
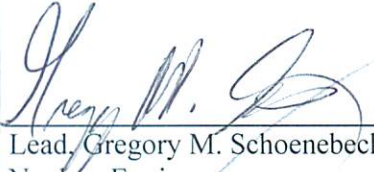
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Conduct of Maintenance Criteria and Review Approach Document		
Authorization and Approval	 C.E. (Gene) Carpenter, Jr. Director Office of Nuclear Safety and Environmental Assessments EA-31 Date: April 4, 2019	 Lead, Gregory M. Schoenebeck Nuclear Engineer Office of Nuclear Safety and Environmental Assessments EA-31 Date: April 4, 2019

1.0 PURPOSE

The mission of the U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments (EA-30) is to assess the effectiveness of safety and emergency management systems and practices used by line and contractor organizations and to provide clear, concise, rigorous, and independent evaluation reports of performance in protecting workers, the public, and the environment from the hazards associated with DOE activities.

In addition to the general independent oversight requirements and responsibilities specified in DOE Order 227.1A, *Independent Oversight Program*, this criteria and review approach document (CRAD), in part, fulfills the responsibility assigned to EA in DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*, to conduct independent appraisals of high consequence activities.

The CRADs are available to DOE line and contractor assessment personnel to aid them in developing effective DOE oversight, contractor self-assessment, and corrective action processes. The current revision of EA's CRADs are available at <http://www.energy.gov/ea/criteria-and-review-approach-documents>.

2.0 APPLICABILITY

The following CRAD is approved for use by the Office of Nuclear Safety and Environmental Assessments (EA-31) for use at DOE Hazard Category 1, 2, and 3 nuclear facilities. It may also be used by other offices within the Office of Environment, Safety and Health to review other DOE operations that invoke the principles of the Conduct of Maintenance.

3.0 FEEDBACK

Comments and suggestions for improvements on this CRAD can be directed to the Director, Office of Environment, Safety and Health Assessments.

4.0 CRITERIA AND REVIEW APPROACH

The review of the Conduct of Maintenance follows the requirements of DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*. The following functional areas are designed as stand-alone sections to be used in any combination based on the needs of the specific appraisal.

OBJECTIVES

MT.1: A DOE-approved Nuclear Maintenance Management Program (NMMP) with changes approved through the Unreviewed Safety Question (USQ) process is in place and maintained.

Criteria:

1. The NMMP description document is submitted for approval by the Field Office Manager at least every three years. (DOE O 433.1B Chg.1, Attachment 2, Section 1.e)
2. The NMMP changes are reviewed using the Unreviewed Safety Question (USQ) process. (DOE O 433.1B Chg. 1, Attachment 2, Section 1.i)
3. Assessments of the NMMP implementation are conducted by the Field Office and Federal and contractor organizations at least every three years or less frequently as directed by DOE/NNSA. (DOE O 433.1B Chg.1, 5.d.(7) and Attachment 2, Section 1.g)
4. Assessments must be risk-informed and appropriately cover potentially high consequence activities. (DOE O 226.1B Attachment 1, 2.b(2))
 - Has the NMMP-DD been submitted to the DOE for review and approval at least every three years (or other frequency as directed by DOE/NNSA)?
 - Are changes to the NMMP reviewed using the USQ process?
 - Does the implemented assessment schedule address all 17 elements of DOE O 433.1B on a three-year frequency or other frequency as directed by DOE/NNSA?
 - Are management assessment assessors trained and qualified, and have adequate knowledge of the areas assessed?

- Do assessments include observation of work activities (including subcontractors), inspection of field conditions, the results of process implementation, and effectiveness of corrective actions for previously identified deficient conditions, with particular focus on credited safety systems?
- Do line managers and supervisors utilize independent groups, such as QA or external services, as a management tool to assist them in assessing maintenance performance?
- Do assessors evaluate maintenance data, analyses, and trending to ensure accuracy of reported results?
- Do assessment reports adequately describe, document, and reflect credible risk-informed performance and appropriately cover high consequence activities?

MT.2: Maintenance organizations and processes with defined roles and responsibilities have sufficient integrated resources to implement the maintenance program.

