifying, segregating, and properly controlling flammable, contaminated, radioactive, and other hazardous materials;
- How parts and materials issued for installation are properly controlled, and appropriate unused parts and materials are promptly returned to inventory;
- Providing input to stock level adjustments, as necessary, to meet facility needs; and
- How lessons learned from experience, such as lead times, parts usage, and supplier reliability, are factored into materials management.

I.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

The procurement process should support maintenance by providing the correct parts, materials, and services in a timely and cost effective manner. Achieving this goal requires efficient coordination from the equipment designers, through processes, which compile a master parts listing, establish and maintain an appropriate supply of these parts, and make them available to the workers in the field. Additional controls are used to ensure the characteristics and quality of materials and services used in all SSCs that are part of the safety basis.

I.2.1 Procurement Policy and Procedures

Policies should be established for the procurement of parts, material, and services. These policies should be understood by procurement personnel and other personnel who interface with them, such as engineers, maintenance supervisors, and work planners.

Identification of the need for specialized services from vendors should be made in time to provide for solicitation of bidders, and for bidding on and awarding contracts. Provisions should be made when possible for general service agreements so that services can be supplied at short notice.

Procedures should be available to describe specific procurement actions and the specific responsibilities of personnel involved in the procurement of special items, such as:

- Safety-class SSCs;
- Safety-significant SSCs;
- Critical spare parts;
- Major project purchases;
- Routine procurement purchases;
- Contracted work and services; and/or
- Hazardous materials.

I.2.2 Spare Parts

Establishing the master catalog of spare parts and appropriate stocking levels requires a significant effort initially and ongoing effort over the life of the facility. The starting point should be the Master Equipment List (MEL), which at a minimum contains a list of all SSCs that are part of the safety basis. This equipment is expanded into its respective subassemblies, components, and piece parts to identify potential spare parts using drawings, manuals, and vendor information. With this list, vendor recommendations, operations and maintenance experience, and engineering judgment, as well as duplicate equipment and common parts used in multiple units, should be balanced to determine the items and amount to stock on hand. Consideration is also required of the lead-time, cost, shelf life, size, and storage requirements for selecting stock levels, as warehouse facilities, their contents, and maintenance compete with other funding priorities.

A catalog (electronic or hard copy) of parts, materials, and equipment normally used at the facility should exist with an up-to-date indication of what is available for issue. This catalog should provide a cross-reference listing that contains such information as manufacturer part number, local part number, name, and component or system for which a part is used. This catalog assists in more efficient planning and execution of maintenance activities.

Spare parts and stocking levels should be reviewed over the life of the facility to ensure they are effectively supporting maintenance and operations. Usage data should be kept and reviewed to identify unnecessary materials kept in stock. Updates should occur when facility modifications add, remove, or change equipment; or periodic maintenance activities are changed. Maintenance should provide input to this process and recommendations when stocking levels are considered inappropriate for maintenance support.

I.2.3 Procurement Control

To maintain the validity of the safety basis, replacement parts and materials should meet the equipment design criteria. A graded approach is used to verify the critical attributes of these items based upon the importance of each item. Not every piece part of a safety system is integral to the system's safety function and may not require the degree of rigor to verify its capabilities as those items that are critical to the safety function. The QA Program should specify the processes used to approve suppliers; upgrade commercially obtained materials; perform receipt inspections; and document, track, and disposition identified deficiencies. Additionally, the terms "like-for-like" or "like-in-kind" should be applied to assure the correct component or part is used.

A process for providing the data that forms the basis for procurement of items, which support all SSCs that are part of the safety basis, and other major purchases (i.e., equipment and construction projects) should exist, typically within the engineering organization. This data should include:

- Critical parameters and their acceptance criteria;
- Unique or special testing requirements/methods;
- Reorder instructions; and
- Suspect/counterfeit parts information.

Procurement controls should be developed and maintained to help maintenance obtain parts, materials, and services promptly. Consideration should be given to the following:

- The ability to track procurement status from receiving through delivery to issue-for-use;
- Ability of the procurement organization to track procurement progress and take necessary measures to meet maintenance and outage schedules;
- Emergency procurement policies and an expediting process to obtain parts, materials, and services that are needed immediately to support safe and reliable facility operation;
- Control and maintenance of QA records to provide documentation for qualified parts and materials, and to ensure traceability of parts and materials;
- Assurance that procurement documents and controls prevent the delivery or use of suspect/counterfeit parts;
- Segregation and status resolution of damaged, nonconforming, or otherwise deficient items. Technical reviews should be initiated promptly to aid in the resolution of these items;
- Retaining special receipt inspection documentation to support future procurement;
- Provisions for qualifying nonqualified material (i.e., commercial grade dedication). An effective upgrade process will result in improved availability of quality parts and materials; and
- Verification of the reliability of supplier performance. This can be accomplished by audits, inspections, or surveillances of supplier facilities.

I.2.4 Receipt and Inspection

When parts, materials, and equipment are received, stores personnel should inspect them before they are accepted. This inspection is conducted to verify that the items delivered agree with the approved purchase documentation, are packaged in accordance with 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 stores personnel and QA 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. 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. Maintenance should have access to this documentation.

Engineering and maintenance personnel may be needed to assist in the receipt inspection of more complicated parts, materials, and equipment. Recurring or special test/inspection packages may be required for maintenance personnel to conduct and document these checks on received material prior to being released for issue. In some situations, outside facilities/organizations may be used to conduct specialized testing beyond the facility's capability.

Special inspections and/or tests should be considered for products that have histories of being counterfeited, such as high strength fasteners, molded case breakers, valves, UL listed items and semi-conductors. Refer to Section K for additional guidance on Suspect and Counterfeit Items (S/CI).

Engineering personnel should approve any deviation from design specifications of material or equipment received before the item is considered for issue. They should also approve any upgrade of material or equipment from a non-safety to a safety category. Nonconforming items should be clearly identified; segregated from normal items to prevent inadvertent use; documented on a nonconformance report and/or a defective or substandard material report; and tracked and resolved as soon as practical by the applicable authority.

I.2.5 Storage

While this guidance has general applicability, it is specifically intended for use by maintenance to ensure that storage of materials under their cognizance is addressed. This stored material may be staged for construction, future maintenance outage, or simply standard spares/materials used by maintenance during their ongoing work.

Material and equipment should be stored in a manner that provides adequate protection and accessibility with due consideration for environmental conditions such as temperature, humidity, and particulates. Items requiring periodic maintenance or checks, such as checking energized heaters, changing desiccant, meggering motors, rotating shafts, or changing cover gas, should be located to simplify this work. A method of tracking the requirements and documenting completion should be used. Consideration should be given to use of the Preventive Maintenance (PM) process for this purpose vice using another stand-alone method.

The receipt and issue of items from stores should be documented promptly so that the inventory record accurately reflects the current inventory. The record system should also indicate the

location of items in the warehouse or other designated storage areas. A method should be used to control access to storage areas.

Shelf life control should be provided for items that degrade over time. 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, or the material should be disposed and new material ordered. Reordering/restocking programs should incorporate appropriate lead times to ensure sufficient material with good shelf life is available for issue.

Material and equipment subject to restricted use and distribution such as Safety Class Items, critical spare parts, certain sealants and compounds, precious metals, etc., should have clearly defined instructions that provide for:

- Unique identification;
- Segregation from normal stock;
- Access control;
- Issue only to those on authorized signature lists; and
- Purchase order tracking and ready traceability from design drawing through purchasing, receipt, storage, handling, and installation.

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.

A system should be established to ensure the proper storage, segregation, and control of hazardous materials such as chemicals, radioactive/reactive organics, reagents, explosives, flammables/combustibles, corrosives, and pesticides/herbicides; specialty equipment and tools; and general materials, equipment, and tools. Controls should be established for field storage of such consumables to ensure that they are properly stored, identified, and used.

A process for periodic general inspections of storage areas should exist. Typical storage control observations should document the following:

- Reactive chemicals are segregated and secured, as required;
- Flammables are marked and stored in proper containers;
- Radioactive substances are properly shielded and marked;
- Carcinogens are segregated from other materials and equipment;
- Stainless steel and other “pedigree” metals are segregated from other metals (particularly carbon steel);
- Motors, pumps, relief valves, and other items are stored on their bases;
- Stacking of items, crates, boxes, barrels, etc. does not exceed stacking recommendations;
- Packaging and seals have not been violated leaving contents exposed to degradation

caused by the intrusion of foreign materials or environmental conditions;

- Machined and threaded surfaces are left adequately protected;
- Applicable insect and rodent controls are in effect;
- Applicable shelf life conditions are in effect;
- The building structure and support systems (e.g. HVAC, lighting) are adequate and in working order; and
- Environmental controls that control moisture, dust, sun exposure, etc. are in effect.

J. MAINTENANCE TOOL AND EQUIPMENT CONTROL

J.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must clearly address the process for control of maintenance tools including calibration of Measuring and Test Equipment.

The NMMP should address the following:

- The availability of proper tools, equipment, and consumable supplies to support work requirements;
- Providing suitable storage for tools and equipment;
- The identification and storage of special tools, jigs, and fixtures to permit retrieval when needed;
- Maintaining equipment and tools in good repair;
- Actions expected when worn or defective items are identified (a method should be established to remove them from service, and to tag and/or segregate them from normal items to prevent unsafe use);
- A process for segregation and disposition of tools and equipment contaminated by radioactive or other hazardous material;
- Provisions for scheduled equipment and tool inspection (including some portable hand tools such as electrical drill motors) on the basis of risk to safety and importance to reliable use;
- Identification, testing, and proper storage of welding, lifting, scaffolding, and rigging equipment, as well as for safety devices and personnel safety equipment;
- How the M&TE Program complies with ANSI/NSCL Z540.3-2006, “American National Standard for Calibration – Requirements for the Calibration of Measuring and Test Equipment”;
- Calibration and control of M&TE to provide accuracy and traceability;
- Maintaining auditable documentation for M&TE items exempted from calibration;
- Removing from service defective and out-of-tolerance test equipment;
- Action required for equipment calibrated/inspected/maintained with out-of-tolerance test equipment; and
- Designating and controlling storage, laydown, and staging areas.

J.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

Adequate tool and equipment control contributes to facility safety and efficiency, reduces maintenance delays, and limits the number of tools potentially contaminated. Methods should be provided for the storage, issue, and maintenance of an adequate and readily available supply of tools and equipment, and for the development of any special tools and equipment needed. A policy should be established for the storage, issuance, decontamination, and reuse of contaminated tools and equipment.

A program for control and calibration of M&TE should be established, consistent with the QA requirements of 10 CFR Part 830, Subpart A, and as implemented by the selected QA standard, and should ensure the accurate performance of facility instrumentation and equipment for testing, calibration, and repair. M&TE devices include tools, gauges, instruments, devices, or systems used to inspect, test, calibrate, or measure parameters. M&TE devices also include permanently installed facility process or control instrumentation. Those items or systems not influencing product quality or verifying conformity to specified requirements may be exempted from calibration. M&TE equipment exempt from periodic calibration should be clearly labeled or addressed through other means to denote its status and preclude its use where calibrated equipment is required. The basis for such exemptions should be documented.

The adequacy of tool and equipment control, including M&TE, to support maintenance and operations should be evaluated as part of the facility's self-assessment program.

J.2.1 Storage and Issuance

The maintenance organization should assign responsibility for the proper storage and issuance of both stationary and portable tools and equipment. Permanent issuance of tools to individuals or groups of facility personnel who use them daily and who are responsible for maintaining them contributes to worker efficiency. Controls, such as sign-out sheets or tool crib attendants, should be used in tool storage areas to provide accountability for and availability of tools.

The storage area(s) should address environmental controls; considering such issues as:

- Isolation/segregation of chemicals;
- Flammability of lubricants and paint;
- Qualification of parts/components;
- Damage to elastomers and polypropylene parts because of exposure to light; and
- Control of radioactive materials.

Worn, defective, or otherwise unusable tools should be segregated so that only safe, usable tools are available. Non-repairable tools should be disposed of in a timely manner.

A method should exist to identify the availability and sources for special tools and equipment obtained from vendors or contractors. When these special tools and equipment are at the facility, they should be controlled in the same manner as other tools and equipment.

J.2.2 Tool and Equipment Maintenance

Maintenance tools and other support equipment should be evaluated for inclusion in the Periodic Maintenance program (see Section E. Types of Maintenance).

J.2.3 M&TE

A comprehensive M&TE Program should comply with 10 CFR Part 830, Subpart A. MT&E calibration should comply with ANSI/NSCL Z540.3-2006, "American National Standard for Calibration – Requirements for the Calibration of Measuring and Test Equipment.

When post calibration validation (closeout) of test equipment is required, M&TE subject to contamination should be packaged and used in a manner that minimizes the possibility of external and internal contamination (e.g., wrapped in clear plastic, taped, and isolated).

J.2.4 Use of Special Tools and Equipment

Special tools, test rigs, special equipment, lifting and rigging equipment, and mockups should be suitable for their intended use, approved by engineering, reviewed under the USQ process, and properly identified.

To improve the use of special tools and equipment use, and enhance job performance and efficiency, instructions should be provided for their use.

K. SUSPECT AND COUNTERFEIT ITEMS (S/CIs)

K.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include incorporation of the process to prevent the use of suspect and counterfeit items into maintenance procedures and work instructions. The controls to prevent entry, detect, control, report, and disposition S/CIs should interface with a facility's maintenance program.

The NMMP should address:

- The controls established to assure that items and services meet specified requirements as set forth in DOE O 414.1D and Title 10 CFR Part 830, Subpart A; and
- The processes to prevent entry, detect, control, report, and disposition of S/CIs per DOE O 414.1D and DOE G 414.1-2B.

