Independent Oversight
Follow-up Review of
Implementation Verification Reviews
at the
Savannah River National Laboratory
Savannah River Site

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Acronyms

ARF	Airborne Release Fraction
CFR	Code of Federal Regulations
CHA	Consolidated Hazards Analysis
CRAD	Criteria, Review and Approach Document
DCF	Design Change Form
DEF	Deficiency
DOE	U.S. Department of Energy
DOE-SR	DOE Savannah River Operations Office
DSA	Documented Safety Analysis
EM	DOE Office of Environmental Management
FHA	Fire Hazards Analysis
FSD	Fire Safety Deficiency
GP	Good Practice
HSS	Office of Health, Safety and Security
IS	Infrastructure Services
IVR	Implementation Verification Review
LCO	Limiting Condition for Operation
MOA	Memorandum of Agreement
N&CSE	Nuclear and Criticality Safety Engineering
NFPA	National Fire Protection Association
OBS	Observation
OLO	DOE-SR Office of Laboratory Oversight
OFI	Opportunity for Improvement
OSUG	Outside Underground
PISA	Potential Inadequacy in the Safety Analysis
RF	Respirable Fraction
RI-AC	Radionuclide Inventory–Administrative Control
SAC	Specific Administrative Control
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
SSC	Structures, Systems, and Components
TEDE	Total Effective Dose Equivalent
TSR	Technical Safety Requirement

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1.0 PURPOSE

The Office of Enforcement and Oversight (Independent Oversight), within the Office of Health, Safety and Security (HSS), conducted an independent review of the identification and implementation of safety basis hazard controls associated with "flashing spray release" and supporting information documented in the Savannah River National Laboratory (SRNL) WSRC-SA-2, *SRNL Technical Area Documented Safety Analysis*, Revision 10; WSRC-TS-97-00014, *SRNL Technical Area Technical Safety Requirements*, Revision 10; and S-CHA-A-00003, *Hazards Analysis For Flashing Spray Release in the Savannah River National Laboratory (SRNL) (U)*, Revision 1. This review was conducted to follow up on questions that were identified during the conduct of the Independent Oversight implementation verification review (IVR) of the U.S. Department of Energy (DOE) Savannah River Operations Office (DOE-SR) and contractor IVR processes during June and July 2011.

The independent review was conducted at the Savannah River Site (SRS) during the period of October 17-27, 2011 by Independent Oversight in coordination with the DOE-SR, Office of Laboratory Oversight (OLO).

2.0 BACKGROUND

Title 10 Code of Federal Regulations (CFR) Part 830.201, *Performance of Work*, states that the operating contractors of nuclear facilities "must perform work in accordance with the safety basis for a hazard category 1, 2 or 3 DOE nuclear facility and, in particular, with the hazard controls that ensure adequate protection of workers, the public, and the environment." In addition, 10 CFR 830, Subpart A, *Quality Assurance Requirements*, establishes requirements for conducting activities that may affect safety at nuclear facilities, including performing work in accordance with the hazard controls, using approved instructions or procedures, conducting tests and inspections of items and processes, and implementing independent assessments to measure the adequacy of work performance.

In February 2008, the Defense Nuclear Facilities Safety Board requested that DOE evaluate the need to conduct "independent validations on a recurring basis" to ensure that facility equipment, procedures, and personnel training related to safety basis controls have not degraded over time. In response, the Department conducted an evaluation that concluded the existing requirements for implementation of safety controls and DOE policy for oversight of the implementation of nuclear safety requirements were appropriate. The evaluation also concluded there was no explicit requirement to validate safety basis controls, so the Department committed to develop guidance on the validation of safety controls and to add that guidance to the Department's directives.

A DOE working group developed a "best practices guide" for the independent validation of safety basis controls. This guide, together with expectations for its implementation, was provided to National Nuclear Security Administration and Office of Environmental Management (EM) sites by joint memorandum from the Assistant Deputy Administrator for Nuclear Safety and Operations and the Deputy Assistant Secretary of Safety Management, respectively, in March 2009. In November 2010, the guidance for performing IVRs was incorporated into DOE Guide 423.1-1A, *Implementation Guide for Use in*

Developing Technical Safety Requirements, Appendix D, *Performance of Implementation Verification Reviews (IVRs) of Safety Basis Controls*.

