Office of Enterprise Assessments
Targeted Review of the Safety Basis
at the Savannah River Site
F-Area Central Laboratory Facility

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Acronyms

BDBA	Beyond Design Basis Accident
CFR	Code of Federal Regulations
CHA	Consolidated Hazards Analysis
CN	Change Notice
CRAD	Criteria, Review, and Approach Document
DBA	Design Basis Accident
DOE	U.S. Department of Energy
DOE-SR	DOE Savannah River Operations Office
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
LCO	Limiting Condition of Operation
MAR	Material at Risk
MOI	Maximally Exposed Offsite Individual
MOU	Memorandum of Understanding
NFPA	National Fire Protection Association
NMED	Nuclear Materials Engineering Division
OE	Operating Experience
OFI	Opportunity for Improvement
OSUG	Outside Underground
SAC	Specific Administrative Control
SAR	Safety Analysis Report
SBRT	Safety Basis Review Team
SER	Safety Evaluation Report
SRIP	Savannah River Implementing Procedure
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
SS	Safety Significant
SSC	Structures, Systems, and Components
TSR	Technical Safety Requirement
VOC	Volatile Organic Compound

Office of Enterprise Assessments Targeted Review of the Safety Basis at the Savannah River Site F-Area Central Laboratory Facility

EXECUTIVE SUMMARY

The Office of Nuclear Safety and Environmental Assessments, within the U.S. Department of Energy (DOE) independent Office of Enterprise Assessments (EA), conducted a targeted review of the Savannah River Site (SRS) F-Area Central Laboratory Facility (referred to as the F/H Laboratory) to evaluate changes in the Safety Analysis Report (SAR) and Technical Safety Requirements (TSRs). The F/H Laboratory is an analytical nuclear facility operated by Savannah River Nuclear Solutions (SRNS) under the direction and oversight of the DOE Savannah River Operations Office (DOE-SR). This review was conducted to evaluate changes in the SAR based on the revised atmospheric radiological dispersion analysis methodology and on the implementation of actions required in DOE Operating Experience (OE) document OE-1: 2013-01, *Improving DOE Capabilities for Mitigating Beyond Design Basis Events*. This EA review also addressed overall conformance of selected aspects of the SAR and the TSR to DOE-STD-3009-94 Change Notice 3, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Document Safety Analyses*. In addition, the EA review included DOE-SR's approved Safety Evaluation Report (SER), Addendum 17, which served as the basis of approval for the SAR and TSR. EA conducted this review over an extended period. Beginning with a site visit in December 2014, EA completed document reviews from January through July 2015 and provided comments to SRNS and DOE-SR, which were followed by comment responses and discussions from August through October 2015.

Overall, the hazard and accident analyses for the revised SAR are appropriate to the complexity of the facility's operations and the associated hazards, and in general, they adequately identify and analyze the hazards and contain a broad set of hazard controls. The SAR accident analysis methodology follows DOE standards and general practices, the consequence calculations are appropriately conservative, and the results confirm that the unmitigated accident consequences to the public are low. The accident analyses clearly describe the accident progressions and evaluate the consequences to identify and classify safety structures, systems and components (SSCs) and specific administrative controls (SACs). For each SSC and SAC, the SAR describes the safety function and functional requirements. For the most part, the safety functions are consistent with those identified in the hazard and accident analyses and the safety functions, functional requirements, and evaluations demonstrate how the SSCs and SACs meet the safety function requirements. Notably, the hazard analysis identified events that were carried forward into the accident analysis and used to evaluate collocated worker consequences and controls, even though no identified events challenge the DOE-STD-3009-94 evaluation guideline for the public.

All the postulated accident scenarios are assumed to result in a full facility fire involving Building 772-F. Consequently, the overall hazard control strategy for the facility involves actions to reduce the material at risk and the source term for that event.

Although the hazard controls are generally complete, significant deficiencies are evident in the hazard control set for the full facility fire, which includes the fire suppression system and the transient combustible control program. In the SAR, the system description, functional requirements, and system evaluation of the F-Area outside underground fire water supply system and the fire suppression system do not adequately define and evaluate the performance requirements necessary to fulfill the safety functions. Consequently, the TSR for the fire suppression system is not sufficient to ensure that the system remains operable (i.e., capable of performing its safety functions). Finally, although the transient combustible administrative control is identified as safety significant, the SAR does not follow through on the credited fire hazard control set by developing this control as an SAC. EA communicated these issues to DOE-SR and SRNS over the course of this review.

Following EA's identification of these specific outside underground fire water supply issues, DOE-SR and SRNS established a working group to develop a sitewide, standardized approach to fire suppression system operability at facilities where the responsibility for the overall system is shared between the nuclear facility and site infrastructure organizations. SRNS is also revising the fire hazard analysis and updating the facility's fire scenarios to support the next annual update of the SAR and TSRs.

Several deficiencies were identified in addition to those in the fire hazard controls. The SAR and TSRs do not designate safety significant administrative controls associated with inventory cabinet location and flammable gas control as SACs, as required by DOE-STD-1186, *Specific Administrative Controls.* Although the administrative controls are integral to the implementation of the control sets, they are carried forward in the SAR and TSRs only as programmatic controls, with no analysis to justify the higher risk involved in using a less reliable form of control. The hazard control set for explosive design basis accidents stemming from flammable gases does not adequately analyze potential preventive controls, and the description of some controls is not sufficient to support identifying the safety function and functional requirements. Additionally, the assumption that the facility's stacks were seismically qualified was not appropriately protected as a hazard control.

DOE-SR approved the revised F/H Laboratory SAR and TSR based on the conclusions in SER Addendum 17. The safety basis review team that evaluated the SER addendum used a graded approach for its review. The SER addendum generally discusses each topical area (i.e., approval basis), including base information, hazard and accident analyses, safety SSCs, SACs, derivation of TSRs, safety management programs, and TSR. The SER addendum includes the review team's comments and their resolution as an appendix. Although the graded approach used to develop the SER addendum is appropriate, the SER addendum does not always provide sufficient information for understanding the basis for the approval.

In conclusion, the SAR hazard and accident analyses are appropriate, and for the most part, the SAR adequately identifies and analyzes the hazards and contains a broad set of hazard controls. EA identified several significant deficiencies in the hazard control set that implements the facility's fire protection strategy, and SRNS and DOE-SR are addressing some of these concerns in the sitewide working group. In addition to these deficiencies, the SAR does not provide any justification for carrying forward some credited safety significant administrative controls as programmatic controls rather than the more reliable specific administrative controls. Management attention is warranted to ensure timely correction of the deficiencies in the limiting condition of operation for the fire suppression system and in the classification of administrative controls.

Office of Enterprise Assessments Targeted Review of the Safety Basis at the Savannah River Site F-Area Central Laboratory Facility

1.0 PURPOSE

The Office of Nuclear Safety and Environmental Assessments within the U.S. Department of Energy (DOE) independent Office of Enterprise Assessments (EA), conducted a targeted review of the Savannah River Site (SRS) F-Area Central Laboratory Facility (referred to as the F/H Laboratory) to evaluate changes in the Safety Analysis Report (SAR) and Technical Safety Requirements (TSRs). This review was conducted within the broader context of an ongoing program of targeted reviews of safety basis documents and associated processes across the DOE complex. In this context, EA evaluated changes in the F/H Laboratory SAR based on the revised atmospheric radiological dispersion analysis methodology and on implementation of actions required in DOE Operating Experience (OE) document OE-1: 2013-01, *Improving DOE Capabilities for Mitigating Beyond Design Basis Events*. EA conducted this review over an extended period. Beginning with a site visit in December 2014, EA completed document reviews from January through July 2015 and provided comments to SRNS and DOE-SR, which were followed by comment responses and discussion from August through October 2015.