K.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

K.2.1 Procurement

DOE O 414.1D establishes requirements to prevent the introduction of S/CIs into the DOE complex during the procurement process. In accordance with DOE O 414.1D, the underlying principles in procurement include:

- Purchasers are required assure that suppliers have demonstrated they are capable of delivering acceptable items in a timely manner;
- Both the extent of procurement controls and verification activities are commensurate with the importance of the item to safe and reliable operation; and
- Persons involved in the procurement process should receive training in S/CI awareness and prevention methods.

K.2.2 Inspection and Acceptance

Item/part number verification and review of certification documentation (e.g., CMTRs, Certificates of Compliance) alone are not sufficient to verify the quality of purchased items. Engineering attributes and QA criteria should also be specified and verified. Consideration should be given to the following:

- History of S/CI concerns with the item;
- Intended safety function of the item;
- Attributes required to perform the function;
- Supplier past performance information;
- Source inspection, surveillance, assessments, or QA audit results;
- Receipt inspection and acceptance testing results;
- Special test and examination methods (e.g., chemical analysis, hardness and tensile

testing); and

- Post-installation testing.

K.2.3 Engineering Involvement

Experience gained through the NRC has demonstrated that effective S/CI processes have these common characteristics:

- Engineering staff involvement in procurement and product acceptance;
- Effective supplier evaluation, source inspection, receipt inspection, and testing programs;
- Thorough, engineering-based processes for review, testing, and dedication of commercial-grade items for suitability in safety systems and mission critical facilities; and
- Engineering staff should receive training in S/CI awareness and design, prevention, and detection methods.

K.2.4 Installed items

DOE O 414.1D requires DOE and its contractors to implement QA programs with procedures for inspecting, identifying, evaluating, testing, removing, replacing, and dispositioning S/CIs installed in safety systems, non-safety systems, and critical load paths of lifting equipment and mission critical facilities. DOE O 232.2 further requires that all installed S/CIs, regardless of their application, be reported by means of ORPS.

K.2.5 Removal and Disposition

Consistent with the guidance provided above, all known S/CIs should be removed as soon as practicable from any location within the DOE complex when an engineering evaluation has determined that the S/CI could create a safety hazard. S/CI may be destroyed, provided:

- The item cannot be traced to a supplier, manufacturer, or distributor;
- The item is not required as material evidence by the local Office of Inspector General (OIG) for litigation;
- The local OIG has authorized destruction of the item; and
- The item is clearly marked or tagged as: S/CI; Rejected; or Not Approved for Use.

L. MAINTENANCE HISTORY

L.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*, the NMMP must include the process for developing and maintaining documented and retrievable maintenance history (i.e., preventive maintenance, repairs, cost data, system availability data, and failure data) to support work planning, performance trending, analysis of problems to determine root causes of unplanned occurrences related to maintenance, and continuous program improvement.

The NMMP should address the following:

- Maintaining maintenance history records for SSCs that are part of the safety basis;
- Considering maintenance history records in planning for corrective maintenance, periodic maintenance, and modifications;
- The availability of maintenance history records for use by appropriate personnel and departments;
- Effectively documenting maintenance work and inspection/test results; and
- Periodic reviews of maintenance history to identify equipment trends and persistent maintenance problems to determine root causes and to assess the impact on facility safety and reliability. Maintenance program adjustments are made or other corrective actions are taken as needed.

L.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

A maintenance history and trending program should be implemented to document maintenance performed, to provide historical information for maintenance planning, to support maintenance and performance trending of facility systems and components, and to improve facility reliability. The documentation of complete, detailed, and usable history will be increasingly important as plant-life extension becomes an issue. Maintenance history enables trending to identify improvements for the maintenance program and needed equipment replacements or modifications. This history should assist in ensuring that root causes of failures are determined, corrected, and used in future work planning.

The maintenance history program should clearly identify the SSCs for which a history is to be maintained, the data to be collected, methods for recording data, and uses for the data. Typically, maintenance history is maintained for all SSCs for which Periodic Maintenance is performed. The program should include the type of equipment, model, serial and identification numbers, location information, and other information listed below.

As a minimum, each SSC included in the safety basis should have a separate maintenance history file. An essential element of the history files is a chronological record (beginning with the date of installation) of the completion data of each work order (for all types of work orders and service calls) including the date of completion, worker notes on completed work orders, labor hours expended, etc. The history file should include data on each review of the history including results of the review, date of review, and names of personnel who performed the review.

NOTE: Examples of component identification/descriptions forms and maintenance history records are shown in Figures III.L-1 and III.L-2, respectively.

Currently, most maintenance history systems are contained in Computerized Maintenance Management Software (CMMS). Some CMMS systems are linked to electronic maintenance manuals created by scanning the paper manuals. The elements of maintenance history are the same for both paper-based and software-based systems. For both types of systems, engineering review and analysis should be performed to ensure the overall maintenance history program contains all the necessary elements. Whether electronically or manually maintained, easy access to the historical data should be provided to all groups needing the information.

L.2.1 Program Development

Equipment Identification The MEL normally identifies many elements of the maintenance history program needed for the maintenance history file described below.

Data Identification The maintenance history program data should be collected and recorded to support the uses discussed below effectively. Some examples of data that should be included or cross-referenced in the program are corrective maintenance records; PM records; modification packages; vendor repair information start-up tests and other baseline data; appropriate surveillance test data; calibration data; and applicable industry experience information. The specific data to be collected should include details of the work performed, special equipment and tools used, procedures or drawings needed, spare parts installed, personnel safety and radiation protection requirements, post maintenance testing results, and any other information that may be useful later.

L.2.2 Data Collection

Data on each completed work order or service call should be reviewed and entered in the maintenance history system. Any apparent errors, inconsistencies, or lack of detail should be noted and corrected by the maintenance supervisor. Data problems identified during history reviews should be referred to the appropriate supervisor for resolution.

L.2.3 Maintenance History File Development

Components may be grouped by system or by component type. The maintenance history file for each component should include the following four sections.

Component Identification and Description Each component should be identified by its name and number as listed in the MEL. In the case of components grouped by type, this may be an index of all individual components and their associated systems. The description should include the manufacturer's name, model, and serial number (see Figure III.L-1 as an example). Additional reference may be made to purchase order number; vendor manuals; drawings; system logic and/or flow diagrams; owner/operator cost center; acquisition data; location; applicable engineering documents; operating requirements/characteristics/history; spare parts list; owner/operator documents; and applicable maintenance procedures. When a component is replaced or modified, the original record should be annotated and retained in the file, and a new record, referencing the original record, should be prepared and placed in the file.

Maintenance Record The maintenance record is a chronological record of all work performed. After the work is completed, the maintenance supervisor should ensure work package information (including the as-found and as-left conditions) is added to the maintenance record. An example of a maintenance record is included in Figure III.L-2. Periodic engineering review of the history file is recorded.

Diagnostic Monitoring Data This section of the Maintenance History file should contain all performance-related information derived from baseline tests and checkout data, predictive maintenance, surveillance tests, and post maintenance tests. Engineering support personnel should review completed test documents to ensure data have been properly analyzed and recorded.

Vendor Correspondence This section of the Maintenance History file should contain any correspondence, inspections, and test results received from the vendor that relate to routine or PM servicing, parts, changes to as-built drawings, etc. Engineering support personnel should review this information and ensure it is filed and properly applied.

L.2.4 Program Use

Equipment failures and abnormal trends should be analyzed and corrective action recommended in a timely manner. In addition, periodic engineering reviews of the maintenance history file should be conducted in accordance with a schedule recommended by the engineering support supervisor and approved by the responsible manager. The purpose of the reviews is to determine whether recurring maintenance problems or other performance trends indicate a need for corrective maintenance, replacements or modifications. The assigned engineer should determine the probable cause and recommend a course of action. This may result in corrective maintenance, component modification or replacement, a change in the preventive or predictive maintenance schedule, or a change in a procedure. The assigned engineer should track performance after corrective action has been performed to ensure deficiencies have been corrected.

Regular users should be trained to access and search the history databases and files.

Maintenance coordinators, supervisors, experienced workers, and work planners should review the maintenance history file on defective and similar components. Their review should consider information on similar deficiencies and performance trends when preparing WRs/WOs and/or work package repair instructions. They should also consider the performance of similar components at other DOE and non-DOE facilities (e.g., INPO reports).

The following uses of maintenance history data should be considered:

- Failure analysis (providing some of the data needed to support analyzing and trending failures);
- Maintenance assessments (providing input to identify maintenance program improvements);
- Preventive Maintenance (providing some of the data useful for identifying and justifying Preventive Maintenance program changes);
- Outage planning (providing some of the data useful for post-outage evaluation and as a basis for planning the next outage);

- ALARA program (providing work-time data useful for radiological exposure evaluation and planning); and
- Plant life extension (providing some of the data needed to support extension of plant design life).

L.3 EXAMPLE DOCUMENTS

SAFETY INJECTION PUMP 1

PEI SI 19724	Bingham Pump
Class I	Model 4 X 6 X 9-CP
Purchase Order AC-4286316	Serial Number 14 SA 479
Vendor Man. Vol. II - Bingham Pumps	Eng. Drawing E6-390162
Flow Diagram AL 480526, Safety Injection	

Applicable Procedures:

MA-4.1924, Safety Injection Pump Disassembly

MA-4.1925, Safety Injection Pump Assembly

MA-4.1926, Safety Injection Pump Seal Replacement

SP-6.2163, Safety Injection Pump Performance Test - Monthly

PM-5.1372, Safety Injection Pump Inspection - Quarterly

PM-5.3916, Safety Injection Pump Inspection - Annual

NOTE: **8 ½-in. x 11"-in. cards are recommended when manual recording is used.**

Figure III.L-1. Example Component Identification and Description.

SAFETY INJECTION PUMP 1

6-12-78 M.J.R. 49731 Inboard seal excessive leakage. Removed and inspected seal; excessive wear. Cleaned and inspected shaft. Installed new seal, part no. 187421. Conducted SP-6.2163; perform SAT. Total craft-resource-hours expended 80.

11-15-79 M.J.R. 51874 Modified first stage impeller retaining nut staking as per Bingham instructions 6-15-79. Internals cleaned and inspected-SAT. Assembled and realigned. Conducted SP-6.2163; perform, SAT. Total craft-resource-hours expended 50.

1-12-80 Reviewed maintenance history file—no problems noted.

Figure III.L-2. Example Maintenance Record

M. AGING DEGRADATION AND TECHNICAL OBSOLESCENCE

M.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include processes for conducting inspections to ensure design features within the safety basis can continue to perform their intended safety functions, and to evaluate aging-related degradation and technical obsolescence.

The NMMP should address the following:

- The specific SSCs subject to aging management degradation inspections;
- Parameters monitored or inspected for the particular structure and component intended function(s);
- Acceptance criteria, against which the need for corrective action will be evaluated, to ensure that the SSCs intended function continues to meet all safety basis requirements;
- Monitoring and trending to provide predictability of the extent of degradation before there is a loss of the SSC's intended function(s) and timely corrective or mitigative actions;
- The monitoring, inspection, and testing frequency and sample size appropriate for timely detection of aging effects;
- The review process for information received during aging degradation inspections;
- Ensuring that preventive maintenance is adequate and that appropriate corrective actions, when required, have been completed and are effective;
- How operating experience of the aging management program, including past corrective actions resulting in program enhancements or additional programs, provides objective evidence to support that the effects of aging will be adequately managed so that the structure and component intended function(s) will be maintained; and
- High value components that are approaching end of life are included in a recapitalization requirements program as defined in DOE O 430.1B.

M.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

Aging inspections have an important role in ensuring SSCs within the TSR can continue to meet design requirements and perform their intended safety functions over the life of the facility. Generally, the current performance of credited SSC is ensured through the performance of surveillance requirements specified in the TSR. Consideration should be made to include aging inspections in the surveillance requirements.

Similarly, defense-in-depth features identified in the safety basis should be evaluated to determine if aging degradation inspections are appropriate to ensure there is not a potential reduction in the overall defense-in-depth occurring over prolonged years of service.

Aging inspections should evaluate degradation of safety function that may have occurred from environmental exposure, exposure to working fluids, corrosion, stress cracking, pitting, and other degradation mechanisms relevant to the credited safety function. The periodicity of these

inspections should be based on an engineering evaluation of these likely degradation mechanisms.

Institute of Nuclear Power Operations, AP-913, *Equipment Reliability Process Description*, should be considered when establishing the aging degradation process within the Nuclear Maintenance Management Plan.

N. SEASONAL FACILITY PRESERVATION

N.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include the process for ensuring the prevention of damage to safety SSCs from adverse weather conditions.

The NMMP should address the following:

- How buildings and equipment with the potential for damage from seasonal weather and environmental conditions are identified, and a risk assessment conducted based on a graded approach;
- The development and implementation of protection plans to ensure that the facility is maintained in a safe condition during severe weather and environmental conditions; and
- Verifying the effectiveness of controls to assure seasonal facility preservation measures effectively prevent equipment and building damage at DOE facilities.

N.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

Seasonal facility preservation includes developing and implementing a plan to address severe weather, environmental, and wildfire conditions for the safe operation and preservation of DOE nuclear facilities, and the prevention of damage to safety SSCs. This section describes example, proactive measures that should be taken by maintenance organizations to adapt the facilities to changing external conditions. This requires that a plan be established for assessments and preventive actions for facilities to ensure protection from adverse local conditions. To give this work appropriate priority, a task team should be established to develop and implement this plan.

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 the following:

- 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.