Criteria:

1. Site management has established an organization structure, functional responsibilities, levels of authority, and interfaces for those managing, performing, and assessing the work. (10 CFR 830.122, Criterion 1 and DOE O 433.1B Chg. 1, Attachment 2, Section 2.b)
2. Site management has established management processes, including planning, scheduling, oversight, resources, and work control. (10 CFR 830.122, Criterion 1 and DOE O 433.1B Chg. 1, Attachment 2, Section 2.b)
 - Are maintenance personnel knowledgeable regarding the organizational responsibilities for managing, performing, and assessing the work?
 - Are the maintenance organization staffing resources sufficient to accomplish assigned tasks?
 - Do overtime, sick-day usage, and maintenance backlog data/ metrics reflect any concerns for staffing levels?
 - Are other supporting organizations, e.g., such as Quality Assurance, Materials Management, and Radiological Controls, sufficiently integrated into the maintenance program?

MT.3: A Master Equipment List (MEL) identifies SSCs credited in the safety basis.

Criterion:

1. A process exists for developing, implementing, managing, and maintaining the MEL that identifies SSCs that are part of the safety basis. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.c)
 - Is the responsibility for developing, managing, and maintaining the MEL clearly assigned?
 - Does the MEL clearly identify an up-to-date comprehensive listing of SSCs that are part of the safety basis?
 - Is each MEL item uniquely identified?
 - Is the MEL expanded into its respective subassemblies, components, and piece parts to identify potential spare parts using drawings, manuals, and vendor information?
 - Are critical spare parts in the MEL identified with stock levels based on usage data, lead-time, cost, shelf life, size, and storage requirements?
 - Are adjustments to spare parts stocking levels made in response to maintenance personnel feedback?

- Does the MEL manager adequately verify the conduct and quality of periodic self-assessments and/ or independent assessments of the MEL and MEL maintenance process?

MT.4: Work control, with System Engineer (SE) involvement, ensures work planning, scheduling, coordination, and control of maintenance activities/ equipment availability.

Criteria:

1. Maintenance activity/ equipment availability is planned, scheduled, coordinated, and controlled. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.d)
2. SEs review and provide input into the development of, and concur on maintenance and test procedures. (DOE O 420.1C, Chapter V, 3.d.(10))
 - Are maintenance work activities consistent with the facility's safety basis?
 - Are maintenance work activities effectively identified, initiated, planned, approved, scheduled, coordinated, performed, and reviewed for adequacy and completeness?
 - Does work planning consider materials, tools, staffing, safety, and quality requirements?
 - Does scheduling and coordination of maintenance activities avoid unnecessary removal of equipment and systems from service and use staffing and resources effectively?
 - Is the integrated maintenance schedule sufficiently detailed to coordinate activities and track progress?
 - Are individual work items grouped and major tasks integrated to make efficient use of technical support?
 - Is a work priority system effectively implemented to manage all maintenance work, including backlogs?
 - Does the accelerated process for urgent corrective maintenance of failed equipment important to safety and/or mission performance continue to follow the ISM model?
 - Does work package planning and scheduling include required resources and special tools/ equipment/ materials to complete the planned maintenance tasks?
 - Are Temporary Modifications (TM) made to configuration controlled SSCs evaluated, authorized, and controlled?
 - Are human performance error reduction tools (e.g., reverse briefing, pausing when unsure, peer checking) effectively integrated into work instructions?
 - Are SEs consulted by maintenance personnel to address unforeseen work performance circumstances?

MT.5: Appropriate types of maintenance provide for safe, efficient, and reliable operation of safety SSCs.

Criterion:

1. Preventive maintenance (PM), predictive maintenance (PdM), reliability-centered maintenance, surveillance and testing, and corrective maintenance (CM) provide safe, efficient, and reliable operation of safety SSCs. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.e)
 - Are PM frequency and actions based on such elements as regulatory requirements, consensus standards (e.g., NFPA), vendor recommendations, ALARA considerations, and performance monitoring, and good engineering practice?
 - Do deferred planned PMs have technical bases agreeable to the SE?

