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DOE STANDARD

GUIDELINE TO GOOD PRACTICES FOR POSTMAINTENANCE TESTING AT DOE NUCLEAR FACILITIES

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FOREWORD

The purpose of the *Guide to Good Practices for Postmaintenance Testing at DOE Nuclear Facilities* is to provide contractor maintenance organizations with information that may be used for the development and implementation of a postmaintenance testing (PMT) process for structures, systems, and components (SSC) at DOE nuclear facilities. This document is intended to be an example guideline for the implementation of DOE Order *4330.4A, Maintenance Management Program,* Chapter II, Element 9, *Postmaintenance Testing.* DOE contractors should not feel obligated to adopt all parts of this guide. Rather, they should use the information contained herein as a guide for developing a PMT process that is applicable to their facility.

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1. INTRODUCTION

1.1 Purpose

This guide is intended to assist facility maintenance operations in the review of existing and in developing new PMT guidelines to be performed following maintenance, which proves that the structures, systems or components (SSC) are operable as designed and confirms the following: (1) the original deficiency has been corrected, (2) no new deficiencies have been created, and (3) the equipment is ready to return to service. A PMT should be performed after all corrective maintenance and after some preventive maintenance activities. The test performed should be commensurate with the maintenance work performed and the importance of the SSC to facility safety and reliability. In some cases, this may only require checkout and verification, other cases may require a Documented PMT. It is expected that each DOE facility may use different approaches or methods than those defined in this guide. The specific guidelines that follow reflect generally accepted industry practices. Therefore, deviation from any particular guideline would not, in itself, indicate a problem. If substantive differences exist between the intent of the Guideline and actual practice, management should evaluate current practice to determine the need to include/exclude proposed features. A change to maintenance practice would be appropriate if a performance weakness was determined to exist. Development, documentation, and implementation of other features which further enhance these guidelines for specific applications, is encouraged.

Additional information pertinent to the implementation of this guideline may be found in DOE-STD-1068-93 *"Guide to Good Practices for Maintenance History at DOE Nuclear Facilities."*

Appendix D is provided for use by facility trainers who provide training regarding this element.

1.2 Background

The information in this guide was developed from commercial and DOE sources. Each facility should select those details that are applicable, add any unlisted knowledge or experience that are applicable, and develop and implement facility-specific PMT guidelines. Facilities that have existing documented PMT should review this guide to identify details that may enhance their existing guidelines.

1.3 Application

The content of this guide is generally applicable to all DOE nuclear facilities. Portions of the guidelines outlined may not be applicable to all facilities because maintenance organizations, disciplines, titles, and responsibilities may vary among DOE nuclear facilities. Facility maintenance personnel should verify the adequacy of or improve existing PMT guidelines by adapting this guide to their specific facility and individual maintenance disciplines.

2. DEFINITIONS

2.1 Acronyms used in this guide. The acronyms used in this guide are defined as follows:

a. ASME - American Society of Mechanical Engineers

b. EQ - Environmental Qualification

c. MJR - Maintenance Job Request

d. PMT - Postmaintenance Test

e. SSC - Structures, Systems, and Components

2.2 Checkout and Verification. A form of PMT using standard maintenance practices, as well as craft skills and knowledge, to prove that equipment is operable as designed. The testing does not require the formal documentation specified for Documented PMT.

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

2.4 Deficiency. An item that does not meet specified standards and requires corrective action.

2.5 Deficiency Identification Tag. A two-part form that includes a string for ease of attachment and may be used to identify a facility material deficiency. The tag should be marked with a serialized number that is used for administrative control and for deficiency location by maintenance personnel. The hard copy of the tag should be placed on or near the deficiency in the facility. The duplicate or carbon of the tag serves as a temporary record of the deficiency until the data is transferred to a maintenance job request.

2.6 Deficiency Identification Sticker. A small, adhesive-backed form which may be used primarily to identify deficiencies in those situations that preclude the use of a Deficiency Identification Tag. The sticker should also be marked with a serialized number. A duplicate should not be required since most stickers are used in control rooms where the deficiency information may easily be directly placed on a maintenance job request.

2.7 Documented PMT. Rigorous. formal documentation of postmaintenance testing required, when specified by the equipment owner.