N.2.1 Facility Preservation during Severe Conditions Plan

Buildings and equipment with the potential for damage from seasonal weather conditions should be identified and a risk assessment based on a graded approach should be conducted. Damage prevention or mitigation plans should be developed that include contingencies for the critical facilities or equipment that are likely to sustain damage. The plan should ensure that, in all cases, the preparatory actions and requirements imposed to provide severe conditions protection, particularly those taken to restrict safety system functions, 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.

The Severe Conditions Protection Plans should be in the form of a checklist or a group of procedures that include the following actions:

- Ensuring that facility plans are validated, verified, and approved;
- Ensuring that manufacturer temperature limitations are considered for exposed equipment;
- Ensuring adequate foul weather and fire protection gear, tools, and equipment are available for use;
- Ensuring periodic maintenance is current for emergency diesel generators, uninterruptable power supplies, and plant battery banks;
- Identifying and performing corrective actions on deficiencies to systems/equipment that prevent/mitigate seasonal hazard problems to ensure that proper operation of equipment is maintained;
- Inspecting on-going job sites for loose materials and debris, which may become missiles in strong winds, and securing them to the maximum extent possible;
- Examining all facilities and equipment assigned to their area of responsibility on a seasonal basis to ensure their readiness (e.g. vehicles are in good repair and have fuel);
- Maintaining a crew call-in list for maintenance crews to respond to specific seasonal hazard related problems;
- Ensuring removal of seasonal weather protection features after the weather season is over; and
- Evaluating plan activities involving maintenance organizations to determine and implement enhancement/improvement opportunities in a timely manner.

Facility managers should consider severe conditions related problems as a priority and take immediate corrective action to minimize damage for anticipated or current weather conditions (N.2.7 may be used as an example checklist for cold weather conditions.). Examples include the following:

- Ensuring predetermined operational changes are executed to protect equipment and facilities assigned, such as modification to set-ups or shut down/start-up of equipment as required to ensure protection from potential damage and to minimize loads on power distribution lines;
- Realigning primary heating, ventilating, and air- conditioning (HVAC) equipment that may affect ambient temperatures;
- Monitoring their assigned facilities for protection and assuring any necessary on-site actions are taken and/or correct personnel are notified to protect equipment and facilities assigned to their area of responsibility;
- Curtailing operations (safe shutdown) of a facility identified as having a high probability for sustaining damage when subjected to unusually severe conditions; and

- Identifying personnel to be evacuated during severe conditions and ensuring any such evacuation is carried out in accordance with approved emergency procedures.

N.2.2 Cold Weather Preparation

A freeze protection plan should be prepared for each DOE nuclear facility. The plan will detail the actions and requirements imposed on the facility to assure protection of the safety equipment/facility. The plan will ensure that, in all cases, the actions and requirements imposed to provide cold weather/freeze protection, particularly before those taken to restrict or cut off nuclear systems coolant, will be reviewed by facility operations and safety personnel to ensure the facility will be maintained in a safe condition to protect the health and safety of the public.

In addition to the list of items in N.2.1, the following should be included to minimize equipment and building damage from cold weather conditions, temperatures less than or equal to 35º F, including hail, snow, and ice:

- Identifying areas where portable heating may be required and obtaining portable heating equipment; portable heaters should be inspected, tested, and staged by facility personnel who are trained in their safe use;
- Monitoring the conditions surrounding wet-pipe sprinkler systems to ensure a temperature of above 40º F is maintained and taking appropriate actions such as making provisions for auxiliary heat, draining, and/or posting a fire watch;
- Ensuring air intakes, windows, doors and any other access points that may result in abnormal flow of cold air into an area susceptible to freeze damage are secured;
- Ensuring heating systems are cleaned, serviced, and functionally tested;
- Ensuring antifreeze used in cooling systems is checked and replaced as necessary;
- Ensuring heating system power and temperature controls are protected against inadvertent deactivation;
- Ensuring systems requiring or deserving special protection due to hazards or costs associated with freeze damage have temperature alarms and/or automatic backup heat sources;
- Ensuring the main water supply cutoffs for each critical facility are identified, tested, and readily accessible to emergency personnel responding to a freeze/thaw incident;
- Inspecting outside storage pads and unheated storage areas to ensure that there are no materials susceptible to freeze damage;
- Implementing snow and ice removal activities;
- Ensuring employees are aware of the need to identify and report any suspected problem with heating or other cold weather protection equipment (e.g., non-insulated water or process pipes, steam trace heaters isolated, broken windows);
- Evaluating the removal of freeze protection equipment from service during the seasonal freeze period;
- Ensuring availability and use of salt, sand, and “ice-chaser” as needed;

- Inspecting outside areas to ensure that gutters and downspouts are provided where there is a potential for ice buildup that may restrict egress;
- Ensuring operations or facility personnel have specific responsibility for monitoring the temperatures in facilities' on and off shifts, including weekends and holidays;
- Alerting personnel and providing increased surveillance in periods of extreme, unusual, or extended cold; and
- Ensuring contingency plans are prepared and available for temporarily curtailing operations in those nuclear facilities, which are likely to sustain freeze damage when unusually severe weather is expected.

N.2.3 Flash Floods and Mud Slides

In addition to the list of items in N.2.1, the following should be included to minimize equipment and building damage due to flash flooding and mudslides:

- Doors and windows closed;
- Vulnerable items covered with tarps;
- Storm drains kept clear of debris;
- Sandbags and dikes used where necessary;
- Water-vulnerable items raised above the expected water line; and
- All vehicles parked/moved to high ground as necessary.

N.2.4 Hurricane Watches and Warnings

In addition to the lists of items in N.2.1 and N.2.3, the items listed below should be included to minimize equipment and building damage from a hurricane:

- Windows boarded up or taped as necessary during a hurricane watch;
- Safe shutdown of vulnerable equipment; and
- Emergency evacuation policies and routes posted.

N.2.5 Tornado Watches and Warnings (High Winds)

In addition to the lists of items in N.2.1, and N.2.3, the following should be included to minimize equipment and building damage from tornadoes:

- Plan for the safe shutdown of vulnerable equipment; and
- Emergency evacuation policies and routes posted.

N.2.6 Extreme Hot/Dry Weather

In addition to the guidelines listed in N.2.1, the following should be included to minimize equipment and building damage from extreme hot/dry weather:

- Plan for the safe shutdown of vulnerable equipment;
- Restrict operations, which involve heat (welding, burning, sparks, etc.);

- Restrict fire hazards (smoking, etc.);
- Ensure an ample supply of portable fire extinguishers is available;
- Ensure fire protection personnel are alerted; and
- Ensure all exits are kept clear.

N.2.7 Example Cold Weather Checklist

SEPTEMBER	
Building Managers	Increase surveillance of assigned facilities to identify areas having a high probability for sustaining freeze damage. Generate Standing WOs or WRs/WOs for corrective action.
Maintenance Department	Increase surveillance of facilities to identify areas having a high probability for sustaining weather related damage. Generate WRs/WOs for corrective action. Check status of winter and foul weather gear, tools, and equipment for personnel required to work outdoors. Plan and schedule final outages on steam system(s). Coordinate semiannual boiler inspections. Plan and schedule seasonal facility preservation WRs/WOs and Periodic Maintenance job request.
OCTOBER	
Facility Manager	Annual reminder to the plant of seasonal facility preservation precautions.
Building Managers	Coordinate with maintenance managers to assure timely scheduling and completion of seasonal facility preservation related WRs/WOs.
Maintenance Department	Complete semiannual boiler inspections. Complete maintenance activities requiring outages of steam system. Request extended workweek for the shops involved in seasonal facility preservation maintenance activities, if required. Ensure a crew call-in list is available for maintenance crews to respond to cold weather related problems. Complete execution of cold weather related WRs/WOs and Periodic Maintenance job request.
MARCH	
Building Managers	Increase surveillance of assigned facilities in anticipation of the spring season. Generate standing WOs and/or WRs/WOs for corrective action.
Maintenance Department	Plan, schedule, and begin execution of standing WOs and/or WRs/WOs relating to the spring season. Schedule Periodic Maintenance job request related to the spring season.

APRIL	
Building Managers	Coordinate with the Maintenance Department to schedule and execute freeze protection/prevention standing WOs and/or WRs/WOs that require close down or turn around work during the warm weather season.
Maintenance Department	Plan, schedule, and execute freeze protection/prevention standing WOs and/or WRs/WOs which require close down or turn around work during the warm weather season. Continue execution of WRs/WOs and Periodic Maintenance relating to spring/summer operations.

N.2.8 Example Wildfire Condition Checklists

In addition to the guidelines listed in Section N.2.1, the following should be included to minimize personnel safety concerns as well as equipment and building damage due to wildfire conditions:

- Activate the Emergency Operations Center;
- Evacuate Laboratory and local areas as appropriate;
- Where appropriate secure HVAC and other vulnerable equipment systems to isolate SSCs from soot and smoke damage;
- Ensure safe shutdown of vulnerable equipment; and
- Verify all exits are kept clear.

O. PERFORMANCE MEASURES

O.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include the process for developing, maintaining, and communicating performance measures to identify maintenance issues requiring corrective action and lessons learned.

The NMMP should address the following:

- How performance indicators are established, measured, trended, and analyzed to identify organizational conditions that are impacting mission goals, including safety and the reliability of SSCs that are part of the safety basis;
- That goals should be established for these performance indicators/metrics;
- Metrics which do not achieve their goal or have undesirable trends should be analyzed to determine the causal factors for this performance;
- Corrective actions should be defined and implemented for unsatisfactory performance or trends in performance;
- The process for validating the effectiveness of corrective action plans;
- Routine management review of the status of performance indicators; and
- How Performance Measures are included in the organizations self-assessment program.

O.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

A program should be in place to regularly provide management with accurate information regarding key maintenance performance. Such information should be measured and used to assess performance and identify areas requiring management attention. Overall indicators relevant to maintenance performance, indicators to measure progress in achieving goals and objectives, and specific indicators for monitoring current performance problems and performance in specific functional areas should be selected. Information should be periodically presented in a systematic way that provides rapid recognition of trends and comparison of actual versus expected results and, where appropriate, clearly indicates corrective action and the results of these actions.

O.2.1 Identifying Performance Indicators

Performance monitoring is a valuable management tool to track the reliability of SSC important to safety and the conduct of maintenance. However, the identification of performance indicators, which accurately predict future performance, is challenging. Metrics tend to count results like lost time accidents and PM accomplishment rate. Typically, a goal is set for each metric and possibly a grade or color associated with various performance results. Unfortunately, past performance is not always a reliable indicator of what is to come. Future performance tends to be more a result of behaviors, how workers follow safety rules or provide feedback on inefficient work practices; how management personnel interact with the staff and receive bad news.

Measuring behavior can be more subjective than objective, but standards should be as well defined as possible.

The selection of core performance indicators should reflect the most important elements of mission and safety performance. The selection of these metrics is itself a message to the organization of what management considers important.

For maintenance, typical indicators include:

- Safety
  - Safety System Availability;
  - LCOs due to equipment failure;
  - Total Recordable Case (TRC) and Days Away/Restricted Time (DART); and
  - Contamination Events.
- Quality
  - Equipment Availability; and
  - Maintenance Rework.
- Production
  - Corrective Maintenance Backlog; and
  - Overdue PMs.

Other examples worthy of consideration include:

- Close-Calls – may identify weak work practices, equipment, or procedures;
- First Aid Cases – may be an indication of safe work practices;
- Overtime Hours – are resources adequate for the work, will backlogs rise;
- Personal Protective Equipment (PPE) Infractions – an indication of safety awareness;
- Sick Days – may indicate the commitment of the workforce (this should not be associated with specific individuals);
- Self-Assessment Compliance – are supervisors/managers getting into the field, are their observations meaningful (reinforces good practices, discourages bad practices); and
- Training Attendance – is training the right priority, are supervisors managing their work to permit attendance.

The initial selection of performance indicators should be a thoughtful process involving all the levels of the organization. The selected metrics should be reviewed periodically and modified as necessary to ensure they provide useful data. The metrics and their purpose need to be understood by all.

EFCOG published a *Performance Metric Manual* in 2002, which explains a performance measurement process piloted at the Savannah River Site. This manual provides a process for metrics, which flow from top to bottom in an organization. Even if not used exactly as described, the manual provides numerous ideas to consider in your own program.

O.2.2 Measuring Performance Indicators

Performance Indicators should be sufficiently defined so that their measurement is a simple matter of counting or transcribing from an organization record or log. Even assessment results that may be somewhat subjective can be given a grade useful for comparison. The periodicity of the data should be thoughtful – typically monthly or quarterly is sufficient. The data should be recorded, retained, and trended over multiple data periods – typically a year or more.

The data should be true and accurate to be of real value in assessing organizational conditions. Established goals should be challenging, but realistic. It would be laudable if an organization never had an occurrence or even a close call, but significant management pressure to achieve that goal may discourage reporting. A close call, properly handled, could fix an organizational deficiency that if left unreported could lead to a significant event. That is clearly not the desired result.

O.2.3 Analyzing Performance Indicators

What is done with performance indicator data is the most important aspect of performance measures. How are changes in data evaluated to be significant or a trend? Some organizations have employed Statistical Process Control (SPC) techniques to establish data normal and standard deviations – this may be a reasonable approach if you have access to the specialized expertise required to make this meaningful. However, most organizations simply look for changes and the apparent causes, and if other related indicators are consistent. If this condition is considered important by the responsible manager or their boss, they are further analyzed.