- Are maintenance and operations personnel encouraged to recommend changes in PM interval based on real-time observations and conditions?
- Are PMs performed by the established due dates or justifications for entering grace periods documented with escalating approvals?
- Are PdM techniques selectively applied, where appropriate, including bearing temperature monitoring, infrared thermography, vibration monitoring, lubricating oil analysis, and acoustic monitoring?
- Does a reliability-centered maintenance approach provide 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?
- Are surveillances planned and completed to maintain a valid safety basis and compliance with the TSR?
- Are causes of unexpected failures determined to support appropriate corrective actions?
- Are CM backlog priorities consistent with plant objectives and the relative importance of the equipment?
- Are completed work-control documents reviewed in a timely manner to check proper completion of maintenance work and verify that corrective action resolved the problem?
- Does management track and periodically assess performance compared to the daily schedule?
- Is there sufficient scheduling of workload such that maintenance intervals are being maintained?
- Is there routine schedule slip or schedule “creep” of PM activities outside nominal periodicity?

MT.6: Maintenance procedures provide appropriate direction of maintenance activities.

Criteria:

1. Maintenance procedures provide for documented and approved work instructions for work on safety SSCs (i.e., work packages, procedures, work instructions, and drawings) (DOE O 433.1B Chg. 1, Attachment 2, Section 2.f)
2. Existing and potential workplace hazards are identified and the risk of associated workers injury and illness is assessed. (10 CFR 851.21)
3. Work is performed consistent with technical standards, administrative controls, and other hazard controls adopted to meet regulatory or contract requirements, using approved instructions, procedures, or other appropriate means. (10 CFR 830.122, Criterion 5)
 - Are procedures technically accurate, complete, up to date, and presented in a clear, concise, and consistent manner to minimize human error?
 - Do appropriate experts (e.g., environmental, health and safety professionals, SEs, the facility owner, and workers) identify maintenance related hazards and ensure work package hazard controls are commensurate with the risk (consequence and probability) of an undesirable outcome?
 - Do instructions possess the appropriate level of detail including, cautions, hold-points post-maintenance testing acceptance criteria?
 - Is the level of procedure use appropriately specified, i.e., continuous use, reference use, or information use?
 - Are maintenance work packages reviewed to ensure the work activity is described, all hazards are analyzed and controls are established, and that human factors principles and appropriate administrative policies are incorporated?

- Are procedures and changes to procedures, which could affect the performance of safety SSCs, reviewed as part of the USQ process?
- Do maintenance personnel confirm latest revision of work performance procedures?
- Do maintenance personnel walk through the procedure at the work performance location to confirm environmental conditions have not changed since the activity was planned and identify any issues with equipment, the procedure, access, unanticipated hazards, controls, etc.?
- Do maintenance personnel ensure proper tools, equipment, and materials are staged/ available for the work performance?
- Are maintenance personnel knowledge of personnel hazards expected during the maintenance activity and safe work practices required to eliminate or mitigate such hazards?
- Do maintenance personnel properly use work performance procedures i.e., reader-worker method, reference use only, use-each-time?
- Do workers know the location of applicable work performance procedures?
- Do maintenance personnel properly adhere to procedural prerequisites, warnings, cautions, notes, hold points, etc.?
- Do maintenance personnel properly respond to inaccurate procedures, unforeseen safety concerns, or unexpected conditions by pausing/ stopping work, consulting with supervision, and involvement of work planners?
- Do maintenance personnel confirm acceptance/ performance criteria to verify completion of maintenance work?

MT.7: Maintenance personnel are appropriately trained and qualified.

