Office of Enterprise Assessments
Assessment of Safety System Management at the Savannah River Site H-Canyon Facility

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Acronyms

ARU	Acid Recovery Unit
ASME	American Society of Mechanical Engineers
AUTO	Auto-start
CAEX	Canyon Exhaust System
CAS	Contractor Assurance System
CFR	Code of Federal Regulations
CGD	Commercial Grade Dedication
CLI	Component Location Identifier
CM	Corrective Maintenance
CMGT	Configuration Management
CMIP	Configuration Management Implementation Plan
CSE	Cognizant System Engineer
DCF	Design Change Form
DCP	Design Change Package
DOE	U.S. Department of Energy
DOE-SR	DOE Savannah River Operations Office
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
FR	Facility Representative
FY	Fiscal Year
GS	General Service
M&TE	Measuring and Test Equipment
MAC	Material Acquisition Center
MAE	Materials Acquisition Engineering
MEL	Master Equipment List
NCR	Non-conformance Report
NMMP-DD	Nuclear Maintenance Management Program Description Document
OFI	Opportunity for Improvement
ORPS	Occurrence Reporting and Processing System
PdM	Predictive Maintenance
PM	Preventive Maintenance
QA	Quality Assurance
RTD	Resistance Temperature Detector
SC	Safety Class
S/CI	Suspect/Counterfeit Item
SHR	System Health Report
SR	Surveillance Requirement
SRIP	Savannah River Implementing Procedure
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
SS	Safety Significant
SSC	Structure, System, and Component
SSO	Safety System Oversight
STAR	Site Tracking, Analysis, and Reporting
TDR	Time Delay Relay
TSR	Technical Safety Requirement
USQ	Unreviewed Safety Question

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA), conducted a safety system management assessment of the evaporator interlocks and the canyon exhaust system at the Savannah River Site H-Canyon Facility. The Office of Environmental Management Savannah River Operations Office (DOE-SR) has overall responsibility for the site. The management and operating contractor for the site, and for H-Canyon in particular, is Savannah River Nuclear Solutions, LLC (SRNS).

EA conducts assessments of safety system management to evaluate site processes for monitoring, maintaining, and operating safety-related systems to ensure their continued capability to reliably perform their intended safety functions. EA selected specific systems for this assessment, with input from DOE-SR, based on the systems' importance to nuclear safety during operation of the facility. The assessment scope included safety basis implementation in the design, configuration management, operations, maintenance, quality assurance, technical support, and feedback and improvement processes.

EA identified three areas where SRNS activities and processes constitute best practices worthy of emulation by other DOE organizations:

- Ultrasound technology is used during lubrication of the exhaust fan bearings to optimize lubrication. This practice has proven effective, extending intervals between lubrications.

- Human performance error reduction tools are highly integrated into the maintenance work process.

- The Operations organization uses an automated tool linked to the watchbill for control room staffing to track proficiency hours for individual operators and aid in ensuring their continued qualification.

EA also noted positive attributes in several other areas:

- Procedures in place to govern safety-related activities in H-Canyon, such as maintenance, operations, and configuration management, are well-developed and effective, with only minor discrepancies noted.

- The procurement process for replacement items and critical spares is structured and implemented to ensure that these items are available with the appropriate quality pedigree when needed.

- H-Canyon uses electronic online system notebooks to track system performance and as compendiums of relevant design and vendor information on key components.

- Lessons learned, assessment results, and feedback are often incorporated into continuing training to improve performance.

The safety-related evaporator interlocks and canyon exhaust system are, in general, managed by SRNS in a manner that adequately ensures their continued reliable functionality. However, EA identified some deficiencies. Based on functionality requirements for the exhaust fans, actions taken previously by SRNS to downgrade the fan clutches from safety class to general service were not appropriate. The installation

process for some safety-related spares does not provide requisite item traceability. Moreover, corrective maintenance on flange bolting for the safety class #1 and #4 fans, and on the #3 fan damper seal, has not been performed in a timely manner, allowing the degraded conditions to remain open for more than five and six years, respectively. This is symptomatic of the broader issue that work prioritization and scheduling weaknesses are contributing to a corrective maintenance backlog and preventive maintenance is regularly completed beyond its due date. A snapshot of surveillances scheduled during this assessment revealed that 47% were beyond the original due date. Seven of 57 were beyond the Technical Safety Requirement grace period, requiring any in-service equipment to be declared inoperable prior to the grace period expiration.

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1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment of safety system management at the Savannah River Site (SRS) H-Canyon Facility. This assessment was conducted within the broader context of an ongoing program of assessments of the management of safety systems across the DOE complex at hazard category 1, 2, and 3 facilities. The purpose of this EA effort is to evaluate processes for monitoring, maintaining, and operating safety systems to ensure their continued reliable capability to perform their intended safety functions.

EA performed this assessment of the SRS H-Canyon from September 10 through October 18, 2018. This report discusses the scope, background, methodology, results, and conclusions of the assessment, as well as the opportunities for improvement (OFIs) identified by the review team.

2.0 SCOPE

EA evaluated the management of the safety class (SC) canyon exhaust fan system (CAEX) and both SC and safety significant (SS) evaporator steam isolation interlocks. The assessment scope included the design, operation, maintenance, testing, technical baseline, configuration management (CMGT), system engineering, and feedback improvement processes as applied to the selected systems/components. EA further examined the flowdown of safety basis requirements into technical baseline documents and the application of appropriate technical requirements in the procurement process for component spares and replacement items.

This review scope was established in cooperation with key interface individuals within DOE-SR and was accomplished in accordance with the *Plan for the Office of Enterprise Assessments Assessment of Safety System Management at the Savannah River Site H-Canyon Facility, September – October 2018*.

3.0 BACKGROUND

H-Canyon and its associated outside facilities consist of multiple related structures and capabilities, located in H-Area of the 310 square mile SRS. Activities performed at H-Canyon include dissolution and recovery of plutonium and enriched uranium materials, removal of fission products, and waste concentration. H-Canyon is hazard category 2 and the 292-H fan house is hazard category 3 based on radiological inventory. Safety analyses of postulated events considering potential hazards led to the designation of both SC and SS controls to address prevention and/or mitigation of those events.

The canyon exhaust fans and associated dampers, instrumentation, and controls are part of the SC portion of the H-Canyon CAEX. These components provide a slight vacuum to ensure that any airborne radioactive material released inside the facility during a postulated event is filtered to protect the public, the co-located worker, and all facility workers.

The SC interlocks for evaporators 6.8E, 7.6E, 7.7E, 9.1E, 9.2E, and 17.8E, and SS interlocks for evaporators 17.2E and 17.6E and for acid recovery unit (ARU) reboiler 604, serve to protect the public,

the co-located worker, and all facility workers by preventing the development of conditions that could potentially result in red oil or process vessel vent filter explosions. (A red oil explosion can occur when tri-butyl phosphate is present with nitric acid under high pressure/temperature conditions. The Russian Tomsk-7 reprocessing facility at Seversk experienced a red oil explosion in 1993.) These interlocks prevent high pressure and/or high temperature conditions by isolating steam flow to the evaporators. Additional SS interlocks within the scope of this assessment included one interlock to prevent inadvertent criticality on evaporator 17.6E and a low-level pump interlock on ARU feed tank 601.

Oversight of H-Canyon is the responsibility of DOE-SR. Savannah River Nuclear Solutions, LLC (SRNS) is the SRS management and operating contractor. Most programmatic functions at H-Canyon are accomplished through sitewide procedures established and maintained by SRNS.

4.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*. EA implements the independent oversight program through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. Organizations and programs within DOE use varying terms to document specific assessment results. In this report, EA uses the terms "deficiencies, findings, and opportunities for improvement (OFIs)" as defined in DOE Order 227.1A. In accordance with DOE Order 227.1A, DOE line management and/or contractor organizations must develop and implement corrective action plans for the deficiencies identified as findings. Other important deficiencies not meeting the criteria for a finding are also highlighted in the report and summarized in Appendix C. These deficiencies should be addressed consistent with site-specific issues management procedures.

As identified in the assessment plan, this EA assessment considered requirements related to safety system management. EA used the objectives, criteria, and lines of inquiry in Criteria and Review Approach Document 31-15, *Safety Systems Management Review*, as the basis for this assessment.

EA examined key documents, such as engineering design documents, work packages, procedures, manuals, analyses, and training and qualification records. EA also conducted interviews with key personnel responsible for developing and executing the associated programs; observed Maintenance and Operations activities; and walked down accessible portions of the selected systems. The members of the EA assessment team, the Quality Review Board, and EA management responsible for this assessment are listed in Appendix A. A detailed list of the documents reviewed, personnel interviewed, and observations made during this assessment, relevant to the findings and conclusions of this report, is provided in Appendix B.

EA has not conducted a recent assessment of H-Canyon. Therefore, there were no items for follow-up during this assessment.

5.0 RESULTS

5.1 Engineering Design

This section discusses EA's assessment of the engineering processes and products related to the selected systems. EA conducted field walkdowns, reviewed technical documents describing the design of the systems, and examined implementing procedures to assess the processes used to develop and maintain those documents.

Objective:

Engineering design documents and analyses are technically adequate and implement the requirements of the documented safety analysis (DSA) such that adequate protection of the public, the workers, and the environment from facility hazards is demonstrated. (DOE-STD-3009-2014 and 10 CFR 830, Part 122)

Criteria:

- *Engineered SSCs and processes are designed using sound engineering/scientific principles and appropriate standards. (10 CFR 830.122, Criterion 6)*

- *Engineering design incorporates applicable requirements and design bases in design work and design changes (e.g., design calculations). (10 CFR 830.122, Criterion 6)*

- *The adequacy of design products is verified or validated by individuals or groups other than those who performed the work. (10 CFR 830.122, Criterion 6)*

- *Verification and validation work is completed before approval and implementation of the design. (10 CFR 830.122, Criterion 6)*

- *Problems identified related to engineering performance and/or products are documented and corrected in a manner that prevents recurrence. (10 CFR 830.122, Criterion 3)*

Engineering Process Review

EA reviewed engineering processes for most primary engineering design functions, including preparation and approval of drawings, calculations, and design changes. The results are briefly summarized below:

- Procedure E7 2.30, *Drawings*, is adequate, straightforward, and detailed.

- Procedure E7 2.31, *Engineering Calculations*, includes well-defined requirements for calculation origination, review/checking, verification, and approval. Moreover, the procedure requires inputs to be justified or have a source reference. If an assumption is not technically justified, the procedure requires an open item to be created and tracked to document the assumption. The open item tracking process is clearly delineated, with provisions in the design change closure process to ensure that open items are closed before an implemented change is placed into service.

- Procedures E7 2.05, *Modification Traveler*; E7 2.37, *Design Change Form*; and E7 2.38, *Design Change Package*, define a design change/facility modification process structured to support the CMGT process in a technically defensible manner. Design change packages (DCPs) are used for most facility design changes. Design change forms (DCFs) may be used to make minor (single discipline) changes or to revise issued DCPs. Modification travelers are required for modifications that cost more than $200,000 and will generally include multiple DCPs. These procedures require documented design inputs and technical justification for the proposed change. An adequate closure process is defined that ensures that the design change is implemented with fidelity and that the affected drawings and other documents are properly updated.

- Procedure E7 2.33, *Notification of Discovered Technical Errors*, states that "This procedure establishes responsibilities, requirements and means for the notification of technical errors discovered during the use of engineering documents and software." However, this procedure was not meant to

be used for technical errors in drawings, calculations, or other internally produced engineering documents, and could benefit from clarification in its intended application. A small sample of reported errors from the last two years indicated that the reports correctly documented errors made by vendors in either their software, programs, or documentation.

These procedures are supplemented by 11Q 1.05, *Nuclear Facility Unreviewed Safety Questions*, which provides excellent guidance on performing the unreviewed safety question (USQ) screening and evaluation processes, responding to potentially inadequate safety analysis situations, and reporting requirements to DOE. 11Q 1.05 also provides comprehensive direction on evaluating "intermediate configurations," or conditions that may occur/exist on an interim basis during implementation of a facility modification.

Engineering Output Review

EA's technical baseline review included a sample of engineering documents, including calculations, drawings, and change packages. Portions of the DSA and technical safety requirements (TSRs) applicable to the selected systems were also reviewed to identify those functional capability requirements necessary to support the safety bases for the systems.