The purpose of analyzing changes in performance indicators is to identify the factors causing the indicator to change. There will be obvious factors, however, these are typically superficial – fixing them is not a long-term solution and may hide an error producing condition. There will likely be human performance factors, but the vast majority of these factors are influenced by organizational conditions that affect more than a single individual. Data gathering and analysis, using the event analysis techniques described in the references above, should go beyond faultfinding and determine the underlying organizational conditions or processes that should be addressed.

The following factors should be considered in these analyses:

- Availability of Physical Resources
    - Tools, equipment;
    - Spare parts, materials;
    - Workers, support personnel;
    - Workspace, light, ventilation;
    - Sufficient labels, gauges, annunciators, and control devices;
    - Availability of tools, materials, technology, equipment, improved lighting, adequate budget, spare parts, etc; and
    - Adequate Predictive/Preventive Maintenance.

- Organization/Facility Structure
  - Clear responsibilities, policies, goals;
  - Logical reporting structure;
  - Effective CM – drawings, procedures, training up-to-date;
  - Available support personnel (QC, RadCon, IH, etc.);
  - Consistent scheduling and adequate work planning; and
  - Effective oversight, self-assessment, and supervision.
- Information
  - Adequate Pre-Job Brief, turnover;
  - Clear and accurate maintenance, operating, or special test procedures/instructions;
  - Accurate and available drawings, equipment manuals, technical specifications;
  - Adequate time to review work procedure and prepare for task;
  - Lessons Learned appropriately applied/shared; and
  - Post-maintenance testing verifies equipment operability.
- Knowledge/Skills/Abilities
  - Effective qualification program;
  - Appropriate worker and supervisor training programs and materials;
  - Effective OJT and skills training;
  - Proper use of self-check and peer-check; and
  - Adequate QA/QC.
- Motivation
  - Work schedule reasonable, overtime not excessive;
  - Appropriate recognition, bonuses; and
  - Fair pay, benefits, job security, advancement opportunity, etc.

O.2.4 Performance Improvement

When the analysis has identified causal factors for undesirable trends in performance, a plan of action should be developed, implemented, and validated to have actually improved performance without undesirable unintended consequences. Too often worker deficiencies are deemed the problem and training the solution, but rarely does discipline, making procedures more complex, and retraining solve broad performance issues. Management should look deeper at the underlying organizational issues that lead to undesired behavior and work to improve those processes and approaches. It may include additional data gathering to refine the problem definition before finalizing the action plan.

P. FACILITY CONDITION INSPECTION

P.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include the process for conducting and implementing routine assessment of facilities to identify issues related to operability, reliability, housekeeping, and general condition.

The NMMP should address the following:

- Planning, conducting, and trending periodic inspections of the material condition of facilities to support safe and reliable plant operation;
- How material deficiencies are identified and logged in the work-control system;
- The expectations and attributes of facility systems and equipment; such as:
    - SSCs are properly preserved and insulated;
    - Instruments, controls, and associated indicators are calibrated, as required;
    - Good lubrication practices are evident;
    - Fasteners, supports, and safety systems are properly installed;
    - No fluid system leaks;
    - Equipment is appropriately protected from adverse environmental conditions;
    - Temporary repairs are minimized; and/or
    - Temporary environmental protection (e.g., dust, humidity, freeze, shock) is provided for facility equipment when needed to support construction, outage, or maintenance activities.

P.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

Management should conduct periodic inspections of safety equipment and facilities to ensure excellent facility condition and housekeeping 10 CFR Part 830.122(h). The condition of a facility depends on many factors, including design, fabrication, modifications, ongoing maintenance, facility work-control programs, and day-to-day operation. After initial facility construction, ongoing maintenance and the control of modifications are prime contributors to keeping systems and equipment in optimum condition to support safe and reliable operation.

DOE O430.1B provides requirements for establishing a Condition Assessment Program of real property assets on a five-year cycle. The Facility Condition Inspection should be integrated with the Condition Assessment Program so that identified repairs can be included as part of Deferred Maintenance reporting as applicable (see DOE O430.1B, *Real Property Asset Management* for more details on Condition Assessment reporting).

Establishing a program for identification and correction of condition deficiencies and housekeeping discrepancies is an important step in maintaining facilities and equipment in a condition of maximum safety, reliability, and availability.

The appearance and proper functioning of facility systems and equipment are key indicators of a well-maintained and -operated facility. Cleanliness and good housekeeping are the responsibilities of all facility employees. Additionally, there should be a periodic, focused inspection effort, by thoroughly trained personnel, to assist in effective identification and correction of facility condition deficiencies. Identification of technical obsolescence in a facility condition inspection is also important to determine whether the performance of SSCs is threatened. The maintenance of systems and equipment within design conditions produces such benefits as minimizing fluid leakage, minimizing 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.

Additionally, facility condition inspections should include items such as asbestos, PCBs, and lead based paint locations and material to assure that they are not damaged or contaminating the area and that they are included in the required identification surveys required by codes, laws, or policies. A good facility condition inspection program, often called Condition Assessment Survey (CAS), should include these building materials as a way to account for them. By combining the surveying and accountability of these hazardous building materials as part of a Site's CAS program it will make it more efficient and effective.

Properly used, a facility condition and housekeeping inspection program is an effective means for identifying and correcting deficiencies. The inspection programs should include such elements as the following:

- Facility managers should set high facility condition and housekeeping standards and communicate them to all personnel to promote a clear understanding;
- 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;
- A CAS with assigned risk assessment code should be used to prioritize schedules for repair;
- Instructions should 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; and/or
- Inspection guidelines and criteria should be prepared to assist the assigned inspectors in performing their inspections.

This section describes the attributes of an effective inspection program for maintaining excellent facility condition and housekeeping.

P.2.1 Standards

Management should establish an atmosphere of proper work ethics; positive attitudes; and specific expectations that are realistic, within the capabilities of the staff, consistent with sound engineering judgment, and cost effective. Management expectations should be communicated to all personnel. Facility managers and supervisors should conduct routine inspections to assess adherence to these expectations. Indicators of good facility condition and housekeeping standards include the following:

- Verifying rotating equipment operates in accordance with design specifications (e.g., bearing temperatures normal, vibration levels normal, etc.);
- Ensuring equipment is properly serviced (e.g., lubrication, fluid system integrity, drive-belts, and filters);
- 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;
- Protective cabinet doors and electrical enclosure covers are installed to maintain design integrity (e.g., all fasteners installed and tightened, filters clean);
- Equipment and systems are insulated to control heat transfer, to control ambient noise levels, and to promote personnel safety;
- Facility equipment and systems subject to corrosion are protected with a preservative;
- Temporary environmental protection is provided, where appropriate;
- Industrial and radiological hazards are minimized (e.g., chemicals, oils, and solvents properly stored; fire barriers maintained; trip hazards nonexistent; radiological postings current and in place; radiological barriers and step-off pads properly established; and sources of contamination identified);
- Walkway and equipment access is maintained;
- Equipment is clean (i.e., dirt, debris, tools, parts, and miscellaneous materials are not allowed to accumulate);
- 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 exist; and
- Illumination of areas, rooms, and grounds is maintained in a manner that provides

sufficient light to perform inspections and minor maintenance.

P.2.2 Scheduling

A schedule process should be established that ensures each inspection is performed periodically. Inspection schedules should specify when they will occur, the area, the inspector, and the general inspection category. The day and time of inspection should be left to the department manager's discretion.

P.2.3 Types of Inspections

Inspections should be separated into focus categories to allow an in-depth look at facility conditions such as the following:

- Material condition: mechanical (M), electrical (E), roof/building (A), or grounds (G);
- Cleanliness/housekeeping (H);
- Nuclear safety (N) or industrial safety (S); and
- Fire protection(F) or radiological protection/control (R)

All applicable categories should be completed for each inspection area periodically.

P.2.4 Conducting Inspections

Each department manager should conduct an inspection of the assigned inspection area according to the schedule. The inspection may be conducted as one evolution or as a series of smaller inspections.

Each inspection should include detailed walk downs of the inspection area, including out-of-the-way and limited-access areas. The inspection should identify deficiencies and corrective actions being taken to improve facility conditions. In this manner, the program serves as a positive feedback mechanism.

The manager should include department personnel on inspections to teach inspection techniques and convey high standards.

P.2.5 Inspection Techniques

While inspections are performed, observe the following:

- Safety practices;
- Work habits;
- Radiological control practices; and
- Work-site orderliness and protection of open systems/components.

Table III.P-1 is an example of an inspection checklist that may be used. Typically, in-depth inspections include the following techniques:

- Touching bearing housings, motors, and pumps to check for excessive heating or vibration;
- Being alert for abnormal sounds or unusual odors;
- Using a flashlight throughout the inspection to enhance visibility;
- Tagging (if used) and documenting deficiencies found during the inspection to provide accurate description and location information for each problem; and
- Referencing deficiencies to specific maintenance procedures or requirements.

P.2.6 Reporting and Follow-up

The inspection coordinator should provide blank inspection report forms to inspectors. Inspectors should submit an inspection report to the inspection coordinator.

For some housekeeping deficiencies, on-the-spot corrections may be possible. In those cases, corrective action should be initiated at the time of the inspection and noted on the report. Significant deficiencies in facility condition and safety should be reported immediately to the shift supervisor for appropriate prompt attention and so noted on the report.

The inspection coordinator should forward copies of each inspection report to the appropriate department managers for corrective actions, and maintain the original inspection reports on file for tracking and evaluating program effectiveness. The coordinator should periodically review these files to identify repetitive problems and trend progress.

Department managers should note on the inspection report the corrective actions planned and conducted for each deficiency under their responsibility and return the inspection report to the inspection coordinator to clear deficiencies on file.

The inspection coordinator should keep the equipment owner/operator informed of program progress. This may be done by written report or by verbal update and should include discussions of generic or specific performance deficiencies, as well as particularly good areas.

P.2.7 Material Deficiency Identification

Material deficiencies should be tracked. Inspectors should enter a description of the deficiency in the tracking system. Deficiency tracking system may include use of deficiency tags, status logs, and/or computer tracking systems, or other equivalent means. Multiple deficiencies of a similar nature, in close proximity to each other, or that are to be included on the same WR/WO (e.g., 10 fasteners missing from a motor control center) may be grouped. The fact that there are multiple deficiencies should be indicated in the tracking system. The date should be used in conjunction with the tracking system identifier to obtain the WR/WO number.

In locations where utilized, the inspector will attach a deficiency tag to the equipment or component, as close as possible to the deficiency. Deficiency tags should be applied in a manner that does not obscure system controls, status indicators, or operating parameter displays. The duplicate copy, which contains the information necessary for completing a WR/WO, should be retained until a WR/WO is initiated.

If the deficiency is inaccessible because of radiation or physical constraints, the hard copy of the deficiency tag should be hung in a clearly visible area as close as possible to the deficiency. For those situations where a deficiency tag may restrict the visibility of facility instrumentation or controls, a smaller deficiency identification sticker should be used.

P.2.8 Work Request/Work Order Initiation

The individual identifying a deficiency should initiate a WR/WO (see Section III.D, *Planning, Scheduling, and Coordination of Maintenance*) according to the following steps:

- Enter the deficiency identification tag or sticker number in the WR/WO index, if applicable. Because the date on the deficiency tag is the date of the WR/WO, the index provides a cross-reference;
- Use the duplicate portion of the deficiency identification tag to enter key information on the WR/WO;
- Record the tag or sticker serial number, date, and description of deficiency on the WR/WO; and
- Note whether it was possible to place the deficiency identification tag in close proximity to the deficiency.

The duplicate may be affixed to the WR/WO or discarded. The system now provides complete traceability from a deficiency, using the tag number and date, to the WR/WO index and then to the WR/WO. The age of a deficiency may be determined in the field from the date on the tag and the status of its repair determined from the work-control system.

P.2.9 Removing Deficiency Tag Stickers

Responsible personnel should ensure that deficiency tags and stickers are removed following the completion of corrective maintenance and after verification that the deficiency has been satisfactorily corrected.

If the tag is lost, or cannot be located, the circumstances should be noted on the original WR/WO. As a part of their review of the completed WR/WO, the maintenance supervisor should verify that the tag or sticker has been removed.

P.2.10 Confirmation of Deficiency Identification Tag and Sticker Use

At least semiannually, the maintenance-planning manager should initiate the following review to check the use of deficiency identification tags and stickers. This review should be a management tool only and should not be considered a permanent record. Alternative methods of status tracking, such as computer databases, status logs, shift turnovers, etc. may be used instead of tags or stickers.

A representative sample of pending WR/WOs and associated tags or stickers should be verified.

P.2.11 Training

Personnel involved in inspections should be knowledgeable of the standards expected by laboratory requirements and the techniques required to perform facility condition inspections. In addition, all personnel should be aware of the importance of good housekeeping and maintaining

the facility in good condition. The facility manager should conduct some inspections with selected individuals.

P.2.12 Procedures

Administrative procedures that describe the inspection program should define expectations. Inspections could be incorporated into the PM or surveillance program similar to other visual inspections, such as housekeeping inspections. Deficiencies identified during the inspection should be documented by the inspector (e.g., by initiation of a maintenance request or by use of an area inspection report). Checklists of equipment to be inspected and types of problems to look for could be useful as guides for inspectors.

P.2.13 Scope of Inspections

The inspection should include detailed walk-downs of assigned areas. Remote and limited-access areas should be included.

Key individuals should accompany the managers and supervisors during their inspections. Once a deficiency is identified, the inspector should attempt to determine the source or cause, how long it has existed, and whether it has been previously identified.

P.2.14 Inspection Program Elements

Routine inspection programs should include the following elements:

- Inspection areas small enough to be thoroughly inspected within the time allotted;
- Each facility area scheduled for periodic inspection; and
- Periodical rotation of inspectors to avoid familiarity with an inspection area, which can hinder deficiency identification.