EA's oversight program is designed to enhance DOE safety and security programs by providing the Secretary and Deputy Secretary of Energy, Under Secretaries of Energy, other DOE managers, senior contractor management, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements and the effectiveness of DOE and contractor line management performance and risk management in safety and security and other critical functions as directed by the Secretary. The DOE independent oversight program is described in and governed by DOE Order 227.1 *Independent Oversight Program*, and EA implements the program through a comprehensive set of internal protocols, operating practices, inspector guides, and process guides. The Office of Nuclear Safety and Environmental Assessments fulfills this responsibility, in part, by conducting independent assessments of nuclear safety and environmental management, including this targeted review of the F/H Laboratory.

2.0 SCOPE

Savannah River Nuclear Solutions (SRNS) manages and operates the F/H Laboratory under the direction and oversight of DOE Savannah River Operations Office (DOE-SR). This targeted review included evaluations of selected elements of the F/H Laboratory safety basis, including hazard and accident analysis; hazard controls; beyond design basis accidents (BDBAs); safety structures, systems, and components (SSCs); specific administrative controls (SACs); TSRs and their derivation; and Federal review and approval of safety basis documents. The focus was to determine overall conformance to DOE-STD-3009-94 Change Notice (CN) 3, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Document Safety Analyses*. Specifically, this report documents EA's review of SAR revision 16, *Central Laboratory Facility – Buildings 772-F, 772-1F, and 772-4F Safety Analysis Report*, and TSR revision 16, *Technical Safety Requirements Savannah River Site F-Area Central Laboratory Facility, Buildings 772-F, 772-1F, and 772-4F*, which were issued by SRNS. The report also documents the review of the DOE-SR SER (*Addendum 17 to SER Issued 08/29/97*) for the F/H Laboratory safety basis.

SRNS submitted the SAR and TSR to the DOE-SR in January 2015 and subsequently updated the SAR (based on DOE-SR comments) in March. DOE-SR approved the SAR and TSR revision 16 and issued SER Addendum 17 in June 2015.

3.0 BACKGROUND

The F/H Laboratory's current mission is to provide radiological and chemical analyses to support the processing activities in H-Canyon and to provide analytical support for waste disposition, material disposition, and area closure activities in line with Environmental Management missions. Laboratory analyses involving chemicals and nuclear materials include, but are not limited to, mass spectroscopy, alpha and gamma pulse height analyses, uranium fluorophotometry, argon inductively coupled plasma spectroscopy, chemical separations and analysis, and waste characterization. Support activities include sample receipt, inspection, and storage, as well as sample inventory.

F/H Laboratory includes four separate nuclear facilities. Building 772-F houses 25 active analytical laboratories and is designated as a hazard category 2 facility. Building 772-1F houses 23 active laboratories and four shielded cells and is designated as a hazard category 3 facility. The outdoor B-25 waste container staging areas are collectively designated as a hazard category 3 facility. Building 772-4F houses the main ventilation exhaust fans and equipment supporting Building 772-F and is designated as a radiological facility.

Revision 16 of the F/H Laboratory SAR incorporates the results of an updated consolidated hazard analysis (CHA) and significant changes to the accident analysis based on revised dispersion modeling and the application of a leak path factor of 1.0 for all release events. The changes in the accident analysis led to changes in the control strategies for the identified hazards and accident scenarios. These include, for example, revisions of the method for identifying material at risk (MAR) to a fine level of detail, introduction of a new design feature (inventory cabinets), and several new SACs. A number of TSR credited hazard controls were also removed from the SAR, primarily those related to passive confinement in the building exhaust systems.

4.0 METHODOLOGY

This review was conducted to evaluate changes in the SAR based on the revised atmospheric radiological dispersion analysis methodology and on the implementation of actions required in DOE OE-1: 2013-01. At SRS, the revised atmospheric radiological dispersion analysis increases the estimated dose consequence to the maximally exposed offsite individual (MOI) in the design basis accident (DBA) scenario by an amount equal to or greater than a factor of 2.9 (Energy Facilities Contractors Group Safety Basis Workshop SRNS Presentation, Dispersion Modeling Project, February 27, 2014). Additionally, the last independent oversight review of the safety basis predates SRS implementation of DOE-STD-3009-94 CN3, so this assessment was planned to examine the effectiveness of SRNS's implementation of the revised standard, as well as DOE-SR's implementation of DOE-STD-1104-2009 in reviewing and approving the SAR and TSR submittal.

EA used a sampling strategy to assess the technical defensibility of the SAR in select areas; such as hazard analysis, accident analysis, enhanced BDBA evaluations, functional requirements of safety controls, and derivation of TSRs. EA also assessed the technical defensibility of the DOE SER and verified whether performance is consistent with the expectations in DOE-STD-1104-2009.

The principal safety basis criteria supporting the assessment are based on selected objectives and criteria from EA Criteria, Review, and Approach Document (CRAD) 31-3, Rev. 0, *Safety Basis Upgrade Review Criteria Review and Approach Document*.

Assessment activities included:

- Walking down selected facilities and associated safety SSCs

- Reviewing contractor processes and documentation associated with revising the SAR and TSRs, including reports, referenced calculations and analyses, manuals, technical basis documents, design media, and design specifications

- Reviewing DOE-SR procedures, processes, and documentation for safety basis review and approval, including, but not limited to: safety basis review team (SBRT) plan and schedules, records for documenting and communicating technical review comments and their disposition, and the approved SER addendum.

EA conducted a scoping visit at SRS in December 2014 to meet with representatives of F/H Laboratory, receive a summary briefing on the F/H Laboratory safety basis focusing on intended changes, and conduct a tour of the laboratory buildings and their process operations. After receiving the approved SAR, TSR, and SER, EA reviewed the documents and submitted written comments communicating potential issues for SRNS and DOE-SR response. EA discussed SRNS's responses to EA's comments in teleconferences with SRNS (including nuclear safety managers, engineering managers, facility managers, and subject matter experts) and DOE-SR personnel (including assistant managers, facility engineers, and subject matter experts). EA subsequently updated the comments. EA followed a similar process for the SER review, with written comments provided to DOE-SR for response, and subsequent teleconferences for clarification. These interactions satisfactorily resolved a number of issues.

Section 5 of this report contains the results of the assessment, Section 6 summarizes EA's conclusions, and Sections 7 and 8 list EA's findings and opportunities for improvement (OFIs). Supplemental information about the team responsible for this review is provided in Appendix A and the list of documents, interviews, and observations is provided in Appendix B. References are listed in Appendix C.

5.0 RESULTS

5.1 Hazard and Accident Analysis

Criteria: The documented safety analysis for a hazard category 1, 2, or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility, evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility. (10 CFR 830, Section 830.204.(b).(3))

EA reviewed the hazard analysis sections of the F/H Laboratory SAR, along with the CHA, to evaluate the hazard identification and hazard analysis processes and the identification of candidate hazard controls. The review included events related to fires, explosions, loss of confinement, and earthquakes for Buildings 772-F and 772-1F. EA also examined the methodology used to determine the facility hazard categorization. Overall, the SAR adequately identifies and analyzes the hazards associated with the

laboratory operations and identifies a broad set of hazard controls; however, the discussions of some accident events do not identify interaction hazards (e.g., stacks from the buildings).