EA reviewed a sample of 11 calculations against the requirements of E7 2.31, finding that most are technically adequate and procedurally compliant. However, a few issues were identified: **(Deficiency)**

- T-CLC-H-00981 includes a stress analysis of an SC steam isolation valve and is inappropriately classified as general service (GS). Safety-related calculations require design verification, while GS calculations do not.

- T-CLC-H-00932, another stress analysis calculation, was classified as GS/SC, which is not permitted by procedure. This analysis included piping with welded attachments but did not evaluate stresses at those attachments. SRNS Engineering Guide 15060-G states that "Welded attachments to the pipe wall shall meet the qualification requirements of ASME Code Cases N-318-3, N-392-1 or shall be qualified by detailed analysis (i.e., finite element analysis) or test."

- Key design input parameters (design temperature and pressure) for the piping analyzed in T-CLC-H-00932 were established via an email that was then attached to the calculation as a source reference. This calculation was then referenced by T-CLC-H-00981 as the source of that information for that calculation. E7 2.31 requires that calculation originators ensure input data is "adequately referenced and/or justified." Section 5.3.1 of E7 2.31 states, "Inputs require a reference back to a source document." However, these procedures do not contain guidance or criteria establishing acceptable forms of design input for engineering calculations and DCPs. (See **OFI-SRNS-1**.)

- Calculations for the SS instrumentation for the evaporators do not correctly analyze, in accordance with ANSI/ISA Standard 67.04.01, the effect of variations in power supply voltage on device accuracy. Calculations J-CLC-H-00722, J-CLC-H-00973, J-CLC-H-00982, and J-CLC-H-00991 state that "No power supply effect is anticipated." Attachments to the calculations describing the instrument loop diagram do not include any details about the power supply(s). Manufacturer's data sheets within the calculations specify that the effect on device accuracy is due to variations in the voltage of the input power supply. ISA Standard 67.04.01 requires the effect of variations in the power supply input voltage to be included in the mathematical determination of the instrumentation accuracy.

EA noted considerable conservatism in the CAEX instrumentation accuracy calculations. Revisiting these calculations could support extending the current annual calibration interval to once every five years while still protecting the TSR safety analysis value. Three other calculations for canyon exhaust SS pressure switches contain an assumption for instrument drift, as no drift information was provided by the manufacturer. SRNS now has eight years of as-found calibration data that can be used to replace this unvalidated assumption. SRNS created 2018-CTS-010767 during this assessment to evaluate the drift assumed for these pressure switches.

The engineering design product review included a sample of 18 DCFs, 7 DCPs, and 3 modification travelers. Most of the packages are technically adequate, clearly indicating the required changes and providing a basis for the proposed changes in the package or referencing other documents for technical justification for the changes. A few DCPs/DCFs do not comply with SRNS procedural requirements: **(Deficiency)**

- C-DCF-H-04390 was issued with no technical justification for the adequacy of the approved change, containing only a statement that "Modifications…are structurally acceptable." C-DCF-H-04428 contained a similar statement. E7 2.37 requires technical justification for an approved design change.

- M-DCF-H-12967 and M-DCF-H-13039 contained no technical justification.

- M-DCP-H-10012 and -10013 contain technical justification in an email documenting that a walkdown was performed instead of actual analysis. The email states, "By review of the existing supports (See Attached Photos) it was determined the supports are located to provide sufficient support for the new additional valve. Therefore, no piping stress analysis or pipe support design is required." This technical evaluation was visual only, with no evaluation of increased stresses due to the newly added isolation valve (see Figure 1: Steam Isolation Valve), reduced analytical margins, or increased pipe support loads. Impact of this valve on the existing pipe supports and on piping stresses in the two inch steam line was likely significant, since the valve is large relative to the piping diameter, is installed horizontally, and has an extended operator.

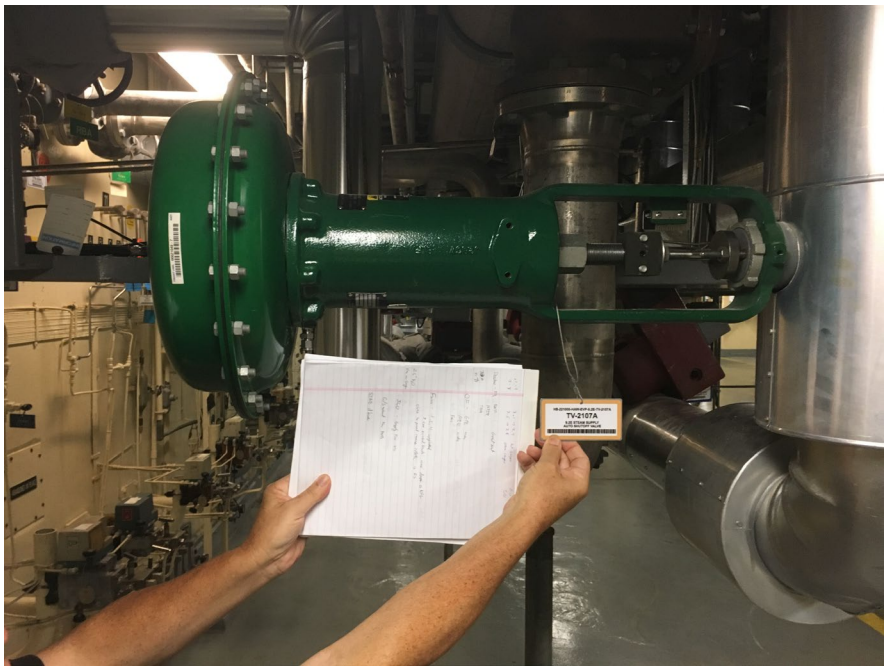

Figure 1: Steam Isolation Valve

Field Walkdown

While on a field walkdown with EA, a DOE-SR facility representative (FR) identified a rod hanger on the steam piping to evaporator 9.2E that was improperly installed. A photograph was taken, and the issue was discussed with SRNS (see Figure 2: Rod Hanger). The clevis on the lower end of the rod hanger is outside of the clamp ears on an extended length threaded stud. A nut holding the clevis on the stud is not fully engaged, lacking at least two threads from full engagement. The rod portion of the hanger is in contact with the body of a valve mounted in an adjacent line. SRNS took prompt action to document the concern and initiate actions to determine an appropriate corrective response.

Figure 2: Rod Hanger

Engineering Participation in the Corrective Action Process

EA reviewed the Engineering organization's participation in the Site Tracking, Analysis, and Reporting (STAR) system, the corrective action process in use across the site. Procedure Q22 CAP-1, *Corrective Action Program*, is the governing procedure. This portion of the assessment focused on issues assigned to Engineering for resolution and closure. EA evaluated a small sample of STAR items, finding that the corrective action plans were technically adequate to correct the identified discrepancies. No issues were identified.

Exhaust Fan Clutch Issue

DOE-SR FR assessment report (2018-SA-002713) identified a concern that the clutches installed to prevent reverse rotation on CAEX fans #1, #2, and #4 had initially been installed as SC and subsequently downgraded to GS. The CAEX system requires two operating fans to achieve the TSR-mandated vacuum in the canyon. Three fans are normally run to increase the operating margin. Therefore, one fan would normally be idle and placed in auto-start (AUTO) status to permit automatic start on low vacuum. The

fans are connected by a common header duct on the inlet side and another on the outlet side. The discharge isolation dampers on all four fans are not leak tight. (The dampers on fans #1, #2, and #4 are designed for limited leakage. The #3 fan damper has damaged seals that also allow backflow.)

On all four fans, this backflow is enough to cause the fans to reverse rotate in the absence of countermeasures. SRNS has determined that reverse rotating fans are not operable, based on a concern that attempting to start a reverse rotating fan would likely lead to breaker trip or a fan shaft coupling failure. Clutches were installed on fans #1, #2, and #4 to prevent reverse rotation. Fan #3 does not have any such preventive measure (see Section 5.4). Figure 3, below, shows a clutch mounted onto a motor shaft extension.

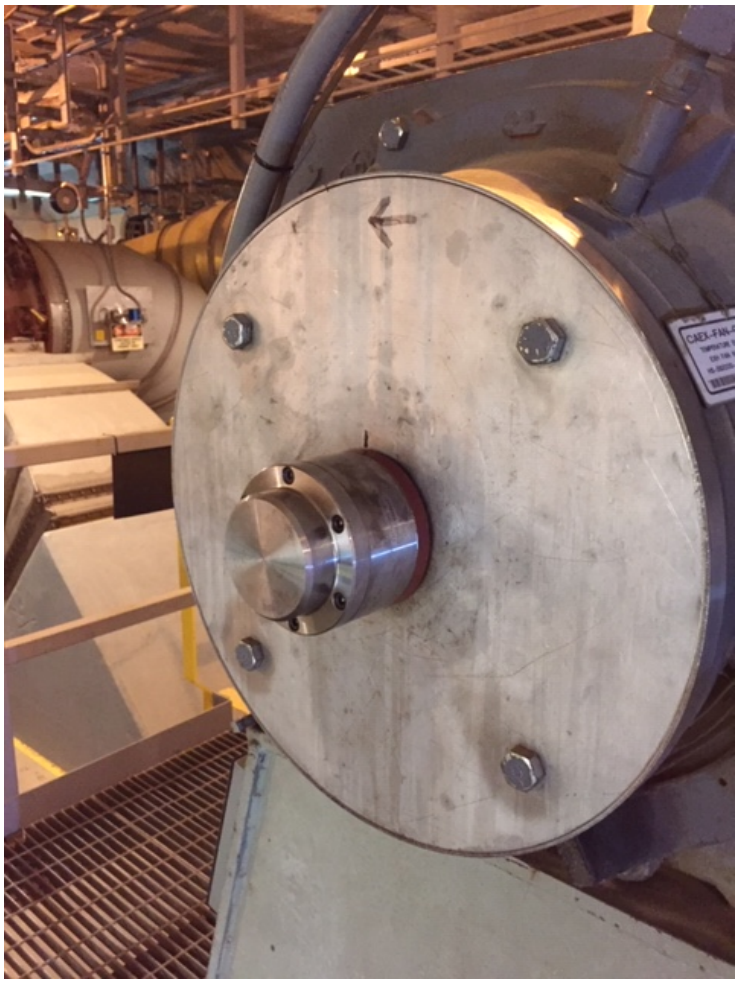

Figure 3: Fan Motor Clutch

While reviewing these conditions, EA identified a functional requirement document, E-FPR-G-00005, *Functional Performance Requirements Upgrade Canyon Exhaust System*, requiring this updated system to meet the single failure criteria from DOE Order 6430.1A, Section 1300-3.3, *Single Failure Criterion and Redundancy*. Compliance with these requirements under all postulated accident and natural phenomena events could not be demonstrated without assuming functionality of the fan clutches. DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facilities Documented Safety Analyses*, Section 4.3.X.2, states, "Identify SSCs whose failure would result in an [SC] SSC losing the ability to perform its required safety function. These SSCs would also be considered [SC] SSCs for the specific accident conditions for which the [SC] designation was made originally." Because the clutches are necessary to ensure operability of those fans placed in AUTO, an SC designation is appropriate. **(Deficiency)**

Review of DSA sections related to the CAEX identified a description of fan discharge damper function in section 4.3.2.2.3 that does not reflect the current capabilities of those dampers. SRNS indicated that this is a known issue, which is being tracked under STAR #2018-CTS-007980 and will be corrected in the next DSA update.

Engineering Design Conclusions

Engineering processes at H-Canyon are generally comprehensive and fundamentally sound, providing a well-constructed basis for completion of engineering tasks. The procedures and process for handling/ closure of open items is particularly effective. The corrective action process is adequately implemented

within the Engineering organization. Most calculations and DCPs were developed in accordance with procedural requirements. EA's examination of the CAEX fan clutch downgrade from SC to GS concluded that the downgrade was not appropriate.

5.2 Quality Assurance

This section discusses EA's assessment of quality assurance (QA) aspects of the procurement process. An important aspect of QA as applied to operating facilities is the need to ensure that both new components and replacement items are designed, manufactured, and procured to sufficient quality standards and that they are capable of performing required safety-related functions.