P.2.15 Deficiency Follow-up

A list should be prepared of all deficiencies not included in the work-control system or some other corrective action system, with responsibility for correction or disposition of each. Personnel assigned corrective action should periodically report to the inspection coordinator the results of the actions planned or conducted and deficiencies should be tracked to resolution by personnel assigned corrective actions and the inspection coordinator, as a fail-safe mechanism.

Reported deficiencies should be monitored to identify recurring, generic, and long-term problems. Action taken to resolve these problems should include a failure or root-cause analysis

Follow-up of selected corrective actions from previous inspections is necessary for evaluating the timeliness and effectiveness of corrective actions and for obtaining the maximum benefit from the inspection program.

The inspection coordinator or an assigned individual should periodically review inspection reports and facility conditions to evaluate the effectiveness of the inspection program.

Q. POST MAINTENANCE TESTING

Q.1 ORDER IMPLEMENTATION GUIDANCE

In accordance with DOE O 433.1B, the NMMP must include processes for post maintenance testing activities; and 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. This Guide does not specifically address the post modification testing process; however, most of the methods described may be used for post modification testing as well.

The NMMP should address the following:

- When and how Post-Maintenance Testing (PMT) should be specified;
- How PMTs are documented and reviewed;
- The role of the CSE in PMT according to DOE O 420.1C; and
- Actions required if a PMT cannot be accomplished immediately after maintenance is completed.

Q.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION AND PROCEDURE DEVELOPMENT

Post maintenance testing integrates with the work-control system, and the health and safety permit system. The PMT should be commensurate with the maintenance work performed and the importance of the equipment to facility safety and reliability. In some cases, testing additional equipment may be required to verify system performance. The status of equipment that has undergone maintenance should be tracked to ensure that all testing is completed before work closeout. Planners should coordinate with System Engineers, as applicable, regarding PMTs.

A PMT should include the following elements:

- The scope, initial conditions and prerequisites, hold points, test requirements, acceptance criteria and post-test restoration; and
- Methods for documenting the results, and verifying that the resulting data meets acceptance criteria.

PMTs may be part of the facility work-control system, which uses the facility Work Request (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 by recording the PMT data directly on the WR or by referencing data recorded on PMT data sheets or documents.

During the initial processing of a WR/WO, the maintenance planner should include predefined PMTs in job instructions based on consultation with the owner/operator. Tests of any equipment affected by code or TSR should be reviewed by cognizant personnel. The WR should be reviewed by the operations organization to verify that the PMT requirements listed will provide adequate verification that the equipment will be capable of performing its design functions. WR/WOs should include applicable post-maintenance testing requirements that verify that the

intent of the maintenance was accomplished (i.e., the intended repair or service was accomplished), the required configuration was restored, and SSC operability was verified.

In addition, post maintenance testing should be done following preventive maintenance and troubleshooting activities that might have affected normal functioning of the SSC. Tests should be conducted under conditions that represent normal operating parameters, such as flow, differential pressure, temperature, input signal values, and fluid type.

Q.2.1 PMT Scope

Post maintenance testing should be accomplished for 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 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.

The following activities are representative of common PMTs:

- Operational exercise of the component (including vibration, pressure, flow, temperature, distance of travel, and other measurements where applicable);
- Calibration or alignment of a component or instrument loop;
- Leak rate testing;
- Stroke, closure, and response times;
- Visual or dimensional inspections and nondestructive tests specified by code;
- Voltage, current, integrity or continuity checks;
- Hydrostatic test, if a pressure boundary was affected; and
- System or component inspections for cleanliness.

A PMT control form like that shown in Figure III.Q-1 may be filled out by the planner and attached to the WR/WO, as appropriate. PMT control instructions may also be provided via procedures/work instructions that are approved as part of the WR/WO during the planning and

authorization process. When a maintenance activity involves several different tests, a separate PMT control form may be used to document each test.

If the scope of work expands beyond the original WR/WO, work should be stopped and the WR/WO should be returned to planning along with any PMT Control Forms for further direction.

At the completion of post maintenance testing, the owner/operator should review the test results and sign the PMT control form/procedure/instructions, indicating acceptability of the equipment based on satisfactory completion of all PMTs. The owner/operator should make the final determination of operability.

The owner/operator is responsible for restoring SSCs to a correct set point for operating or standby mode following testing. This may be accomplished by instructions in the test procedure, by conducting specific system lineups, or by other formal methods.

For troubleshooting WR/WOs, the test requirements normally cannot be determined until the troubleshooting is complete. A record should be kept of work performed during troubleshooting to ensure that post maintenance testing covers the troubleshooting scope. The supervisor responsible for the troubleshooting should generate a new WR/WO for necessary work. Testing requirements should then be identified through the normal planning and review process.

If facility conditions dictate that the PMT cannot be completed immediately after maintenance is performed, the WR/WO should be held as an open WR/WO until testing may be completed. Danger or caution tags may be required for the equipment until proper post maintenance testing can be completed. Safety equipment should not be declared operative until the PMT is complete. WR/WOs waiting testing should be tracked to closure. Examples of delayed testing would include steam system valves or flanges repaired during unit outage periods that cannot be tested until normal operating facility conditions exist.

When the stop work conditions are corrected, retest requirements should be evaluated to determine whether prior testing should be repeated.

If the PMT is unsatisfactory, deficiencies identified during testing should be documented and corrected by generating a WR/WO.

If a PMT 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.

Various classifications of equipment will require different levels of procedure support for PMT. Where applicable, existing surveillance test procedures can be used to evaluate the operational acceptability of the equipment. If an existing surveillance test is used for the PMT, it should also verify operability of all components and features either directly or potentially affected by the maintenance activity, verify that maintenance was performed properly, and ensure that the initial deficiency was corrected. If only part of the procedure is to be performed, the applicable sections, including necessary prerequisites and precautions, should be identified and caution should be used to ensure that previous sections are reviewed for system status, lineups, or prerequisites. An engineering or system acceptance test procedure, alignment check procedure, generic test procedure, special test procedure, or Craft/Maintenance Work Instructions may also

be used to provide PMT instructions. PMT procedures/instructions used for a range of generic equipment, such as manual valves or flow controllers, should include data sheets for specific equipment when acceptance specifications or performance data are required.

Test equipment should be specified and provision made for recording the equipment identification and calibration due date.

A single test or a combination of tests such as those listed above should be specified to provide a complete PMT.

Q.2.2 PMT Performance, Documentation, and Acceptance

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 acceptability should be entered or cross-referenced to maintenance history on the WR.

Deficiencies identified during post maintenance testing should be documented and corrected on the original WR, 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. TSR should be consulted for safety equipment, and appropriate actions should be taken until the equipment is properly tested and returned to service.

Equipment ID No.	POST MAINTENANCE TEST CONTROL FORM	WR/WO No.

Description of Test:

Test Instructions:

Attachments:
Pages

Test Form Prepared By:

	Name	Badge	Date

Test Start Approval:

	Equipment Owner	Badge	Date

Test Results (Comments):

Satisfactory Unsatisfactory

Corrective Actions Taken:			
Test Performed By:	Name	Badge	Date
Test Accepted By:	Equipment Owner	Badge	Date
Test Accepted By:	Maintenance Supervisor	Badge	Date

Figure III.Q-1. Example Post Maintenance Test Control Form

APPENDIX A: NMMP-DD OPTIONS AND EXAMPLES

Approximately 20 years ago, a very long and prescriptive Order established the Maintenance Implementation Plan (MIP) requirement. The Original MIP's were supposed to be (1) a comprehensive description of the level of compliance with each Order requirement, (2) the identification of Improvements that were needed to achieve full compliance with the Order's requirements, and (3) a schedule for implementing the needed improvements. Subsequent Order revisions were much less prescriptive. In recent years, an acceptable approach at some sites was to fulfill the MIP requirement by describing the current maintenance program using an applicability matrix showing the list of procedures and other documents that implement each of the Orders elements of maintenance.

The current Order no longer requires a MIP but requires a similar document, a Nuclear Maintenance Management Program Description Document (NMMP-DD).

A.1 OPTIONS FOR THE NMMP-DD FORMAT, EXAMPLES OF NMMP SUMMARIES

The following summary of the above NMMP-DD guidance identifies five options for the NMMP-DD format (based on the definition of an applicability matrix provided in the last two paragraphs of "Current NMMP-DD Requirements" above):

1. An applicability matrix **plus** a separate graded approach document (listed in the matrix) that addresses each of the 17 maintenance elements where the graded approach is applied.
2. An applicability matrix **plus** a separate graded approach document **plus** a separate NMMP-DD Summary.
3. An applicability matrix **plus** a separate NMMP-DD Summary document that includes documentation of the graded approach for each of the 17 maintenance elements where the graded approach is applied.
4. An NMMP-DD Summary that comprehensively describes the big picture and identifies NMMP procedures and the graded approach (if applicable) for each of the 17 maintenance elements. (If the NMMP-DD Summary identifies the NMMP procedures, then there is no need for an applicability matrix.)
5. A NMMP Manual that describes the implementation of the 17 maintenance elements including references to and summaries of applicable procedures plus a separate graded approach document, which could be an Appendix of the Manual.

At the end of this Section, an example NMMP-DD format is provided for an applicability matrix. This matrix has columns to support option 2 above. This example matrix would also support options 1 and 3 by eliminating one column.

The five options above specifically identify two separate documents that are not procedures: (1) a separate graded approach document and (2) an optional separate NMMP Summary document. The applicability matrix should list other separate documents including, but not limited to:

- The "Training Implementation Matrix";
- The Master Equipment List, or portion thereof, showing all SSCs that are part of the

safety basis, and their categorization; and

- A listing of the TSRs for which maintenance personnel are primarily responsible to perform or have a supporting role.

The level of detail appropriate or desired for the recommended NMMP Summary is difficult to describe. Therefore, an example NMMP Summary is provided in Appendix 2. Undoubtedly, there will be differing, credible opinions regarding what is a good example of the desirable level of detail.

An applicability matrix plus a brief graded approach document that is primarily the formal definition contained in 10 CFR Part 830 should not considered to be compliant with the Order's requirements for the NMMP-DD, even though the procedures reflect the results of applying the graded approach. Documenting the basis for the graded approach should include the justifications for concluding that the alternate methods are sufficient to ensure an adequate level of safety commensurate with the identified hazards. (DOE O 251.1C) (See the above analysis of the essential elements that should be part of the graded approach documentation.)

A.2 RECOMMENDED FORMAT FOR A NMMP-DD UTILIZING AN APPLICABILITY MATRIX

The applicability matrix shown below has been designed to cover the three NMMP-DD requirements: (1) Correlation of Requirements to Applicable Facilities, (2) Correlation of implementing documents to Specific CRD Requirements, and (3) Documentation of the basis for applying the graded approach. (The last two paragraphs of "Current NMMP-DD Requirements" above define an applicability matrix.)

The tabular NMMP-DD format provides:

- A column to identify the facilities where the procedures, and graded approach are applicable;
- One NMMP-DD can cover multiple nuclear facilities;
    - Sites with multiple categories of nuclear facilities might choose to create a separate NMMP-DD for each category. If so, the "applicable facilities" column can be deleted; and
    - A column to refer to the paragraph of the graded approach document (or section of the document) that identifies the where, why, and what elements of the graded approach.
- An optional column to show a corresponding paragraph or section of the recommended “NMMP Summary”; and
- An optional section at the bottom of the table that can be used to identify the documentation for implementation of the maintenance requirements contained in DOE O 430.1B, Real Property Asset Management.

For sites choosing the NMMP-DD Manual Option, the table below can be modified to show the paragraphs or sections of the Manual that are applicable to each requirement.

During NMMP-DD, planning and development the table below can be used to document changes needed for procedures or other documents or actions needed for continuous improvement goals.