EM provides direction to and oversight of the design and operation of its nuclear facilities at SRS through DOE-SR. DOE-SR oversees the operation of 12 nuclear facilities, including SRNL, which is categorized as a hazard category 2 nuclear facility pursuant to DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23*, *Nuclear Safety Analysis Reports*. OLO exercises line management responsibility for SRNL. Savannah River Nuclear Solutions, LLC (SRNS) operates SRNL under a DOE management and operation contract.

In January 2009, SRNL identified that under some specific conditions, liquids could be superheated during a fire and the conditions could lead to a flashing spray release of radiological material. SRNL declared the situation to be a potential inadequacy in the safety analysis (PISA), which was confirmed by the follow-up analysis and unreviewed safety question evaluation. SRNL subsequently completed a hazard analysis and developed revisions to the documented safety analysis (DSA) and technical safety requirements (TSR) to address the situation. The revisions, approved in May 2010, included significant changes to the safety basis hazard controls. In particular, SRNL designated the building fire sprinkler system and portions of the fire water supply system serving the building as safety significant, resulting in the need to analyze the systems for functionality, reliability, and maintainability and to develop and implement a significantly expanded set of hazard controls. SRNL completed a safety basis implementation plan for the revision, and OLO conducted an independent IVR in the summer of 2010.

Independent Oversight conducted an independent review of the IVR processes at the SRS EM nuclear facilities in June and July 2011 to determine whether the site had implemented programs and processes to accomplish IVRs. The results of this review are documented in a report, HSS Office of Safety and Emergency Evaluations Independent Oversight Review of the IVR Processes at the SRS Environmental Management Nuclear Facilities, dated September 2011. This follow-up review was conducted to evaluate the effectiveness of the site IVR processes through a more detailed examination of the implementation of the revised DSA and TSR controls resulting from the changes discussed above.

Appendix A provides supplemental information about the Independent Oversight review. Appendix B provides additional details on information reviewed by the Independent Oversight team.

It is important to note that SRNL has identified and the Office of Laboratory Oversight had concurred in a path forward, with regard to the SRNL DSA, prior to the conduct of this review. The contractor recognized that the SRNL DSA was one of the older DSAs in place on the site, and was in need of revision to meet current nuclear safety expectations and format. SRNL, with the knowledge and approval of OLO, is taking steps to develop and submit a modern DSA for the nuclear facility at SRNL.

3.0 SCOPE

Independent Oversight reviewed the processes used by SRNS to establish and implement the safety basis hazard controls established by the revisions to the SRNL DSA and TSR to address flashing spray events. The review assessed the extent to which SRNL meets the objective of Section A of HSS Criteria, Review and Approach Document (CRAD) 64-19, *Engineering Design and Safety Basis, Inspection Criteria, Inspection Activities, and Lines of Inquiry Criteria*, for safety structures, systems, and components (SSC) functions and design and two objectives (Objectives 3 and 4) of HSS CRAD 45-39, *Implementation Verification of Safety Basis Controls*. A limited set of criteria from HSS CRAD 64-34, *Fire Protection Inspection Criteria, Approach, and Lines of Inquiry*, was also included in the plan. The scope of the review included SRNL's documents and activities related to analyzing the new information on flashing

spray releases, establishing hazard controls, defining the functional requirements of the safety systems and administrative controls, and implementing the established controls.

SRNL established engineered hazard controls and a specific administrative control (SAC) to mitigate the consequences of events involving the potential for flashing spray release that, if not mitigated, could result in consequences to workers that exceed guidelines. The engineered controls included both the Building 773-A sprinkler system (which the DSA credits with protection against a full facility fire) and portions of the onsite underground (OSUG) fire water supply system (which supports the sprinkler systems in A-Area, including Building 773-A). The classification of both of the existing systems was appropriately upgraded from "general service" to "safety significant" as part of the SRNL response to the PISA.

The engineering review conducted by Independent Oversight included a detailed technical review of the safety bases related to these two systems, including the revised hazard and safety analyses, backfit analyses, supporting documents, and implementing programs and procedures. The purpose of the review was to verify the systems' ability to perform their safety function as defined in the DSA, which is to deliver an adequate amount of water (pressure and flow) to a fire in each sprinkler system coverage area (including the most hydraulically remote area) for two hours. SRNL also established an SAC that limits the amount of material susceptible to this type of release, and Independent Oversight examined whether the SAC appropriately supported the safety analysis and was adequately implemented in the facility.