SRNS prepared a separate hazard analysis document (S-CHA-F-00017, *Consolidated Hazards Analysis for Operations in F/H Laboratory*) to support the SAR, which exhibits an appropriate level of analysis given the complexity of the operations and the hazards associated with the facility. The CHA briefly describes the facility and its operational processes, provides an appropriate description of the methodology used to identify the hazards associated with operations, and discusses the methods and results of the hazard evaluations. The CHA addresses the inputs and assumptions supporting the analysis and references the results of the scoping calculations supporting the consequence estimates in the hazard evaluation. Completed hazard evaluation tables document the analyses of the individual hazard events, and the overall results are organized in a table of representative and unique events by event category (e.g., operational, external) and event type (e.g., fire, explosion, natural phenomena hazard).

The SAR adequately describes the hazard analysis process and results, including transcription of the CHA results into the applicable sections of Chapter 3. It appropriately identifies the radiological MAR, the chemical hazards, and potentially hazardous energy sources. The hazard control selection process makes use of appropriate tables to describe the consequence evaluation levels and the selection criteria. Notes under the selection criteria table establish "goals" for selecting an appropriate set of controls to reduce the risk to the workers and the public. The control selection preferences generally follow the DOE-STD-3009-94 CN3 hierarchy of controls. As described, the hazard control process is implemented by selecting a primary level of control and then by considering additional levels of control (from the defense-in-depth controls) for events with significant consequences. Significant contributors to defense-in-depth are designated as safety significant (SS). Additional levels of control may also be identified as defense-in-depth, although not credited as part of the control set.

The results of the hazard analysis are presented as a set of representative and unique events that include operational events (e.g., fires, explosions, and loss of confinement), external events, and natural phenomena hazard events. Each of the representative and unique events is discussed, including suitable summaries of the event scenario and the unmitigated consequences. Separate subsections discuss the hazard controls for worker safety protection for each of the representative and unique events, providing suitable discussions of the hazard mitigation strategies and hazard control sets and incorporating tables that identify the control name, safety function, and functional classification. Although the hazard analysis does not specifically identify events that would challenge the public evaluation guideline (25 rem at the SRS boundary), the representative events that exceed the SRS onsite evaluation criteria (100 rem at 100 meters) are conservatively carried forward into the accident analysis. EA noted that the analysis of representative events goes beyond the requirements of DOE-STD-3009-94, enhances the understanding of the potential accidents and related hazard controls and allows for substantial improvements in the safety of the facility.

The hazard analysis addresses an appropriate range of hazardous materials and energy sources and addresses an acceptable set of hazard events. The identified hazard mitigation strategies and control sets are mostly complete; however, the hazard analysis does not fully address the structural interaction hazards resulting from seismic events, as further described below.

The design qualifications of the stacks are not protected as a SAR-derived hazard control. In discussing external events, SAR § 3.3.2.1.10 asserts: "There are no interaction hazards from the stacks associated with Buildings 771-1F, 772-F, and 772-4F based on the design qualifications of the stacks (Ref. 37, 38) or from containers located outside the buildings." Although SAR §§ 2.2.1.1, 2.2.1.2, and 2.2.1.3 discuss the qualification of the stacks, the hazard analysis (i.e., initial conditions in Table 3.3-8 and inputs and assumptions for the Building 772-F seismic event) does not include the assumption that the stacks will

not collapse in the evaluation basis earthquake. The hazard analysis also does not evaluate the unmitigated consequences of stack collapse and, based on the results, does not identify hazard controls (i.e., SS stack structure) to prevent such collapse. (See Finding **F-SRNS-1**.)

Based on facility segmentation, Building 772-1F and the adjacent B-25 Waste Storage Area are designated hazard category 3 facilities. As described above, the F/H Laboratory comprises four facilities, the hazard categorizations of which are presented in SAR §3.3.2.3.1. Although DOE-STD-1027-1992 allows segmentation, the SAR does not provide a full technical basis for the segmentation of the B-25 storage area in a seismic event, nor does it explain the use of a less conservative value than the evaluation basis earthquake for the peak ground accelerations used to evaluate the ability of Building 772-1F structure to protect the segmentation. Consequently, the SAR does not identify and evaluate some potential safety functions associated with the facility structures:

- The evaluation of the facility structure between the B-25 Waste Storage Area and Building 772-1F in SAR § 3.3.2.3.1 does not address the effect of an earthquake followed by a fire. The initial conditions in SAR Table 3.3-8 indicate only that the safety function of the Building 772-1F structure is to provide segmentation in case of fire.

- The hazard analysis (event GF-7-002, *Earthquake with Fire in Building 772-1F*) credits the building structure with providing segmentation during the earthquake, and the event is not carried forward into the accident analysis for refinement as a DBA. Although the evaluation basis earthquake for the F/H Laboratory buildings (see SAR § 3.4.2.6) is stated to have a peak ground acceleration of 0.20 g, the functional requirement for Building 772-1F is to withstand a peak ground acceleration of 0.13 g. The higher peak ground acceleration of 0.20 g could result in failure of the walls in Building 772-1F (WSRC-TR-95-00080 assumes that the building collapses during an evaluation basis earthquake). Without additional controls and justification, failure of the structure during an evaluation basis earthquake and subsequent fire spread could challenge the credited segmentation of the B-25 storage area.

EA reviewed the SAR accident analyses for fires, explosions and earthquake scenarios to determine whether the accident analyses provide adequate descriptions of the accident sequences, conservatively estimate consequences, and properly identify safety SSCs and SACs to protect the workers, the public, and the environment.

Several representative hazard events were carried forward and analyzed as DBAs. These include a full facility fire in Building 772-F, a volatile organic compound (VOC) explosion, a hydrogen explosion in a dissolution vessel (either Building 772-F or Building 772-1F), and a seismic event.

The accident analysis methodology presented in the SAR is clear and follows DOE standards and practices. The MAR used to determine the source term for the analysis is described in sufficient detail to support understanding of the division of the Building 772-F MAR into liquids and powders that are subject to an appropriate container control strategy and various potential release mechanisms. The leak path factor for this SAR update has been revised to 1.0 for all the unmitigated accident analyses. To address a previously identified sitewide issue in the accident consequence calculations, SRNS completed a series of parametric airborne dispersion studies using improved meteorological data, surface roughness, and deposition velocity. Based on a limited series of data runs, the studies show that the consequences could increase by a factor of 2.5 to 3.5. Since the final values of input parameters could increase these ratios, the accident analysis conservatively increases the consequences calculated using the current model by a factor of 5.

The mitigated and unmitigated radiological exposure consequences determined by the accident analysis are presented in SAR Table 3.4-1. In all scenarios, the accident analysis confirms that the unmitigated consequences to the public (i.e., MOI) are low (< 3 rem) and do not challenge the DOE-STD-3009-94 CN3 evaluation guideline. For the collocated worker, the analyses show that the unmitigated event consequences are high (based on the assumption in each scenario that the result is a full facility fire) and exceed the SRS onsite evaluation criteria. The results are consistent with the MAR inventory and hazard categorization of Building 772-F.

The SAR accident scenario description begins with an examination of the potential accident initiators and a detailed description of the unmitigated accident progression. Since the accidents exceed the SRS onsite evaluation criteria for the collocated worker, a mitigated accident analysis, which includes a discussion of the mitigating controls, is appropriately presented and provides useful insight into the accident sequence. The controls selected for these accidents are properly categorized as SS. For example, the accident analysis for a fire in Building 772-F postulates that an uncontrolled quantity of flammable materials accumulates, ignites, and spreads fire throughout the building. The accident scenario includes a detailed description of the mechanism by which the MAR is affected and explains the selection of damage ratios. The mitigated sequence identifies the selected controls that limit the fire to a single room with no containers that are susceptible to pressurized release.

