Lessons Learned from Assessments of Safety System Management at U.S. Department of Energy Nuclear Facilities

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Acronyms

ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance, LLC
CFR	Code of Federal Regulations
CSE	Cognizant System Engineer
CRAD	Criteria and Review Approach Document
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
FR	Facility Representative
NFPA	National Fire Protection Association
NNSA	National Nuclear Security Administration
NQA	Nuclear Quality Assurance
SHR	System Health Report
SRNS	Savannah River Nuclear Solutions, LLC
SSCs	Structures, Systems, and Components
SSM	Safety System Management
SSO	Safety System Oversight
TA-55	Technical Area 55
TSR	Technical Safety Requirement
UCOR	URS|CH2M Oak Ridge, LLC

LESSONS LEARNED FROM ASSESSMENTS OF SAFETY SYSTEM MANAGEMENT AT U.S. DEPARTMENT OF ENERGY NUCLEAR FACILITIES

Executive Summary

The U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted eight assessments of safety system management (SSM) at DOE high-hazard (hazard category 1 and 2) nuclear facilities between January 2019 and September 2023. These facilities were under the direction of the DOE Offices of Environmental Management and Nuclear Energy and the National Nuclear Security Administration. The objective of these assessments was to evaluate the effectiveness of SSM by assessing selected active safety structures, systems, and components (SSCs) to determine whether they were operated and maintained in a manner to ensure that they can reliably perform the intended function of protecting workers and the public from analyzed hazards. The assessments also evaluated the effectiveness of DOE oversight of the contractors' SSM performance. This lessons-learned report identifies common strengths and weaknesses, best practices, and recommendations to promote organizational learning and improve performance throughout the DOE complex.

Overall, the selected active safety SSCs were appropriately operated and maintained to ensure the SSCs can reliably perform their intended functions. EA identified 10 best practices in the assessed SSM programs:

- Two best practices involved the use of the iQ WorkSmart computer system by Battelle Energy Alliance, LLC (BEA) to effectively manage the Advanced Test Reactor engineering change processes; manage maintenance, assets, supply chains, operations coordination, and compliance processes; and develop and manage system health reports (SHRs).
- BEA's cognizant system engineers (CSEs) use the E.R. Suite SystemIQ® software to effectively develop SHRs. The computer software integrates system health information in one place, organizes the system health reporting and scoring process, and assembles the SHRs, providing an effective centralized system for the CSEs to manage their system health information and reports.
- The URS|CH2M Oak Ridge, LLC required reading program provides an exceptionally thorough and systematic approach using a software tool to notify Liquid and Gaseous Waste Operations operators of procedural changes and associated training requirements.
- At H-Canyon, Savannah River Nuclear Solutions, LLC (SRNS) uses ultrasound technology during lubrication of the exhaust fan bearings to optimize lubrication, thereby extending intervals between lubrications.
- Human performance error reduction tools are highly integrated into the SRNS H-Canyon maintenance process.
- The SRNS H-Canyon Operations organization uses an automated tool linked to the watchbill list for control room staffing to track proficiency hours for individual operators and aid in ensuring their continued qualification.
- The Triad National Security, LLC's Technical Area 55 (TA-55) SHR process and "Path to Green" approach provides an exceptional tool for monitoring the performance and overall status of safety-related systems. Triad's investment in creating and maintaining these documents, with quarterly updates, has resulted in an effective tool for ensuring that safety class systems continue to perform with high reliability.
- The Savannah River Remediation, LLC Concentration, Storage and Transfer Facilities' system health database tool for managing periodic SHRs is easy to navigate and effective for assembling high-level information for senior management to easily understand the status of the system.

- Consolidated Nuclear Security, LLC effectively manages Pantex Plant's stock items and replacement parts in the warehouse by applying color-coded stickers that provide a visual indicator of acquisition level, controlled expiration date, critical spare indicator, property-controlled items, and storage level.

EA identified the following weaknesses warranting improvements in SSM, as the underlying issues were identified at more than one of the sites assessed:

- Approximately half of the identified issues were based on inadequate implementation of site-specific requirements (e.g., work orders for safety equipment that had not received engineering reviews, SHRs that did not contain all required information, and equipment modifications that were performed without approved design documents) contained in internal policies, standards, and procedures.
- At four of eight sites, calculations and design documents included improper SSC functional classifications, inadequate technical bases and justifications, missing or inadequate design inputs, technically inadequate analysis, and non-conservative assumptions.
- At two of seven sites, procurement procedures lacked requirements for precluding suspect or counterfeit items from entering the site supply systems and for addressing their disposition.
- At two of eight sites, procedure development, validation, and reverification issues involved technical inaccuracies and inconsistent guidance.
- At three of seven sites, DOE site office Facility Representative and Safety System Oversight programs had insufficient staffing, which hinders DOE's ability to provide adequate oversight of SSM activities.