4.0 RESULTS

The results of this review are organized in accordance with the three CRAD objectives that were the focus of the review. As discussed in Section 3, Objective 1 below corresponds to the objective of Section A of HSS CRAD 64-19 and Objectives 2 and 3 correspond to the two relevant objectives of HSS CRAD 45-39, which include the selected criteria from HSS CRAD 64-34.

In accordance with the DOE-SR manual for integrated performance assurance, issues identified during this review are characterized as a concern, deficiency, or observation. Additionally, the performance assurance manual identifies a good practice as "an activity that is performed in a manner warranting emulation, commendation, or application to other problems or facilities." Issues and good practices are annotated in the report by characterization and number (for example, DEF-1 would be the first identified deficiency) and explained in more detail in Section 6.0 on this report.

Objective 1: Safety SSC functions and design are effective.

Independent Oversight reviewed the safety analyses associated with revisions to the DSA and TSRs that address flashing spray hazards to verify that they appropriately addressed the hazards inherent to this phenomenon and were used to establish the identity, functions, and significance of safety SSCs. The safety bases and supporting documentation were assessed to ensure that they demonstrated the adequacy of safety basis hazard controls to eliminate, limit, or mitigate identified hazards. The safety basis review addressed the methods SRNL used to ensure that functional requirements and performance criteria for SSCs were adequately specified and that TSRs were developed to ensure the continued operability of the safety SSCs. The review also evaluated whether safety SSCs and safety software were designed to meet their safety functions, using sound engineering principles and appropriate quality assurance standards.

In January 2009, SRNL identified that liquids heated above the boiling temperature of the liquid could flash on release. The excess heat above the boiling point of the liquid could be expended in the bulk vaporization of the liquid, and the remaining liquid could be fragmented into fine droplets; that is, such a

release could result in a flashing spray release. However, SRNL determined that the potential for a flashing spray release would result only from Teflon® digestion vessels and that the safety basis was non-conservative with respect to the consequence of a full facility fire because the analysis of Teflon® digestion vessels had not been discussed in the DSA. SRNL developed a justification for continued operations to support continued operations while the DSA and TSR were being revised to incorporate additional dose consequences from flashing spray releases for fire-related events. The justification for continued operations relied on the fire protection program and radionuclide inventory controls to reduce the risk from the flashing spray phenomenon.

SRNL safety basis analysts subsequently determined that the potential consequences from events involving a flashing spray release mechanism are higher than those from the evaporative boiling release that had been assumed in the previous accident analysis. The higher consequences result from the higher airborne release fraction (ARF) and respirable fraction (RF) factors associated with a pressurized, superheated liquid flashing spray release. SRNL developed a technical report for a flashing spray release, *Airborne Release and Respirable Fractions for Flashing Spray Releases for Laboratory Applications at SRNS* (SRNS-TR-09-00431), to determine new ARF and RF values to use for accident analyses.

Independent Oversight's review of the technical report determined that it provides technically justifiable ARF and RF values to conduct flashing spray accident analyses. The report also adequately summarizes information regarding container failure and includes the detailed methodology for calculating the ARFs and RFs for a variety of containers.

A consolidated hazards analysis (CHA) was developed for flashing spray accident events to determine the risk involved with Building 773-A and its operation. Facility walkdowns, reviews of the radionuclide inventory-administrative control (RI-AC) database, and examination of current and known future missions determined that approximately 2% of the radiological inventory in the building is in liquid form. Of the liquid inventory, approximately 10% of the liquids were found in containers susceptible to flashing spray (Teflon® digestion vessels). To ensure conservatism in the consequence analyses, analysts assumed that 20% of the liquids had the potential to flash spray in a fire.

Independent Oversight reviewed the radiation dose consequence calculations supporting the CHA and determined that the calculations provide an in-depth examination of the hazards for flashing spray events and accurately calculate the potential consequence results. The radiation dose calculations were conducted through an engineering calculation, *Updated Source Term and Radiation Dose Calculations to Support SRNL Safety Basis Documentation* (S-CLC-A-00130), which utilizes a spreadsheet to document the source term and radiological dose calculations. Inputs to the spreadsheet include:

- Evaluation guidelines used for onsite (occupationally exposed person) and offsite (maximally-exposed offsite individual) consequences – 100 rem and 25 rem, respectively
- Individual room and full facility inventories
- ARFs and RFs (from SRNS-TR-09-00431)
- Melcor Accident Consequence Code System, version 2, (MACCS2) 95% SRS-specific total effective dose equivalent (TEDE) values (rem/curie)
- TEDE-based release durations.