2.8 Maintenance. Day-to-day work that is required to maintain and preserve plant and capital equipment in a condition suitable for its designated purpose and includes preventive, predictive, and corrective (repair) maintenance.

2.9 Maintenance Job Request (MJR). Means of obtaining maintenance services, available on both paper and electronic mediums and initiated by maintenance customers. An MJR is normally issued to Maintenance Planners and Estimators and is used to define, plan, and execute maintenance activities. It serves as documentation of a deficient equipment condition and requires detailed documentation of work performed, spare parts, procedures, or testing to verify that maintenance was performed correctly. The MJR may also serve as documentation for completion of minor maintenance activities such as lubrication, light-bulb replacement etc. ("MJR" is the equivalent of a "Work Request")

2.10 Maintenance Procedure. A document providing direction to implement policy, comply with external directives, or meet operational objectives in a consistent manner. A procedure provides necessary delineation of roles, responsibilities, action steps, and requirements.

2.11 Outage. Condition existing whenever production has stopped or mission capability is lost due to planned or unplanned occurrences.

2.12 Periodic Maintenance. Maintenance activities accomplished on a routine basis (typically based on operating , hours or calendar time). Periodic Maintenance includes inspections, lubrications, and technical safety specifications surveillance (functioning testing, bearing temperature, pump speeds, etc.).

2.13 Planned Maintenance. Preventive maintenance activities performed prior to structure, system, or component failure and may be initiated by predictive or periodic maintenance results, by vendor recommendations, or by experience/lessons learned. These include items such as scheduled valve repacking, replacement of bearings as indicated from vibration analysis, major or minor overhauls based on experience factors or vendor recommendations and replacement of known life-span components. For example, repacking a valve due to packing leakage would be corrective maintenance, but scheduled repacking prior to leakage would be planned maintenance.

2.14 Postmaintenance Test (PMT). Documented postmaintenance testing or standard checkout and verification, performed following maintenance, which proves that the equipment is operable as designed and confirms the following:

- The original deficiency has been corrected.
- No new deficiencies have been created.
- The equipment is ready to return to service.

2.15 Predictive Maintenance. Actions necessary to monitor, find trends, and analyze the parameters, performance characteristics, properties, and signatures associated with equipment, systems, or facilities that are indicative of decreasing performance or impending failure.

2.16 Preventive Maintenance. All those systematically planned and scheduled actions performed for the purpose of preventing equipment, system, or facility failure.

2.17 Root Cause. A determination based on analytical techniques that determines the fundamental cause of failure.

2.18 Structures, Systems and Components (SSC). Physical items designed, built, and/or installed to support the operation of a facility.

2.19 Surveillance Test. A functional test of installed SSC for periodic monitoring of performance adequacy.

2.20 Technical Support. The engineering, design, specialized inspections, planning, or other such support of capital asset maintenance and repair.

2.21 Troubleshooting. The process of locating and identifying SSC malfunctions through deductive and inductive reasoning and/or testing. The process may include (but is not limited to) activities such as taking readings, pulling fuses, stroking valves, changing electronic modules, partial or complete disassembly of a component, etc.

3. POSTMAINTENANCE TESTING

3.1 DISCUSSION

3.1.1 The applicable equipment/facility owner/operator has overall accountability for defining PMT, establishing acceptance criteria, and verification that acceptance requirements are satisfied prior to returning an item to normal service. Documented PMT is required when specified by the SSC owner/operator. Checkout and Verification should be performed by the maintenance craftsperson whenever a Documented PMT is not required.

The objective of PMT is to verify that SSC are capable of performing their intended function when returned to service following maintenance and to ensure that the original deficiency is corrected. PMT requires close coordination among various facility groups and contract personnel. PMT integrates with the work control system and the Health and Safety permit system. An effective PMT may be directly related to facility reliability. This guide does not specifically address the postmodification testing process; however, most of the methods described may be directly used for postmodification testing as well.

PMT involves the following key elements:

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

This guide is intended to assist in the development of PMT activities.