Recommendations

This lessons-learned report provides the following recommendations to DOE field element managers and site contractors for improving SSM programs.

DOE Field Element Managers

To enhance DOE site office oversight of SSM activities:

- Develop effective strategies such as programs and incentives that ensure adequate Facility Representative and Safety System Oversight staffing levels.

Site Contractors

To improve compliance with internal requirements:

- Ensure that requirements implementation matrices are used to verify the flowdown of requirements into implementing processes and strengthen training and qualification programs for procedural compliance.

To improve technical bases and justifications for proposed changes to safety SSCs, as well as the accuracy and completeness of engineering design documents, analyses, and calculations:

- Provide guidance in engineering procedures regarding the expectations for appropriate technical bases for acceptance criteria and technically defensible engineering design documents, calculations, and analyses.

To improve the procurement processes for controlling suspect or counterfeit items:

- Ensure that the procedures relied upon for controlling suspect or counterfeit items contain requirements to collect, maintain, disseminate, and use the most accurate, up-to-date industry information on suspect or counterfeit items and suppliers, including whether vendors have previously supplied suspect or counterfeit items.

To improve the technical accuracy and performance of procedures:

- Perform validation and verification of operating procedures, using performance demonstrations, to ensure accuracy and adequate performance.

LESSONS LEARNED FROM ASSESSMENTS OF SAFETY SYSTEM MANAGEMENT AT U.S. DEPARTMENT OF ENERGY NUCLEAR FACILITIES

1.0 INTRODUCTION

The Office of Environment, Safety and Health Assessments, within the Office of Enterprise Assessments (EA), conducted assessments of U.S. Department of Energy (DOE) nuclear facility safety system management (SSM) under the direction of the DOE Offices of Environmental Management and Nuclear Energy and the National Nuclear Security Administration (NNSA). The objective of these assessments was to evaluate the effectiveness of SSM by assessing selected active safety structures, systems, and components (SSCs) to determine whether they were appropriately operated and maintained to ensure the safety SSCs can reliably perform the intended function of protecting workers and the public from analyzed hazards, and assess the effectiveness of DOE oversight of the contractors' performance in the area of SSM. This lessons-learned report identifies common strengths and weaknesses, best practices, and recommendations to promote organizational learning and improve performance throughout the DOE complex.

2.0 METHODOLOGY

EA manages the Department's independent oversight program. This program is designed to enhance DOE safety and security programs by providing the Secretary and Deputy Secretary of Energy, Under Secretaries of Energy, DOE managers, senior contractor managers, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements, as well as the effectiveness of DOE and contractor line management performance, risk management in safety and security, and other critical functions as directed by the Secretary. DOE Order 227.1A, *Independent Oversight Program*, describes and governs the DOE independent oversight program. EA implements the program through a comprehensive set of internal protocols and assessment guides.

This report reflects an analysis of the collected results of EA's assessments of SSM from eight assessments evaluating SSM programs at seven high-hazard (hazard category 1 and 2) nuclear facilities conducted between January 2019 and September 2023. The assessed sites and facilities, along with the responsible contractors, local DOE offices, and DOE Headquarters program offices, are listed in Table B-1. The table also shows the criteria and review approach documents (CRADs) used for the assessment and safety SSCs evaluated for each facility.

The lessons learned are based on grouping significant observations from these eight assessments into the CRAD 31-15, *Safety Systems Management Review*, and CRAD 30-11, *Safety Systems Management Review*, functional areas: engineering design, quality assurance, configuration management, maintenance, surveillance and testing, operations, cognizant system engineer (CSE), safety basis, and feedback and improvement for selected safety systems. The adequacy of Federal oversight of contractor SSM activities was also part of the EA assessment scope.

Appendix A lists the contributors to this lessons-learned effort, the members of the Quality Review Board, and the EA management responsible for this evaluation. Appendix B addresses the scope of this review, applicable CRADs, analysis methodology, and the EA assessment reports used in this review.

3.0 RESULTS

This portion of the report summarizes the results, including strengths and weaknesses, from the assessment reports, as well as potential concerns identified.

This lessons-learned review analyzed 10 best practices and 55 issues (7 findings and 48 deficiencies) identified in the 8 assessments conducted between January 2019 and September 2023. These assessment results were categorized into functional areas as shown in Table 1 below.

Table 1. EA-identified Best Practices, Findings, and Deficiencies

Functional Area	Number of Assessments that Included Functional Area	Best Practices	Findings	Deficiencies
Engineering Design	7	1	4	10
Quality Assurance	7	1	2	10
Configuration Management	7	0	0	3
Maintenance	6	3	0	7
Surveillance and Testing	8	0	0	2
Operations	6	2	1	8
Cognizant System Engineer	8	3	0	4
Federal Oversight	7	0	0	1
Feedback and Improvement	8	0	0	3
Safety Basis*	1	0	0	0
Totals		10	7	48

* Although the safety basis functional area is not included in CRAD 31-15, it is included in its successor document, CRAD 30-11, and was included in one SSM assessment.