The engineering calculations for radiation dose were reviewed by peers to ensure their accuracy, as required.

Although the calculations for the flashing spray release were adequately performed and checked, SRNS recently identified a technical issue affecting all the nuclear facilities at SRS, including SRNL. This issue

could alter the overall margin of safety in the consequence calculations. SRS translated site meteorological data for the period 1997-2001 into corresponding stability class distributions and used them in MACCS2 to calculate the SRS-specific TEDE values. Discrepancies in the surface roughness and atmospheric dispersion coefficient can result in dose consequence calculations that are three times too low. Therefore, a release of radiological materials could result in dose consequences to the collocated workers and public that are higher than those currently calculated. The site is currently addressing these dispersion modeling issues and has initiated an overall path forward, which has three phases: DOE-SR/National Nuclear Security Administration direction/plan concurrence, technical recommendations development and approval, and prioritization and implementation.

The SRNL DSA considers four accident scenarios involving explosions: flammable or process flammable gas explosions occurring outside a Section E Cell, process flammable gas explosions occurring in a Section E Cell, and process explosions occurring both inside and outside a Section E Cell. The scenarios consider that flammable or process flammable gas explosions may initiate a fire but assume that fires will not breach the Section E Cell walls, either from inside or outside the cell. The CHA for flashing spray events credits the building fire sprinkler system as a mitigative engineered control to reduce the intensity and propagation of a fire. The sprinkler system is also credited in the DSA as a mitigative control for flammable or process flammable gas explosions that occur in a room or laboratory outside a Section E Cell (for example, see SRNL DSA Table A-14, Section 4.4.14.1, and Section 5.5.7.7).

Although the DSA credits the ability of the fire sprinkler system to mitigate a flammable or process flammable gas explosion, neither the DSA nor its supporting documents contain a qualitative or quantitative analysis to demonstrate that the system will be operable after these types of explosions. Discussions with SRNL personnel revealed that the intent of the DSA was to credit the sprinkler system only for the smaller process flammable gas explosion, with an implicit assumption that the volume of gas involved in the explosion would be insufficient to cause an explosion large enough to damage the sprinkler systems. Further, the discussions indicated that the sprinkler systems were not intended to be credited for the potentially larger explosions that could result from flammable gas distribution system releases due, for example, to equipment failure. Nonetheless, the DSA does not fully describe the sprinkler system's functional requirements necessary to mitigate the accidents for which it is currently credited and does not address the system's ability to function after an initiating event. (See deficiency **DEF-1**.)

During review of the safety bases, Independent Oversight identified that control of SRS Road 1 is a key assumption in establishing the site boundary with respect to SRNL. SRS Road 1, which passes in close proximity to Building 773-A, is a federally maintained site road and is controlled by SRS; however, the general public has ready access to the road, and unless SRNS can establish and maintain control of the road during an emergency, the public could be exposed to radioactive contamination if an emergency event occurs at Building 773-A. Independent Oversight confirmed that SRNS has established and adequately implemented processes to ensure that the site access roads (including South Carolina routes 125 and 278 and SRS Road 1) can be appropriately closed in an emergency. During a site area or general emergency, emergency procedures specify that site security contractor personnel (Wackenhut Services, Inc.) will establish roadblocks at locations, specified in a security operations procedure, at a minimum two-mile radius for each area on site. For an event originating at SRNL, roadblocks would be established on SRS Road 1. The after-action report from the fiscal year 2009 site annual emergency preparedness exercise indicates that the ability to control public access to these roads was last demonstrated during that exercise. Although processes for controlling road access are in place, the DSA does not explicitly document the assumption that Road 1 can be controlled. In addition, the procedures that describe the process for evacuation and access control of SRS Road 1 during emergency events are not listed in the SRNL TSR linking document and connected back to the DSA. (See observation **OBS-1**.)