Criteria:

1. Maintenance personnel are trained and qualified for the work performed in accordance with DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.g; DOE O 426.2 Chg 1 Attachment 1, 1.5.d; and 10 CFR 830.122, Criterion 2)
2. Provide continuing training to personnel to maintain their job proficiency. (10 CFR 830.122, Criterion 2 and DOE 426.2 Chg 1 Attachment 1, 1.7.a)
 - Are maintenance personnel who perform work on engineered safety features and systems having a direct impact on the safe operation of the facility trained on the a) purpose of the system, b) general description of the system including major components, relationship to other systems, and all safety implications associated with working on the system; and c) related industry and facility-specific experience?
 - Do maintenance personnel training records document one year of job-related experience, specific initial training, and retraining evidence to maintain proficiency?
 - Are equivalencies granted for individual competencies based on objective evidence of previous education, training, certification, or experience?
 - Does training include an adequate mix of formal classroom and computer- based courses, self-study, mentoring, on-the-job training (OJT), and special assignments?
 - Are maintenance department supervisors and/or selected experienced workers directly involved in OJT?
 - Do maintenance personnel demonstrate a working knowledge of the work control process?
 - Are maintenance supervisors subject to a formalized training program that provides the necessary training to develop and maintain managerial and supervisory skills?

- Are periodic systematic evaluations of the maintenance training and qualification program conducted at least every three years?

MT.8: Configuration management ensures controlled alignment of safety SSCs with technical basis documents.

Criteria:

1. A configuration management program and implementing procedures control approved modifications and prevent unauthorized modifications to safety SSCs. (DOE O 433.1B Chg. 1, Attachment 2, Sections 1.i and 2.h)
2. System maintenance, repair, and modification must be controlled through a formal change control process to ensure that changes are not inadvertently introduced and that required system performance is not compromised. (DOE 420.1C Chapter V, 2.c.4)
 - Do maintenance planners demonstrate adequate knowledge and application of a formal change control process to ensure proper function of required SSCs?
 - Do planners understand the applicability of the USQ process when planning temporary modifications?
 - Do SEs perform adequate physical configuration control walk downs and assessments to ensure actual physical configuration agrees with the design requirements and documentation?
 - Do maintenance personnel demonstrate effective surveillance and testing performance to verify continuing SSC functionality to safety basis design requirements?
 - Are planners and maintenance personnel familiar with the need for engineering review and approval if maintenance will not result in returning SSCs to their documented design configuration?

MT.9: Parts, materials, and services are procured and made available when required.

Criteria:

1. Integration of the procurement process with the NMMP ensures the availability of parts, materials and services for maintenance activities. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.i)
2. Procure items and services that meet established requirements and perform as specified. (10 CFR 830.122, Criterion 7)
3. Evaluate and select prospective suppliers on the basis of specified criteria. (10 CFR 830.122 Criterion 7)
4. Establish and implement processes to ensure approved suppliers continue to provide acceptable items and services. (10 CFR 830.122 Criterion 7)
5. Identify and control items to ensure proper use. (10 CFR 830.122, Criterion 5)
6. Maintain items to prevent damage, loss, or deterioration. (10 CFR 830.122, Criterion 5)
 - Do maintenance personnel inspect parts, materials, and equipment upon receipt for installation to ensure they are correct, in good condition, and not counterfeit?

MT.10: Maintenance tools and equipment are controlled.

Criteria:

1. Maintenance tools and equipment are controlled including the calibration of Measuring and Test Equipment. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.j)
2. Calibrate and maintain equipment used for data collection. (10 CFR 830.122 Criterion 5)
3. Calibrate and maintain equipment used for inspections and tests (10 CFR 830.122 Criterion 8)
 - Are proper tools, jigs, fixtures, equipment, and consumable supplies suitably stored and maintained in good repair to support work?
 - Are tool, equipment, safety devices, and personnel safety equipment inspections scheduled based on the risk to safety and reliable use?
 - Are worn, defective, contaminated, out-of-tolerance, or otherwise unusable tools/ equipment identified and tagged and/or segregated to remove them from service and prevent unsafe use?
 - Do maintenance personnel effectively implement a Measuring and Test Equipment (M&TE) Program that complies with ANSI/NSCL Z540.3-2006, “American National Standard for Calibration – Requirements for the Calibration of Measuring and Test Equipment?”
 - Do maintenance personnel store tools with environmental controls (e.g., chemical, flammable, etc.)?
 - Are special tools, test rigs, special equipment, lifting and rigging equipment, and mockups suitable for their intended use, approved by engineering, reviewed under the USQ process, and properly identified?