The accident analyses provide suitably detailed discussions of the source term for the scenario, including a discussion of the inputs and assumptions and a tabular presentation of the source term parameters used in the calculation. Both the unmitigated and mitigated radiological exposure consequences are presented and compared to the onsite evaluation criteria to determine the need for SS controls. The final subsection of the accident analysis summarizes the controls necessary to ensure that the consequences "do not exceed the SRS on-site evaluation criteria and to further reduce the associated risk." The control summary identifies these controls as SS and describes the corresponding safety function. For example, the fire accident scenario identifies six SS controls (including High Pressure Powder Release Container Isolation Control, Building 772-F Fire Suppression System, Inventory Cabinet Design, Inventory Cabinet Controls, Fire Protection Program - Building 772-F Service Floor Combustible Liquid Fuel Restrictions, and Fire Protection Program - Transient Combustible Control) in addition to the controls associated with the accident scenario initial conditions.

Although the accident analysis is generally sound, the analysis of the design basis operational fire in Building 772-F is inaccurate (see Finding **F-SRNS-2**):

- One scenario described for the operational fire in Building 772-F DBA involves a spill while filling the diesel fuel tanks on the service floor of Building 772-F. The supporting calculation, F-TRT-F-00019, *Technical Report for F&H Laboratory Fuel Fire Scenarios* (SAR Chapter 4, reference #25), states that a spill could occur while filling the diesel tanks and "If the integrity of the tanks is compromised an indeterminate amount of fuel could spread onto the floor and into the dike." The heat release rate and the burn duration for this scenario were not analyzed, so the performance of credited hazard controls (e.g., fire suppression system) cannot be evaluated.

- The analysis for the above scenario (also described in calculation F-TRT-F-00019) suggests that the large floor area will limit the buildup of temperatures at the service floor level and that dissipation of heat will prevent propagation through the unprotected floor penetrations (to the main floor). This heat dissipation would be true for a smooth ceiling configuration. However, the service level ceiling is constructed of deep concrete pockets (approximately 18 inches), thus inhibiting the migration of heat and hot gases across the pocketed ceiling and potentially allowing the hot gases to build up in the area where there are multiple penetrations to the main level that are not fire barrier qualified with the

requisite fire-rated sealant. The Building 722-F operational fire DBA does not reflect this physical configuration and its effect on the spread of the fire.

Follow-up discussions with SRNS and DOE-SR revealed that the facility is revising the fire hazard analysis and plans to incorporate and update the fire scenario analyses (while retiring the supporting calculation, F-TRT-F-00019). The fire hazard analysis is being revised to support the next annual update of the SAR and TSR.

5.2 Hazard Controls

Criteria: The documented safety analysis for a hazard category 1, 2, or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility, derive the hazard controls necessary to ensure adequate protection of workers, the public, and the environment, demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the hazard controls current at all times and controlling their use. (10 CFR 830.204.b.4)

EA reviewed several DBAs to evaluate the derivation and functional classification of hazard controls, including identification of safety functions and evaluation of whether the controls are able to satisfactorily eliminate, prevent, or mitigate the identified hazards.

In the DBAs, the accident analysis results are presented clearly and properly characterized in terms of public and collocated worker safety. Safety significant controls are identified to prevent or mitigate accidents exceeding the SRS onsite evaluation criteria. The selection of controls follows the defined methodology, and the selected controls are generally adequate to prevent or mitigate the analyzed accidents; however, some deficiencies were identified, as further described below.

The hazard control set for the explosive DBA is incomplete, and the description of some controls is not sufficient to support fully identifying their safety function(s) and functional requirements. In addition, the hazard control set does not follow the preferred hierarchy of controls from DOE-STD-3009-94; in which preventive controls are preferred over mitigative controls (see Finding **F-SRNS-3**):

- In the VOC Cloud Explosion DBA, the discussion of accident initiators includes releases of VOCs into a room, glovebox, or laboratory module, but the flammable gas control program safety function does not specify the locations where flammable gases are analyzed and authorized for use. In particular, the SAR discusses the potential for buildup of flammable gas in an enclosed glovebox but does not include any controls explicitly for the use of flammable gases in gloveboxes. (See **OFI-SRNS-1**.)

- There is no discussion of the method for determining a limit for allowable quantities of flammable gases under the flammable gas control program (§5.5.5.7.3.2). (See **OFI-SRNS-1**.)

- The SAR credits mitigative controls for explosive events and DBAs without providing an adequate technical basis for omitting preventive controls. For example, the VOC Cloud Explosion DBA adopts a mitigative control strategy without evaluating controls to prevent deflagration.

5.3 Beyond Design Basis Accidents

Criteria: The documented safety analysis for a hazard category 1, 2, or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility, evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of

radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility. (10 CFR 830, Section 830.204.b.3)

The BDBA section of the SAR declares that the unmitigated analysis of the operational events, including criticality, and the seismic event encompass the potential BDBAs. The SAR analyzes a BDBA for tornados and high winds and concludes that no additional actions are necessary based on the estimated consequences.

Since the estimated dose consequences to the MOI from events in the facility are less than DOE-STD-3009-94 CN3 evaluation guideline (25 rem), the OE-1:2013-01 requirements do not apply.

5.4 Safety Structures, Systems, and Components

Criteria: The documented safety analysis for a hazard category 1, 2, or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility, derive the hazard controls necessary to ensure adequate protection of workers, the public, and the environment, demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the hazard controls current at all times and controlling their use. (10 CFR 830, Section 830.204.(b).(4))

Safety analyses must be used to establish: (a) the identity and functions of safety class and safety significant structures, systems, and components (SSCs), (b) the significance to safety of functions performed by safety class and safety significant SSCs, and (c) the SACs needed to fulfill safety functions. (DOE Order 420.1B, Change 1, Chapter I, Section 3.a.1)

EA reviewed SAR Chapter 4 for the facility structures, gloveboxes, fire suppression system, and inventory cabinets (a new credited design feature) to verify that the SAR demonstrates the credited SSCs' ability to perform their safety functions.

The F/H Laboratory does not contain any safety class SSC, consistent with accident analysis results. Five passive design features and one active SSC are identified as SS for the protection of the facility and collocated workers. For each of the SS SSCs, the SAR appropriately describes the safety function and includes a system description, functional requirements, system evaluation, and TSR controls. SAR Table 4.7-1 summarizes the SSCs, including summary descriptions that tie the safety analysis in Chapter 3 to the safety function and performance requirements. Generally, the safety functions are consistent with those identified in the hazard and accident analyses, and the safety functions, functional requirements, and system evaluations support a sufficient understanding of how the SSCs meet the safety function requirements. However, EA identified the following deficiencies.

The system description, functional requirements, and system evaluation of the F-Area outside underground (OSUG) fire water supply system and the F/H Laboratory fire suppression system are insufficient to demonstrate that these systems will meet their intended safety functions (see Finding **F-SRNS-2**):

- SAR § 4.4.10.3 describes the functional requirement for the fire suppression system as the "ability to deliver an adequate amount of water (pressure and flow) to a fire in its coverage area" and continues to describe the need for the OSUG fire water supply system to supply fire water greater than the demand required by Building 772-F. In describing the memorandum of understanding (MOU) with the responsible site infrastructure group, SAR § 4.4.10.3 addresses some operability (functional) requirements, such as the need for at least one pump to be operable, but neither SAR § 4.4.10.3 nor § 4.4.10.4 defines the specific performance requirements necessary for the OSUG fire water supply

system (e.g., minimum pump flow and pressure parameters) to remain operable. Further, SAR §§ 4.4.10.5 and 5.5.1.1.1 do not define the surveillances necessary to verify continued operability of the OSUG supply (e.g., periodic testing of the fire water supply pumps, verification of an unobstructed flow path).