Overall, EA identified that SSM processes implemented at the assessed nuclear facilities adequately ensured that the selected active safety SSCs were appropriately operated and maintained to ensure the safety SSCs can reliably perform the intended function of protecting workers and the public from analyzed hazards. Approximately half of the 55 EA-identified issues were based on site specific requirements found in internal policies, standards, and procedures. Therefore, improvements in the management of internal requirements and procedural compliance may be warranted. In general, the EA assessments of Federal oversight programs found that the Federal Oversight programs effectively implemented the DOE oversight requirements of DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*. Further details are provided in the following sections of this report.

3.1 Engineering Design

This portion of the lessons-learned review addresses the strengths and weaknesses associated with engineering design documents and analyses that implement the requirements of the nuclear facility safety basis.

Strengths

In general, EA assessments of engineering design found that contractors had implemented adequate processes for developing and maintaining engineering design products (e.g., calculations, drawings, design changes) and that the engineering design products appropriately incorporated applicable requirements from the facility safety basis. Operations personnel were knowledgeable about the importance of the safety-basis-credited active safety systems.

Weaknesses

EA assessments identified 14 issues (4 findings and 10 deficiencies) associated with engineering design. Unless stated elsewise, each issue correlates to a specific nuclear facility and does not imply broad applicability at that site or across multiple sites.

The findings involved the following:

- Technical bases for acceptance criteria associated with confinement system leakage requirements were inadequate, contrary to an internal procedure.
- Initial or continued equipment qualification for confinement system components was lacking, contrary to the facility documented safety analysis (DSA).
- Nuclear quality assurance requirements were not incorporated into engineering processes, contrary to NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications,* part I, requirement 3, paragraphs 100, 300(a), 400, and 500.
- Design documents contained incorrect results due to missing or outdated inputs, as well as non-conservative design margins, contrary to 10 CFR 830.122(f), *Criterion 6-Performance/Design*.

The deficiencies involved the following:

- There were three instances at separate nuclear facilities of calculations with non-conservative assumptions, improper SSC functional classifications, inadequate design inputs, insufficient information, and technically inadequate analysis, contrary to internal procedures.
- Proposed changes lacked technical justifications, contrary to internal procedures.
- The DSA-required functional classification of a component in a safety class system was inappropriately downgraded to general service.
- Piping and instrumentation diagrams contained errors and omissions, contrary to internal procedures.
- System requirements and performance criteria for safety class SSCs were not documented, contrary to DOE Order 420.1C, *Facility Safety*, attachment 2, chapter V, section 3.c.(2)(a).

- Acceptance criteria were not established for annual visual inspections of safety class SSCs, contrary to 10 CFR 830, subpart B, appendix A, G.6.(5).
- Bases in the DSA for one facility were inadequate for determining exhaust ventilation flowrates sufficient to maintain the atmosphere below required flammability limits or that an aging safety SSC meets current nuclear air cleaning criteria.
- Procedures improperly invoked the graded approach for the specification of post-modification test requirements for safety SSCs, contrary to internal procedures.

EA identified the following weakness affecting three sites:

- Calculations and design documents included improper SSC functional classifications, inadequate technical bases and justifications, missing or inadequate design inputs, technically inadequate analyses, and non-conservative assumptions.

3.2 Quality Assurance

This portion of the lessons-learned review addresses the strengths and weaknesses associated with quality assurance practices and processes implemented to ensure that safety systems will conform to required standards and perform as designed.

Strengths

In general, EA assessments of quality assurance found that contractors had implemented adequate processes for verification of safety system design, procurement, and modifications. Adequate processes were used for the procurement of SSCs through qualified suppliers and the use of commercial grade dedication.

It was noted that the procurement process implemented by Savannah River Nuclear Solutions, LLC (SRNS) for replacement items and critical spares, which is structured and implemented to ensure that these items are available with the appropriate quality pedigree when needed, was identified as a strength at the H-Canyon Facility. National Technology and Engineering Solutions of Sandia, LLC at Sandia National Laboratories – New Mexico has implemented an effective process for training and qualifying lead auditors.

Weaknesses

EA identified 12 issues (2 findings and 10 deficiencies) associated with quality assurance. Unless stated elsewise, each issue correlates to a specific nuclear facility and does not imply broad applicability at that site or across multiple sites.

The findings involved the following:

- Critical characteristics (with attributes and acceptance criteria) appropriate for the SSC safety function were not identified in commercial grade item packages, contrary to NQA-1, part I, requirement 3, paragraph 300.
- Training and qualification requirements for personnel performing quality control inspections were not established in accordance with DOE Order 414.1D, *Quality Assurance*, attachment 2, sections 2 and 8, and DOE Order 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, attachment 1, chapter I, section 4.b.(3)(a).