Objective:

QA practices and processes are implemented in a manner that ensures safety systems will conform to required standards and perform as designed. (10 CFR 830, Subpart A)

Criteria:

- *Requirements are established for procurement and verification of items and services. (10 CFR 830.122, Criterion 7)*

- *Processes are established and implemented that ensure that approved suppliers continue to provide acceptable items and services. (10 CFR 830.122, Criterion 7)*

EA evaluated component procurement documents, receipt inspection/commercial grade dedication (CGD) performance, and critical spare parts management associated with the following SC and SS safety-related component replacements:

- CAEX tunnel pressure gauge
- CAEX fan #4 "R" motor starter contacts "A", "B", & "C"
- CAEX fan #1 discharge damper solenoid
- CAEX fan #2 inboard and outboard bearings
- Evaporator (6.8, 7.6, 7.7, 9.1, 9.2, 17.8) thermowells
- Evaporator (6.8, 7.6, 7.7, 9.1, 17.8) resistance temperature detectors (RTDs).

EA interviewed CSEs (assigned to the CAEX System and evaporator and ARU steam flow interlocks) and quality assurance personnel; walked down the CAEX system, Evaporator 7.6, the H-Canyon Material Acquisition Center, and N-Area receiving warehouse; and observed a Commercial Grade Dedication priority meeting.

Procurement Documents

SRNS procurement procedures E7 3.46, *Replacement Item Evaluation/Commercial Grade Dedication*; Q19 1-0, *Receiving Inspection*; and 1Q 8-1, *Identification and Control of Items*, define an adequate graded approach, process, and roles and responsibilities for developing procurement documents and verifying the receipt of procured safety-related components. SRNS assigned one cognizant system engineer (CSE) to the CAEX, four CSEs to the eight evaporator steam flow interlocks, and one CSE to the ARU. Training records confirmed that all EA-interviewed CSEs have completed the SRNS engineering procurement training module, which includes some CGD information, as a basic engineering qualification requirement. Fully qualified CSEs demonstrated adequate procurement process knowledge

during interviews. The two partially qualified CSEs had very little knowledge of the procurement process but indicated they were learning on the job and had immediate access to a fully qualified, experienced mentor. EA observed the CSEs' adept use of the engineering records systems Smartplant Foundation, Asset Suite, and Engineering Plant and Facilities Management to obtain component information on safety systems.

The H-Canyon safety-related components within the scope of this EA assessment have not required many component replacements over the past 15 years. Although 1Y 8.20, *Work Control Procedure*, Attachment 8.5, does not require the inclusion of materials/parts requisitions and CGD packages in work orders, 14 of the 15 sampled work order records include procurement-related information, providing an effective procurement documentation trail. All sampled work orders clearly demonstrate proficient replacement procedural execution, including recorded calibrated measuring and test equipment (M&TE), checked off/initialed procedural steps, completed hold points with QA inspector signoffs, defined performance acceptance criteria, and as-found/as-left measurements.

Qualified Suppliers

Of the sampled safety system components, six were thermowells. Of the six thermowell replacement work orders, only one included a procurement request as a "Level 1" procurement (i.e., requires purchase through a qualified supplier). The other five thermowell replacement work order procurement requests were identified as "Level 2" procurements (i.e., requires a Receipt Inspection Criteria Package and CGD). This is reflective of a bulk order (several thermowells) with subsequent withdrawals from site stores of individual thermowells as needed. EA confirmed that SRNS listed the evaporator thermowell supplier on the SRNS Qualified Suppliers List; the supplier has been qualified since 2003. SRNS performed the most recent supplier source surveillance, which focused specifically on the current thermowell procurement specification, and did not identify any issues. The SRNS assessor was qualified at the time of the surveillance.

Receipt Inspection/Commercial Grade Dedication

Q19 1-0 specifies an adequate process for verifying that procured items satisfy documented procurement requirements and ensuring that any suspect/counterfeit items (S/CIs) are identified. Procured item receipt normally occurs at the SRNS N-Area receiving warehouse. SRNS securely stores received items in N-Area or the H-Canyon Material Acquisition Center (MAC) until the items are removed for installation. The MAC is a secure Level B storage building, which protects stored items from the effects of temperature extremes and humidity, with appropriately roped-off access bearing restricted access signs and a locked entry door. EA observed proper storage of sampled thermowells (etched with a heat number) and RTDs (properly tagged with a serial number); both collections of thermowells and RTDs included QA procurement documentation.

CSEs rely on the Material Acquisition Engineering (MAE) group to meet procurement CGD requirements. SRNS formed the MAE group in June 2016 to process all CGD documents for procured items not acquired from qualified suppliers. SRNS has staffed the MAE group with ten QA professionals, led by a qualified expert who demonstrated a comprehensive understanding of the CGD process consistent with ASME NQA-1. EA observed effective interaction between CSE supervisors and the MAE group regarding an extensive list of pending CGD priorities. The MAE implements E7 3.46, which provides an adequate process consistent with ASME NQA-1, Part II, Subpart 2.14, *Quality Assurance Requirements for Commercial Grade Items and Services*, 2009.

SRNS purchased 14 of the 15 EA-sampled safety system components as commercial items subject to the SRNS CGD process. The CGD plans for sampled components that were included in work orders

incorporated appropriate design authority, approved technical evaluations, failure effects analyses, critical characteristics, and acceptance criteria consistent with E7 3.46. Prior to component installation, SRNS ensured that safety-related components had the proper quality pedigree. For example, several thermowell replacement work orders consistently included a completed hold point (signed and dated) for an SRNS qualified inspector to verify the proper commercial graded dedication critical characteristics in a referenced formal inspection report.

Item Control/Critical Spare Parts Management

Although SRNS does not use a specific procedure to ensure identification and maintenance of critical spares, E7 3.04, *SSC Performance Monitoring*, provides adequate guidance to CSEs for evaluating available spares for SC/SS components. Each CSE has appropriately developed a list of critical spares for their assigned safety systems, which includes all SC/SS components associated with their assigned safety systems. CSEs report the availability status of critical spares in onsite stores in their annual system health presentation.

Availability of critical spare parts is predicated on onsite stores as indicated in the procurement database. EA sampled three CSE-identified critical spares, an evaporator RTD, an evaporator steam control valve, and an evaporator solenoid valve, for availability in onsite inventory storage facilities. EA walked down the MAC storage facility and the N-Area. All three EA-sampled components were located at either the MAC or the N-Area facilities with proper tags and requisite environmental storage conditions as specified on inventory records.

Work orders contain sufficient QA documentation to trace back the quality pedigree to the source. SRNS purchased safety-related components, such as evaporator thermowells and RTDs, in small lots. The manufacturer uniquely identified each component within the lot with a heat number or serial number that provides a unique identity for each item. However, contrary to the requirements of 1Q 8-1, installation documents and/or database records for the evaporator thermowells and RTDs do not provide traceability of manufactured components to the point of installation. (**Deficiency**) If the manufacturer notified SRNS of a significant problem with a specific thermowell or RTD, SRNS would be unable to determine the vessel in which the component was installed.

Quality Assurance Conclusions

Sampled safety system procurement documentation indicates that H-Canyon effectively implements the SRNS procurement system, with CSEs relying on the MAE group to develop or modify CGD plans for procuring safety-related components from non-qualified suppliers. A sampled procurement through a qualified supplier and all sampled receipt inspections/CGDs were consistent with SRNS procurement controls. CSEs have effectively identified critical spares. However, SRNS has not maintained requisite item traceability of safety-related thermowells and RTDs from the manufacturer to the point of installation.

5.3 Configuration Management

This section discusses EA's assessment of the H-Canyon CMGT program based on the requirements of DOE-STD-1073-2003, *Configuration Management Program*.

Objective:

CMGT programs and processes are adequate to ensure that safety systems continue to meet safety basis requirements and changes are properly controlled. (DOE Order 413.3B, Attachment 2; DOE Order

420.1B, Chapter V [or DOE Order 420.1C as applicable to the facility]; and DOE-STD-1073-2003 if applicable)

Criteria:

- *The CMGT process adequately integrates the elements of system requirements and performance criteria, system assessments, change control, work control, and documentation control. (DOE Order 413.3B, Attachment 2; DOE Order 420.1B, Chapter V [or DOE Order 420.1C as applicable to the facility], and DOE-STD-1073-2003 if applicable)*

- *CMGT is used to develop and maintain consistency among system requirements and performance criteria, documentation, and physical configuration for the SSCs within the scope of the program. (DOE Order 420.1B, Chapter V)*

- *System design basis documentation and supporting documents are kept current using formal change control and work control processes. (DOE Order 420.1B, Chapter V)*

- *Applicable requirements and design bases are incorporated in design work and design changes. (10 CFR 830.122, Criterion 6)*

- *Changes to system requirements, documents, and installed components are formally designed, reviewed, approved, implemented, tested, and documented. (DOE Order 420.1B, Chapter V)*

- *System piping and instrumentation diagrams have been prepared, are maintained, and reflect the installed configuration of the associated safety system. (DOE-STD-1073-2003, Section 6.4)*

EA examined program documents and implementing procedures for various aspects of CGMT as defined in DOE STD-1073-2003 as outlined below.

Much of the H-Canyon Facility pre-dates DOE requirements for CMGT. However, a functioning program is now in place and there is a cadre of CSEs who are assigned to the H-Canyon SSCs and have direct responsibilities for maintaining configuration of their assigned systems. To support the re-establishment of CMGT at H-Canyon, a technical baseline reconstruction effort was initiated in Fiscal Year (FY) 2002 but was completed for only a few systems. Due to longstanding deficiencies with CMGT, when tasks requiring the use of drawings, piping and instrumentation diagrams, and other CMGT documents are planned, field walkdowns are routinely conducted to validate field conditions against existing CMGT documents.

Manual E7, *Conduct of Engineering*, contains the suite of CMGT procedures that overall define an adequate program. Specific procedures in Manual E7 address the H-Canyon technical baseline, design change control, work control, document control, and assessments, which are discussed below.

Technical Baseline

G-CMIP-H-00001, *H-Canyon Configuration Management Implementation Plan*, provides an adequate current overview of the implementation and status of CMGT per the requirements of Manual E7. The plan reports the status of the effort to complete the technical baseline reconstruction for each system, subdivided into the following major tasks: performing walkdowns, defining component location identifiers (CLIs), updating drawings, installing component labels, and updating the master equipment list (MEL). These tasks were fully completed for 2 of the 13 SC systems (H-Canyon Exhaust and Emergency

Electrical Power) and 1 of the 17 SS systems (ARU) since technical baseline reconstruction was initiated in FY 2002. Progress has been minimal since FY 2004 due to the lack of funding and resources. The implementation plan does not discuss compensatory actions and/or alternative implementation plans/actions. Such discussion is necessary given the lack of progress over several years.

The technical baseline list is adequately defined within two documents: G-TBL-H-00003, *H-Canyon Technical Baseline List*, and G-TBL-H-00002, *HB-Line Technical Baseline List*. These documents define and assign the essential, support, or general category to H-Canyon safety-basis-related documents, procedures, system drawings, setpoints, and calculations. Additional references are sometimes made in support databases, such as Lotus Notes, Document Control, SafetyNet, ProCal Program, and the MEL. EA reviewed a sample of documents from the CAEX and found that they properly support the technical baseline and CMGT requirements. Each document is uniquely identified and assigned the appropriate technical baseline category (essential, support, or general).

Design Change Control

The process for design change control defined in procedures E7 2.05, E7 2.37, and E7 2.38 is well constructed and in compliance with DOE requirements, as discussed in Section 5.1, above. Preparers are required to identify design input documents and other related documents that might be impacted by the planned change. Implementation processes are structured to establish and maintain configuration control through package closure. Requirements documents may also be prepared for large modifications. The CSEs are involved in every stage of the preparation process and again at closure. The DCFs and DCPs that EA reviewed are of good quality, with only a few exceptions as previously noted.

Work Control

For the sample reviewed, work control activities are adequately identified, initiated, planned, scheduled, coordinated, performed, approved, validated, and reviewed per Manual 1Y, *Conduct of Maintenance*. The work control activities are formally documented into work packages that include the necessary processes to maintain CMGT. In the case of a modification to an SSC, a CMGT process is invoked that defines and includes specific DCPs and/or DCFs. EA reviewed several DCPs that adequately implemented Manual E7, Procedure 2.38, *Design Change Package*. For example, EA's review of C-DCP-H-16004, *Concrete Coring and Sleeve Assembly Installation in the 221 H Section 3 Personnel Tunnel*, determined that the DCP was adequate. The package follows the major steps in the procedure for DCP preparation, review/approval, and implementation/closure. The required documents are included and approved in the package. The before and after tunnel change modifications are adequately shown on drawings and tracked with a Design Change Notification. Other configuration changes are correctly identified on the Design Authority Document Impacts Review Checklist. The checklist identifies changes to one operations procedure and references the CLIs for the fire protection seals, the need for installing labels, and the need to revise four drawings (A-AB-H-7135, W147144, W147146C, CC-H-08361).