Independent Oversight also reviewed the safety basis changes and the processes used to ensure that the functionality and operability of the fire sprinkler system were adequately assessed and appropriately documented. The revision to the DSA for the flashing spray release accident was supported by two backfit analyses that addressed the upgrade of the classification of the Building 773-A sprinkler system and portions of the OSUG fire water supply system to safety significant. The backfit analyses were found to provide an acceptable means of evaluating the fire water supply and sprinkler systems and to determine the extent of compliance for achieving a safety significant system classification. The analysis provided a technical basis for the gaps that were identified, and SRNS implemented enhancements to address the functionality, maintainability and reliability of the systems in keeping with the guidance in DOE Guide 420.1-3, *Implementation Guide for DOE Fire Protection and Emergency Services Program.*

Although SRNL followed an appropriate process for upgrading the system classifications, a number of technical issues were identified in the backfit analyses' descriptions of the functional requirements of the fire water supply system that were incorporated in the DSA. Some of these issues were identified by SRNS and DOE-SR during the planning phase of this review. In September 2011, SRNL appropriately initiated the PISA process for these issues, which led to an unreviewed safety question evaluation. That evaluation concluded that the composite issues constituted a positive unreviewed safety question, and SRNL instituted additional compensatory measures. The issues identified include:

- The required fire water volume to address a two-hour fire was based on the flow rate for the hydraulically most demanding sprinkler area (1,021 gallons per minute to the D-Wing Main Floor) rather than the area requiring the highest flow rate (1,214 gallons per minute to A-Wing East Library).

- The analyses of the "dedicated" fire water in the tank did not account for several factors that reduce the amount of available water, including the elevation of the fire water suction nozzle above the tank bottom, appropriate elevations between the non-safety service water system tank nozzle and fire water nozzle, loss of fire pump suction due to air entrainment when the fire water nozzle would be uncovered, and vortexing.

Two other issues involving the amount of water available to satisfy the 2 hour fire water demand were identified.

- The discussion of available water to meet the fire water demand (in DSA Section 4.4.14.1, System Evaluation) includes the active water makeup function of the well water system, which is classified as general service, and the backfit analysis did not address the functionality, maintainability, and reliability of the well water system.

- The potential for depletion of the available water supply due to normal usage of the service water system (also classified general service) during a fire was not addressed in the DSA system evaluation.

The revised SRNL DSA and its supporting documents do not provide clear descriptions and technically accurate calculations for required and available water volume and system hydraulic performance for the full range of conditions needed to support operability of the Building 773-A sprinkler system, and the implied dependence on non-safety systems is not adequately supported. (See deficiency **DEF-2**.)

In response to identified weaknesses at SRNL and other site facilities, in early October, SRNS established a fire protection program improvement project with a dedicated project manager and embarked on an "extent of condition" review. The project team has been charged with completing a causal analysis/mistake-proofing analysis of the errors in the A-Area backfit analysis. Under the improvement

project, Site Infrastructure Engineering will conduct a review of engineering products. Other action items include revising the fire water backfit analysis, reviewing other backfit analyses and the underlying process, clarifying and enhancing criteria, completing combustible loading walkdowns at other facilities, and completing material condition inspections of the fire water supply systems in A- and K-Areas. The initial list of action items is suitably focused on known weaknesses in the fire protection program.

In October, SRNL revised the PISA to include additional issues that were identified during Independent Oversight's onsite review as suggested by the guidance in DOE Guide 424.1-1B, *Implementation Guide for Use in Addressing Unreviewed Safety Question Requirements*, that allows for situations involving external audits that generate multiple concerns that might trigger entering the PISA process and provides an option for timely consultation with DOE and development of a mutually agreed-upon approach to handling the concerns. This approach includes developing an expeditious schedule for addressing, prioritizing, and dispositioning each identified issue. The following additional issues were included in the revised PISA:

- The adequacy of available net positive suction head to prevent the fire water pumps from cavitating throughout the expected operating range (tank levels, water temperatures, pump flows) was not analyzed.

- The hydraulic performance analyses for the water supply/sprinkler systems, which relied on data from tests performed with the fire water storage tank filled to overflowing, did not account for the performance reduction that would accompany the reduction in tank level during a fire. Data available during the review indicated that with only the Number 1 fire pump operating, the required pressure and flow would not be available at the hydraulically most remote area for tank levels ranging from approximately mid-level and to the lowest usable level in the tank. (Note: Although the Number 3 fire pump has a higher rated performance, no test data was available to demonstrate the water supply system's hydraulic capability when operating with this pump alone.)

These issues also affect the determination of the required volume of water necessary to support the operation of the fire sprinkler system. (See deficiency **DEF-2**.)