The deficiencies involved the following:

- Nonconformance reports for in-stock, expired shelf-life items were not maintained, contrary to an internal procedure.
- There was no procedural requirement to identify limited shelf-life items to Quality Assurance or warehouse personnel, contrary to NQA-1, part I, requirement 8, paragraph 302.
- Temperature and humidity levels required to prevent damage and minimize deterioration of warehouse stored items were not monitored and recorded, contrary to an internal procedure.
- Some records did not provide traceability of safety SSCs from manufacturing to installation, contrary to internal procedures.
- Some design products (e.g., calculations and drawings) did not conform to governing procedural requirements.
- Installed modifications were made without approved design documents, contrary to 10 CFR 830.122(f).
- Implementing procedures at two sites lacked requirements to preclude suspect and counterfeit items from entering the site supply systems or provide for their proper disposition, contrary to DOE Order 414.1D, attachment 3, sections 2.e and 2.i.
- Procedural requirements were inadequately implemented, involving insufficient information in calculations and system health reports (SHRs), use category of surveillance procedures, and process completion records, contrary to DOE Order 414.1D, attachment 2, criterion 5.a.
- Procedures contained inaccuracies and conflicting requirements, contrary to DOE Order 414.1D, attachment 2, criterion 4.a.

EA identified the following weakness affecting two sites:

- Procurement procedures lacked requirements for precluding suspect or counterfeit items from entering the site supply systems and for addressing their disposition.

3.3 Configuration Management

This portion of the lessons-learned review addresses the strengths and weaknesses associated with configuration management programs and processes implemented to ensure that safety systems continue to meet safety basis requirements and changes are properly controlled.

Strengths

In general, EA assessments of configuration management programs found that contractors had implemented adequate processes to ensure that SSC configurations agreed with design requirements and system changes were properly controlled. System design changes are properly evaluated through the unreviewed safety question process and undergo appropriate performance assessments to ensure that safety functions of modified SSCs are maintained.

Weaknesses

EA identified three deficiencies associated with configuration management. Unless stated elsewise, each issue correlates to a specific nuclear facility and does not imply broad applicability at that site or across multiple sites. These deficiencies involved the following:

- A configuration management program did not address system assessments and aging degradation, contrary to DOE Order 420.1C, attachment 2, chapter V, sections 3.c.(1)(b) and (e).
- Not all instrumentation and gauges were labeled, contrary to an internal procedure.
- A review of a proposed component labeling procedure revision to identify needed labeling of safety instrumentation and gauges was incomplete, contrary to DOE Order 420.1C, attachment 2, chapter V, section 3.c.(1), and DOE-STD-1073-2016, *Configuration Management*, section 4.9.

EA determined that there were no weaknesses affecting more than one nuclear site.

3.4 Maintenance

This portion of the lessons-learned review addresses the strengths and weaknesses associated with maintenance activities, including planning and scheduling, performed to ensure that safety systems can reliably perform intended safety functions when required.

Strengths

In general, EA assessments of maintenance management programs found that contractors had implemented the elements of DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*, and qualified craft personnel performed maintenance activities properly. Safety and mission-essential SSC maintenance activities were effectively planned and well-coordinated between operations, maintenance, engineering, safety, and work control organizations, and adequate resources were allocated.

Weaknesses

EA identified seven deficiencies associated with maintenance programs. Unless stated elsewise, each issue correlates to a specific nuclear facility and does not imply broad applicability at that site or across multiple sites. These deficiencies involved the following:

- Safety SSCs were operated in a degraded condition for extended periods of time, contrary to 10 CFR 830.122(e)(3).
- Annual test procedures did not fully verify that safety SSCs used for fire protection can meet performance requirements, contrary to National Fire Protection Association (NFPA) 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.
- Required attributes for spare parts were not properly identified on the critical spare parts list, contrary to internal procedures.
- Equipment failures and their causes were not captured and tracked in the site computerized maintenance management system, contrary to internal procedures.
- A quality hold point was not properly documented, contrary to internal procedures.
- A work document field change was not obtained upon discovery that the work document referenced the wrong section of the surveillance procedure, contrary to internal procedures.
- An engineering review of a work order for a safety SSC was not obtained, contrary to internal procedures.

EA determined that there were no weaknesses affecting more than one site.

3.5 Surveillance and Testing

This portion of the lessons-learned review addresses the strengths and weaknesses associated with surveillance and testing activities performed in accordance with technical safety requirement (TSR) surveillance requirements.

Strengths

In general, EA assessments of surveillance and testing found that contractors were adequately performing the required safety system surveillance and testing activities necessary to ensure that safety SSCs can perform their credited safety functions. Safety and mission-essential SSC maintenance activities were effectively planned and well-coordinated between operations, maintenance, engineering, safety, and work control organizations, and adequate resources were allocated. Of note, personnel responsible for performing inspection, testing, and maintenance at the Los Alamos National Laboratory, Technical Area 55 (TA-55) displayed a high level of knowledge of system operability.