Document Control

Document control processes/procedures are adequately defined in Manual E7, beginning with E7 1.02, *Engineering Overview and Graded Approach,* and other procedures depending on the type of CMGT change needed. Depending on the change complexity, the change results, for example, in a DCF (E7 2.37), DCP (E7 2.38), field change request (E7 1.55), or modification traveler (E7 2.05). Within each change process, the design authority engineer/CSE assigns the responsibility of approving the change documents to the appropriate point of contact for nuclear and criticality safety engineering, fire protection engineering, structures and buildings engineering, and the area CMGT based on the potential impacts to the safety basis program, fire protection program, CMGT program, and structural integrity program.

EA reviewed several examples of changes to CMGT using the document control change processes. The applicable document control processes to address the changes were completed, and CMGT records and databases were updated.

Overall, the drawings reviewed during this EA assessment are also adequate. As one example, the electrical and instrumentation drawings for evaporator 7.6E were reviewed. The drawings adequately show current changes to the temperature loop and other changes. The different completed change packages and also open packages were retrieved in SmartPlant and provide the details necessary to understand the changes to the evaporator 7.6E system drawings.

Assessments

H-Canyon has in place an approach document G-ESR-G-00087, *Site Configuration Management Assessment Plan and Schedule*, that adequately identifies the process for scheduling and conducting assessments to detect, document, determine the cause of, and initiate correction of inconsistencies among design requirements, documentation, and physical configuration. H-Canyon had adequate CMGT assessment schedules for FY 2016, 2017, and 2018 that included several CMGT functional area assessments and CSE walkdown assessments. Most assessments were completed as scheduled.

Most of the CMGT functional area assessments reviewed by EA were performance-based reviews and were appropriately identifying weak areas. However, additional rigor is needed for some of these assessments. For example:

- Assessment 2017-SA-002482, *Evaluation of Overall H-Canyon Configuration Management Implementation Plan* [CMIP], reviewed the CMIP and appropriately verified that H-Canyon has an implementation schedule that includes CMGT actions, required resources, assigned organizational responsibilities, and a current resource and schedule summary. The CMIP appropriately contains a recommendation that management explore the addition of a CMGT resource to relieve some of the administrative burden from the engineers and management. This recommendation had not been implemented at the time of this EA assessment. 2017-SA-002482 missed the opportunity to question why the CMIP's implementation status has remained fixed since 2004 and indicate that further discussion on the path forward was needed, as discussed earlier in this section.

- Assessment 2017-SA-002832, *Master Equipment List*, documents an adequate performance-based review that determined that, with one exception, SSCs that are part of the safety basis are maintained by work control processes, preventive and corrective maintenance (CM) programs, and equipment assignments. The exception was that for one CLI an insufficient work history was entered into the Asset Suite database. The assessment appropriately identified an OFI to reinforce, with work groups, the requirement to enter a sufficient amount of information on completed work orders into the database.

- Assessment 2016-SA-006526, *FA-09 Design Requirements-Element 9.2*, conducted a performance-based review to ensure that the technical baseline is established and reflected in facility conditions by sampling CLIs in the MEL and drawings, and verifying that the CLI labels installed in the facility match the MEL. A finding is appropriately identified concerning several deficiencies between the installed labels and the MEL. In addition, the assessment appropriately identifies a task to investigate the extent of condition of the finding by performing another sample of CLI labels in FY 2018. In assessment 2018-SA-000946, Manual 2S, Procedure 5.11, *Equipment and Pipe Labeling H-Canyon*, two systems were reviewed and one was found to have labeling deficiencies. The deficiencies identified in this assessment were corrected, however no further actions were taken to address the need for additional assessments to review the full extent of labeling deficiencies.

- Assessment 2017-SA-003751, *Temporary Modifications*, reviewed implementation of two active temporary modifications at H-Canyon to the requirements in Procedure E7 2.06, *Temporary Modification Control*. H-Canyon routinely performs this assessment as a lessons learned because of previous CMGT problems in this area. The assessment concluded that these temporary modifications had adequately completed the required screens (USQ, design authority technical review, consolidated hazards analysis process) and had adequately identified all impacted documents and impacted organizations. The assessment further appropriately identifies a finding that the Document Control organization had not been provided information/documents on this temporary modification. This is a significant breakdown because Document Control is the organization/database to retrieve current documents on SS/SC systems at H-Canyon.

EA reviewed 12 recently completed CSE walkdowns. Desktop instruction M&O-2009-00007, *M&O Engineering Desktop Instruction System Walkdowns*, adequately establishes the expectations for these walkdowns. However, the scope/purpose section for the walkdown assessment documentation does not include a reference to the desktop instruction, even though the results section closely follows its guidance. The instruction has a list of items to inspect, observe, and document for the selected system, such as leaks, missing tags, areas of rust, and broken/degraded components. Most of the reviewed walkdowns, per the desktop instruction, provides a concise list of the caution and other types of tags attached to system components, missing labels, leaks, leak containment setups, and other observations. When applicable, the results of drawing walkdowns are reported and include any identified discrepancies. The H-Canyon CSE walkdown process is adequately defined and implemented, and the real-time information that is obtained from these walkdowns supports the quality of the routine safety health briefings and contributes to improving safety-related SSC CMGT.

Configuration Management Conclusions

The H-Canyon CMGT program is adequately described in Manual E7. H-Canyon has pursued a long-term effort to implement a technical baseline reconstruction, but progress has stalled for many years and much work remains. It is well known at H-Canyon that CMGT is suspect; therefore, when key CMGT documents are used to perform tasks, the documents (such as system drawings) are initially verified with field conditions. For the CMGT documents reviewed by EA, work control and document control processes are adequately performed in accordance with Manual E7 and are supported by various CMGT databases. H-Canyon annually conducts an adequate set of planned and scoped assessments that are directed at specific configuration functional areas and CSE walkdowns. These assessments are routinely identifying and correcting CMGT deficiencies, such as process implementation deficiencies, labeling problems, and drawing inaccuracies.

5.4 Maintenance

This section discusses EA's assessment of maintenance activities related to the selected systems. Safety-related systems must be maintained in a manner that ensures that they will be capable of performing their safety functions when required. The facility maintenance program is established for this purpose, through a combination of preventive maintenance (PM), CM, and predictive maintenance (PdM).

Objective:

Maintenance activities are properly planned, scheduled, and performed to ensure that safety systems can reliably perform intended safety functions when required. (DOE Order 433.1B)

Criteria:

- *The safety system is included in the nuclear facility maintenance management program and the DOE-approved Nuclear Maintenance Management Plan required by DOE Order 433.1B. (DOE Order 433.1B)*

- *Maintenance processes for the system are in place for CM, PM, and PdM; to manage the maintenance backlog; and consistent with the system's safety classification. (DOE Order 433.1B, Attachment 2)*

- *Maintenance activities associated with the system, including work control and post-maintenance testing, are formally controlled to ensure that changes are not inadvertently introduced, the system fulfills its requirements, and system performance is not compromised. (DOE Order 420.1B, Chapter V, and DOE Order 433.1B, Attachment 2)*

EA assessed elements of the SRNS maintenance program implemented at H-Canyon, including CM, PdM, and PM programs; maintenance performance measures and conduct; training; and processes for precluding introduction of S/CI. Assessment activities also included:

- Detailed walkthroughs of the SC evaporator interlocks and the CAEX fans

- Review of a sample of CM, PdM, and PM records from the previous two years for the selected systems

- Interviews with key Maintenance organization management and staff members

- Review of the Occurrence Reporting and Processing System (ORPS) reports from the last two years

- Observation of maintenance and calibration activities performed during the onsite planning and data collection periods

- Attendance at routine daily H-Canyon maintenance/work management meetings.

Nuclear Maintenance Management Program

Maintenance of safety system SSCs is adequately addressed in the nuclear maintenance management program description document (NMMP-DD) for SRS nuclear facilities, as required by DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*. The NMMP-DD also complies with DOE Order 430.1B, *Real Property Asset Management*, as it relates to the maintenance of those assets. The NMMP-DD is implemented in H-Area through SRNS procedures listed in the NMMP-DD. The NMMP-DD has been approved by DOE-SR.

The maintenance program is appropriately identified as a safety management program in TSR Section 5.7.2 and receives self-assessments on a three-year cycle. Each year, the facility maintenance management and staff perform self-assessments on multiple maintenance topics so that all areas of the maintenance program are assessed every three years. EA reviewed the assessments performed during the last three years and found no issues.

EA reviewed a sample of 72 completed maintenance work packages (both CM and PM) out of a total of 815 work packages performed during the last three years on the systems selected. Isolated deficiencies

were noted, including missing data sheets, inconsistent use of placekeeping, and unclear documentation of work history. Despite these minor exceptions, the maintenance work package documentation is thorough and in good order.

Corrective, Preventive, and Predictive Maintenance

SRNS has implemented adequate CM and PM processes at H-Area for the evaporator interlocks and CAEX fans, except as noted below. PM activities for H-Area safety systems are performed by maintenance mechanics dedicated to either the H-Canyon or outside H-Area facilities. PdM using ultrasound technology is effectively used on rotating equipment, such as the CAEX fans, as discussed below. EA observed PM activities involving thermography, vibration analysis, and use of ultrasonic technology to lubricate fan bearings. EA also reviewed a sample of PdM work orders performed in the H-Area and found no issues.

Maintenance processes, including provisions for CM and PM covering the evaporator interlocks and CAEX fans, are addressed in SRNS sitewide procedures and are consistent with the system SC designations. The work control process adequately identifies the hazards, associated controls, and work steps for each activity (i.e., CM, PdM, or PM), and a work package is generated specifically for that scope of work. However, there are weaknesses in the H-Area work planning and scheduling process.

The PM program, as described in SRNS Manual 1Y, Procedure 5.02, *Preventive Maintenance Program*, requires PM activities to be scheduled and performed prior to the prescribed PM due date. For example, 1Y 5.02, *Preventive Maintenance Program*, Sections 4.9, 4.10, and 4.11, include responsibilities for facility managers and work window managers and staff to ensure that facility systems and resources are available so that PM can be performed on or before the established due date. Conversely, procedure-specified responsibilities for the H-Area maintenance manager include ensuring that PM activities are performed before the end of the grace period that follows the due date. According to the H-Area maintenance manager, it is routine practice for these activities not to be performed by the established due dates. There are no required management approvals or justifications for PM activities to enter the grace period (typically 25% of the interval) following the PM due date, and many PM activities even exceed the grace period.

If a PM will exceed the grace period, a deferral form is prepared/approved and a justification for continued use of the SSC is prepared by the Engineering organization. More than 182 PM deferrals were issued for H-Area for FY 2018. The practice of allowing PM activities to routinely enter the PM grace period contributes to the large PM backlog and limits the effectiveness of the PM program. Because H-Area routinely allows the use of the grace period, without justification and escalating approval from such organizations as Systems Engineering, Operations, and Facility Management, PM is not being performed as intended. (See **OFI-SRNS-2**.)

With the exception of a PM to inspect and clean programmed logic controllers every 6 months, the PM activities for evaporator interlocks are limited to TSR surveillance tests (typically functional tests and annual instrument calibrations). For more discussion on calibration performance see Section 5.5, below.

PM activities for the four CAEX fans include monthly thermography and vibration analysis to predict bearing degradation and replacement, semi-annual cleaning and inspection of fan auto transfer switches, and quarterly bearing re-lubrication guided by ultrasound technology.

The use of ultrasound technology to guide the bearing lubrication process provides assurance that the fan bearings are not over-lubricated. Over-lubrication can cause bearings to overheat and prematurely fail. The practice of using ultrasound technology began in the SRS K-Area in 2016 and has been migrated for

use in other areas of SRS. Another benefit of this practice is the change from a schedule-based monthly bearing PM to a condition-based PM that is conducted quarterly, reducing the number of lubrications by 67% while providing greater assurance of proper lubrication. EA considers this to be a **Best Practice**.