3.2 SCOPE

3.2.1 This guideline describes the elements needed to develop and implement the PMT process. The following elements are addressed in this guideline:

3.2.1.1 assignment of responsibility for determining PMT requirements

3.2.1.2 PMT procedures

3.2.1.3 conducting the tests

3.2.1.4 control and documentation of PMT activities

3.2.1.5 reviewing test results

3.2.1.6 maintaining configuration management

3.3 RESPONSIBILITIES

3.3.1 The owner/operator of items requiring Documented PMT is responsible for:

3.3.1.1 defining the need for a PMT

3.3.1.2 defining the level of PMT and approval of documents

3.3.1.3 defining operational parameters and criteria

3.3.1.4 ensuring that PMT is properly authorized, performed, reviewed, and documented prior to returning the equipment to service

3.3.1.5 ensuring that excessive and redundant PMT is minimized

3.3.1.6 ensuring that all delayed tests are performed prior to or in conjunction with returning the equipment to service

3.3.1.7 making the final equipment operability determination prior to returning the equipment to service

3.3.1.8 assisting maintenance as required by performing applicable testing

3.3.1.9 restoring SSC to correct setpoints for operating or standby modes following testing

3.3.1.10 approval of completed PMT data and acceptance for return to service

3.3.1.11 emphasize the need to ensure configuration management

3.3.2 The maintenance manager, accountable for maintenance of the facility, is responsible for implementing approved PMT as noted below:

3.3.2.1 ensuring that PMT is properly specified prior to beginning work and is consistent with the scope of work performed

3.3.2.2 ensuring that test procedures and in-shop testing are properly performed, reviewed, and documented by qualified personnel

3.3.2.3 monitoring the overall effectiveness of PMT and incorporating changes based on equipment history and performance or industry experience

3.3.2.4 ensuring that when problems, anomalous results, and errors exist, work stops and concerns are brought to the attention of applicable managers prior to proceeding with testing

3.3.2.5 verifying configuration management items are maintained

3.3.2.6 ensuring that results of PMT are recorded in maintenance history or that results of PMT are easily retrievable using maintenance history (see *DOE-STD-1068-93 "Guide to Good Practices for Maintenance History at DOE Nuclear Facilities")*

3.3.2.7 coordinating with the owner/operator when PMT is performed

3.3.3 The technical support group should assist as required in the preparation and performance of the recommended PMT based on design bases, vendor recommendations, standards, codes, and engineering analyses. The technical support manager should also be responsible for making recommendations for changes based on facility or equipment modifications and in-house and industry experience.

3.4 POSTMAINTENANCE TESTING

3.4.1 Guidelines

3.4.1.1 A satisfactory test is one that verifies; the ability of a particular SSC to perform its intended function, the original deficiency has been corrected, and no new or related problems have been created by the maintenance activity. All MJRs should be reviewed to determine the need for Documented PMT.

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

3.4.1.3 Tests should be conducted in accordance with written instructions or formal procedures, as appropriate. The instruction/procedures should measure performance versus criteria on key parameters and allow for documentation and review of test data for the SSC. An example PMT Control form and PMT Test Data Sheet are shown in Appendices A and B respectively. The results should be documented and filed with the MJR or cross-referenced by the MJR to the applicable document.

3.4.1.4 The following are some examples of types of maintenance activities where PMT may be of value:

- maintenance that affects the integrity or operation of a fluid or gas system, or components within those systems
- maintenance that affects the wall thickness of pressure boundaries or affects mechanical strength of components or fittings
- maintenance that affects electrical distribution equipment, such as breakers, bus work, or high-voltage connections

- maintenance that affects electrical control circuitry or electronic components, such as protection relays, limit switches, permissive relays, controllers, circuit cards or transmitters
- maintenance that affects instrument detectors or components in an instrument loop
- equipment that is included in special programs such as the in-service inspection and environmental qualification programs
- maintenance that affects or removes design-approved radiation shielding
- health physics and chemistry instrumentation
- measuring and test equipment
- maintenance that affects the engineered function of a SSC
- maintenance of a Safety Class Item
- temporary systems that have been installed as substitutes for normally operational systems or portions of systems

3.4.1.5 The following activities are representative of common PMT:

- visual or dimensional inspections and nondestructive tests specified by code
- voltage, current, integrity or continuity checks
- 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

- closure and response times, strokes
- hydrostatic test if a pressure boundary was affected

3.4.1.6 Combinations of the elements listed above may be specified as appropriate to provide complete PMT. Examples of maintenance performed and associated PMT are given in Appendix C. The examples are provided as guidance only. The actual required testing should be tailored to the specific maintenance performed.

3.4.2 Control of Postmaintenance Testing

Control and documentation of PMT activities are a part of the facility's work control and equipment status control systems.