NMMP-DD Applicability Matrix for DOE Nuclear Facilities at XYZ Site

All General and Specific Requirements are Quotations from the DOE O 433.1B CRD

Par. #	Title	Requirements	NMMP Summary Par	Procedure # / Document Title	Graded Approach Par.	Applicable Facilities
General Requirements						
1.a	Overall NMMP	Federal and contractor organizations responsible for hazard category 1, 2, or 3 nuclear facilities, as defined by DOE Standard 1027-92 must develop and implement a nuclear maintenance management program (NMMP) through tailored application (e.g., graded approach) of the Specific Requirements in this attachment. The definition of graded approach is provided in Title 10 Code of Federal Regulations (CFR) Part 830.3. The NMMP must describe the safety management program for maintenance and the reliable performance of structures, systems and components (SSCs) that are part of the safety basis at hazard category 1, 2 and 3 DOE nuclear facilities. Guidance on applying the Specific Requirements, including a graded approach, is provided in DOE G 433.1-1A, Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1B. The referenced Guide is available on the DOE Directives web site, www.directives.doe.gov.				
1.b	Nuclear SSC Maintenance	Federal and contractor organizations must conduct all maintenance of SSCs that are part of the safety basis in compliance with an approved NMMP.				
1.c	Equivalencies & Exemptions	Federal and contractor organizations must ensure that equivalencies and exemptions from the maintenance management program elements of this attachment are identified, formally documented with supporting justification, and approved in accordance with DOE O 251.1C. Central Technical Authority (CTA) or designee concurrence is required for both exemptions and equivalencies to this Order for nuclear facilities.				
1.d	NMMP Implementation Documents	Federal and contractor organizations must implement the NMMP through federal or contractor-approved documents, respectively. This is normally accomplished with a manual or a set of implementing procedures.				
1.e	NMMP Description Document	Federal and contractor organizations must submit NMMP description documentation to DOE for review and approval prior to the startup of new hazard category 1, 2, and 3 nuclear facilities and at least every three years for all nuclear facilities. NMMP description documentation must be, at a minimum, an applicability matrix or a combination of multiple documents. The following elements must be covered:				

NMMP-DD Applicability Matrix for DOE Nuclear Facilities at XYZ Site

All General and Specific Requirements are Quotations from the DOE O 433.1B CRD

Par. #	Title	Requirements	NMMP Summary Par	Procedure # / Document Title	Graded Approach Par.	Applicable Facilities
	• 1.e.(1)	Correlation of the requirements in this attachment to the applicable facilities;				
	• 1.e.(2)	Correlation of the implementing documents (i.e., procedures, work instructions, etc.) to the specific requirements in this attachment; and Attachment 2 DOE O 433.1B Page 2 4-21-2010				
	• 1.e.(3)	Documentation of the basis for applying a graded approach, if applicable.				
1.f	Submission of NMMP Description Document(s)	Federal and contractor organizations with previously approved maintenance management program documentation must submit either an addendum or page changes to the program documentation to reflect the changes made as a result of the implementation of requirements in this attachment. If no changes are needed, a memorandum to that effect may be submitted as the addendum. Changes must be submitted to DOE for approval within 90 days from the date of inclusion of the requirements in this attachment in the contract.				
1.g	Periodic NMMP Assessments	Federal and contractor organizations must conduct assessments of NMMP implementation, at least every three years or less frequent if directed by the DOE SO in accordance with DOE O 226.1B and 10 CFR Part 830 subpart A. DOE G 433.1-1A provides acceptable approaches for conducting NMMP assessments.				
1.h	NMMP DSA Reference	Federal and contractor organizations must ensure that NMMPs are identified in the applicable documented safety analysis (DSA) in accordance with 10 CFR Part 830.204.				
1.i	USQ Process Applicability	Federal and contractor organizations must review proposed changes to the NMMP, which could affect the performance of safety SSCs, as part of the ongoing Unreviewed Safety Question (USQ) process. This review is intended to evaluate whether safety SSCs are maintained and operated within the approved safety basis, as required by 10 CFR Part 830.203. Changes, which would result in a positive USQ, must be submitted to DOE for approval prior to the change taking effect.				
1.j	NMMP Implementation Timeframe	These requirements will be fully implemented within 1 year of its issuance, unless a different implementation schedule is approved by the SO with concurrence of the CTA.				

NMMP-DD Applicability Matrix for DOE Nuclear Facilities at XYZ Site

All General and Specific Requirements are Quotations from the DOE O 433.1B CRD

Par. #	Title	Requirements	NMMP Summary Par	Procedure # / Document Title	Graded Approach Par.	Applicable Facilities
Specific Requirements						
2.a.(1)	DOE Orders	The NMMP must be integrated with applicable programs (e.g., Safety Management Programs) and requirements identified by Federal regulations and other DOE Orders and Manuals (and their CRDs) to include.				
	• 2.a.(1)(a)	DOE O 226.1B, Implementation of Department of Energy Oversight Policy				
	• 2.a.(1)(b)	DOE O 414.1D, Quality Assurance				
	• 2.a.(1)(c)	DOE O 420.1C, Facility Safety				
	• 2.a.(1)(d)	DOE O 430.1B, Real Property Asset Management				
	• 2.a.(1)(e)	DOE O 440.1B, Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees; (Note: DOE O 440.1B is only applicable to DOE)				
	• 2.a.(1)(f)	DOE O 422.1, Conduct of Operations (formerly DOE O 5480.19)				
	• 2.a.(1)(g)	DOE O 426.2, Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities (formerly DOE O 5480.20A)				
	• 2.a.(1)(h)	DOE O 458.1, Radiation Protection of the Public and the Environment (formerly DOE O 5400.5)				
	• 2.a.(1)(i)	DOE O 450.2, Integrated Safety Management				
2.a.(2)	Federal Regulations	Code of Federal Regulations				
	• 2.a.(2)(a)	10 CFR Part 830, Nuclear Safety Management; Subpart A, Quality Assurance Requirements				
	• 2.a.(2)(b)	10 CFR Part 830, Nuclear Safety Management; Subpart B, Safety Basis Requirements				

NMMP-DD Applicability Matrix for DOE Nuclear Facilities at XYZ Site

All General and Specific Requirements are Quotations from the DOE O 433.1B CRD

Par. #	Title	Requirements	NMMP Summary Par	Procedure # / Document Title	Graded Approach Par.	Applicable Facilities
	• 2.a.(2)(c)	Integrated Safety Management System (ISMS) provisions contained in 48 CFR Part 970.5223-1, Integration of Environment, Safety, and Health into Work Planning and Execution				
	• 2.a.(2)(d)	10 CFR Part 835, Occupational Radiation Protection				
	• 2.a.(2)(e)	10 CFR Part 850, Chronic Beryllium Disease Prevention Program				
	• 2.a.(2)(f)	10 CFR Part 851, Worker Safety and Health Program				
2.b	Maintenance Organization & Administration	The management structure that applies sufficient resources (e.g., oversight and independent assessment, management involvement, funding, assignment of personnel roles and responsibilities, facilities, tools, and equipment) necessary to support the requirements described in this attachment and ensures integration with other programs. Attachment 2 DOE O 433.1B Page 4 4-21-2010				
2.c	Master Equipment List	The process for developing, implementing, managing, and maintaining the master equipment list (MEL) at a level that clearly identifies the structures, systems, and components (SSCs) that are part of the safety basis.				
2.d	Planning, Scheduling & Coordination of Maintenance	The process for planning, scheduling, coordination, and control of maintenance activities, and properly emphasizing equipment availability. The process must describe the application of a System Engineer Program in accordance with DOE O 420.1C in the planning and execution of maintenance activities.				
2.e	Types of Maintenance	The process for utilization of appropriate types of maintenance (i.e., preventive maintenance, predictive maintenance, reliability-centered maintenance, surveillance and testing, and corrective maintenance) to provide for safe, efficient, and reliable operation of safety SSCs.				
2.f	Maintenance Procedures	The process for developing and implementing documented and approved work instructions for work on safety SSCs (i.e., work packages, procedures, work instructions, and drawings).				
2.g	Training & Qualification	The training and qualification program for maintenance positions specified in DOE O 426.2 (formerly DOE O 5480.20A)				

NMMP-DD Applicability Matrix for DOE Nuclear Facilities at XYZ Site All General and Specific Requirements are Quotations from the DOE O 433.1B CRD						
Par. #	Title	Requirements	NMMP Summary Par	Procedure # / Document Title	Graded Approach Par.	Applicable Facilities
2.h	Configuration Management	The incorporation of the configuration management program to control approved modifications and to prevent unauthorized modifications to safety SSCs.				
2.i	Procurement	The appropriate integration of the procurement process with the NMMP to ensure the availability of parts, materials and services for maintenance activities.				
2.j	Maintenance Tool & Equipment Control	The process for control of maintenance tools including calibration of Measuring and Test Equipment.				
2.k	Suspect & Counterfeit Items	The incorporation of the process to prevent the use of suspect and counterfeit items into maintenance procedures and work instructions.				
2.l	Maintenance History	The process for developing and maintaining documented and retrievable maintenance history (i.e., cost data, system availability data, and failure data) to support work planning, performance trending, analysis of problems to determine root causes of unplanned occurrences related to maintenance, and continuous program improvement.				
2.m	Aging Degradation & Technical Obsolescence	The process for conducting inspections to evaluate aging-related degradation and technical obsolescence to determine whether the performance of SSCs is threatened. DOE O 433.1B Attachment 1 4-21-2010 Page 5 (and Page 6)				
2.n	Seasonal Facility Preservation	The process for ensuring the prevention of damage to safety SSCs from adverse weather conditions.				
2.o	Performance Measures	The process for developing, maintaining, and communicating performance measures to identify maintenance issues requiring corrective action and lessons learned.				

NMMP-DD Applicability Matrix for DOE Nuclear Facilities at XYZ Site

All General and Specific Requirements are Quotations from the DOE O 433.1B CRD

Par. #	Title	Requirements	NMMP Summary Par	Procedure # / Document Title	Graded Approach Par.	Applicable Facilities
2.p	Facility Condition Inspection	The process for conducting and implementing routine assessment of facilities to identify issues related to operability, reliability, housekeeping, and general condition.				
2.q	Post Maintenance Testing	The process for conducting post maintenance testing to verify that safety SSCs can perform their intended function when returned to service.				
Maintenance Requirements in CRD of DOE 430.1B, RPAM						
5	Maintenance	The contractor must maintain real property assets in a manner that promotes operational safety, worker health, environmental compliance, property preservation and cost-effectiveness while meeting the program missions. This requires a balanced approach that not only sustains the assets, but also provides for their recapitalization and includes the following as a minimum.				
5.a	Maintenance Management Program	A maintenance management program that includes a condition assessment of the real property assets, a work control system, management of deferred maintenance, a method to prioritize, and systems to budget and track maintenance expenditures.				
5.b	Five year Sustainment Funding	Identification of 5-year maintenance and repair requirements (sustainment) and funding for deferred maintenance reduction.				
5.c	Five Year Recapitalizati on Funding	Identification of 5-year recapitalization requirements to replace or modernize existing facilities.				

NMMP-DD Applicability Matrix for DOE Nuclear Facilities at XYZ Site All General and Specific Requirements are Quotations from the DOE O 433.1B CRD						
Par. #	Title	Requirements	NMMP Summary Par	Procedure # / Document Title	Graded Approach Par.	Applicable Facilities
5.d	Condition Assessment Surveys and Deferred Maintenance Estimates	Condition assessments must be performed on real property assets at least once within a five-year period, and may be required more frequently for mission essential facilities and infrastructure. The condition assessment program shall utilize a tailored approach based on facility status, mission and importance and the magnitude of the hazards associated with facilities and infrastructure. Inspection methodology shall be consistent with industry practice, and shall include identification of safety and health hazards. Deferred maintenance estimates will be based on nationally recognized cost estimating systems or the DOE Condition Assessment Information System (CAIS). The condition assessment program will support the reporting requirements of FIMS. *Note: The HQ Guidance Tab of the FIMS website http://www.fimsinfo.doe.gov includes the current year's guidance for condition assessment surveys and for identifying, reporting, and managing deferred maintenance.*				

APPENDIX B: NMMP ASSESSMENT GUIDANCE

B.1 SUMMARY OF NMMP ASSESSMENT REQUIREMENTS INCLUDED IN DOE ORDERS

The organization's NMMP shall be included within the scope of the site assurance/assessment program, as required by DOE O 226.1B, *Implementation of DOE Oversight Policy* and other DOE directives.

DOE O 433.1B (par. 4.d.) states that "Assessments of NMMP implementation must be conducted, at least every three years or less frequent if directed by the SO in accordance with DOE O 226.1B, to evaluate whether all CRD requirements are appropriately implemented." The phrase "every three years or less frequent" is properly interpreted to mean "at least every three years." The SO may decide to require full or partial assessments annually or every two years.

DOE O 433.1B contains the following assessment requirements:

1. Par. 5.d.(7) requires Field Office Managers (including NNSA) to "Conduct comprehensive self-assessments and assessments of contractor maintenance management programs as specified in paragraph 4 above and in accordance with DOE O 226.1B."
   a. Field Office self-assessments focus on oversight responsibilities and may include assessment of the field office's process and performance for review and approval of the NMMP.
   b. Field Office assessments of the contractor's nuclear maintenance management should be based on regulatory and contractual requirements and the approved NMMP-DD.
2. Attachment II, par. 1.f states that federal and contractor organizations (GOGO & GOCO) "must conduct assessments of NMMP implementation, at least every three years or less frequent… DOE G 433.1-1 provides acceptable approaches for conducting NMMP assessments."

B.2 ADDITIONAL BACKGROUND/ GUIDANCE SUPPORTING IMPLEMENTATION, PROCEDURE DEVELOPMENT, AND/ OR EXAMPLES

Analysis of the Potential Scopes of Various Types of Assessments

Five potential scopes for assessments are listed below for the purpose of understanding differences in the various types of assessments. Assessment scopes may include:

1. The adequacy of the field office oversight of the contractor's NMMP;
2. The adequacy of the NMMP-DD in capturing regulatory and contractual requirements;
3. The implementation of the NMMP into work processes; or
4. The contractor's performance against the regulatory and contractual requirements, and/or the NMMP-DD.

Utilization of This Guide for Various Types of Assessments

This Guide is intended to be an aid for all the potential scopes of assessments, but it is especially intended to provide guidance for scopes 3 and 4.

Each of the Guide's Section III sub-sections identifies items applicable to a generic NMMP under DOE O 433.1B. They provide a broad based starting point for developing an assessment plan and lines of inquiry for the various types of assessments and their potential scopes.

The approved NMMP-DD provides a description of the locally implemented program and should be the basis for assessing program execution. (Scope 5)

Utilizing an independent Subject Matter Expert as a team member is a recommended practice for contractor self-assessments, for field office self-assessments, and for field office assessments of the contractor's performance.

Preparing Documentation Useful for Assessments

Approval of the NMMP is based on review and approval of the NMMP-DD.

This Guide provides an acceptable, but not mandatory, means of complying with the requirements of the Order. Alternative methods that satisfy the Order's requirements are also acceptable. However, any implementation selected must be justified to ensure an adequate level of safety (commensurate with the hazards) is achieved. (DOE O 251.1C par. 5.d(1))

The NMMP-DD documents all alternate methods selected along with the associated justification. The justification should be part of the documentation of the basis for applying the graded approach. This documentation is especially useful during field office review and approval of the NMMP-DD and during assessments that focus on scopes #3 and #4. (See five potential scopes above.)