EA's evaluation of the evaporator interlocks and CAEX fans found them to be in an adequate condition, with only a few SSCs out of service or in an alarm condition. However, these systems have experienced equipment problems during the last three years. For example, time delay relays (TDRs) for CAEX fans #1 and #3 have failed and were reported in three ORPS reports. ORPS reports EM-SR-SRNS-HCAN-2015-0012, dated December 17, 2015, and EM-SR-SRNS-HCAN-2016-0007, dated March 31, 2016, reported fan #1 TDR failures. Each time the TDRs failed on CAEX fan #1, the relays were replaced. CAEX fan #3 also experienced two TDR failures on March 15, 2015 (identified in ORPS EM-SR-SRNS-HCAN-2015-0005) and April 27, 2016 (for which there is no ORPS report). Again, the TDRs were replaced. Non-conformance report (NCR) 2016-NCR-30-0032, *Agastat Time Delay Relays (TDR) Model 7024AB*, was initiated on May 26, 2016, to document the degraded, non-conforming condition associated with the TDR failures. H-Canyon engineering determined that there was a problem with the use of that relay in this application, which is designed to allow the fan to restart on full voltage after a momentary loss of power. Temporary modifications were performed in 2017 to disable the TDRs. The temporary modifications were closed on September 26, 2018, when the temporary modifications were made permanent through design changes E-DCF-H-08952 and -08954. The degraded condition lasted 42 months, reflecting inadequate priority for the correction of functional issues on safety class components. Moreover, two other NCRs have remained open for extended timeframes on various CAEX fans:

- The first of these two NCRs (2013-NCR-30-0036, *Missing Inlet Flange Fasteners on H-Canyon Exhaust Fans 1 and 4*) documented that inlet flange bolts were missing from CAEX fans #1 (2 of 32) and #4 (4 of 32). The inlet flange connects the fan to the suction side ductwork, is seismically qualified, and must maintain a seal to prevent excessive leakage. A USQ performed for this NCR documented that the required functions could still be accomplished, and the interim corrective action was to perform a quarterly inspection of the flange bolts to ensure no further degradation. Correction of this problem is currently projected for September 2019, 5 years and 11 months after the degraded condition was first identified. The NCR will remain open until the missing bolts are replaced.

- The second degraded condition (2012-NCR-30-0012, *292-H CAEX Fan #3 Discharge Damper*) is associated with the CAEX fan #3 discharge damper and was identified on April 10, 2012. The damper seal material is partially missing, allowing air to flow back through the damper when the associated fan is in standby or off mode, causing the fan to rotate in reverse. In this degraded condition, the fan cannot be relied upon to auto-start from the standby position, a safety basis function. The interim corrective action involves either running the fan continually or placing it in the OFF position. If the fan is turned off, maintenance mechanics are dispatched to place a block of wood against the shaft of the fan to stop its reverse rotation prior to restarting the fan. Operating the fan continually causes more wear on fan components and potentially affects the long-term reliability of the fan. This degraded non-conforming condition has been allowed to continue for more than six years. This NCR is now being tracked on the list of NCRs presented in the monthly Milestone Management Meeting between DOE-SR and SRNS management. Subpart A of 10 CFR 830, § 830.122(e)(3) requires DOE contractors to "maintain items to prevent their damage, loss, or deterioration." Contrary to this requirement, the damper for CAEX fan #3 has operated in a degraded condition since April 2012. **(Deficiency)**

Three practices associated with the H-Area maintenance program are contributing to adverse trends in maintenance performance. First, the management process for preparing and implementing the work week schedule allows work activities to be merged into the work week schedule without a requirement to justify the need for impacting the existing schedule. This practice removes other pre-planned activities,

such as PM and surveillance tests, from the work week schedule, causing cascading schedule impacts. (See **OFI-SRNS-3**.) Second, the practice of locking in the work week schedule only one work day before the beginning of the work week also allows the displacement of PM activities that are due because organizational requests are prioritized ahead of other work, including PM. The third area relates to allowing PM activities and surveillances to routinely enter the associated grace period, as discussed above. (See **OFI-SRNS-2**.)

Performance Metrics

The SRNS maintenance program uses two formal performance metrics to track maintenance performance: CM backlog and PM deferrals. These metrics are presented monthly to H-Area management. In addition, several informal metrics are used at the Maintenance Department level to track maintenance performance, including a metric to track the number of PM activities that are in "plan" status but beyond the PM due date (a new metric). Other metrics include open high priority CM tasks, CM man-weeks of backlog, and CM man-weeks of backlog (safety related). Of these performance measures (both formal and informal), only the formal metrics (i.e., CM Backlog and PM Deferrals) have established goals to monitor performance. Currently, performance reflected in the formal measures is not achieving targeted goals. The CM backlog for August 2018 as reported at the monthly management team meeting was 18.12 man-weeks based on 460 open tasks. The goal for this metric is less than 12.5 man-weeks. PM deferrals for August 2018 were 2.12% of the total active PM, meeting the goal of less than 2.25%. However, H-Canyon did not meet this goal for 10 of the preceding 12 months. No specific actions to improve performance were discussed in the monthly performance measure documents.

The metrics in use (both formal and informal) are an adequate set of maintenance performance measures. However, SRNS is not leveraging the measures to improve maintenance performance. DOE Order 433.1B defines performance measures as "the process for developing, maintaining, and communicating performance measures to identify maintenance issues requiring corrective action and lessons learned." (See **OFI-SRNS-4**.)

Conduct of Maintenance

EA observed pre-job maintenance walkdowns of the job sites, pre-job briefings, and field activities by Maintenance personnel. Workers effectively integrated human performance error reduction tools into the performance of the work. During pre-job briefings, supervisors and workers discussed specific human performance error reduction tools related to the job activity and subsequently implemented them as work was conducted. These tools included three-way communication, procedure placekeeping, and peer checks. EA considers the integration of human performance error reduction tools into work performance to be a **Best Practice**.

EA observations included seven PM activities and one CM activity during this assessment. Maintenance personnel were knowledgeable of the procedures, and the associated tasks were adequately performed.

Based on limited-scope system walkdowns, EA found that the configuration of the evaporator interlocks and CAEX fan subsystems was consistent with the as-built drawings and system alignment procedures. Overall, maintenance of the interlocks and CAEX fans is conducted such that system configuration is properly managed throughout the maintenance process.

Maintenance Training

H-Area has implemented a training program for maintenance workers (i.e., electrical and instrumentation technicians, and maintenance mechanics). The training program consists of generic maintenance task

training, site access training, and H-Area topical training, including safety basis training. The generic maintenance training provides base qualifications through the SRNS sitewide maintenance qualification process. After completion of base qualification, maintenance staff are assigned to a facility at SRS where they receive facility-specific access and topical training. EA reviewed the training program and determined that the program provides the knowledge, skill, and ability to perform generic maintenance tasks (e.g., instrument calibration, torqueing a flange). All maintenance staff observed by EA were knowledgeable about their tasks. However, the training program does not equip the mechanics and electrical/instrument technicians to perform specific work on H-Area SSCs independently. EA interviewed three maintenance first-line supervisors, who described the process that they use to ensure that their assigned workers are qualified to perform work on H-Area equipment. Although there was some variation in the process used to determine qualification, each supervisor relied on his or her subjective judgement/opinion to make sure that assigned staff had observed the specific activity and then performed it along with a more experienced person before assigning them to perform the task independently. This informal H-Area on-the-job training process is not documented or included in the qualification program for maintenance workers to ensure that it is consistently and objectively applied. (See **OFI-SRNS-5**.)

H-Area has implemented an adequate process to guard against S/CIs. Manual 1B, Procedure 5.19, *Suspect and Counterfeit Item Program*, describes the prevention, identification, evaluation, notification, and disposition of S/CIs. In addition, engineers and maintenance personnel receive initial and periodic training on the identification and disposition of S/CIs found in the facilities, so that as work is performed and systems are walked down, they can identify and disposition any existing S/CI. EA reviewed training records for the required S/CI training and found no issues.

Maintenance Conclusions

Overall, H-Area has implemented a maintenance program that complies with DOE Order 433.1B. SRNS has addressed the requirements through the NMMP-DD and its implementing documents. Procedures for conducting CM are effective in restoring the functionality of safety system equipment after equipment failure. However, work prioritization and scheduling weaknesses contribute to CM backlog and PM activities being completed beyond their due date.

Observed work activities were performed in accordance with established controls, work hazards were properly identified and controlled, and maintenance workers exhibited good questioning attitudes, use of human performance error reduction tools, and conduct of operations behavior. Two best practices in the area of maintenance are noted. However, maintenance on the CAEX fan #3 damper and CAEX fan #1 and #4 bolting has not been adequate to restore those components from a degraded non-conforming condition in a timely manner. Management attention is needed to improve the scheduling and implementation of PM and surveillance requirements (SRs) and to increase the effectiveness of maintenance performance measures.

5.5 Surveillance and Testing

This section discusses EA's assessment of the surveillance and testing process. The evaporator interlocks and CAEX fan subsystems have safety functions that are necessary to prevent or mitigate hazards identified in the facility safety analyses. SRs ensure that these SSCs remain in compliance with the approved TSRs. Many of the SRs, which are met through the PM program, are discussed in more detail in Section 5.4 of this report.

Objective:

Surveillance and testing activities are properly performed in accordance with TSRs and Specific Administrative Controls.

Criteria:

- *Requirements relating to test, calibration, or inspection assure that the necessary operability and quality of safety SSCs is maintained; that facility operation is within safety limits; and that limiting control settings and limiting conditions for operation are met. (10 CFR 830.3 and Table 4)*

- *Instrumentation and M&TE for the system are calibrated and maintained. (10 CFR 830.122, Criterion 8)*

The H-Area DSA identifies postulated events that require the evaporator interlocks and/or the CAEX fans to prevent or mitigate radiation dose to the maximally-exposed offsite individual or the co-located worker. The DSA requirements have been properly flowed down to the TSRs and implementing procedures (see also Section 5.1, above). EA reviewed 33 surveillance testing packages that were completed during the last 3 years, including calibrations of TSR equipment and functional tests. All of the reviewed packages were properly completed and met established acceptance criteria.

EA noted that surveillances are not routinely completed by the associated due date. H-Canyon TSR 4.0.2 states that the "25% extension is intended for operational flexibility both for scheduling and for performing surveillances. It should not be relied upon as a routine extension of the specified interval." However, the 25% extension (or grace period) is routinely used due to competing priority and scheduling issues. For example, the Plan of the Day package for October 10, 2018, included a status of all H-Area TSR surveillances coming due in the next 30 days. Of the 57 surveillances listed, 7 were delinquent, meaning that they had exceeded the 25% grace period allowed by TSR 4.0.2. Components affected by the seven delinquent surveillances were declared inoperable and the limiting condition for operability was entered until the surveillance is completed. Further, 20 of the listed surveillances were past due and in the associated grace period. This is a significant percentage (47%) of the surveillances that need to be completed within the next 30 days. (See **OFI-SRNS-2**.)

EA observed several daily operational TSR surveillance checks. The Operations and Maintenance personnel performing these surveillance activities were knowledgeable of the procedures and performed them properly.

EA observed performance of the *Water Monitor, Source Check and Maintenance*, for A and B water tables. This surveillance is performed weekly per TSR SR 4.2.2.1 to demonstrate continued operability of the devices relied upon to monitor facility cooling water discharge for radiological contaminants. EA also observed calibration of three TSR instruments associated with evaporator interlocks. The SRs were performed adequately without issue.

Instrumentation and Measuring and Test Equipment Calibration Program

Instrument calibrations are a standing item on the daily work schedule. Each month a large number of instruments come due for re-calibration. For example, 132 instruments were due in October 2018, only 9 of which are SC or SS. No SS/SC instrument calibrations were past due at the time of this assessment. H-Canyon management has recently shifted attention to facility instrument calibrations by including a list of calibrations due for a particular month and ensuring that instruments are calibrated on or before the calibration due date. If a non-TSR instrument cannot be calibrated by the due date, a justification is

required for any extensions to the due date.

H-Area has a single tool room that provides M&TE and coordinates/maintains M&TE calibrations. Manual 1Q, Procedure 12-1, *Control of Measuring and Test Equipment*, adequately defines the requirements and responsibilities for control of standards and M&TE used to support calibration of evaporator interlock and CAEX fans instrumentation. The M&TE observed during the onsite portion of the assessment were properly calibrated and maintained. In addition, EA reviewed a sample of M&TE calibration reports and found no issues.