3.4.2.1 During the initial processing of an MJR, the maintenance planner should include predefined PMT in job instructions based on consultation with the owner/operator.

3.4.2.2 Appendix A, PMT Control Form, should be filled out by the planner and attached to the MJR, as appropriate.

3.4.2.3 When a maintenance activity involves several different tests, a separate PMT Control Form may be used to document each test.

3.4.2.4 The maintenance planner should obtain assistance from the owner/operator, technical support, the responsible system engineer, or other groups as needed to ensure that all testing requirements and acceptance criteria are specified.

3.4.2.5 The maintenance supervisor responsible for the work should review the MJR prior to beginning work, including the PMT Control Form. During this review, the supervisor is responsible for understanding the specified testing for the intended work and providing feedback for inadequacies.

3.4.2.6 The owner/operator should approve the MJR prior to the start of maintenance work.

3.4.2.7 PMT should be performed according to approved instructions provided in the planning and authorization process. If the scope of work expands beyond the original MJR, work should be stopped and the MJR should be returned to planning along with any PMT Control Forms for further direction.

3.4.2.8 If more than one group is involved in testing, the owner/operator should coordinate the performance of the PMT.

3.4.2.9 Following maintenance, permission to begin any testing should be approved by the owner/operator by signing the PMT Control Form.

3.4.2.10 At the completion of PMT, acceptability of the equipment based on satisfactory completion of all PMT should be approved by the owner/operator, by reviewing attached test results and signing the PMT Control Form. Final determination of operability should be made by the owner/operator.

3.4.2.11 Restoring SSC to a correct setpoint for operating or standby mode following testing are the responsibility of the owner/operator. This may be accomplished by instructions in the test procedure, by conducting specific system lineups, or by other formal methods.

3.4.2.12 For troubleshooting MJRS, 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 PMT covers the troubleshooting scope. The supervisor responsible for the troubleshooting should generate a new MJR for necessary work. Testing requirements should then be identified through the normal planning and review process.

3.4.2.13 If the test cannot be completed immediately after maintenance is performed, the MJR should be held as an open MJR until such time as testing may be completed. MJRs awaiting testing should be tracked in a central file for follow-up to closure.

As facility conditions allow, testing may be performed and the MJRs may be closed out. 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.

3.4.2.14 If the test is unsatisfactory, deficiencies identified during testing should be documented and corrected by generating an MJR.

3.4.2.15 When the stop work conditions are corrected re-test requirements should be evaluated to determine if prior testing should be repeated.

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

3.4.3 Use of Procedures for Postmaintenance Testing

The various classifications of equipment required to ensure safe and reliable facility operation should require different levels of instruction/procedural support for PMT activities. Available sources of PMT instruction/procedures should include (but are not limited to) engineering test procedures, surveillance test procedures, maintenance procedures, calibration procedures, and activity-specific generated instructions.

3.4.3.1 If an applicable surveillance test procedure exists, then that procedure may be used to verify operability of the equipment. A surveillance test may be used for PMT if it not only proves system operability, but 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.

3.4.3.2 If only applicable sections of a procedure are used, caution should be used to ensure that previous sections are reviewed for system status, lineups, or prerequisites. Applicable sections with supplemental precautions or prerequisites should be specifically referenced on the modification request or supplemental document.

3.4.3.3 If a surveillance test, calibration, or special procedure does not exist to test particular equipment following maintenance, a special test procedure may be written, or the test may be performed in accordance with instructions written for the MJR. With any of these procedure methods, the required and actual testing performed should be described, data recorded, acceptance criteria specified, and appropriate reviews and approvals performed and documented. If special test procedures are written to perform PMT, the appropriate safety and technical reviews should be performed in accordance with facility procedures.

3.4.3.4 Test instructions should include details such as initial conditions and prerequisites, hold points, cautions, personnel qualification requirements, personnel safety requirements, clear acceptance criteria, and posttest restoration.

Test instructions should be as specific as possible and should avoid using vague criteria such as "verify proper operation" or "check for excessive temperature."

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

APPENDIX A
EXAMPLE POSTMAINTENANCE TEST CONTROL FORM AND INSTRUCTIONS

Appendix A
INSTRUCTIONS FOR COMPLETING POSTMAINTENANCE TEST CONTROL FORM

1. The Maintenance Supervisor should ensure that the Test Form Preparer (typically the planner estimator) has provided on the form the equipment identification, the MJR number, description of the test, the test instructions and attachments, signatures, badge numbers, and dates.