Weaknesses

EA identified two deficiencies associated with surveillance and testing. Unless stated elsewise, each issue correlates to a specific nuclear facility and does not imply broad applicability at that site or across multiple sites. These deficiencies involved the following:

- Surveillance and testing procedures for safety SSCs used for fire protection did not include all acceptance criteria required by NFPA 25, sections 8.2.2.(c) and (d).
- In multiple instances of surveillance documentation, required information was missing, contrary to internal procedures.

EA determined that there were no common weaknesses affecting more than one site.

3.6 Operations

This portion of the lessons-learned review addresses the strengths and weaknesses identified through the evaluation of whether operations are conducted in a manner that ensures the safety systems are available to perform intended safety functions when required.

Strengths

Overall, EA assessments of operations found that operations activities are adequate to ensure that operators are informed of conditions, operate equipment properly, monitor system function and status, and identify problems when they occur. Adequate performance was observed in shift turnovers, operator rounds, system walkdowns, and system equipment lineups.

Weaknesses

EA identified nine issues (one finding, eight deficiencies) associated with operations. Unless stated elsewise, each issue correlates to a specific nuclear facility and does not imply broad applicability at that site or across multiple sites.

The finding involved the following:

- TSR immediate actions in response to a failure of a safety class SSC functional test during performance of the facility's pre-operational checklists were not fully implemented, contrary to the facility DSA.

The deficiencies involved the following:

- Some completed surveillance procedures were not performed as written, contrary to internal procedures.
- Some procedures were not technically and administratively accurate, contrary to DOE Order 422.1, attachment 2, section 2.p.(3).
- Administrative control of some equipment was implemented with uniquely numbered seals instead of locks, contrary to internal procedures.
- Unqualified personnel performed demonstrations of shiftly and annual surveillances, contrary to internal procedures.
- Formal training was not provided for some workers tasked with implementing TSR safety class SSC limiting condition for operation actions, contrary to DOE Order 426.2, attachment 1, chapter I, section 4.b.(3)(a).
- Some safety class system surveillance procedures containing editorial and performance errors were not identified during the procedure development, validation, use, or periodic review processes, contrary to an internal procedure.
- Safety class system maintenance procedures contained errors that were not identified during use, contrary to an internal procedure.
- Some procedures were not marked with their level of use, contrary to an internal procedure.

EA identified the following weakness affecting two sites:

- Procedure development, validation, and reverification issues involved technical inaccuracies and inconsistent guidance.

3.7 Cognizant System Engineer

This portion of the lessons-learned review addresses the strengths and weaknesses associated with the evaluation of CSE program implementation effectiveness in ensuring that safety SSCs are capable of reliably performing as intended.

Strengths

Overall, EA assessments found that CSE programs were adequate, and qualified CSEs were assigned to active safety SSCs. In general, CSE programs were staffed with knowledgeable personnel and had effective training and qualification programs, and the CSEs understood the potential impacts of their work on nuclear safety. Of note, the operability determination process used by Battelle Energy Alliance, LLC at the Advanced Test Reactor was considered thorough and robust and has been used effectively to address safety SSC operability issues. SRNS uses electronic online system notebooks at the H-Canyon facility to track system performance and as compendiums of relevant design and vendor information on key components.

Weaknesses

EA identified four deficiencies associated with CSE programs. Unless stated elsewise, each issue correlates to a specific nuclear facility and does not imply broad applicability at that site or across multiple sites.

These deficiencies involved the following:

- Some CSEs were not attaching safety SSC trending data to SHRs, contrary to an internal procedure.
- A master equipment list that identified safety class SSCs that were part of the safety basis was lacking, contrary to DOE Order 433.1B, attachment 2, section 2.c.
- Design criteria, including codes and standards, associated with the safety class SSCs were not documented, contrary to DOE Order 420.1C, attachment 2, chapter V, section 3.c.(2)(a).
- The system design description for a reactor safety system was not kept current, particularly with regard to completing timely updates following system design changes, contrary to DOE Order 420.1C, attachment 2, chapter V, section 3.c.(2).

EA determined that there were no common weaknesses affecting more than one site.

3.8 Feedback and Improvement

This portion of the lessons-learned review addresses the strengths and weaknesses associated with the evaluation of the effectiveness of feedback and improvement processes and preventing recurrence of safety SSC issues.

Strengths

Overall, EA assessments found that contractors have established and implemented effective feedback and improvement processes. Worker feedback mechanisms, management and independent assessments, and processes for managing identified issues were adequate. Lessons learned, assessment results, and safety system feedback information are often incorporated into continuing training to improve performance. Periodic self-assessments of safety system engineering, configuration management, and operations processes are performed, and feedback information is used regularly to focus attention on issues and drive performance improvement.