- The system description, functional requirements, and system evaluation of the Building 772-F fire suppression system (§ 4.4.10) do not specifically discuss the exclusion of the diesel room or the shielded areas from coverage in the TSR limiting condition of operation (LCO).

- SAR § 4.4.10.3 does not evaluate the required fire suppression system attributes, and § 4.4.10.5 does not specifically address the TSR surveillance tests necessary to ensure that the system meets its stated safety function.

After EA identified the specific OSUG fire water supply system issues, DOE-SR and SRNS established a working group to develop a sitewide, standard approach for MOUs that describe fire suppression systems at facilities where the responsibility for the overall system is shared between nuclear facility and site infrastructure organizations. One goal of the working group is to establish a proper set of surveillances to confirm that the fire suppression systems remain operable. In addition, SRNS is revising the fire hazard analysis and updating the facility's fire scenarios to support the next annual update of the SAR and TSR.

The SAR safety functions, performance criteria, and system evaluations of passive design features are not always clear enough to ensure that the safety function is adequately identified and protected:

- The system evaluation for the inventory cabinets (SAR § 4.4.14.3) concludes that based on referenced engineering evaluations, there would be no release from the inventory cabinets during the postulated fire scenarios. However, the evaluation does not discuss whether the cabinet fire endurance rating can meet the expected (calculated) heat release from the DBA fire.

- Gloveboxes are identified as passive design features providing confinement of radiological and chemical materials (SAR § 4.4.4.1), but the discussion of the safety function does not identify the design pressure of the gloveboxes, which is credited with protecting workers in the event of an explosion during the dissolution process. Additionally, the glovebox integrity survey program does not provide specific periodic engineering inspections to ensure that the glovebox meets its design pressure rating.

- The system description of the Building 772-F structure (SAR § 4.4.1.2) does not include the weight of the roof-mounted air handling units and their effect on the building's seismic response. The structural specifications in SAR § 2.2.1.1 and the supporting technical report (WSRC-TR-95-0800) describe the installed supports that the air handling units require to ensure that the building's roof will survive a 0.20 g earthquake.

5.5 Specific Administrative Controls

Criteria: As appropriate for a particular DOE nuclear facility, the section of the technical safety requirements on Administrative Controls will provide information on organization and management, procedures, recordkeeping, assessment, and reporting necessary to ensure safe operation of a facility consistent with the technical safety requirement. In general, the administrative controls section addresses (1) the requirements associated with administrative controls (including those for reporting violations of the technical safety requirement); (2) the staffing requirements for facility positions important to safe conduct of the facility; and (3) the commitments to the safety management programs identified in the

documented safety analysis as necessary components of the safety basis for the facility. (10 CFR 830, Appendix A, Table 4)

An SAC exists when an administrative control is identified in the DSA as a control needed to prevent or mitigate an accident scenario, and has a safety function that would be SS or SC if the function were provided by an SSC. (DOE-STD-1186, Section 1.2)

EA reviewed SAR Chapter 4 to verify that the SAR demonstrates the ability of the credited SACs to perform their safety functions. EA examined the programmatic administrative controls (safety management programs) in the SAR and TSR and, specifically, the SACs for MAR control, service floor fuel restrictions, sealed dissolution container control, and inventory cabinet control.

SAR Chapter 4 identifies seven SACs for the protection of collocated workers. For each SAC, the SAR provides a description and its safety function and an evaluation of the SAC's ability to meet the safety functions. The safety functions are mostly consistent with those identified in the hazard and accident analyses. The safety functions, functional requirements, and SAC evaluations sufficiently support an understanding of how the SACs meet those requirements.

The SACs for MAR controls establish two detailed sets of controls that are designed to be implemented through LCOs (seven in total). The first set of controls establishes MAR limits in designated areas, while the second set of controls establishes container configurations and associated MAR limits to maintain the initial conditions of the hazard analysis. The controls are adequately linked to the initial conditions for the hazard and accident analyses, and the bases for the controls are clear. The SACs require periodic surveillances to verify that the hazardous material inventory limits have not been exceeded. The SACs for service floor fuel restrictions, sealed dissolution container control, and inventory cabinet control also appropriately describe the SAC and its safety function, along with an evaluation of the SAC. However, EA identified several deficiencies in designating credited administrative controls as SACs.

The SAR did not designate some administrative controls classified as SS in Chapter 3 as SACs or include them in the Chapter 4 control evaluation. In several instances, the hazard and accident analyses credited (i.e., risk reduction in specific accident scenarios) preventive or mitigative administrative controls as SS controls, but those controls were not carried forward as SACs, as required by DOE-STD-1186, *Specific Administrative Controls*. To qualify as an SAC, the administrative control must provide a specific preventive or mitigative function for accident scenarios identified in the SAR when the safety function has importance similar to, or the same as, the safety function of a safety SSC. In most cases, by directly performing a safety-related function, these administrative controls are an integral part of a scenario-specific control strategy (see Finding **F-SRNS-4** and **OFI-SRNS-2**):

- The safety function of the inventory cabinet location is to prevent radiological releases by protecting the integrity of the cabinets. For example, SAR §3.4.2.2.1.3 states: "The Inventory Cabinet Control Program is credited to provide approved and authorized locations that are not susceptible to explosion hazards, eliminating the release from the Inventory Cabinets due to the deflagration blast wave." The inventory cabinet control is defined in SAR § 5.5.5.7.11 (TSR SAC 5.7.11), but the safety function for this control does not include specific inventory cabinet locations (Items 1.a, 1.b, and 1.c). The safety function of the administrative control, which has importance similar to an SS SSC function, is to ensure there is no release of radiological material from the cabinet in all postulated event scenarios involving thermal stress, missile impact, explosion, and impact from falling debris.

- The hazard analysis credits the transient combustible program control as an SS control to minimize or exclude the amount of combustibles (to reduce fire intensity, size, and duration) for all DBAs (e.g., full facility fire, explosions, and earthquake-initiated facility fire), but SAR Chapter 4 does not

designate the control as an SAC. The transient combustible program control is identified as an element of the facility fire protection program. The safety function of the transient combustible control, which has importance similar to an SS SSC safety function, is to "minimize or exclude the amount of transient combustibles which reduce fire intensity and size." Additionally, combustible controls are not identified for high hazard areas that are excluded from the operability statement in TSR 3.1.1 and could be more susceptible to fires (e.g., diesel generator room, fuel tanks, pathways to the shielded cells). Given the recognized deficiencies of the fire suppression system, the transient combustible control program provides an important safety control to ensure that the SS fire suppression system can perform its safety function. (See **OFI-SRNS-3**.)

- The flammable gas control program is credited as an SS control for the VOC cloud explosion DBA, but the flammable gas control is identified only as an element of a programmatic administrative control, and not an SAC. The program is the primary control for lowering the consequences to collocated workers by limiting the effects of the explosion to a single laboratory module.

5.6 Technical Safety Requirements and Their Derivation

Criteria: A contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility must: (1) develop technical safety requirements that are derived from the documented safety analysis; and (2) obtain DOE approval of technical safety requirements and any change to technical safety requirements. (10 CFR 830, Section 830.205.(a).(1)&(2))

Technical safety requirements establish limits, controls, and related actions necessary for the safe operation of a nuclear facility. (10 CFR 830, Appendix A, Section G.4)

EA reviewed a sample of the TSRs and their associated derivation in SAR Chapter 5 to verify the accurate translation of the SSC and SAC performance requirements into a set of formal, implementable operational requirements that preserve and maintain the identified safety functions, functional requirements and performance criteria requirements from Chapters 3 and 4 of the SAR. EA examined the LCOs associated with the fire suppression system and MAR controls and evaluated several administrative controls.