2. The Maintenance Supervisor should ensure that the Test-Start Approval signature, badge number, and date have been obtained from the Equipment Owner, (or designee) prior to starting test.

3. The Test Performer should fill in the Test Results (Comments) section of form, indicating whether test was Satisfactory or Unsatisfactory and any Corrective Actions taken, if applicable.

4. Upon completion of test the Test Performer should sign, add badge number, and date.

5. The Maintenance Supervisor should obtain signature, badge number, and date from the Equipment Owner in the applicable Test Accepted By section.

6. The Maintenance Supervisor should sign, add badge number and date to indicate test acceptance in the applicable Test Accepted By section.

7. The Test Performer and Maintenance Supervisor should ensure that the PMT Control Form is kept together with the complete job package.

NOTE:

- **If an equipment-specific data sheet and a PMT procedure are available, they may be referenced instead of duplicating the test-result data.**

- **The location of the completed data sheets, if separate from the job package, should be identified.**

- **Appropriate signatures on this PMT Control Form are required and should be returned to the PE with the job package.**

APPENDIX B
EXAMPLE POSTMAINTENANCE TEST DATA SHEET

Appendix B
EXAMPLE POSTMAINTENANCE TEST DATA SHEET

MJR#:_____

RADIO UNIT POSTMAINTENANCE TEST DATA SHEET

Operational Tests

REFERENCE	TEST	PASS	FAIL	CONDITION
Section VII.A.	Pretest Setup			
Step 6.				All radio display LEDs are OFF.
Step 8.				Radio PTT LED lights.
Section VII.B.	Radio Unit Low Battery Alarm			
Step 2.				COS printout occurs for group E point 3.
Step 4.				ALARM printout occurs for group E point 3.
Section VII.C.	Station and Radio Loss of AC Power			
Step 2.a.	Station Loss of AC Power			Radio LED 5 lights and an ALARM printout occurs for group A and point 5.
Step 2.b.	Radio Loss of AC Power			POWER FAIL printout occurs.
Section 4.a.				All radio display LEDs are OFF.
Section 4.b.				A COS printout occurs for Group A point 5.
Step 4.c.				A POWER RECOVERY printout occurs.
Section VII.D.	Fail-Fail Alarm			
Step 2.				Radio LEDs 1, 6, and 7 are lit.
Step 5.a.				All radio display LEDs are OFF.
Step 5.b.				ALARM printout occurs for group A points 1, 6, and 7.
Step 5.c.				COS printout occurs for group A points 1, 6, and 7.

Appendix B
EXAMPLE POSTMAINTENANCE TEST DATA SHEET

MJR#:_____

RADIO UNIT POSTMAINTENANCE TEST DATA SHEET
Operational Tests

REFERENCE	TEST	PASS	FAIL	CONDITION
Section VII.E.	Fail-High Alarm			
Step 3.				Radio LEDs 1, 3, and 6 are lit.
Step 7.a.				All radio display LEDs are OFF.
Section 7.b.				ALARM printout occurs for group A points 1, 3, and 6.
Step 7.c.				COS printout occurs for group A points, 1, 3, and 6.
Step VII.F.	High-Fail Alarm			
Section 3.				Radio LEDs 1, 2, and 7 are lit.
Step 7.a.				All radio display LEDs are OFF.
Step 7.b.				ALARM printout occurs for group A points 1, 2, and 7.
Section 7.c.				COS printout occurs for group A points 1, 2, and 7.
Section VII.G.	High-High Alarm			
Step 2.				Radio LEDs 1, 2, and 3 are lit.
Step 5.a.				All radio display LEDs are OFF.
Step 5.b.				ALARM printout occurs for group A points 1, 2, and 3.
Step 5.c.				COS printout occurs for group A points 1, 2, and 3.