Weaknesses

EA identified three deficiencies associated with feedback and improvement. Unless stated elsewise, each issue correlates to a specific nuclear facility and does not imply broad applicability at that site or across multiple sites.

These deficiencies involved the following:

- A formal process to analyze and trend feedback information to detect adverse conditions was lacking, contrary to internal procedures.
- An implementing procedure did not comply with the DOE Order 232.2A, *Occurrence Reporting and Processing of Operations Information*, attachment 1, section 4.b, requirements for causal analysis of all Occurrence Reporting and Processing System reportable events.

- A program procedure did not define a process for assessing deficiency significance or address the timeliness of resolution of deficiencies, contrary to DOE Order 226.1B, attachment 1, sections 2.b.(3) and 2.b.(5), and NQA-1, requirement 16.

EA determined that there were no common weaknesses affecting more than one site.

3.9 Safety Basis

This portion of the lessons-learned review addresses the strengths and weaknesses associated with the evaluation of the adequacy with which safety SSCs have been evaluated and/or demonstrated to be capable of fulfilling their required safety functions for all required operating and accident conditions. Because the safety basis functional area is not included in CRAD 31-15 (although it is included in the successor document, CRAD 30-11), it was only evaluated in one SSM assessment.

Strengths

The assessment that included the safety basis functional area concluded that the contractor had established and implemented an adequate safety basis for the assessed SSC. The SSC is adequately described in the DSA and appropriately evaluated to ensure that it will meet its safety function when called upon, and the TSRs are properly derived from the DSA.

Weaknesses

No specific weaknesses were identified.

3.10 Federal Oversight

This portion of the lessons-learned review addresses the strengths and weaknesses associated with the evaluation of the effectiveness of Federal safety oversight provided by Safety System Oversight (SSO) and Facility Representative (FR) programs in ensuring that safety systems can reliably perform as intended.

Strengths

Overall, EA assessments of Federal oversight found that the Federal oversight programs effectively implemented the DOE oversight requirements of DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*. Day-to-day oversight and formal assessments provided by FRs were thorough, effective, and well-documented. The FRs were experienced and knowledgeable of safety system status and operational activities.

Weaknesses

EA identified one deficiency associated with Federal oversight. This deficiency involved the following:

- The oversight program did not comply with DOE Order 226.1B, section 4.a.(1), requirements for developing and implementing an effective program commensurate with the level of risk of the activities.

Two additional weaknesses that were not classified as deficiencies or findings were also identified. One weakness involved the Federal oversight of a contractor's CSE program and the operability of the safety SSCs. This weakness was attributed to the lack of a specific requirement that this oversight be performed by an individual qualified as an SSO engineer. The second weakness was associated with oversight procedures not being updated, oversight activities not being completed as planned, and corrective actions not being completed in a timely manner.

EA identified the following weakness affecting three sites:

- Site office FR and SSO programs had insufficient staffing, which hinders DOE's ability to provide adequate oversight of SSM activities.

3.11 Conclusions

EA identified the following weaknesses that warrant improvements in SSM; the underlying issues associated with these weaknesses were identified at more than one of the eight sites assessed.

- Approximately half of the identified issues were based on inadequate implementation of site-specific requirements (e.g., work orders for safety equipment that had not received engineering reviews, SHRs that did not contain all required information, and equipment modifications that were performed without approved design documents) contained in internal policies, standards, and procedures.
- At four of eight sites, calculations and design documents included improper SSC functional classifications, inadequate technical bases and justifications, missing or inadequate design inputs, technically inadequate analysis, and non-conservative assumptions.
- At two of seven sites, procurement procedures lacked requirements for precluding suspect or counterfeit items from entering the site supply systems and for addressing their disposition.
- At two of eight sites, procedure development, validation, and reverification issues involved technical inaccuracies and inconsistent guidance.
- At three of seven sites, DOE site office FR and SSO programs had insufficient staffing, which hinders DOE's ability to provide adequate oversight of SSM activities.

4.0 BEST PRACTICES

A best practice is a safety-related practice, technique, process, or program attribute observed during an appraisal that may merit consideration by other DOE and contractor organizations for implementation because it has been demonstrated to substantially improve the safety or security performance of a DOE operation, or it represents or contributes to superior performance (beyond compliance). Additionally, a best practice could be identified because it solves a problem or reduces the risk of a condition or practice that affects multiple DOE sites or programs, or it provides an innovative approach or method to improve effectiveness or efficiency. The following best practices were identified at the time that the individual assessments were conducted and may be valuable to other DOE nuclear facility projects:

- Two best practices involved the use of the iQ WorkSmart computer system by Battelle Energy Alliance, LLC (BEA) to effectively manage the Advanced Test Reactor (ATR) engineering change processes; maintenance, assets, supply chains, operations coordination, and compliance processes; and to effectively develop and manage SHRs.
- BEA's CSEs use the E.R. Suite SystemIQ® software to effectively develop SHRs. The computer software integrates system health information in one place, organizes the system health reporting and scoring process, and assembles the SHRs, providing an effective centralized system for the CSEs to manage their system health information and reports.