SAR Chapter 5 appropriately addresses the F/H Laboratory operating modes and derives TSR LCOs for the fire suppression system, the MAR controls, and the LR-56S Loading Station vapor space control. The administrative programs are included under SAR § 5.7, *Procedures, Programs and Manuals*, including the embedded administrative controls designated as SACs. Passive design features include the inventory cabinets, the structural integrity of Buildings 772-F and 772-1F, the gloveboxes, and shielded cells.

The TSR content generally conforms to DOE Guide 423.1-1A. Nonetheless, EA identified the following TSR issues, which, in general, reflect the previously identified issues in SAR Chapters 4 and 5.

The TSR for the fire suppression system is not sufficient to ensure that the system remains operable and capable of performing its established safety functions (see Finding **F-SRNS-2**):

- The operability statement for LCO 3.1.1, Fire Suppression System Building 772-F, does not describe the minimum functional capability or performance level of equipment required for the safe operation of the facility. In addition, the identified surveillances are insufficient to demonstrate that the fire suppression systems can perform their credited safety function. The specified surveillance requirements (SAR § 4.4.10.5 and 5.5.1.1.1 and TSR LCO 3.1.1) do not include all the applicable inspections and tests required by the relevant codes and standards, such as NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, and there is no

technical justification for their exclusion. For example, the semiannual inspector's flow test, valve position checks, periodic monitoring system pressure, and periodic verification of an unobstructed flow path are not included as surveillance requirements.

- No TSR surveillance requirements are specified to ensure that the fire water supply system is operable. (Note: As previously discussed, SAR § 4.4.10.5 and 5.5.1.1.1 do not define the surveillances necessary to maintain operability of the OSUG supply to the F/H Laboratory fire suppression system.)

- The fire suppression system process area applicability statement for TSR LCO 3/4 1.1.1 excludes the diesel generator room; Shielded Areas A, C, and E; and the attic. However, the corresponding sections of the SAR (4.4.10 and 5.5.1) provide no discussion to support their exclusion. The TSR bases discuss difficulties with personnel access to the attic and shielded areas in relation to the performance of maintenance and surveillance activities, but do not provide a technical justification for excluding these areas from LCO applicability. (See **OFI-SRNS-3**.)

The TSR does not require periodic inspections of passive design features to ensure that they continue to meet their intended safety function. The structural integrity program and specific requirements related to periodic inspection of the safety-related design features are not included in Chapter 5 of the SAR or in TSR § 5.0, Administrative Controls, even though several SAR Chapter 4 sections (e.g., for Buildings 772-F and 772-1F) state that the structural integrity of the SSC is "monitored in accordance with the Structural Integrity Program." The laboratory facilities are currently evaluated for structural integrity on a periodic basis in accordance with site conduct-of-engineering procedures. In response to EA comments, SRNS stated that the structural integrity program is slated to be added to the TSR in the next annual update. Notably, in the current documents:

- SAR § 5.6.1 does not discuss the important attributes of design feature safety functions, refer to either Chapter 2 or 4 for that discussion, or address the characteristics of the design features that are subject to physical degradation and require periodic inspection to ensure that they continue to meet their safety functions.

- TSR § 6.0 indicates that the design features are controlled with respect to the existing drawings, design specifications, and Code of Record, but does not discuss the aspects of the design features, such as the structural integrity of the buildings, that require periodic inspection and maintenance to protect them from the effects of aging.

5.7 Federal Review and Approval

Criteria: DOE will review each documented safety analysis to determine whether the rigor and detail of the documented safety analysis are appropriate for the complexity and hazards expected at the nuclear facility. In particular, DOE will evaluate the documented safety analysis by considering the extent to which the documented safety analysis (1) satisfies the provisions of the methodology used to prepare the documented safety analysis and (2) adequately addresses the criteria set forth in 10 CFR 830.204(b). DOE will prepare a Safety Evaluation Report to document the results of its review of the documented safety analysis. A documented safety analysis must contain any conditions or changes required by DOE. (10 CFR 830, Appendix A, Section F.3)

DOE will examine and approve the technical safety requirements as part of preparing the safety evaluation report and reviewing updates to the safety basis. (10 CFR 830, Appendix A, Section G.5)

EA reviewed the SER addendum to evaluate whether it establishes an appropriate approval basis for the SAR and TSR (revision 16). The SER addendum is the 17th addition to the original SER, which was issued in August 1997. The practice of approving annual safety basis submittals through SER addenda is a typical configuration management approach used by many DOE site offices and endorsed by DOE-STD-1104-2009.

The SAR and TSR review was completed and the SER was prepared in accordance with Savannah River Implementing Procedure (SRIP) 400, Chapter 421.1, *Nuclear Safety Oversight*, dated October 28, 2014. Attachment A of the procedure, *Safety Evaluation Report (SER) Format/Content Guidance*, addresses safety basis document reviews (including review and approval of SAR and TSR updates) and provides guidance on the review approach, risk acceptance, format, and content of SERs. A review plan was prepared and guided the completion and documentation of the review. SRIP Chapter 421.1 is being updated to reflect the currently approved version of DOE-STD-1104-2014, which was issued in December 2014 and made mandatory for line management by DOE Order 420.1C, Change 1, *Facility Safety*, on February 27, 2015.

The DOE-SR SBRT consisted of a team leader, the Facility Representative, a criticality safety engineer, the facilities program manager, and a fire protection engineer. The safety basis approval authority's SAR and TSR approval letter, as issued by the DOE-SR Deputy Manager, establishes the SER addendum as the basis for approval. No conditions of approval were specified.

The SER addendum's executive summary provides a list of the objectives of the submittal, a summary of the new and revised hazard controls, and a list of the controls that were removed, and concludes that the safety basis demonstrates there are "no unacceptable risks" to the public or workers from the hazards at the F/H Laboratory. The bulk of the SER consists of six approval basis sections (base information, hazard and accident analysis, safety SSCs, SACs, derivation of TSR, safety management programs, and TSR) that cover the results of the SBRT review. Each of the review sections consists of a statement of the review criterion and an evaluation section addressing whether the criterion has been met.

The review criteria are appropriately referenced to the specific DOE-STD-1104-2009 section. Generally, the evaluation section provides a short synopsis of the changes made to the SAR in revision 16, states that the criterion has been met, and provides a rationale for the conclusion. For example, the review of §5.2, which addresses the accident analysis, indicates that the SBRT evaluated the accident analyses, supporting calculations, and other references. The SBRT concluded that the methodology for performing the accident analysis is consistent with DOE-STD-3009-94 CN3. The SER addendum summarizes the inputs to the source term calculations and the methods and inputs to the radiological dose consequence calculations, and also discusses the appropriateness of the method for calculating radiological dose. It then summarizes each of the DBAs and lists the credited hazard controls. For each DBA, the SBRT states its agreement with the radiological dose consequence analysis and the acceptability of the hazard control set.

The SER addendum uses a similar format to document the review of the changes to the safety SSCs and the SACs. The fire suppression system is addressed only briefly, since no associated technical changes had been made to the SAR and TSR. The inventory cabinets and a new credited safety SSC (i.e., design feature) are briefly described, along with their TSR controls. Similarly, three revised SACs and three new SACs are described. The SBRT concluded that the "facility identified the correct set of SACs that implement SS controls," but there is no similar summary statement for the SSCs.