In addition to the technical issues discussed above, the design adequacy of the fire water system electrical supply was not fully evaluated in the backfit analysis, as required by DOE Order 420.1B, *Facility Safety*, page II-1, paragraph 3.a and page II-4, paragraph 3.c. The analysis excluded some electrical equipment from the safety significant system boundary and was limited to the fire pump controllers. The switchgear and circuit breakers are also important to ensure a reliable electrical power supply to the fire water pumps. The A-Area operator records nearly all of the breaker positions and the operating parameters for the electrical supply on the round sheet daily; these items are marked with a "$" sign, the local marking indicating that they are related to safety systems. In addition, the weekly fire pump test (discussed further below) functionally tests the system each week. The system's mechanical components were evaluated using system performance attributes (such as functionality, maintainability, and reliability), but this level of evaluation was not applied to the electrical supply system. As a result, enhancements that would normally be applied to upgraded equipment, such as additional test or maintenance requirements, were not considered for the general service equipment that was not upgraded. Consequently, the fire water system electrical supply was not fully evaluated within the backfit analysis, as required by the order, and as discussed in the guideline established in DOE Guide 420.1-3, *Implementation Guide for DOE Fire Protection and Emergency Services Programs for Use with DOE O 420.1B*, page 29, paragraph 4.21. (See deficiency **DEF-3**.)

Independent Oversight also reviewed the TSR surveillance requirements and technical bases that define the operability of the safety significant fire suppression systems. Limiting Condition for Operation

(LCO) 3/4.1, *Fire Suppression System*, requires that the building sprinkler system be operable in all modes for each coverage area in the building. Operability is defined in the technical Bases as "the ability to deliver an adequate amount of water (pressure and flow) to a fire in its coverage area for 2 hours." The technical Bases also identify the six sections in the building that are equipped with sprinkler systems and include the requirements that operability be checked by periodic measurements and functional tests. Suitable surveillance tests are specified to periodically verify water tank level and water and air pressure at the risers. A number of tests, including an annual functional test of the fire pumps and main drain, inspector's tests, and calibration of supporting instrumentation, are specified appropriately in accordance with National Fire Protection Association (NFPA) 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

While overall the surveillance tests are sound, several weaknesses in the TSRs and their technical Bases were identified. For operability, the SRNL TSR requires a pressure equal to or greater than 60 psig at each wet pipe sprinkler control valve. The TSR Bases indicate that these readings provide an indication of operability for the wet pipe sprinkler system(s); however, they do not provide a technical justification for the established pressure limits or explain why the first fire water supply pump starting set point, nominally just above 60 psig, would be an acceptable pressure to indicate the operability of this standby system. Currently, the service water system maintains normal fire water system pressure at 90-100 psig through an orifice located in a system-to-system cross connect. During the review, the orifice size was determined to be 1-1/4-inches, leading to a calculated flow through the orifice of 158 gallons per minute at 60 psig. This information implies that a significant amount of water could be released from the fire water distribution system due to a leak or actuation of sprinkler heads (approximately equivalent to 11 sprinkler heads operating simultaneously), or both, before the discharge header pressure reached the TSR limit of 60 psig or the first electric fire water pump started. This level of potential leakage from the fire water system had not been evaluated to determine its effect on fire sprinkler system hydraulic performance and operation. Thus, the TSR limit of a static riser pressure equal to or greater than 60 psig and the first pump starting pressure setpoint do not provide a suitably analyzed indication of system operability.

Two similar weaknesses were identified with the dry pipe sprinkler system TSR and its technical Bases. First, the TSR requires a water supply pressure greater than or equal to 60 psig and an air supply pressure less than or equal to 65 psig at each dry pipe valve sprinkler control valve. These readings are intended to provide an indication of operability for the dry pipe sprinkler system, but these operability requirements do not ensure that the dry pipe valve opens upon loss of air pressure and delivers water to the sprinklers in accordance with the time requirements established in NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. Dry pipe valves operate on a differential trip ratio of 5 to 1 (water supply to air pressure) to account for the design of the internal clapper and respective surface area exposed to the supply and system side of the valve. The TSR limits of 65 psig and 60 psig do not account for this differential trip ratio and thus could delay opening of the dry pipe valve. Second, a test to document and evaluate the time for delivery of water to the dry pipe systems is required by NFPA 25, which establishes the maximum time for water delivery, based on the design hazard (Dry System Water Delivery - Table 7.2.3.6.1). For example, the D-Wing dry pipe sprinkler system was designed for "extra hazard," for which the NFPA-required time limit for water delivery to the system is a maximum of 45 seconds. This requirement is not addressed in the TSR Bases for this surveillance or included in the implementing surveillance test. (See further discussion under Objective 3.)