REMARKS:_____

_____

_____

Verifying Craft Worker: _____ _____
Signature Badge#

APPENDIX C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

NOTE:
- **This list of activities and tests is a guide only and is not meant to be all-inclusive. The testing selected should depend on the scope of completed maintenance and the requirements established by the owner/operator.**
- **An appropriate test for nearly all mechanical work would be a general leakage inspection and any testing required by ASME codes or equipment-specific procedures.**

Maintenance Activity	Recommended Test
Repair Electric motor	1. Perform the following checks: insulation resistance, winding resistance, polarization index, high potential. 2. Verify proper direction of rotation and proper phase relationships. 3. Operate the equipment and verify absence of abnormal noises. 4. Obtain baseline vibration-analysis data. 5. Measure the bearing temperatures. 6. Measure the starting and the running current for each phase. 7. Check oil levels. 8. Check air-filter cleanliness.
Repair circuit breaker.	1. Verify adjustment of circuit breaker trips. 2. Perform trip-shaft torque measurements if applicable. 3. Measure phase-to-phase and phase-to-ground insulation resistances. 4. Measure microhms across each main contact. 5. Perform automatic-function test on the breaker (open and closes on required signals). 6. Measure breaker-response time. 7. Verify operation of auxiliary trip devices and relays. 8. Perform manual operation checks on the breaker. 9. Check breaker parameters (e.g., breaker operating voltage, current, control power, status lights).

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Adjust packing of or repack air-operated or motor-operated valve (MOV).	1. Using air or motor operator, verify full stroke of valve to ensure freedom of movement. **(NOTE: Valve stroke required may be different from operative capability).** 2. Perform stroke timing test. 3. Check running current on motor. (If running check has increased by more than 8 percent of the baseline value, evaluate the need to perform diagnostic testing of the valve). 4. Check for leakage at normal operating pressure. 5. Perform leak rate test if required.
Repair internals of air-operated or motor-operated valve.	1. Leak-test valve if required by technical safety specifications or surveillance procedures. 2. Perform retesting required for adjusting packing. 3. Verify position indications (remote and local). 4. Grease/lubricate MOV.
Repack manual valve or adjust packing.	1. Verify that valve stem moves freely without binding. 2. Check for leakage at operating pressure.

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Repair (or replace) MOV motor-operator	1. Perform full-stroke exercising checks (two strokes) done at normal system flow, pressure, temperature. 2. Test seat leakage. 3. Perform stroke timing test. 4. Measure the running and the starting current of motor. 5. Verify torque and limit-switch settings. 6. Test automatic functions. 7. Check position verification. 8. Check packing leakage, at operating pressure. 9. Greast/lubricate MOV. 10. Perform appropriate diagnostic tests to establish a new baseline.
Repair (or replace) air-operated valve.	1. Perform full-stroke exercise checks at normal system parameters. 2. Test seat leakage. 3. Perform stroke timing test. 4. Test automatic functions. 5. Check position verification. 6. Verify control-valve loop alignment. 7. Check packing leakage at operating pressure. 8. Check positioner and E/P or S/P converter calibration.
Repair solenoid valve.	1. Perform full-stroke exercise checks. 2. Test seat leakage. 3. Test automatic functions. 4. Check position-indication verification.
Repair (or replace) isolation valve	1. Perform any code-required strength or seat-tightness testing. 2. Perform technical-specification-required leak-rate and operability testing. 3. Verify position indication.

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Repair pressure-regulating valve.	1. Check set-point calibration. 2. Test valve-seat leakage.
Repair safety valve/relief valve.	1. Test relief set-point (bench test or in-place test). 2. Test valve-seat leakage. 3. Check position indications proper; check for chatter and packing leakage.
Repair (or replace) safety-related pumps on nonsafety-related pumps.	1. Test in accordance with ASME code, as required. 2. Perform appropriate surveillance test. 3. Check direction of rotation if motor leads were disconnected. 4. Inspect suction filters, oil level, cooling flows, suction and discharge pressures, bearing temperatures, packing or seal leakage. 5. Run baseline vibration analysis. 6. Measure applicable pump and motor performance data. 7. Perform automatic function tests. 8. Inspect base plate/foundation.
Perform maintenance on ventilation system fan/filter unit.	1. Perform function tests and manual start. 2. Check dynamic balance. 3. Check bearing temperatures, vibration levels, abnormal noise, airflows. 4. Measure running current. 5. Perform filter inspections and tests.