MT.11: Suspect and counterfeit items (S/CIs) are prevented from use in safety SSCs.

Criteria:

1. Maintenance performance prevents the use of S/CIs in safety SSCs. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.k)
2. A process is implemented for training personnel preventing entry of S/CIs into the DOE supply chain, and to ensure detection, control, reporting, and disposition of S/CIs. (DOE O 414.1D Chg. 1, Attachment 3, 2.c.)
3. S/CIs discovered in safety SSCs or any application whose failure could result in a loss of safety function, or present a hazard to public or worker health and safety, are reported through the DOE Occurrence Reporting and Processing System (ORPS) (DOE O 232.2, Attachment 2, Group 4, Subgroup C)
 - Does the organization designate a position responsible for S/CIs activities?
 - Do maintenance managers, supervisors, and workers receive training S/CIs processes and controls (including prevention, detection, and disposition of S/CIs)?
 - Are appropriate maintenance and engineering personnel involved in 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?
 - Are discovered S/CIs installed in safety SSCs or any application whose failure could result in a loss of safety function, or present a hazard to public or worker health and safety reported through ORPS?

MT.12: Maintenance history supports work planning and performance analysis.

Criterion:

1. Documented and retrievable maintenance history (i.e., cost data, system availability data, and failure data) supports work planning, performance trending, analysis of problems to determine root causes of unplanned occurrences related to maintenance, and continuous program improvement? (DOE O 433.1B Chg. 1, Attachment 2, Section 2.1)
 - Are maintenance history records for SSCs maintained in accordance with a defined records management process?
 - Are maintenance history records considered in planning for corrective maintenance, periodic maintenance, and modifications?

MT.13: Inspections evaluate age related degradation and technical obsolescence.

Criterion:

1. Inspections evaluate aging-related degradation and technical obsolescence to determine whether the performance of SSCs is threatened. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.m)
 - Does the NMMP delineate how maintenance personnel coordinate and address issues associated with aging and degradation inspections?

MT.14: Seasonal Facility Preservation prevents damage to safety SSCs.

Criterion:

1. Safety SSCs are protected from adverse weather conditions. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.n)
 - Are buildings and equipment analyzed for the potential damage from seasonal weather and environmental conditions?
 - Are protection plans developed and implemented to ensure maintenance of facilities and equipment in a safe condition during severe weather and environmental conditions?
 - Do maintenance personnel verify the effectiveness of controls to assure seasonal facility preservation measures effectively prevent equipment and building damage at DOE facilities?
 - Do maintenance personnel implement appropriate measures to address severe weather conditions? For example:
 - Identifying areas where portable heating would be required;
 - Monitoring conditions surrounding wet-pipe sprinkler systems to ensure pipes do not freeze
 - 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 the main water supply cutoffs for each critical facility are identified, tested, and readily accessible to emergency personnel responding to a freeze/thaw incident
 - Ensuring antifreeze used in cooling systems is checked and replaced as necessary;
 - Ensuring heating system power and temperature controls are protected against inadvertent deactivation;

- Isolating systems to prevent soot and smoke damage from fires; and
- Identifying systems that could be exposed to flood or flash floods are raised or otherwise protected above the expected water line.

MT.15: Performance measures promote maintenance improvement.

Criteria:

1. The organization maintains and communicates performance measures to identify maintenance issues requiring corrective action and lessons learned. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.o)
2. Identify the causes of problems, and work to prevent recurrence as part of correcting the problem. (10 CFR 830.122 Criterion 3)
 - Are performance indicators with goals established, measured, trended, and analyzed to identify organizational conditions that are impacting mission goals, including safety and the reliability of safety SSCs?
 - Are metrics, which do not achieve their goal or have undesirable trends, analyzed to determine the causal factors for this performance?
 - Does the organization use techniques to establish data normal and standard deviations of results?
 - Are apparent causes for deviations further analyzed to address underlying issues to prevent recurrence?
 - Does the organization use PdM data (e.g., vibration, thermography, and ultrasound) trends to determine the degree of required maintenance prior to equipment failure?
 - Does management periodically review and communicate the status of performance indicators, trends, and factors causing the indicator to change?