- The URS|CH2M Oak Ridge, LLC (UCOR) required reading program provides an exceptionally thorough and systematic approach using a software tool to notify Liquid and Gaseous Waste Operations operators of procedural changes and associated training requirements.
- At H-Canyon, SRNS uses ultrasound technology during lubrication of the exhaust fan bearings to optimize lubrication, thereby extending intervals between lubrications.
- Human performance error reduction tools are highly integrated into the SRNS H-Canyon maintenance process.
- The SRNS H-Canyon Operations organization uses an automated tool linked to the watchbill list for control room staffing to track proficiency hours for individual operators and aid in ensuring their continued qualification.
- The Triad National Security, LLC's TA-55 SHR process and "Path to Green" approach provides an exceptional tool for monitoring the performance and overall status of safety-related systems. Triad's investment in creating and maintaining these documents, with quarterly updates, has resulted in an effective tool for ensuring that safety class systems continue to perform with high reliability.
- The Savannah River Remediation, LLC Concentration, Storage and Transfer Facilities system health database tool for managing periodic SHRs is easy to navigate and effective for assembling high-level information for senior management to easily understand the status of the system.
- Consolidated Nuclear Security, LLC effectively manages Pantex Plant's stock items and replacement parts in the warehouse by applying color-coded stickers that provide a visual indicator of acquisition level, controlled expiration date, critical spare indicator, property-controlled items, and storage level.

5.0 RECOMMENDATIONS

The following recommendations are based on the analysis of assessments as summarized in section 3.0 of this report. While the underlying weaknesses (findings and deficiencies) from the individual assessments did not apply to every reviewed site, the recommended actions are intended to provide insights for potential improvements at all DOE nuclear sites. Consequently, DOE field element managers and site contractors should evaluate the applicability of the following recommended actions to their respective nuclear facilities project and/or organizations and consider their use as appropriate in accordance with Headquarters and/or site-specific program objectives.

DOE Field Element Managers

To enhance DOE site office oversight of SSM activities:

- Develop effective strategies such as programs and incentives that ensure adequate FR and SSO staffing levels.

Site Contractors

To improve compliance with internal requirements:

- Ensure that requirements implementation matrices are used to verify the flowdown of requirements into implementing processes and strengthen training and qualification programs for procedural compliance.

To improve technical bases and justifications for proposed changes to safety SSCs, as well as the accuracy and completeness of engineering design documents, analyses, and calculations:

- Provide guidance regarding the expectations for appropriate technical bases for acceptance criteria and technically defensible engineering design documents, calculations, and analyses.

To improve the procurement processes for controlling suspect or counterfeit items:

- Ensure that the procedures relied upon for controlling suspect or counterfeit items contain requirements to collect, maintain, disseminate, and use the most accurate, up-to-date industry information on suspect or counterfeit items and suppliers, including whether vendors have previously supplied suspect or counterfeit items.

To improve the technical accuracy and performance of procedures:

- Perform validation and verification of operating procedures, using performance demonstrations, to ensure accuracy and adequate performance.

Appendix A
Supplemental Information

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Appendix B
Scope, Requirements and Guidance, and Assessed Sites

This lessons-learned report identifies common strengths and weaknesses, best practices, and recommendations, with the goal of increasing organizational learning throughout the U.S. Department of Energy (DOE) complex. This lessons-learned report is based on an analysis of eight Office of Enterprise Assessments (EA) assessments of DOE high-hazard (hazard category 1 and 2) nuclear facilities between January 2019 and September 2023. The facilities, assessed safety systems, and criteria review and approach document (CRAD) objectives included in the assessment scope are detailed in Table B-1. These facilities are under the direction of the DOE Office of Environmental Management, the National Nuclear Security Administration (NNSA), and the Office of Nuclear Energy. The objective of these assessments was to evaluate the effectiveness of the management and operating contractor's processes and activities used to manage and maintain the performance of safety SSCs to ensure their continued capability to reliably perform their intended safety functions, and to evaluate the adequacy of DOE oversight of the contractors' safety system management (SSM) performance.

The assessments included elements from the following CRADs to determine whether the policies, procedures, and operational performance met DOE objectives for effectiveness in the areas examined. These elements address the adequacy of programs and performance.

- CRAD 31-15, *Safety Systems Management Review*
- CRAD 30-11, *Safety Systems Management Review*
- CRAD 30-07, *Federal Line Management Oversight Processes*

Strengths, weaknesses, and deficiencies identified in the independent assessment reports for the facilities listed in Table B-1 were binned into the following functional areas from CRAD 31-15 (in addition to CRAD 31-15, elements of CRAD 30-07 were used in the evaluation of Federal oversight in six of eight assessments), and CRAD 30-11 for analysis:

- Engineering Design
- Quality Assurance
- Configuration Management
- Maintenance
- Surveillance and Testing
- Operations
- Cognizant System Engineer
- Federal Oversight
- Feedback and Improvement
- Safety Basis.