Although the SER addendum is mostly complete in summarizing changes and stating the SBRT's judgment that the review criteria are met, EA identified a general weakness in documenting the bases for the SBRT's conclusions about acceptability. This is contrary to SRIP 400, Chapter 421.1, Attachment A,

§ 3.0 guidance, which indicates that "for each safety basis change or major topic, the reviewer should describe what DOE did to determine acceptability of the accident analyses (e.g., comparison to a standard, walkdowns, independent calculations, etc.). Provide sufficient detail to clearly demonstrate how each review criterion is satisfied." Given the graded approach and the limited nature of the SAR change, the SER addendum does not always support the approval by providing a rationale for whether the SAR and TSR changes meet the evaluation criteria.

As noted, in evaluating the revised accident analyses, the SBRT documented its review of the revised accident methodologies (SER addendum § 5.2) but did not include similar discussions of the basis for concluding that the hazard control set chosen for the DBA was adequate to prevent or mitigate the accident. For each DBA (§§ 5.2.1-5.2.6), the SER addendum concludes "that use of SS controls described for this event will effectively mitigate the event for the CW [collocated worker] and FW [facility worker]," with no further discussion of the basis for the conclusion. The SER addendum does not document the rationale for acceptability of the control set based on the designation of some of the identified SS controls as programmatic administrative controls rather than SACs (see further discussion below). For example:

- The discussion in the summary paragraph of SER addendum § 5.2.2 addresses the radiological consequences of the event (hydrogen explosion in the dissolution vessel) but does not explain the adequacy of the suite of hazard controls (e.g., sealed dissolution container control, glovebox and glovebox integrity survey program are credited) in the DBA controls, particularly those related to protecting the facility worker from the physical effects of the deflagration.

- The description of the VOC Cloud Explosion DBA in SER §5.2.3 includes a paragraph on the deflagration hazard (indicating that it is most likely to occur in a glovebox), but the SER addendum does not provide the rationale for the acceptability of the control set to prevent a deflagration in the glovebox. (See **OFI-SR-1**.)

In addition, Section 6.0 of the SER addendum on SSCs and SACs does not state whether the revised and new safety SSCs and SACs are consistent with hazard and accident analysis logic and thus limits the understanding of the basis of approval. Although the conclusion of § 6.2 of the SER is that the "identified SACs are sufficiently documented and evaluated in the SAR," no rationale is provided to support the SBRT conclusion. Also, SER § 6.2 does not explain the adequacy of the SAR in justifying the use of SACs over engineered features (i.e., safety SSCs), as suggested by DOE-STD-1104-2009 § 4.8. Finally, in some instances the SER does not fully explain its judgment of acceptability for the completeness of information in the SAR that establishes TSR requirements. For example:

- The discussion of the TSR controls (SER addendum § 6.1.2) indicates that the structural integrity of the building and its interaction with the inventory cabinets is monitored by the structural integrity program, but the SER does not discuss the structural integrity program's acceptability as a control.

- As discussed above, the SER addendum does not identify and evaluate the reason the SAR did not designate SS administrative controls as SACs (see § 5.5 of this report). Examples include transient combustible controls, inventory cabinet location controls, and flammable gas controls. (See Finding **F-SRNS-4**.)

- The SER addendum (§ 7.1.2) repeats the statement from the SAR that the surveillance frequency for MAR inventory is satisfactory because facility-specific "procedures require radionuclide inventories to be accounted for on a frequency and at quantities that ensure this surveillance frequency for 772-F is appropriate," but the SER addendum does not explain the rationale for accepting the surveillance frequencies. Although it refers to the existence of additional administrative controls and a supporting

computer program, it does not discuss these programmatic elements in the context of the acceptability of the annual surveillance frequency. Further, the TSR does not include the radionuclide inventory control program as a programmatic administrative control, and the SER addendum does not discuss its importance in establishing the inventory surveillance requirements.

- The Building 772-1F fire suppression system was downgraded from SS to defense-in-depth and the corresponding LCO was deleted because of the decrease in mitigated consequences when new SACs were identified (e.g., high pressure powder release container control). The SER addendum (§ 9.2.1.1) states that the reduced potential for a high energy release supports designating the Building 772-1F fire suppression system as defense-in-depth, but does not provide the rationale for accepting the resulting risk of fires in the building to justify downgrading the system and removing the LCO from the TSR. (See **OFI-SR-1**.)

The SER review criteria in SRIP 400, Chapter 421.1, Attachment A differ from those in DOE-STD-1104-2009. For example, DOE-STD-1104-2009 (§ 2.3) provides a set of six approval basis evaluation criteria for evaluating the adequacy of SSCs and SACs, but Attachment A identifies only one criterion; consequently, the SER addendum discusses only one of six approval basis criteria to evaluate the SSCs and only two of six to evaluate the SACs. (See **OFI-SR-1**.)

6.0 CONCLUSIONS

Overall, the hazard analysis for the SAR is appropriate to the complexity of the facility's operations and the associated hazards. For the most part, the SAR adequately identifies and analyzes the hazards, and it contains a broad set of hazard controls. Brief discussions of the mitigation strategies and hazard control sets for worker protection address each of the identified representative and unique hazard events. The F/H Laboratory SAR correctly does not identify any safety class SSCs or SACs. The SAR accident analysis methodology is clear and follows DOE standards and general practices. The consequence calculations are appropriately conservative, and the results confirm that the unmitigated accident consequences to the public are low. For the collocated worker, the analyses show that the unmitigated event consequences exceed the SRS onsite evaluation criteria. Generally, the accident analyses adequately describe the accident progressions and evaluate the consequences to identify and classify SS SSCs and SACs to prevent or mitigate accidents that could exceed the collocated worker evaluation guidelines. The selection of controls follows a defined methodology, and the selected controls are generally adequate to prevent or mitigate the analyzed accidents. Notably, the hazard analysis identifies events that will be carried forward into the accident analysis to evaluate collocated worker consequences and controls, even though no identified events challenge the DOE-STD-3009-94 evaluation guideline for the public. This can contribute to improvements in the safety of the facility.

The hazard control strategies and control sets identified in the hazard and accident analyses are mostly complete. All the postulated accident scenarios are assumed to result in a full facility fire, so the overall hazard control strategy for the facility appropriately involves actions to reduce the MAR and source term for this event. These actions reduce the calculated dose to the collocated worker to below the SRS onsite evaluation criteria, but do not reduce the overall risk to the level targeted by the SAR. The LCOs for controlling the facility MAR are appropriate and reflect the inputs and assumptions of the safety analysis.

Although the hazard controls are generally complete, some hazard controls are not successfully carried forward through the SAR and into the TSR, and significant deficiencies are evident in the hazard control strategy for the full facility fire. In the SAR, the system description, functional requirements, and system evaluation of the F-Area OSUG fire water supply system and the fire suppression system do not adequately define and evaluate the performance requirements necessary to fulfill the intended safety

functions. Consequently, the TSR requirements for the fire suppression system are not sufficient to ensure that the system is operable (i.e., capable of performing its established safety functions). In addition, the SAR does not provide a technical basis for excluding the diesel generator room from fire suppression system coverage in the TSR. Further, the SAR analysis of the operational fire in Building 772-F does not fully address the heat release rate, which can affect the fire's intensity, duration, and progression as well as the inventory control cabinet performance. Finally, although the transient combustible administrative control is identified as SS, the SAR does not follow through on the fire control strategy by developing this control as an SAC.

Following the EA observations and identification of the OSUG fire water supply system issue, DOE-SR and SRNS established a working group to develop a sitewide, standardized approach to fire suppression system operability at facilities where the responsibility for the overall system is shared between the nuclear facility and site infrastructure organizations. One goal of the working group is to establish a proper set of surveillances to confirm that the fire suppression systems remain operable. In addition, SRNS is revising the fire hazard analysis and updating the facility's fire scenarios to support the next annual update of the SAR and TSR.