As stated in the Forward and Introduction, this Guide is also useful for DOE employees during the review and approval of NMMP's and NMMP-DD's by providing example means of achieving Order compliance and criteria for evaluating alternative proposals. The field office should document their analysis performed during review of the NMMP-DD for NMMP approval. This documentation is especially useful during assessments focused on scopes #2 and #3. (See five potential scopes above.)

A Suggested Best Practice for Field Office Assessments of the Contractor's NMMP Performance

Assessment of the contractor's NMMP implementation, required at least every three years, is most effectively satisfied by performing multiple, limited-scope assessments over the course of three years addressing the individual elements and activities of the NMMP with summary analysis of these assessments to provide for overall NMMP condition. Additionally, assessments of related programs (e.g., Quality Assurance, Training) should touch on maintenance practices. Applicable assessment results should at least be included in the summary analyses of the NMMP.

The 17 sub-sections or elements discussed in Section II of this Guide provide a reasonable listing of unique assessment areas, however some elements may be quite large (e.g. Section II.D: Planning, Scheduling, and Coordination of Maintenance) and can be further divided (e.g. work planning, work control, work authorization, hazard identification).

An example NMMP Assessment Master Plan to implement the multiple, limited-scope assessment practice is provided in Table A-1.1. This approach can be used by DOE Field Offices and contractors.

Use of this example template is suggested when developing plans for NMMP self-assessments and assessments.

Three-Year NMMP Assessment Plan

FY11				FY12				FY13			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
A	G	C	J	E	H	F		N/P	I	O	K
	B	L	D1		D2		D3		M		Q
			R				R				R/S

Table V-1: Example NMMP Assessment Plan

Topics:

A. Integration with Regulations and DOE Orders and Manuals (and their CRDs);

B. Maintenance Organization and Administration;

C. Master Equipment List;

D. Planning, Scheduling, and Coordination of Maintenance;
   1. Hazard Identification & Control;
   2. Work Planning;
   3. Work Authorization;

E. Types of Maintenance;

F. Maintenance Procedures;

G. Training and Qualification;

H. Configuration Management;

I. Procurement;

J. Maintenance Tool and Equipment Control;

K. Suspect and Counterfeit Items;

L. Maintenance History;

M. Aging Degradation and Technical Obsolescence;

N. Seasonal Facility Preservation;

O. Performance Measures;

P. Facility Condition Inspection;

Q. Post Maintenance Testing;

R. Annual NMMP Summary (analysis of all NMMP assessments during the year);

S. Triennial NMMP Assessment (analysis of all NMMP assessments during the previous three years).

APPENDIX C: DEFINITIONS, ACRONYMS, AND REFERENCES

A. DEFINITIONS

A.1 KEY TERMS

Term or Phrase	Description
Hazard Categories	The consequences of unmitigated releases of radioactive and/or hazardous material are evaluated as required by DOE-STD-1027-92 and classified by the following hazard categories. CATEGORY 1. The hazard analysis shows the potential for significant offsite consequences. CATEGORY 2. The hazard analysis shows the potential for significant onsite consequences. CATEGORY 3. The hazard analysis shows the potential for only significant localized consequences.
Nonreactor Nuclear Facility	Those facilities, activities or operations that involve, or will involve, radioactive and/or fissionable materials in such form and quantity that a nuclear or a nuclear explosive hazard potentially exists to workers, the public, or the environment. It does not include accelerators and their operations, and does not include activities involving only incidental use and generation of radioactive materials or radiation such as check and calibration sources, use of radioactive sources in research and experimental and analytical laboratory activities, electron microscopes, and X-ray machines.
Nuclear Facility	A reactor or a nonreactor nuclear facility (see definition above) where an activity is conducted for or on behalf of DOE and includes any related area, structure, facility, or activity.
Nuclear Maintenance Management Program (NMMP)	The operating organization's program, defined by a set of DOE or contractor approved documents, which establish the processes and requirements for conducting maintenance on Structures, Systems, and Components (SSCs) that are part of the safety basis for DOE Hazard Category 1, 2, and 3 nuclear facilities. The operating organization may elect to apply the same processes to SSCs outside the scope of the subject order.
Nuclear Maintenance Management Program-Description Documentation (NMMP-DD)	The document or set of documents, which describe how an organization responsible for one or more Hazard Category 1, 2, and 3 nuclear facilities will manage their nuclear maintenance program to be compliant with the requirements of DOE O433.1B. This documentation is submitted to DOE for review and approval prior to startup and at least every three years thereafter. The documentation covers: Correlation of the Order requirements to the applicable facilities; Correlation of the implementing documents to the specific Order requirements; and Documentation of the basis for applying a graded approach, if applicable.

Term or Phrase	Description
Structures, Systems, and Components (SSCs)	Physical items designed, built, or installed to support the operation of the facility. A structure is an element or a collection of elements to provide support or enclosure such as a building, freestanding tank, basin, dike, or stack. A system is a collection of components assembled to perform a function such as piping; cable trays; conduits; or heating, ventilation, and air conditioning. A component is an item of equipment such as a pump, valve, or relay or an element of a larger array such as a length of pipe, elbow, or reducer.
Safety-Class Structures, Systems, & Components (Safety-Class SSCs)	SSCs whose preventive or mitigative function is necessary to keep hazardous material exposure to the public below the offsite Evaluation Guidelines. The definition would typically exclude items such as primary environmental monitors and most process equipment. (10 CFR Part 830)
Safety-Significant Structures, Systems, & Components (Safety-Significant SSCs)	SSCs which are not designated as Safety Class SSCs, but whose preventive or mitigative function is a major contributor to defense in depth and/or worker safety as determined from safety analyses. (10 CFR Part 830)
Safety Structures, Systems, & Components (Safety SSCs)	Safety Class SSCs and Safety Significant SSCs (10 CFR Part 830)
Structures, Systems, and Components (SSCs) that are part of the safety basis	Safety-Class and Safety-Significant SSCs; other systems that perform important defense-in-depth functions; and equipment relied on for the safe operation and safe shutdown of the nuclear facility, and for maintaining the facility in a safe shutdown condition as documented in the safety basis (e.g., DSA). Support systems to Safety SSCs that are required for the safety functions are also included.

A.2 OTHER TERMS

Term or Phrase	Description
Acceptance Tag	A final receipt inspection identifier affixed to an item before declaring an item acceptable for issue. It indicates all purchase requirements have been met.
Applications Parts List (APL)	A list of parts required to perform a specific maintenance activity. Typically set up as a standard list attached to a standard job for routine tasks.
Apprentice	A trade or crafts person in training
Asset	Equipment or an item of the physical plant
Asset Management	The systematic planning and control of a physical resource throughout its life. This may include the specification, design, and construction of the asset, its operation, maintenance and modification while in use, and its disposal when no longer required.

Term or Phrase	Description
As Low As Reasonably Achievable (ALARA)	The term is most often used in reference to chemical or radiation exposure levels. The objective is to ensure that hazardous chemical and radiation exposures to workers and releases of hazardous chemical and radioactivity to the environment are maintained below regulatory limits and deliberate efforts are taken to further reduce exposures and releases. In this document, ALARA focuses on radiological hazards as defined in 10 CFR Part 835.
Availability	The proportion of total time that equipment is capable of performing its specified functions, normally expressed as a percentage. It can be calculated by dividing the equipment available hours by the total number of hours in any given period.
Average Life	The average of how long a component typically operates before it fails. Commonly referred to as 'Mean Time Between Failures' (MTBF)
Backlog	Commonly used as a Performance Indicator, backlog is work that is requested, but not complete (including periodic maintenance past its due date).
Baseline	1. A quantitative expression of projected costs, schedule, and technical requirements; the established plan against which the status of resources and the progress of a project can be measured. 2. A set of operating readings and/or parameters taken when a system or equipment is operating under known conditions (usually new or rebuilt) used for comparing future readings to troubleshoot or assess the system/equipment health.
Benchmarking	The process of comparing performance with other organizations; identifying comparatively high performance organizations and learning what it is they do that allows them to achieve that high level of performance.
Bill of Materials (BOM)	List of all the parts and components that make up a particular asset
Calibration	The set of operations that establish, under specified conditions, the relationship between values indicated by a measuring instrument, or measuring systems, and the corresponding standard, or known values derived from the standard.
Certification	An indication by the appropriate authority that the deviations determined in the calibration do not exceed specified limits.
Component	A subassembly of an Asset, usually removable in one piece and interchangeable with other standard components, such as a pump, valve, motor, or instrument.
Computerized Maintenance Management System (CMMS)	A computerized system to assist with the effective and efficient management of maintenance activities through the application of computer technology. A CMMS generally includes a computerized Work Order system, facilities for scheduling Routine Maintenance Tasks, recording and storing Standard Jobs, Bills of Materials and Applications Parts Lists, as well as numerous other features.

Term or Phrase	Description
Condition Assessment Survey (CAS)	A periodic inspection of capital assets using universally accepted methods and standards for planning purposes. CAS results in a determination of the current condition of capital assets, their estimated time of failure, and the estimated cost to correct the identified deficiencies.
Condition Based Maintenance (CBM)	An equipment maintenance strategy based on measuring the condition of equipment to assess how and when it may fail, and then taking appropriate action to avoid that failure. Equipment may be monitored using Condition Monitoring, Statistical Process Control techniques, by monitoring equipment performance (System Engineer), or through the use of the human senses. (Also known as Predictive Maintenance)
Condition Monitoring	The use of specialist equipment to measure the condition of equipment (e.g. Vibration Analysis, Oil/Grease Analysis, Thermography).
Corrective Maintenance	The repair, restoration, or replacement of failed or malfunctioning equipment, system, or facilities to restore the intended function or design condition.
Craft Person (Trades Person)	A maintenance/construction worker who has attained a defined set of knowledge, skills, and abilities through formal training in an apprenticeship program.
Deactivation	The process of placing a facility in a safe and stable condition, including the removal of hazardous and radioactive materials and energy sources, to minimize the long-term cost of a surveillance and maintenance program that is protective of workers, the public and the environment.
Decommissioning	The decontamination and/or dismantlement of a facility to retire it from service with adequate regard for the health and safety of workers, the public, and the environment.
Decontamination	The removal of radioactive and hazardous materials by mechanical, chemical, or other techniques to achieve a stated objective or end condition.
Defect	Impairment or other condition that will require maintenance attention at some time, but which is not currently preventing the equipment from fulfilling its intended function.
Deficiency	A condition that deviates from the as-designed configuration of an SSC, which degrades its ability to accomplish its intended function.
Deficiency Tag	A small tag or sticker that is used to identify a facility material deficiency. The tag may be marked with a serialized number for administrative control, Work Order identification, and deficiency location by maintenance personnel.
Facility	Land, buildings, and other structures, their functional systems and equipment, and other fixed systems and equipment installed therein, including site development features outside the plant, such as landscaping, roads, walks, parking areas, outside lighting and communication systems, central utility plants, utilities supply and distribution systems, and other physical plant features. These include any of the DOE owned, leased, or controlled facilities, and they may or may not be furnished to a contractor under a contract with DOE.

Term or Phrase	Description
Failure Mode	The particular type or manner of failure. For example, a motor-driven pump may fail to run due to different failure modes such as a seized shaft or faulty circuit breaker.
Field Elements	All operations offices and field offices including Site Offices, Service Centers, and Energy Technology Centers.
Functional Test	A test to verify that a component or system meets one or more of its design capabilities. (e.g. an Emergency Diesel Generator starts within 10 seconds following a loss of power)
Hazardous Materials	Any solid, liquid, or gaseous material that is toxic, explosive, flammable, corrosive, or otherwise physically or biologically threatening to health. Oil is excluded from this definition.
Housekeeping	The level of cleanliness, orderliness, and preservation of a facility, its systems, and components. Also, the activities associated with improving these conditions.
Hurricane Watch/ Warning	A Hurricane Watch is issued when there is a threat of hurricane conditions within 24-36 hours. A Hurricane Warning is issued when hurricane conditions (winds greater than 74 mph, or dangerously high water and rough seas) are expected in 24 hours or less.
Independent Verification	A check of component condition or status by an individual not involved in performing or observing the establishment of that condition or status.
Infrastructure	All real property, installed equipment, and related real property that is not solely supporting a single program mission at a multi-program site or that is not programmatic real property at a single program site.
In-Service	Any SSC considered operating or operable for the existing facility-operating mode.
Lessons Learned	Any experience, example, observation, or insight based upon the same or similar activity that imparts wisdom and/or beneficial knowledge to an employee during the conduct of their work.
Life-Cycle	The life of an asset from planning through acquisition, maintenance, operation, remediation, disposition, long-term stewardship, and disposal.
Maintenance	The proactive and reactive day-to-day work that is required to maintain and preserve facilities and associated SSCs in a condition suitable for performing their designed purpose. It includes periodic (preventive, predictive, or seasonal) and corrective maintenance.
Maintenance Backlog	See “Backlog”
Maintenance Management	The process for administering maintenance utilizing such concepts as organization, plans, procedures, schedules, cost control, periodic evaluation, performance indicators, and feedback with adequate provisions for interface with other disciplines.