The safety basis functional area is not included in CRAD 31-15; however, it is included in its successor, CRAD 30-11, and was evaluated in one SSM assessment.

Table B-1. Summary of EA Assessments

Assessed Site (Date)	Nuclear Facility/SSC and CRADs utilized	Contractor	DOE Headquarters Program Office	DOE Field Element
Idaho National Laboratory (January 2023)	Advanced Test Reactor CRAD 31-15, Rev. 1 CRAD 30-07, Rev. 0 Confinement System, Radiation Monitoring and Seal System	Battelle Energy Alliance, LLC	Office of Nuclear Energy	Idaho Operations Office
Los Alamos National Laboratory (July 2022)	Technical Area 55 CRAD 31-15, Rev. 1 • Objectives SS.1 – SS.5, and SS.7 – SS.9 CRAD 30-07, Rev. 0 Safety class diesel and electric fire water pumps and safety class portions of their support systems	Triad National Security, LLC	National Nuclear Security Administration (NNSA)	NNSA Los Alamos Field Office
Oak Ridge National Laboratory (May 2022)	Liquid and Gaseous Waste Operations CRAD 31-15, Rev. 1 • Objectives SS.3 – SS.9 CRAD 30-07, Rev. 0 Liquid Low-Level Waste System	URS|CH2M Oak Ridge, LLC	Office of Environmental Management	Oak Ridge Office of Environmental Management
Pantex Plant (May 2023)	Cell facilities CRAD 31-15, Rev. 1 • Objectives SS.1, SS.2, and SS.5 – SS.9 CRAD 30-07, Rev. 0 Cell Equipment Blast Door Interlocks	Consolidated Nuclear Security, LLC	NNSA	NNSA Production Office
Savannah River Site (January 2019)	H-Canyon Facility CRAD 31-15, Rev. 1 • Objectives SS.1 – SS.7, and SS.9 Canyon exhaust fan system and evaporator steam isolation interlocks	Savannah River Nuclear Solutions, LLC	Office of Environmental Management	Savannah River Operations Office

Assessed Site (Date)	Nuclear Facility/SSC and CRADs utilized	Contractor	DOE Headquarters Program Office	DOE Field Element
Savannah River Site (August 2019)	Concentration, Storage, and Transfer Facilities CRAD 31-15, Rev. 1 Safety class (SC) waste tank high liquid level conductivity probes and alarms; safety significant (SS) 242-16H evaporator tube bundle pressure control and relief system; and SS 242-25H evaporator lance steam pressure control and relief system.	Savannah River Nuclear Solutions, LLC	Office of Environmental Management	Savannah River Operations Office
Savannah River Site (April 2023)	Concentration, Storage, and Transfer Facilities CRAD 31-15, Rev. 1 CRAD 30-07, Rev. 0 SC tank 30, 32, and 37 temperature indicators; SS waste tank hydrogen monitor and interlock; and the transfer facility ventilation system for H-Area Pump Tank (HPT)-2/H-Area Pump Pit (HPP)-2/HPT-3/HPP-3/HPT-4/HPP-4/H-Area Diversion Box (HDB)-2	Savannah River Mission Completion, LLC	Office of Environmental Management	Savannah River Operations Office
Sandia National Laboratories – New Mexico (September 2023)	Annular Core Research Reactor facility CRAD 30-11, Rev. 0 • Objectives SS.1 – SS.3, SS.5, SS.7, and SS.8 CRAD 30-07, Rev. 0 Reactor safety system and pool water level monitoring system	National Technology and Engineering Solutions of Sandia, LLC	NNSA	NNSA Sandia Field Office

Source Documents

EA Report, *Independent Assessment of Safety System Management of Cell Equipment Blast Door Interlocks at the Pantex Plant - May 2023*

EA Report, *Independent Assessment of Safety System Management at the Savannah River Site Concentration, Storage, and Transfer Facilities - April 2023*

EA Report, *Independent Assessment of Safety System Management for the Advanced Test Reactor at Idaho National Laboratory - January 2023*

EA Report, *Independent Assessment of TA-55 Fire Water Pump Safety System Management at the Los Alamos National Laboratory - July 2022*

EA Report, *Independent Assessment of Safety System Management for Liquid and Gaseous Waste Operations at Oak Ridge National Laboratory - May 2022*

EA Report, *Safety System Management Assessment at the Savannah River Site Liquid Waste Concentration, Storage, and Transfer Facilities - August 2019*

EA Report, *Assessment of Safety System Management at the Savannah River Site H-Canyon Facility - January 2019*

EA Report, *Independent Assessment of Safety System Management at the Sandia National Laboratories – New Mexico Annular Core Research Reactor Facility* – September 2023