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Repair (or replace) manual, motor- and air-operated dampers.	1. Check full stroke. 2. Check damper leakage. 3. Check automatic function and interlocks. 4. Check stroke timing. 5. Check position indication.
Rebuild (or repair) air compressor.	1. Check for leakage at operating pressures. 2. Measure bearing temperatures. 3. Measure baseline-vibration levels. 4. Check for unusual noise. 5. Check parameters (discharge pressure, cooling flow, oil level, air temperatures).
Perform turbine maintenance.	1. Test automatic start functions. 2. Check turbine (pump) performance (flow, speed, bearing temperature, and vibration amplitude). 3. Test turbine protective features. 4. Test manual start. 5. Check oil levels. 6. Check for fluid leakage at normal system parameters. 7. Measure baseline vibration data. 8. Check for rotor grounds. 9. Grease sliding plates at foundation and pedestal. 10. Check auxiliaries for heating and cooling.

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Perform maintenance of emergency diesel generator (EDG) and related components.	1. Test automatic-start function. 2. Check EDG fluid parameters (e.g., lube- oil level, cooling-water temperature and flow, governor-control oil system, fuel-oil sampling). 3. Test EDG automatic protective features (overspeed, generator differential, low lube-oil pressure, high crankcase pressure, etc.). 4. Test EDG synchronization and load. 5. Test EDG manual start. 6. Check diagnostic baseline parameters (e.g., vibration, cylinder compression). 7. Check voltage regulation and frequency.
Perform heat-exchanger maintenance.	1. Check heat-exchanger parameters (temperature, flow, external leakage, etc.). 2. Test heat-exchanger performance (heat balance). 3. Check hydrostatic or operational test for tube and tube-sheet leakage.
Perform piping-system maintenance.	1. Flush system. 2. Check ASME code requirements. 3. Perform pressure/hydrostatic test. 4. Check integrity of mechanical joints. 5. Check cleanliness and verify system filled and vented. 6. Verify correct fluid-chemical parameters. 7. Verify that piping supports heat tracing, and insulation are restored. 8. Review for unusual pipe displacement. 9. Ensure that instrumentation lines are attached to pipe and properly refilled.

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Make new (or repair) weld.	Test in accordance with the ASME code (this is required for systems covered by the code). Facility guidelines are specific for applicable categories.
Replace component in instrument loop.	1. Calibrate replaced component. 2. Ensure that component is installed properly. 3. Inspect mechanical joints under normal operating or hydrostatic test pressure to verify no leakage. 4. Verify proper operation of instrument loop by comparing with ● Other readings of the same parameter on different instrument channels. ● Readings between channels that monitor the same variables and bear a known relationship to each other. ● Readings between channels that monitor different variables and bear a known relationship to one another. 5. Measure loop-response time if a time constant is associated with instrument response. 6. Perform operational checks on process.

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Replace switch devices (pressure, flow, temperatures, level).	1. Calibrate pressure switch and verify actuation and reset points. 2. Inspection mechanical joints under normal operating or hydrostatic test pressure to verify no leakage. 3. Verify, in accordance with technical manual and technical safety specifications, that environmental qualification requirements have not been degraded by installation or maintenance. 4. Ensure that switch is valved in after maintenance and that indication is as expected.
Perform instrumentation transmitter channel maintenance.	1. Perform channel checks 2. Calibrate all channel components except sensor. 3. Calibrate sensor channel (complete channel). 4. Test operation of trip activation device. 5. Calibrate in-core detector channel (normalization). **NOTE: During channel calibration verify that all automatic actuation interlock set points and resets function properly.**
Perform maintenance of radiation monitors.	1. Perform channel checks. 2. Perform source checks. 3. Test automatic functions. 4. Calibrate channel.

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Perform transformer maintenance.	1. Check transformer parameters (oil temperature, oil level, oil pressure, tap settings, cooling-fan status). 2. Test transformer operability (primary/secondary voltage and current). 3. Check insulation resistance high-potential, polarization index.
Repair (or replace) static inverters.	1. Verify voltage and currents. 2. Check inverter load. 3. Perform transfer test, if applicable.
Perform electrical maintenance on load center and distribution panel.	1. Verify voltage and lead current. 2. Visually check for fastener tightness, cleanliness.
Repair cranes and hoists.	1. Perform load test. 2. Check limit-switch operability. 3. Check brake/clutch operability.
Perform battery maintenance.	1. Check battery parameters (specific gravity, electrolyte level, cell voltage, electrolyte temperature, battery-terminal voltage). 2. Verify that battery cells, cell plates, terminals, and connections are free of corrosion. 3. Perform battery service discharge test. 4. Perform battery performance discharge test.