Surveillance and Testing Conclusion

The surveillance testing and calibration program, in conjunction with the maintenance program discussed above, adequately maintains the SSCs in a condition that ensures that the TSRs are satisfied. The M&TE maintenance and calibration program is well organized and effective. The observed surveillance and testing activities for H-Area were performed properly and adequately translate the TSRs into useable procedures and programs. However, improvement is needed in the scheduling of TSR surveillances to meet due dates rather than routinely relying on, and occasionally exceeding, the 25% grace period.

5.6 Operations

This section discusses EA's assessment of safety-related H-Canyon exhaust fans and evaporator interlocks operation. Typical Operations activities include daily surveillances and periodic functional checks, as well as responses to alarms. The full spectrum of surveillance and testing is discussed in Section 5.5, above.

EA accompanied operations personnel on multiple occasions, primarily to observe performance of daily rounds, including daily surveillances associated with the safety-related diesel generators and their support systems. EA also observed several shift turnovers, log keeping, system lineups, and control area activities.

Objective:

Operations are conducted in a manner that ensures the safety systems are available to perform intended safety functions when required. (DOE Order 422.1)

Criteria:

- *The operator must establish and implement operations practices to ensure that shift operators are alert, are informed of conditions, and operate equipment properly. (DOE Order 422.1, Attachment 2)*

- *The operator must establish and implement operations practices for developing and maintaining accurate, understandable written technical procedures that ensure safe and effective facility and equipment operation. (DOE Order 422.1, Attachment 2)*

- *The operator must establish and implement operations practices for initial equipment lineups and subsequent changes to ensure that facilities operate with known, proper configuration as designed. (DOE Order 422.1, Attachment 2)*

- *Operator training must be sufficiently comprehensive to cover areas that are fundamental to the candidate's assigned tasks to ensure that personnel are capable of safely performing their job duties. The training program must include a core of subjects, such as instrumentation and control and major system facilities, as applicable to the facility and position. (DOE Order 426.2, Attachment 1, Chapter II.6)*

- *The training program must include on-the-job and classroom training to ensure personnel are familiar with all aspects of their positions, including normal and emergency procedures, administrative procedures, location and function of pertinent safety systems and equipment, and TSRs. (DOE Order 426.2, Attachment 1, Chapter II.6)*

- *Formal processes have been established to control safety system equipment and system status to ensure that proper operational configuration control is maintained. (DOE Order 422.1, Attachment 2)*

Conduct of Operations Program

The evaporator interlocks are implemented with sensors in the canyon (accessed with remote handling equipment only), with transmitters and steam supply isolation valves on the second level of the canyon, and with control indications in the canyon control room. EA accompanied the building operator conducting rounds on the second and third levels of the canyon to observe that process. Rounds were recorded on paper procedures, which the operator verified to be the correct revision prior to use. The "round sheets" appropriately identified readings associated with a safety basis control using a dollar sign identifier as required by PS-TS-AP-4005, *Procedural Document Structure*. All readings were correctly recorded, and the datasheet was completed sequentially, even when this was inconvenient for the operator, because 221-H-RSE-770, *221-H Building Operator #1 Round Sheet*, is classified as a Technical-UET (Use Every Time) procedure, and 2S 1.3, *Procedure Compliance,* requires the steps to be performed sequentially unless procedure guidance allows otherwise. (See **OFI-SRNS-6**.)

EA also observed routine rounds for the canyon exhaust fans. Results of these rounds for the fans and other nearby systems are recorded digitally using an electronic tablet. The rounds include a mix of surveillances for the diesel generators, which provide backup power to the fans, the SC air supply to the fan dampers, and the SC exhaust fans, as well as observation of other equipment located in the area. As with the paper rounds, readings associated with a safety basis control are highlighted with a dollar sign identifier. The operator performing the rounds demonstrated a high degree of ownership of the area and corrected housekeeping issues caused by strong winds prior to performing his rounds.

H-Canyon shift turnovers are guided by a checklist, in accordance with SRNS Procedure 2S 4.1, *Shift Turnover*. Copies of completed turnover checklists for a variety of H-Canyon positions are available electronically as part of the Site Operations Standardized Tools. EA observed turnovers being conducted by shift operations managers, building/crane first line managers, and power support operators. All observed personnel conducted the turnovers in accordance with the procedure and in a professional manner, with a discussion about logbook entries, facility conditions, and the status of work in progress.

EA also reviewed logbooks maintained by the control room first line manager, shift technical engineer, outside facilities first line manager, and power support operator. Log entries were chronological, with time entries in the left margin as required by SRS Procedure 2S 2.4, *Operating Logs*. EA observed regular entries, corrections, and late entries in the logs, all of which were performed in accordance with 2S 2.4. EA found that log keeping is adequate and meets requirements.

Access to control areas in both the canyon control room and the crane control room was in accordance with SRNS Procedure 2S 5.3, *Control Area Activities*, with one exception. Canyon control room door 448 was not placarded to indicate that it was not to be used for entry. However, EA observed numerous occasions where personnel appropriately requested permission to enter both control rooms in accordance with the requirements of 2S 5.3. The implementation of access control in the control areas is adequate.

EA evaluated operator aides found in both control areas and process areas. Operator aides were logged using Site Operations Standardized Tools available on InSite (the sitewide internal homepage) and reviewed as required. EA identified no unapproved operator aides. Some handwritten or typed notes were attached to various desks, file cabinets, and computer monitors in the control area; however, the information on the notes (such as phone lists) did not meet the definition of an operator aid in DOE Order 420.1C, *Facility Safety*, Attachment 2, Section 3.i. Overall, the use and control of operator aides is adequate.

Operator Training and Qualification

The H-Canyon operator training program consists of a mix of classroom and on-the-job training, with the specifics varying by the position. PROGNSBPPDES000115, *H Canyon/H-Outside Facilities Operations Training and Qualification Program Addendum to SRSTPD01, SRS Operations Training Program Description*, has a matrix of watchstation titles and associated qualification/certification requirements. EA reviewed qualification requirements for 14 certified positions and 6 qualified positions. Qualification cards list the requirements for the position and document completion dates. Qualified examiners administer oral boards in order to evaluate knowledge and understanding of various systems and processes. Requirements for all positions included abnormal response training and nuclear criticality safety training. The training material emphasizes the importance of safety systems for protection of the workers. The training requirements are adequate.

EA reviewed a sample of training material, including material pertaining to the selected safety systems, all of which was developed in a systematic manner in accordance with DOE Order 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*. EA also examined some of the written examination material pertaining to conduct of operations, knowledge of safety systems, and criticality safety. The training material and the related test questions are adequate.

EA reviewed a small sample of written examinations and the results of oral examinations for three students for the position of Shift Technical Engineer. The completed documents indicate an effective program, with generally high scores on written exams, although all three individuals scored less than 100%. EA attributed the scores to a testing program that was sufficiently difficult to challenge the students' knowledge. Records of oral boards likewise demonstrated a healthy, functioning process that was challenging to both new and experienced staff. Evidence of remedial training for knowledge weaknesses revealed by oral boards was also present in the reviewed training records. The examination process is effective at determining the students' level of knowledge.

H-Canyon has a proficiency requirement for watchstanders to have served 10 hours in the last 3 calendar months. H-Canyon uses a computer-based tool, the Automated Qualification Matrix, to compose the watchbill for each shift. This system ensures that the watchstander is current with the required proficiency hours, and updates the proficiency hour running total. The use of the Automated Qualification Matrix was first noted by EA in *Office of Enterprise Assessments Assessment of Savannah River Site Tritium Facility Safety System Management – December 2016.* EA considers the coupling of the watchbill roster and proficiency database to be a **Best Practice**.

Operations staff also receive continuing training on a variety of topics. At the time of this EA assessment, operational incidents resulting in inadvertent transfers had occurred. The training course NSBGHITRSTGD000101, *Eight Attributes to Prevent Inadvertent Transfers*, was revised and administered as continuing training to reduce future incidents. The training is presented to operating staff over a period of weeks so that shift personnel all become trained on the same material. Observation of the continuing training found it to be adequate and timely.

Procedure Development, Use, and Adherence

The H-Canyon Procedures Group works with other elements such as Operations, Maintenance, and Engineering to develop operating procedures, alarm response procedures, surveillance procedures, and other procedures that impact the H-Canyon mission. A database is maintained of procedure "owners" in organizations such as Operations or Maintenance, who provide technical input for the procedures, while the procedure writers use standardized tools to ensure that the procedures are user-friendly and include techniques to minimize errors. H-Canyon procedures are periodically reviewed to ensure that they remain technically accurate. However, EA identified several discrepancies:

- Three procedures contain references to operating entities that are no longer at SRS (Prime South, WSRC, and Energy Conversion).

- Four other procedures provided inconsistent guidance to the control room operator to communicate specific information to the building operator.

- A High Activity Waste System round sheet states that the round sheet is for low activity waste. This error has persisted since 2012.

- An alarm response procedure, 221-H-ARP-HY-1.5, *HY-1.5 9.2E Evap High Temp*, directs the operator to confirm the high temperature condition by observing the distributed control system display for the 9.1 evaporator instead of the 9.2 evaporator. This error has persisted since 2011 and was part of the alarm response procedures in the control room.

EA discussed these and other procedure issues with the H-Canyon deputy facility manager, who agreed that operator attention to detail should have identified these issues earlier. **(Deficiency)** The H-Canyon Facility manager later stated his intention to use some of the identified items as a training exercise to challenge the operators to find the procedural errors as a method of improving their attention to detail.

System Lineups and Equipment Status Control

Prior to EA's initial visit for this assessment, H-Canyon experienced two events involving inadvertent transfers of cold chemical solutions to H-Canyon process vessels. The first occurred on August 30, 2018, while the second occurred less than a week later on September 4, 2018. Proper control of system lineups is recognized by H-Canyon as essential to preventing inadvertent transfers.

H-Canyon controls the lineup of process vessels and utility services with initial system lineup procedures. Most liquid transfers within the canyon are accomplished using steam jet transfers. The steam jets are controlled by "gang valves." A cam bar connects the valves to a motor for operation by the control room. Gang valves supply steam to the jets to move solutions or supply compressed air to the jet to purge steam from the line and cool the line to reduce condensation, and the resulting vacuum that would pull radioactive solutions backwards into the gang valve corridor if the line were not sufficiently cooled. When not in use, gang valves are in the vent positon. Although the gang valves are controlled from the

control room, an operator is stationed nearby to ensure proper valve operation to prevent overfilling process vessels. The use of the gang valve operator to ensure proper gang valve operation is appropriately cautious.

Control of the solution transfer route is important to ensure that the solution is moved from the desired originating vessel to the desired destination vessel. Some transfers require "jumpers" (piping segments that can be remotely connected and disconnected using the canyon cranes) to be repositioned. Non-radioactive solutions, including process chemicals, steam, and cooling water, are controlled by valves on the second level of the canyon. This is the area where the steam isolation valves for the evaporators are located. Manual block valves are aligned using system lineup procedures for desired operation. Some of the manual valves are administratively controlled, using a process based on 2S 5.5, *Control of Equipment and System Status*, Section 5.5. However, although 2S 5.5 describes the use of control locks for administrative control of equipment, H-Canyon has implemented this practice using plastic tamper-indicating seals with unique numerical identifiers. The database of control lock points is available using the Site Operations Standardized Tools. Although EA observed that the seals and database are effective, the lack of any local procedure that describes the implementation of 2S 5.5, Section 5.5, with seals instead of locks indicates an inadequate approach to procedure compliance by area management. **(Deficiency)**

Controlling the status of the SC CAEX fans is also important for ensuring compliance with TSRs. As noted in Section 5.4, above, CAEX fan #3 cannot be relied on to auto-start due to a degraded damper seal. EA identified that the fan operating procedure did not prohibit placing fan #3 in AUTO, even though this condition has existed for several years. Instead, operator awareness was relied on to ensure that fan #3 was either running or placed in the OFF position. The shift turnover sheets were modified during this assessment to caution against placing #3 in AUTO. This action was timely and appropriate while other solutions are pursued by H-Canyon.

Operations Conclusions

The evaporator interlocks and the canyon exhaust fans are operated in a manner that ensures the systems will be able to perform their intended functions when required. Operators are informed on the status of the systems and have access to the Site Operations Standardized Tools. Operators are well trained and informed on the importance of the systems. A previously identified best practice for automatic tracking of credit operator proficiency hours based on watchstanding hours is used by H-Canyon. However, operator attention to detail has not met management expectations, as evidenced by the undetected procedural errors and the occurrence of two inadvertent transfers.