MT.16: Facility condition inspections monitor facility conditions.

Criteria:

1. Conduct and implement routine assessments of facilities to identify issues related to operability, reliability, housekeeping, and general condition. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.p)
2. System assessments must include periodic reviews of system operability, reliability, and material condition. (DOE 420.1C Chapter V, Section 3.c.(3))
3. Facility Condition Inspections are integrated with the Condition Assessment Program of real property assets. (DOE O 430.1B, 4.c.(9) (e)) [only if in contract]
 - Does the organization plan, conduct, and trend periodic inspections of the material condition of facilities to support safe and reliable plant operation?
 - Does the organization identify material deficiencies and log them into a work-control system for correction?
 - During facility condition inspections, do maintenance personnel identify technical obsolescence of parts and equipment that could threaten SSC design performance?
 - Do facility managers integrate Facility Condition Inspections with the Condition Assessment Program of real property so that identified repairs can be included as part of Deferred Maintenance reporting?

MT.17: Post-maintenance testing confirms safety SSC functional performance.

Criteria:

1. Post maintenance testing verifies that safety SSCs can perform their intended function when returned to service. (DOE O 433.1B Chg. 1, Attachment 2, Section 2.q)
2. Post maintenance testing must be conducted to confirm continued capability to fulfill system requirements. (DOE 420.1C Chapter V, 3.c.(4))
 - Do planners coordinate with SEs in developing post-maintenance testing (PMT) scope, initial conditions and prerequisites, job instructions, hold points, test requirements, acceptance criteria and post-test restoration?
 - Does the organization properly tag out safety SSCs until completion of PMT?
 - Are methods provided for documenting the results, and verifying that the resulting data meets acceptance criteria?
 - Are deficiencies identified during post maintenance testing documented and corrected?
 - Does the organization review the test results and formally indicate acceptability of the equipment and determination of operability?

REVIEW APPROACH

Record Review:

- Safety basis documents, system design descriptions and supporting documents (e.g., system diagrams, pipe and instrumentation drawings, calculations).
- USQ process procedure(s) and the results of USQ evaluations.
- Maintenance records, plans, and schedules for aging system equipment and components.
- Maintenance work backlogs and deferrals.
- Vendor manuals, industry standards, DOE orders, and other requirements used as technical bases for development of system maintenance work packages.
- System or component history files for selected system components for the past three years.
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- Procurement processes and records for system components and services.
- Surveillance and/or testing procedures and the supporting DSA TSRs and bases for the system and major components and a sample of the test results.
- Maintenance personnel training for the system, focusing on the technical completeness and accuracy of the training manual and lessons plans.
- System modification, maintenance, and procurement work packages.
- Sample database records of system deficiencies, problems, engineering issues, and corrective actions.
- Previous and present oversight assessment plans and schedules of planned surveillance and assessment activities.
- Maintenance assessment program descriptions, procedures, instructions, guidance, and contractual requirements.
- Assessment activity schedules for independent, management, and other self-assessments and external reviews/inspections of maintenance.
- Self-assessments, independent assessments, causal analyses, corrective action plans, lesson-learned documents, Price-Anderson Amendment Act notifications and corrective action plans, close-out reviews as they relate to the requirements and functions of the system(s) selected for review and/or other safety systems if appropriate.

- Documented Safety Analysis
- Technical Safety Requirements

Interviews:

- Cognizant System Engineer(s)/ System Engineer(s) who support the facility
- Surveillance and testing personnel
- Configuration management SME
- Maintenance Manager
- Maintenance supervisors
- Maintenance Personnel
- Facility Manager

Observations:

- Selectively walk down system equipment and components and compare the actual physical installation of the system to documentation of the system design and safety basis; review safety component and services procurement programs (including the quality assurance program) and sample procurement packages.
- Walk-through of the surveillance test procedures with appropriate facility personnel (e.g., test technicians, engineers, operations personnel).
- Normal maintenance activities.