Several deficiencies were identified in addition to those in the fire hazard controls. The SAR and TSR do not designate SS administrative controls associated with inventory cabinet location and flammable gas control as SACs, as required by DOE-STD-1186. Although the administrative controls are integral to the implementation of the control sets, they are carried forward in the SAR and TSR only as programmatic controls, with no analysis to justify the higher risk involved in using a less reliable form of control. Further, the hazard control set for explosive DBAs, which include accidents stemming from flammable gases, does not fully analyze potential preventive controls, and the description of some controls is not sufficient to support identifying the safety function and functional requirements.

DOE-SR approved the revised F/H Laboratory SAR and TSR based on the conclusions in SER Addendum 17. The SBRT's review plan established a graded approach for the review. The SER addendum discusses each topical area (i.e., approval basis), including base information, hazard and accident analyses, safety SSCs, SACs, derivation of TSR, safety management programs, and TSR, and includes the SBRT's comments and their resolution as an appendix. Although the graded approach used to develop the SER addendum is appropriate, the SER addendum does not always provide a sufficient rationale to justify accepting the SAR and TSR changes.

In conclusion, the SAR hazard and accident analyses are appropriate, and for the most part the SAR adequately identifies and analyzes the hazards and contains a broad set of hazard controls. However, EA identified several significant deficiencies in in the hazard control set that implements the facility's fire protection strategy. In addition, the SAR does not provide any justification for carrying forward some credited SS administrative controls as programmatic controls rather than as the more reliable SACs. EA also identified that the hazard control set for explosions caused by flammable gases was incomplete and that the assumption that the facility's stacks were seismically qualified was not appropriately protected as a hazard control. Management attention is warranted to ensure timely correction of the deficiencies in the limiting condition of operation for the fire suppression system and in the classification of administrative controls.

7.0 FINDINGS

As defined in DOE Order 227.1, *Independent Oversight Program*, findings are significant deficiencies or safety issues that warrant a high level of management attention. If left uncorrected, findings could adversely affect the DOE mission, the environment, the safety or health of workers and the public, or

national security. Findings may identify aspects of a program that do not meet the intent of DOE policy or Federal regulation. DOE line management or contractor organizations must develop and implement corrective action plans for EA review findings. Cognizant DOE managers must use site- and program-specific issues management processes and systems in accordance with DOE Order 227.1 to manage these corrective action plans and track them to completion.

Savannah River Nuclear Solutions, Inc.

F-SRNS-1: The SAR does not fully identify, evaluate, and protect the safety functions associated with the facilities' stacks. (DOE-STD-3009-94 CN3, § 4.3)

F-SRNS-2: The system description, functional requirements, system evaluation, TSR, and supporting technical basis, for the F-Area OSUG fire water supply system and the fire suppression system are insufficient to demonstrate that the systems will remain operable and capable of performing their established safety functions. (DOE-STD-3009-94 CN3, §§ 4.3 and 5.5)

F-SRNS-3: The hazard control set for the explosive accidents is incomplete, and the description of some controls is not sufficient to support identifying the safety function and supporting functional requirements. (DOE-STD-3009-94 CN3, §4.3)

F-SRNS-4: The SAR does not appropriately designate some credited SS administrative controls as SACs. (DOE-STD-3009-94 CN3, § 4.5 and DOE-STD-1186-2004, § 2.1)

8.0 OPPORTUNITIES FOR IMPROVEMENT

This EA review identified a number of OFIs. These potential enhancements 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 minor issues identified during the EA review. In some cases, OFIs address areas where program or process improvements can be achieved through minimal effort. It is expected that the responsible line management organizations will evaluate these OFIs and accept, reject, or modify them as appropriate in accordance with site-specific program objectives and priorities.

Savannah River Nuclear Solutions, Inc.

OFI-SRNS-1: While developing controls to prevent flammable gas explosions in the facility, consider the following elements in the SAC program:

- Calculations for each location where flammable gas is to be used (e.g., laboratory room or glovebox) to demonstrate that the lower flammability limit will not be reached during expected upset conditions
- Programmatic controls to limit the locations and amounts of flammable gas to those demonstrated safe by the calculations
- Inspections to verify that where the lower flammability limit can be reached, required minimum ventilation flow is maintained.

OFI-SRNS-2: Consider specific training for safety analysts that focuses on the requirements for identifying, developing, and writing SACs, including the safety function and performance criteria.

OFI-SRNS-3: In conjunction with the analysis of facility fires and designation of process area applicability, evaluate the elements of the transient combustible control program and consider:

- Limiting or excluding transient combustibles in process areas with known fire suppression system vulnerabilities
- Limiting or excluding transient combustibles or flammable materials from areas near the inventory control cabinets.

Savannah River Operations Office

OFI-SR-1: While updating SRIP 400, Chapter 421.1, consider:

- Stating the need to re-evaluate the credited control set every time a DBA is revised
- Developing a table, including a rationale for eliminating DOE-STD-1104-14 criteria, to guide the graded approach process
- Periodically reviewing the SER and its addenda to verify that incremental changes to the safety basis documents have not adversely affected the approval bases of the facility.

Appendix A
Supplemental Information

Dates of Review

Onsite Review: December 2014
Document Review: January to July 2015
Comment Review and Responses / Discussion: July to October 2015

Office of Enterprise Assessments

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
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Appendix B
Key Documents Reviewed, Interviews/Discussions, and Observations

Documents Reviewed

- WSRC-SA-96-26, *Central Laboratory Facility – Buildings 772-F, 772-1F, and 772-4F Safety Analysis Report*, Rev. 16, March 2015
- WSRC-TS-95-18, *Technical Safety Requirements Savannah River Site F-Area Central Laboratory Facility, Buildings 772-F, 772-1F, and 772-4F (U)*, Rev. 16, January 2015
- DOE/SR Letter, *Approval of F/H Laboratory Safety Analysis Report Revision 16 and Technical Safety Requirements Revision 16*, June 2, 2015, NMED-15-0026 and enclosure *Addendum 17 to SER Issued 08/29/97*, (DOE/SR NMED approved 5/29/15)
- S-CHA-F-00017, *Consolidated Hazards Analysis for Operations in F/H Laboratory*, Rev. 3, March 2015
- (DOE-SR) Savannah River Implementing Procedure 400, Chapter 421.1, *Nuclear Safety Oversight*, Rev. 7, October 28, 2014
- (DOE-SR) Nuclear Material Engineering Division, Safety Basis Document Review Plan – *F/H Laboratory Facility Safety Analysis Report and Technical Safety Requirements*, September 2014
- F-TRT-F-00019, *Technical Report for F&H Laboratory Fuel Fire Scenarios*, April 24, 2013
- WSRC-TR-95-00080, Rev. 0. *Natural Phenomena Hazards Qualification of Buildings 772-F, 772-1F, and 772-4F Structures, Systems and Components (SSCs) (U*), April 5, 1995
- (SRNS) F-ESR-F-00147, Fire Protection Engineering – Engineering Evaluation, *772-1F North Wall Exposure*, May 19, 2006
- (SRNS) F-DCF-F-00229, Design Change Form, Criteria for Sprinkler Demand in 772-F, August 23, 2011
- (SRNS) F-FHA-F-00006, *Fire Hazards Analysis for the 772-F Facility*, June 16, 2010
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Interviews/Discussions

- DOE-SR Facility Engineer
- DOE-SR Nuclear Materials Engineering Division (NMED) Director
- DOE-SR NMED Senior Technical Advisor
- DOE Subject Matter Experts
- SRNS Area Manager

- SRNS F-Area Engineers
- SRNS Facility Nuclear Safety Basis Manager
- SRNS Fire Protection Engineer
- SRNS F-Area/Labs Engineer

Observations

- Facility Walkdowns

Appendix C
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