5.7 Cognizant System Engineer Program

This section discusses EA's assessment of the CSE program. DOE Order 420.1C requires that facility contractors at hazard category 1, 2, and 3 facilities implement a CSE program for all SC and SS systems and designated defense-in-depth systems.

Objective:

CSE program implementation is effective in ensuring that safety systems can reliably perform as intended.

Criteria:

- *The DOE contractor has established a system engineer program to ensure continued operational readiness of systems within the program scope. (DOE Order 420.1C, Attachment 2, Chapter V)*

- *The system engineer program must be applied to active SC and SS SSCs as defined in the facility's DOE-approved safety basis, as well as to other active systems that perform important defense-in-depth functions, as designated by facility line management. (DOE Order 420.1C, Chapter V.2)*

- *Hazard category 1, 2, and 3 nuclear facilities must have a system engineer program, as well as a qualified CSE assigned to each system within the scope of the program. (DOE Order 420.1C, Chapter V.3)*

SRNS's CSE program is described in several manuals, as outlined in the Standards/Requirements Identification Document. SRNS CSEs are considered to be design authorities, per procedures E7 3.04 and 1.10, *Engineering Program Roles, Responsibilities, Accountabilities, and Authorities(R2A2)*, with associated roles and responsibilities that, in aggregate, satisfy the order requirements. CSEs are assigned to all SC and SS systems.

The CSE is the focal point for system documentation, with roles in the CMGT process (see Section 5.3, above), procurement of spare parts and replacement items (see Section 5.2, above), and maintenance of the system based on manufacturer guidance (see Section 5.4, above). EA reviewed aspects of the CSE program descriptions to assess performance of the CSEs assigned to the selected systems in key areas.

The H-Canyon CSEs rely on frequent system walkdowns, extensive field presence, and involvement in issue resolution to meet system monitoring expectations and ensure adequate system performance. System availability, maintenance, and configuration attributes are analyzed for each safety system. The reports evaluate data relating to the system, such as the number of hours of availability during the period, the maintenance backlog for the system, and any system concerns. The CSEs also provide support to Operations and Maintenance when needed and coordinate to provide backup for each other within the facility. An adequate engineering desktop instruction guides CSE safety system walkdowns, which are generally thorough and well documented.

System Notebooks

Procedure E7 3.04 provides both guidance and requirements for CSEs in maintaining system notebooks to help manage and maintain their assigned systems. A system notebook is required for all vital safety systems that require performance monitoring. The notebook is also an important tool for transitioning between engineers. Procedurally required contents of the system notebook broadly include system health assessments, performance monitoring trends, system walkdowns, engineering paths forward, a list of applicable regulatory documents, system operations logs, NCRs, occurrence reports, a spare parts list, open CM activities, technical training related to the system for associated personnel, and records of system design changes. EA found the development of system notebooks to be a positive aspect of the overall CSE program. The assigned CSEs for H-Canyon systems are well informed on the status and physical conditions of their systems and adept at accessing information on their systems through the electronic online system notebook platform.

Although performance metrics and trending included in system notebooks are generally thorough, one area did not fully meet the intent of the procedural requirements. E7 3.04 requires trending that would allow forecasting of issues that affect system performance; however, CM and equipment failures (indicators of system health) are not tracked or trended in system notebooks. (See **OFI-SRNS-7**.)

System Health Reports

Procedure E7 3.04 requires formal assessments to measure system health for vital safety systems every 12 to 15 months. Informal assessments, system walkdowns, and monitoring of system performance

throughout the course of that period culminate in a system health report (SHR) to SRNS H-Canyon management.

EA examined the SHRs for three CSEs for the period of 2015 to 2017. The SHRs were staggered, and each covered a period of one year. Contents vary somewhat but generally include a system overview, surveillances, operability, maintenance summary, walkdowns, equipment aging concerns, and recommended actions. Additional slides provide supporting detail. With the exception noted above for trending of equipment failures, the reviewed SHRs appropriately distill information from the system notebooks and provide the information necessary to keep H-Canyon management informed of system performance.

CSE Training and Qualifications

SRNS's training and qualification program for CSEs is compliant with the applicable portions of DOE Order 426.2. It includes applicable required reading, a series of practice oral boards, core and facility requirements training, and a requalification program. However, the four CSE qualification cards reviewed by EA do not meet the minimum requirements of DOE Order 420.1C, Attachment 2, which lists seven areas for CSE qualification. The qualification cards do not address one of the seven areas: vendor manuals, product warnings, and updates related to assigned systems. CSE continuing training also does not include topics such as facility instrumentation and control, DSA and TSRs, and engineered safety features, which are suggested by DOE Order 426.2, Attachment 1, Section 7.b, for other facility personnel. Of the six CSEs assigned to the evaporator interlock and CAEX systems, four are fully qualified with three to five years of H-Canyon experience, and two evaporator CSEs have completed about 50% of their qualification requirements, with each having less than two years of experience at H-Canyon.

Cognizant System Engineer Program Conclusions

Overall, the CSE program is well implemented and complies with DOE requirements. The CSEs are knowledgeable of their assigned systems, adequately trained, and qualified to a level commensurate with their experience. The system notebooks are thorough and provide an excellent tool for the CSEs in supporting system operation/maintenance, but could be enhanced by including tracking and trending of CM and equipment failures. The SHRs are designed for H-Canyon management and are a good summary of system notebook information.

5.8 Feedback and Improvement

This section discusses the effectiveness of SRNS's feedback and improvement processes in addressing and preventing the recurrence of safety system issues. SRNS monitors and evaluates a variety of feedback sources to identify weaknesses and make improvements. EA examined SRNS's acquisition of vital safety system health information, the conduct of management and independent assessments, issues management, and the use of feedback information to make improvements.

Objective:

Feedback and improvement processes are effective in addressing and preventing the recurrence of safety system issues. (10 CFR 830, Subpart A)

Criteria:

- *Identify the causes of problems and work to prevent recurrence as a part of correcting the problem. (10 CFR 830.122, Criterion 3)*

- *Contractors must monitor and evaluate all work performed under their contracts to ensure that work performance meets the applicable requirements for environment, safety, and health, including QA, integrated safety management, safeguards and security, cyber security, and emergency management. (DOE Order 226.1B, Attachment 1, Section 1)*

Safety System Feedback

As discussed in Section 5.7, above, CSEs effectively implement E7 3.04 to acquire safety system feedback information necessary to detect and prevent problems in quality and to ascertain the health elements for SSCs, including maintainability, reliability, availability, and aging effects.

A 2017 SRNS self-assessment, 2017-MFO-000621, *System Notebook Content*, identified the need to include details on abnormalities/issues, indications observed before/during/after the event, and path taken to successfully resolve the abnormality/issue. SRNS assigned two CSEs to modify its system notebooks (2017-CTS-000806, *System Notebook Content*), one of whom has since left H-Canyon. Because E7 3.04 was not revised to include this expectation, other CSEs were unaware of this issue, diminishing the value of the self-assessment finding.

Organizational Assessment Feedback

H-Canyon benefits from several sources of assessment feedback including self-assessments/management field observations performed by H-Canyon personnel and independent assessments performed by the SRNS Independent Evaluation Board (IEB) and the QA organization. All assessment reports are tied to one or more of 23 functional areas based on the scope of the assessment. Seven Functional Areas (01 (Design), 04 (Training), 06 (Safety Documentation), 08 (Quality Assurance), 09 (Configuration Management), 10 (Maintenance), and 21 (Procurement)) have a close nexus to vital safety systems. From January 2017 to August 2018, H-Canyon performed 190 self-assessments, with 67 assessments performed in these seven functional areas, on topics including the master equipment list, component tagging, modification travelers, unreviewed safety questions, and vital safety system walk downs. The IEB completed 17 independent assessments of H-Canyon covering 17 of the 23 functional areas; the most recent IEB independent assessment of the H-Canyon CSE program was in August 2018 (2018-SUR-34-0005). Of the 207 H-Canyon assessments conducted between January 2017 to August 2018, 2018-SUR-34-0005 provided the most detail, specifically addressing Conduct of Engineering training, the MAE, the contractor assurance system (CAS), and lessons learned.

The H-Canyon issues management lead monitors all SRNS assessments, identifies any related to H-Canyon, and provides applicable assessment reports to the H-Canyon Management Review Team (MRT) for any needed actions to include in STAR. EA reviewed three MRT meeting minutes since January 2018, confirming consistent processing of assessment reports and STAR issues.

Issues Management

All interviewed CSEs were knowledgeable of the SRNS issues management program, which is adequately addressed in 22Q CAP-1 and 22Q CA-1, *Causal Analysis*. Although none had self-initiated a STAR issue, each had addressed assigned actions in the STAR system. An interview indicated that the

CSEs' supervisor understands the need for immediate reporting to the appropriate levels of management if significant conditions adverse to quality are identified.

SRNS's response to two recent STAR issues addressing two separate CAEX fan electrical trips included such topics as troubleshooting, apparent cause identification, and return to service. Both issues were also reported in DOE ORPS. Subsequent to returning the fans to operable status, SRNS determined that both circuit breaker trips resulted from dirt in a potentiometer connected to the overload device. SRNS identified an action to develop a work order to clean the potentiometer on fan #4 (first tripped circuit breaker) by January 10, 2019. The second tripped circuit breaker (fan #1) resulted in a planned action to revise the PM procedure to clean all fan potentiometers by February 28, 2019. Although initial response actions were adequate, the planned future maintenance is not timely with respect to a repeat failure that impacts the operability of a SC system. EA discussed this concern with SRNS management, who demonstrated their responsiveness by initiating work orders for each fan to clean the potentiometers and eliminate the apparent cause.

Feedback Use and Improvement

The annual SHRs discussed in Section 5.7, above, provide an example of feedback used effectively to improve system performance. Component performance metrics provide technical bases for detecting equipment/system issues. The following two examples illustrate effective use of safety system feedback information:

- The CAEX CSE collected bearing acoustics, vibration, and temperature monitoring data that indicated increasing readings over time, leading SRNS to change the inboard fan # 1 bearings to a more contemporary type of bearing resulting in significantly lower bearing vibration readings.

- The CAEX CSE's monitoring of a fan bearing grease change maintenance evolution performed on a 24-month frequency identified bearing grease discoloration that led to an increased grease change frequency of 12 months.

Reports from SRNS's CAS for the past three years do not include any engineering perspective on nuclear facility safety systems. However, the SRNS engineering management recognized this omission, has developed a Facility Health Dashboard, and now presents these metrics at the quarterly Environmental Management Integration Meeting, which includes senior managers from SRNS and DOE. The Facility Health Dashboard consists of 11 sub-metrics including, for example, ventilation, mechanical systems, electrical systems, and safety support systems. Additionally, an H-Canyon Daughter Score Card addresses five programmatic performance elements including operations, quality assurance, maintenance, training/ qualifications, and procedures. Collectively, the metrics apply a color coded priority-based approach to provide useful overall vital safety system performance information to appropriately drive senior management attention. SRNS has not yet migrated these metrics into its CAS.

SRNS established an adequate lessons learned program in 22Q OE-1, *Operating Experience Program*. All six CSEs understood the SRNS lessons learned program, reviewed email notifications from their supervisor on potentially applicable lessons learned topics, and used the information from some of these emails to improve program performance. For example, one evaporator CSE reported that the recent Los Alamos glove box glove puncture incident provided a valuable lesson about the importance of glove safety when using needles to sample products. Another evaporator CSE reported sharing an informal lessons learned among the operations staff during the April 2016 pause session regarding the routine recording of process temperatures on round sheets every six hours. Failure to circle significant temperature changes in red ink in accordance with operations procedures caused delays in recognizing important process deviations.

Feedback and Improvement Conclusions

SRNS implements an appropriate balance of independent oversight and self-assessments to detect and prevent quality problems and routinely addresses and responds to applicable assessment findings. Over 70 self and independent assessments since January 2018 address functional areas related to vital safety system management and performance. CSEs acquire safety system performance information and preserve it in system notebooks, providing an effective means of documenting the technical baseline and historical system performance. SHRs document effective STAR issue monitoring and feedback information use. H-Canyon MRT meeting minutes indicate that management routinely monitors all H-Canyon-related STAR issues and assessments and ensures responsive actions. Although H-Canyon engineering performance metrics have not yet rolled up to the SRNS CAS report, engineering senior management has recently developed a suite of 16 useful vital safety system-related facility and programmatic performance metrics and reported the results to SRNS and DOE senior managers.