Appendix C
SELECTED MAINTENANCE ACTIVITIES AND POSTMAINTENANCE TESTS

Maintenance Activity	Recommended Test
Repair (or replace tank/ pressure-vessels)	1. Check tank/vessel integrity for leakage. 2. Check tank parameters (proper level, pressure, temperature indications). 3. Check tank-content parameters (e.g., boron concentration, radiation level, viscosity, particulate contamination, other). 4. Check tank cleanliness. 5. Check ASME code requirements, as appropriate. 6. Check condition of internal coatings.

APPENDIX D
POSTMAINTENANCE TESTING
SAMPLE LESSON PLAN

Appendix D
POSTMAINTENANCE TESTING
SAMPLE LESSON PLAN

LESSON PLAN

1. The instructor should be familiar with the following background information:

   a. Postmaintenance testing is normally performed by maintenance personnel to verify that they are returning the SSC back to the customer in its design condition. This type of testing is in contrast with operability testing, which is normally performed by owner/operators and/or fabrications personnel to verify that the maintained SSC now operates in the overall configuration as designed. PMT should include the following:

      - identification of all facility SSC requiring PMT,
      - testing requirements that are commensurate with the extent/type of maintenance performed,
      - methods to track equipment that has had completed maintenance, but is waiting on PMT, and
      - a system to properly coordinate, document the results, and verify the acceptance criteria of the test.

2. To teach this lesson, the following training housekeeping items are required:

   a. Location for the training,

   b. Approximately 30 minute time period for the training,

   c. Notification of selected employees, and

   d. A copy of the site's PMT guidelines.

3. This lesson has the following trainee enabling objectives:

   a. Outline a PMT guide.

   b. Give an example of a PMT.

4. PMT is normally performed by maintenance personnel to verify that they are returning the SSC back to the customer in its design condition. The following are components of PMT:

   a. A controlled documentation of types of tests, approved by the owner/operator, should be provided to the planning organization to identify the PMT that apply to each activity. These tests should be specified by the planner on each associated MJR. This documentation (list of tests) should be updated as new maintenance repair configurations are encountered.

   b. The level of testing performed should be based on the work accomplished and the importance of the component to safe and reliable site operation. Types of SSC requiring PMT include the following:

      - maintenance that effects integrity or operation of a liquid or gas system,
      - maintenance that effects the mechanical strength or components or fittings,
      - maintenance that effects or removes design related radiation shielding,
      - electrical distribution equipment such as breakers, bus work, or high voltage connections,
      - electrical control circuitry such as protection relays, limit switches, or permissive relays,
      - electronic components such as controllers, circuit cards, and transmitters,
      - instrumentation, and measuring and test equipment, and
      - temporary systems that have been installed as substitutes for normal operating systems.

c. Some examples of PMT include the following:

- hydrostatic or pressure tests with visual inspection for leaks,
- visual inspection for loose fasteners and mechanical misalignments,
- valve stroke time, operations of interlocks, comparison against other similar components, and measurements of vibration, flow, pressure, and temperature,
- calibration or alignment of an instrument,
- continuity, voltage, or current test, and
- SSC inspection for cleanliness.

d. The deficiencies identified during PMT should be documented and corrected on the original MJR, or on a new MJR before the original MJR is accepted is completed by the customer. The original MJR should reference any new MJR or documents written to resolve these deficiencies.

5. Discuss with the trainees the site's PMT guide or the framework of generating one if it does not exist at that facility.

CONCLUDING MATERIAL

Review Activity:

DOE
FM
DP
EH
EM
ER
NE
NS
RW

Field Offices
AL
CH
ID
NV
OR
RL
SR
OAK
RF

Area Offices
Amarillo
Brookhaven
Fernald
Kansas City
Kirtlant
Princeton

Facilities
ANL
KC AlliedSignal
NBL
LBL
LANL
LLNL
ORAU
PANTEX M&H
PNL
PPPL
RF-EG&G
SNL
NV REECo
NV EG&G
OR OSTI
WHC
ID-EG&G
RF
SLAC
WSRC

Preparing Activity:

DOE-EH-63

Project Number:

MNTY-0007