The backfit analysis identified numerous functional requirements to support the fire water supply system classification change to safety significant, but it did not identify the automatic start feature of the fire water pumps as being required. The DSA does not discuss the automatic start feature of the pumps. The functional test of the automatic start feature, which is critical to performance of the fire water pump safety function, was not specifically included in the TSR surveillance requirements or the annual fire pump

surveillance test procedure, and the pressure switches were not identified in the TSR as requiring calibration. The weekly fire pump run test (A-784-720-023, *Building 784-A Electric Driven Fire Pump Exercise*) does protect the DSA assumption and exercise the automatic pump start feature, but it is not designated a TSR surveillance. (See further discussion under Objective 3.)

Overall, the surveillance tests and the operating rounds support the determination that the fire sprinkler system continues to be operable, but as discussed above, several weaknesses in the TSRs and their supporting Bases were identified. (See deficiency **DEF-4**.)

Objective 2: Contractor IVRs or similar reviews and site office oversight activities are sufficient to verify that safety basis hazard controls have been effectively incorporated into implementing administrative and operating procedures and work control documents.

Independent Oversight reviewed the administrative and implementing procedures associated with the TSRs to verify that the procedures are adequately written, reviewed, approved, controlled, and maintained. The review included an examination of the SRNL administrative procedures to verify that TSR-required surveillance tests are appropriately scheduled and conducted, test results are appropriately evaluated, and corrective actions are identified as necessary and completed in a timely manner. Independent Oversight also determined whether the operating procedures are adequate to maintain facility operations within the approved safety basis.

Independent Oversight's review of procedures and observation of activities provided evidence that for the most part, procedures can be performed step-by-step as written. Procedures and processes adequately control working copies and ensure that the most recent approved revision is used for work. The daily round sheets used by both SRNL and Infrastructure Services (IS) adequately address the required daily surveillances and include a method of communication to the SRNL shift operators to verify and record the readings taken by the IS operators. The review also showed that procedure problems are usually identified and corrected following established processes. The SRNL TSR linking document provides an effective crosswalk between TSR hazard controls and the implementing documents, though it does not extend to the IS implementing documents and, as noted above, does not capture the safety analysis assumption concerning control of SRS Road 1. (See observation **OBS-2**.)

Surveillance tests are appropriately scheduled and performed in accordance with established operations processes. A TSR surveillance matrix provides detailed information about the current schedule of surveillances. This matrix includes the monthly and quarterly schedule, long term schedule, and "best management practice" (programmatic and defense-in-depth) surveillance schedule. The TSR schedule provides the next due date and also the date of last performance. In addition, plan-of-the-day and plan-of-the-week processes support effective, on-time performance of the scheduled surveillances. Records of the last two completed surveillances are maintained by the surveillance coordinator and are readily available to operations personnel. All the surveillance tests examined during the review had been completed in accordance with the schedule.

SRNL processes and procedures adequately ensure that surveillance test and inspection results are appropriately evaluated and that corrective actions are identified. Procedures (both normal and TSR-related) and rounds sheets identify specific steps or readings associated with the operability of safety significant equipment by marking them with a dollar sign ($) for ready recognition. Acceptance criteria are clearly identified in the surveillance, test, and operating procedures, and appropriate notification steps are included for out-of-specification readings. Review and evaluation of surveillance test results, including design agent authority review, are included appropriately in the surveillance tests. In addition, SRNL has written a set of surveillance procedures that provide a bridge between the facility's TSR

requirements and the test procedures implemented by IS and ensure that the IS procedure results are adequately managed.