Term or Phrase	Description
Maintenance Procedure	Generic term for documents providing maintenance directions (e.g., work packages, procedures, work instructions, and drawings). The level of detail of these directions is based on the complexity of the task; the hazards involved; and the knowledge, skill, and abilities of the workers.
Master Equipment List (MEL)	A detailed listing of SSCs that are a part of the safety basis. Typically, the MEL includes additional facility equipment with the safety items flagged for identification.
Material Deficiency	A system or component with a defect that does not conform to a specified standard.
Measuring & Test Equipment (M&TE)	Tools, gauges, instruments, devices, or systems used to inspect, test, calibrate, or measure parameters. M&TE devices include permanently installed facility process or control instrumentation.
Minor Maintenance	Work of such a simple nature that a detailed Work Package is not required. Typically, correction of deficiencies on equipment where: • A lockout/tagout is not required • The component is not important to safety • The integrity of the component will not be violated • Welding is not required • Disassembly of the component or part will not be required • Post-Maintenance Testing is not required
Mission Critical	An SSC essential to the safety, quality, and production of a DOE facility.
Outage	The condition that exists when normal production operations have ceased. SSCs and processes are shut down, aligned, or in an appropriate status as a result of planned or unplanned events.
Performance Criteria	A defined condition or set of conditions to evaluate the level of performance in a subject area.
Performance Measures (Indicators/Metrics)	A set of objective criteria, which may be used to evaluate historical performance. The results of some criteria may be used as an indication of likely future performance.
Performance Objectives	The contractual statement of wants, needs, and expectations that define the outcome/objective of the organization.
Performance Test	See “Functional Test”
Periodic Maintenance	Preventive, predictive, or seasonal maintenance activities performed on a routine basis (typically based on calendar or operating hours).
Planned Maintenance	Maintenance scheduled as a result of periodic maintenance results indicating a future failure.
Post-Maintenance Test (PMT)	Testing performed following maintenance to verify that a particular SSC, piece of equipment, or process performs its intended function based on its design criteria; and that the original deficiency has been corrected and no new deficiencies created.

Term or Phrase	Description
Predictive Maintenance (PdM)	See Condition Based Maintenance (CBM)
Preventive Maintenance (PM)	Periodic and planned actions taken to maintain design capabilities and to extend operating life. Regulatory and code requirements; TSR surveillances, in-service inspection and testing; vendor recommendations; and other forms of maintenance action and frequency selection are based on historical data, engineering judgment, or analytical methods.
Radiological Area (RA)	Any area containing radiological hazards within a controlled area (but not including the controlled area) defined as a "radiation area," "high radiation area," "very high radiation area," "contamination area," "high contamination area," or "airborne radioactive area."
Reliability Centered Maintenance (RCM)	A structured process commonly used to determine the equipment maintenance strategies required for any physical asset to ensure that it continues to fulfill its intended functions in its present operating context.
Repair	See "Corrective Maintenance"
Root Cause	An action or condition that, if corrected or eliminated, would prevent the recurrence of a failure or malfunction by identifying and correcting faults (often hidden).
Run-to-Failure	Equipment Maintenance Strategy where no scheduled maintenance tasks are performed on the equipment. The only maintenance performed on the equipment is Corrective Maintenance.
Safety Review	A review performed by a technically competent engineer to determine whether a proposed change to any SSC may have any adverse impact on facility safety. (USQD Review)
Safety Management Program	A program designed to ensure a facility is operated in a manner that adequately protects workers, the public, and the environment by covering a topic such as: quality assurance; maintenance of safety systems; personnel training; conduct of operations; inadvertent criticality protection; emergency preparedness; fire protection; waste management; or radiological protection of workers, the public, and the environment. (10 CFR Part 830)
Seasonal Maintenance	The process for ensuring the prevention of damage to safety SSCs from adverse weather conditions.
Shelf Life	An expiration date or specific period during which an item should meet its original design specifications
Site	A geographic entity, leased or owned by the Federal Government, comprising land, buildings, and other structures required to perform DOE program activities.
Staging Areas	Area designated and approved by the maintenance supervisor, for staging parts, materials, and supplies until a maintenance job is ready to work.
Surveillance Test	Functional Test of equipment and/or systems to satisfy the TSR.

Term or Phrase	Description
Surveillance and Maintenance (S&M)	Activities conducted in a cost effective manner throughout the facility life-cycle phase including periodic inspections and maintenance of structures, systems, and equipment necessary for the satisfactory containment of contamination and protection of workers, the public, and the environment.
Technical Safety Requirements (TSRs)	Those requirements that define the conditions, safe boundaries, and the management or administrative controls necessary to ensure the safe operation of a nuclear facility and to reduce the potential risk to the public and facility workers from uncontrolled releases of radioactive materials or from radiation exposure due to inadvertent criticality. A TSR consists of operating limits, surveillance requirements, administrative controls, use and application instructions, and the bases thereof.
Thermography	The process of monitoring the condition of equipment through the measurement and analysis of heat. Typically conducted using infrared cameras and associated software. Commonly used for monitoring the condition of high voltage insulators and electrical connections, as well as for monitoring the condition of refractory in furnaces and boilers.
Tornado Watch/Warning	Tornado Watch – Meteorological Conditions are conducive to the development of tornadoes in and close to the watch area. Tornado Warning - A tornado has actually been sighted by spotters or indicated on radar and is occurring or imminent in the warning area.
Trending	The recording and, normally, plotting of data values over time, noting consistency and changes. The term may also reference the analysis of this data to evaluate if conditions are headed in an undesirable direction, and if and when they will be out of the acceptable range without corrective action.
Troubleshooting	The process of locating and identifying malfunctions through deductive and inductive reasoning and/or testing.
Utility Service	A service, such as the furnishing of electricity, natural gas, steam, water, or sewer service.
Value Engineering	A systematic approach to assessing and analyzing the user's requirements of a new asset, and ensuring that those requirements are met, but not exceeded.
Vibration Analysis	The process of monitoring the condition of equipment, and the diagnosis of faults in equipment through the measurement and analysis of vibration within that equipment in order to predict the need to correct problems.
Work Request (WR)	The prime document (paper or electronic) submitted by personnel to request the initiation of a maintenance task. Issued to Maintenance Planners and Estimators, and used to define, plan, and execute maintenance activities. This is usually converted to a work order after the work request has been planned.
Work Order (WO) (Work Package)	The prime document used by maintenance to manage tasks. It may include such information as a description of the work required; the task priority; the job procedure to be followed; and the parts, materials, tools, and equipment required to complete the job. The WO may also serve as documentation for completion of minor maintenance activities such as lubrication, light bulb replacement, etc.

B. ACRONYMS

The following are acronyms commonly used in maintenance handbooks.

ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
CRD	Contractor Requirements Document
CSE	Cognizant System Engineer
DOE	Department of Energy
EPRI	Electric Power Research Institute
EQ	Environmental Qualification
ES&H	Environment, Safety, and Health
HVAC	Heating, Ventilating, and Air-Conditioning
ISMS	Integrated Safety Management System
LCO	Limiting Condition for Operation
M&TE	Measuring and Test Equipment
MEL	Master Equipment List
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
MTBF	Mean Time Between Failures
OJT	On-The-Job Training
ORPS	Occurrence Reporting and Processing System
PM	Preventive Maintenance
PMT	Post Maintenance Test
QA	Quality Assurance
QC	Quality Control
RWP	Radiation Work Permit
SAR	Safety Analysis Report
SSCs	Structures, Systems, and Components
TSR	Technical Safety Requirements
USQ	Unreviewed Safety Question
WR/WO	Work Request/Work Order

C. REFERENCES

C.1 REGULATIONS

1. 10 CFR Part 830, *Nuclear Safety Management*.
2. 10 CFR Part 835, *Occupational Radiation Protection*.
3. 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*.
4. 41 CFR Part 102, *Federal Management Regulations*.
5. 41 CFR 102.84, *Annual Real Property Inventories*.
6. 41 CFR Part 109, *DOE Property Management Regulations*.
7. 48 CFR 45.5, *Support Government Property Administration*
8. DEAR 970.5223-1, *Integration of Environment, Safety and Health into Work Planning and Execution*.

C.2 POLICIES

9. DOE P 420.1, *DOE Nuclear Safety Policy*.
10. DOE P 450.4A, *Integrated Safety Management Policy*.

C.3 ORDERS

11. DOE O 130.1, *Budget Formulation*.
12. DOE O 135.1A, *Budget Execution Funds Distribution and Control*.
13. DOE O 200.1A, *Information Technology Management*.
14. DOE O 225.1B, *Accident Investigations*.
15. DOE O 231.1B, *Environment, Safety and Health Reporting*.
16. DOE O 232.2, *Occurrence Reporting and Processing of Operations Information*
17. DOE O 360.1C, *Federal Employee Training*.
18. DOE O 412.1A, *Work Authorization System*.
19. DOE O 413.1B, *Internal Control Program*.
20. DOE O 414.1D, *Quality Assurance*.
21. DOE O 420.1C Chg 1, *Facility Safety*.
22. DOE O 425.1D, *Verification of Readiness to Start Up or Restart Nuclear Facilities*.
23. DOE O 430.1B Chg 2, *Real Property Asset Management*.
24. DOE O 436.1, *Departmental Sustainability*.
25. DOE O 440.1B Admin Chg 1, *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees*.
26. DOE O 450.2, *Integrated Safety Management*.
27. DOE O 452.1D, *Nuclear Explosive and Weapon Surety Program*.
28. DOE O 452.2D, *Nuclear Explosive Safety*.
29. DOE O 458.1, Admin Chg 3, *Radiation Protection of the Public and the Environment*.

30. DOE O 5480.30 Chg 1, *Nuclear Reactor Safety Design Criteria*.

C.4 GUIDES

31. DOE-EGS-95-01, *Enforcement Guidance Supplement*.
32. DOE-EGS-98-01, *Enforcement Guidance Supplement*.
33. DOE-EGS-98-02, *Enforcement Guidance Supplement*.
34. DOE-EGS-99-01, *Enforcement Guidance Supplement*.
35. DOE-EGS-99-02, *Enforcement Guidance Supplement*.
36. DOE-EGS-00-01, *Enforcement Guidance Supplement*.
37. DOE G 414.1-2B Admin Chg 1, *Quality Assurance Program Guide*.
38. DOE G 430.1-1, *Cost Estimating Guide.*
39. DOE G 430.1-2, *Implementation Guide for Surveillance and Maintenance During Facility Transition and Disposition.*
40. DOE G 440.1B Admin Chg 1, *Worker Safety and Health Program for DOE (Including the National Nuclear Security Administration) Federal and Contractor Employees.*
41. DOE G 440.1-7A, *Implementation Guide for use with 10 CFR Part 850, Chronic Beryllium Disease Prevention Program*.
42. DOE G 450.4-1C, *Integrated Safety Management System Guide*.
43. DOE G 1324.5B, *Implementation Guide for use with 36 CFR Chapter XII–Subchapter B, Records Management. DOE Personal Property Letter 970-3 Revision 1, High Risk Personal Property*.
44. DOE Personal Property Letter 970-3 Revision 1, *High Risk Personal Property*.

C.5 STANDARDS

45. DOE STD-1027-92 Chg 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*.
46. DOE-STD-1029-92 Chg 1, *Writer's Guide for Technical Procedures*.
47. DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*.
48. DOE-STD-1031-92 Chg 1, *Guide to Good Practices for Communications*.
49. DOE-STD-1032-92 Chg 1, *Guide to Good Practices for Operations Organization and Administration.*
50. DOE-STD-1033-92 Chg 1, *Guide to Good Practices for Operations and Administration Updates Through Required Reading*.
51. DOE-STD-1034-93 Chg 1, *Guide to Good Practices for Timely Orders to Operators*.
52. DOE-STD-1035-93 Chg 1, *Guide to Good Practices for Logkeeping*.
53. DOE-STD-1036-93 Chg 1, *Guide to Good Practices for Independent Verification*.
54. DOE-STD-1037-93 Chg 1, *Guide to Good Practices for Operations Aspects of Unique Processes*.
55. DOE-STD-1038-93 Chg 1, *Guide to Good Practices for Operations Turnover*.
56. DOE-STD-1039-93 Chg 1, *Guide to Good Practices for Control of Equipment and*

System Status.

57. DOE-STD-1040-93 Chg 1, *Guide to Good Practices for Control of On-Shift Training*.
58. DOE-STD-1041-93 Chg 1, *Guide to Good Practices for Shift Routines and Operating Practices*.
59. DOE-STD-1042-93 Chg 1, *Guide to Good Practices for Control of Area Activities*.
60. DOE-STD-1043-93 Chg 1, *Guide to Good Practices for Operator Aid Postings*.
61. DOE-STD-1044-93 Chg 1, *Guide to Good Practices for Equipment and Piping Labeling*.
62. DOE-STD-1045-93 Chg 1, *Guide to Good Practices for Notifications and Investigation of Abnormal Events*.
63. DOE-STD-1070-94, *Guidelines for Evaluation of Nuclear Facility Training Programs*.
64. DOE-STD-1073-2003, *Configuration Management Program*.
65. DOE-STD-1120-2005, *Integration of Environment, Safety, and Health into Facility Disposition Activities, Volume 1 and 2*.
66. DOE-STD-7501-99, *The DOE Corporate Lessons Learned Program*.

C.6 HANDBOOKS

67. DOE-HDBK-1003-96, *Guide to Good Practices for Training and Qualification of Maintenance Personnel*.
68. DOE-HDBK-1110-2008, *ALARA Training for Technical Support Personnel*.
69. DOE-HDBK-1117-99, *Guide to Good Practices for Maintenance Supervisor Selection and Development*.
70. DOE-HDBK-1028-2009, *Human Performance Improvement Handbook*.

C.7 MEMORANDUM

71. *Activity Level Work Planning and Control Processes, Appendix B,* NNSA, January 2006.