6.0 FINDINGS

EA did not identify any findings during this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified some OFIs to assist cognizant managers in improving programs and operations. While OFIs may identify potential solutions to findings and deficiencies identified in appraisal reports, they may also address other conditions observed during the appraisal process. EA offers these OFIs only as recommendations for line management consideration; they do not require formal resolution by management through a corrective action process and are not intended to be prescriptive or mandatory. Rather, they are suggestions that may assist site management in implementing best practices or provide potential solutions to issues identified during the assessment.

Savannah River Nuclear Solutions, LLC:

OFI-SRNS-1: Consider providing guidance to working level engineers on the selection of appropriate/ technically defensible design input sources for engineering calculations and design change documents.

OFI-SRNS-2: Consider implementing administrative requirements, including technical justifications and management approvals, for the PM and TSR surveillance due date extensions as a means of improving overall schedule performance and reducing maintenance backlog.

OFI-SRNS-3: Consider locking the work week schedule earlier (e.g., at T-2 or 2 weeks prior to the start of the work week) and establishing administrative controls to justify and approve work merged into the schedule after it is locked in order to optimize the planning process and minimize schedule perturbations.

OFI-SRNS-4: Consider defining goals for all maintenance performance metrics and establishing requirements for developing specific actions to address areas that are not meeting goals so that these metrics can be leveraged to improve maintenance performance.

OFI-SRNS-5: Consider enhancing the maintenance qualification program for mechanics and electrical/instrumentation technicians to include task qualifications specific to H-Area maintenance activities to ensure they are qualified to perform assigned tasks independently.

OFI-SRNS-6: Consider changing the procedure type for H-Canyon round sheets from technical "Use Every Time" to "Round Sheet" in accordance with PS-TS-AP-4005 so that readings may be collected in any sequence convenient to the operator.

OFI-SRNS-7: Consider tracking and trending CM and equipment failures in the existing system notebooks, and summarizing equipment failures in SHRs to improve system health monitoring/reporting and as a means of identifying common mode equipment failures.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Assessment: September 10 – October 18, 2018

Office of Enterprise Assessments (EA) Management

William A. Eckroade, Acting Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Deputy Director, Office of Environment, Safety and Health Assessments
C.E. (Gene) Carpenter, Jr., Director, Office of Nuclear Safety and Environmental Assessments
Kevin G. Kilp, Director, Office of Worker Safety and Health Assessments
Gerald M. McAteer, Director, Office of Emergency Management Assessments

Quality Review Board

Steven C. Simonson
John S. Boulden III
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EA Site Lead for SRS H-Canyon

Kevin Witt

EA Assessors

Charles Allen – Lead
Kenneth Johnson
Michael Marelli
William Miller
Glenn Morris
Jeffrey Snook
Gregory Teese

Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

1B 5.19, *Suspect and Counterfeit Item Program*
1Q 6-1, *Document Control*, Revision 9, 09/08/2016
1Q 8-1, *Identification and Control of Items*, Revision 13, 5/24/18
1Q 9-4, *Work Planning and Control*, Revision 13, 12/17/08
1Q 12.2, *Control of Installed Process Instrumentation (IPI)*
1Q 12.3, *Control and Calibration of Radiation Monitoring Equipment*, Revision 14, 6/23/2016
1Y 2.01, *Savannah River Site Maintenance Management*, Revision 4, 10/10/2018
1Y 2.06, *Maintenance Program Administration*, Revision 2, 3/31/2014
1Y 5.01, Conduct of Maintenance, Revision 7, 10/1/2004
1Y 5.02, *Preventive Maintenance Program*, Revision 14, 8/22/2018
1Y 5.05, *Predictive Maintenance Program*, Revision 4, 5/22/2014
1Y 8.2, *Work Control Procedure*, Revision 28, 7/26/18
1Y 8.03, *Troubleshooting*, Revision 10, 6/27/2018
1Y 8.20, *Work Control Procedure*, Revision 28, 7/26/2018
1Y 9.01, *Post Maintenance Testing*, Revision 8, 6/14/2018
2S 1.1, *Procedure Administration*, Revision 25, 9/27/2018
2S 1.3, *Conduct of Operations*, Revision 11, 08/23/2018
2S 2.1, *Communications*, Revision 13, 4/10/2018
2S 2.4, *Operating Logs*, Revision 11, 10/26/2017
2S 3.1, *Required Reading*, Revision 5, 9/28/2017
2S 3.2, *Control of On-Shift Training*, Revision 4, 6/11/2015
2S 4.1, *Shift Turnover*, Revision 7, 9/13/2018
2S 4.2, *Shift Briefings*, Revision 3, 10/22/2015
2S 4.3, *Watchbill Administration and Watchstanding Proficiency*, Revision 9, 3/22/2018
2S 4.4, *Shift Routines and Operating Practices*, Revision 6, 7/23/2015
2S 4.5, *Timely Orders to Operators*, Revision 4, 4/30/14
2S 5.3, *Control Area Activities*, Revision 4, 9/28/2017
2S 5.4, *Round Sheets*, Revision 6, 8/23/2018
2S 5.5, *Control of Equipment and System Status*, Revision 12, 3/22/2018
2S 5.9, *Hazardous Energy Control*, Revision 2, 3/10/16
2S 5.10, *Operator Aid Postings*, Revision 3, 2/9/2017
2S 5.14, *Control of Interrelated Processes*, Revision 1, 8/10/17
4B 1, *Training and Qualification Program*, Revision 8, 8/10/2017
4B 2, *Qualification/Certification Program Requirements*, Revision 11, 6/14/2018
4B 3, *Analysis, Design and Development of Training*, Revision 4, 8/10/2017
4B 4, *Training Implementation and Evaluation*, Revision 5, 8/10/2017
4B 5, *Training Processes, Records and Documentation*, Revision 3, 8/10/2017
8Q 32, *Hazardous Energy Control (Lockout/Tagout)*, Revision 23, 1/28/2016
11Q 1.05, *Nuclear Facility Unreviewed Safety Questions,* Revision 10, 5/16/2011
22Q CAP-1, *Corrective Action Program*, 3/1/18
22Q CA-1, *Causal Analysis*, 3/1/18
22Q OE-1, *Operating Experience Program*, Revision 0, 12/14/17
211-H-1403, *Rodding Tank 601 for Solvent*, Revision 10, 7/5/2017
211-H-1502, *Entering Building 294-H Sand Filters*, Revision 16, 10/17/2017
211-H-1505, *Inspect/Repair Building 291-H Stack, Tunnel, and Duct*, Revision 17, 10/17/2017
211-H-1507, *Recycle Vessel Vent Fan Operation*, Revision 21, 7/11/2017

211-H-4045, *Acid Recovery Unit*, Revision 49, 7/8/2015
211-H-9245, *Central Exhaust Filter Replacement at 292-H*, Revision 12, 2/23/2017
211-H-ARP-17B-2-3A, *604 Reboiler Hi Temp*, Revision 3, 10/6/2010
221-H-0052, *Emergency Response to a 291-H Stack Liner Failure*, Revision 15, 8/5/2014
221-H-0054, *Building 221H Actions Taken for Loss of 150-PSIG Steam Header*, Revision 12, 1/31/2017
221-H-0055, *Increased Activity in Segregated Cooling Water System*, Revision 28, 1/22/2016
221-H-0056, *Loss of Instrument, Plant, or Process Air*, Revision 7 IPC-2, 8/15/2018
221-H-0060, *Actions for 221-H Following a Total/Partial Power Outage*, Revision 19 IPC-01, 4/9/2018
221-H-0063, *Total Cooling Water Failure*, Revision 12 IPC-01, 6/7/2018
221-H-0067, *Control Room Abandonment*, Revision 11, 7/23/2018
221-H-267, *Valving Tank 11A to Canyon Vessels*, Revision 46, 3/17/2014
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221-H-350, *Starting Up and Shutting Down Evaporator 6.8E, 7.6E, 7.7E, or 17.8E*, Revision 21, 3/12/2014
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Interviews

- DOE-SR Facility Representative (2)
- DOE-SR FR Supervisor
- DOE-SR SSO Engineer

- H-Canyon Facility Manager
- H-Canyon Deputy Facility Manager
- H-Canyon Operations Manager
- H-Area Procedures Lead
- H-Area Training Manager
- Instrumentation and Control Engineer
- H-Canyon Shift Operations Manager
- H-Canyon Control Room First Line Manager
- H-Canyon Control Room Operator (3)
- H-Canyon Building Operator (2)
- H-Area Nuclear and Criticality Safety Engineering Manager
- H-Area Nuclear and Criticality Safety Engineering Deputy Manager
- H-Area Outside Facilities Power Support Operator
- H-Area Outside Facilities First Line Manager
- H-Canyon Deputy Maintenance Manager
- H-Area Maintenance Manager
- H-Canyon Maintenance Manager
- H-Areas Support Engineering Manager
- H-Canyon CSEs (6)
- H-Canyon CSE Supervisor
- H-Canyon MAC Lead
- H-Canyon QA Manager
- H-Canyon Maintenance First Line Supervisor (3)
- H-Canyon Maintenance Planner
- H-Canyon PdM Manager
- H-Canyon Surveillance Testing Coordinator
- H-Canyon Work-Week Manager (2)
- H-Canyon Work Management Manager
- H-Canyon Engineering Manager
- H-Canyon Process Engineering Manager
- H-Canyon Work Order admin
- H-Canyon STARS/Assessment Program Manager
- H-Canyon Cause Analysis Program Manager
- SRNS CAS Manager
- SRNS Cause Analysis Program Manager
- SRNS MAE Manager
- SRNS Receipt Inspection Manager (N-Area)
- SRNS Supplier Qualification Manager
- SRNS ORPS/Lesson Learned Program Manager
- SRNS STAR Program Manager

Observations

- Daily Maintenance Meeting
- Evaporator and CAEX System Walkdowns
- Facility Representative Weekly Telecon (2)
- Lessons Learned Training on Inadvertent Transfer
- MAE-CSE CGD priority discussion meeting

- MAC Walkdown
- CAEX Fan Bearing Lubrication PM (4)
- Closed Cooling Water (CCW) Water Table Source Checks (2)
- CM on ARU Steam Trap
- Plan of the Day Meeting (6)
- Pre-job Briefs (8)
- TSR Instrument Calibrations (3)
- N-Area Receipt Inspection Walkdown
- Shift Test Engineer Meeting
- Shift Turnover Meetings (4)
- Toolbox Meeting (2)
- Power Support Operator Outside Surveillance Rounds
- 2nd Level Operator Surveillance Rounds
- Tour of H-Canyon Control Room
- Tour of H-Canyon 2nd Level
- Conduct of Operations Expectations Meeting
- H-Canyon Staff Meeting

Appendix C
Deficiencies

Deficiencies that did not meet the criteria for a finding are listed below, with the expectation from DOE Order 227.1A for site managers to apply their local issues management processes for resolution.

- Several calculations do not comply with the requirements of E7 2.31 and/or Engineering Guide 15060-G. Problems include improper classification, inadequate design inputs, and technically inadequate stress analysis. (See Section 5.1.)

- Several DCFs do not contain technical justification for the proposed change as required by E7 2.37. Similarly, contrary to the requirements of E7 2.38, the technical justification for some DCPs is inadequate. (See Section 5.1.)

- Contrary to the requirements of DOE-STD-3009-94, the clutches on three CAEX fans were downgraded from SC to GS. (See Section 5.1.)

- H-Canyon installation documentation or database records do not provide traceability of evaporator thermowells and RTDs from the point of manufacturing to the point of installation in accordance with 1Q 8-1. (See Section 5.2.)

- Contrary to 10 CFR 830, Subpart A § 830.122(e)(3), the damper for CAEX fan #3 has operated in a degraded condition since April 2012 (2012-NCR-30-0012) and CAEX fans #1 and #4 have had degraded flange bolting since October 2013 (2013-NCR-30-0036). (See Section 5.4.)

- Contrary to the requirements of DOE Order 422.1, Attachment 2, Section 2.p.(3).j, not all procedures are technically and administratively accurate. (See Section 5.6.)

- Contrary to the requirements of 2S 5.5, administrative control of equipment is implemented with uniquely numbered seals instead of locks, without any local procedure authorizing the use of seals in place of locks. (See Section 5.6.)