Generally, operating procedures and practices adequately support facility operations within the approved safety basis. Procedure TO-07-009, *Operation of 773-A Fire Protection Systems*, provides directions for conducting valve line-ups, including independent verification, to maintain operational configuration control over the fire water and fire sprinkler valves. In addition, AD-00-028, *Control of Fire System*, provides detailed instructions for managing the SRNL fire system, including impairments. The procedure addresses roles and responsibilities of key individuals and provides direction for response to both planned and unplanned impairments to the system. It also includes a list of compensatory measures to be considered for system impairment. Further, AOP-07-001, *Response to 773-A Fire Sprinkler Systems and Shielded Cells Halon Systems Impairments*, provides additional instructions for recognizing and responding to fire system impairments. The surveillance test procedures that were reviewed appropriately ensure that the facility is in the correct operating mode to support performance of the tests and also properly address return to service after testing. Additionally, an operating process is in place to track and control entry into and exit from LCO actions, and a facility procedure, AD-00-027, provides direction for the Shift Operations Manager in determining the operability of the system before exiting an LCO.

SRNS recognized that management of the fire water supply to the SRNL fire sprinklers requires close coordination between two separate SRNS operating entities, one of which typically supports non-nuclear facilities. To achieve this coordination, SRNL and IS established a memorandum of agreement (MOA) that formally documents responsibilities for operation of the system. Under the MOA, IS provides data to SRNL to meet the facility's TSR requirements; including, for example, tank level indication and water flow test results. IS also must request authorization from SRNL for planned outages to the fire water supply system and any planned modifications, inform SRNL immediately upon discovery of an unplanned outage, and provide SRNL with notification (and review) of procedure revisions or new procedures associated with TSR implementation. The MOA also describes the scope and boundary of the supply systems covered by the memorandum and lists the safety significant components. The MOA establishes a process to coordinate fire water supply system impairments that includes a documented authorization request to the SRNL Shift Operations Manager, in addition to the process described in Procedure 5.6 of the SRS 2Q Manual, *Fire Protection Program Manual*. Finally, the MOA establishes specific procedures for handling the daily operating rounds, including use of the "$" sign for TSR-related steps and notification of SRNL control of the results.

Independent Oversight reviewed several work packages for maintenance conducted on the fire water pumps and their supporting electrical equipment. Those packages provided evidence that the work planning process implemented the coordination process described in the MOA and, for example, addressed the operating status of the facility and work package review by designated facility personnel. The fire water pump packages correctly identified the pumps as safety significant, and work package instructions generally contained sufficient detail for trained, experienced personnel to perform the work as described. The packages also addressed post-maintenance testing and return to service.

The overall work package process was sound, although review of the completed work packages revealed several issues. First, a weakness was identified in the impairment process. Using two packages, both safety significant fire water supply pumps were simultaneously taken out of service for corrective maintenance on September 19, 2011, and were not returned to service for seven days. The required reviews and approvals were completed in accordance with the MOA that establishes control of IS activities for the fire water supply and distribution. The IS impairment permit identified the fire safety deficiency (FSD) as category V, and the SRNL permit identified the impairment as an FSD category IV. (There are five categories of impairments noted in SRS 2Q Manual, procedure 4.1, *Fire Safety Deficiency Classification*, based, for example, on risk and programmatic impacts. FSD V is the lowest priority

impairment.) With both fire pumps removed from service, a higher impairment, such as FSD category II, should have been documented. Nonetheless, SRNL identified additional compensatory measures by confirming the diesel fire pump was in service, as specified on the SRNL fire permits and subjecting the process to management and engineering review prior to entering the outage, and expediting the work with overtime.

Second, although there was no violation of a specific LCO requirement, the simultaneous removal of both pumps from service for a planned maintenance activity reveals a weakness in the TSR requirements that allow the sprinkler system to be rendered inoperable while the only TSR-required compensatory action is to institute a fire patrol. In this case, the compensatory actions for removing the safety significant system from service do not adequately differentiate among the risks associated with sprinkler system outages. For example, action statement A (and its TSR Bases) does not differentiate between the risk of a single out-of-service sprinkler system and the risk of a condition that renders all 16 systems out of service (as in the condition described above), though the latter situation would represent a much higher risk of facility-wide fire than the former. SRNL indicated that the LCO action (to implement a fire patrol) was structured to provide adequate response to a full sprinkler system outage and therefore is a conservative response to outages that affect fewer systems. However, as noted above, additional compensatory measures were recommended and initiated as part of the impairment process for the outage. The LCO action statement also does not directly address impairment of the electric fire water pumps and is limited to the sprinkler system(s). Overall, weaknesses in the compensatory measures required by the LCO allowed the fire water pumps to be removed from service for an extended period without an appropriately documented analysis of the risks and required compensatory measures. (See observation **OBS-7).**

A third issue is that the appropriate functional requirements were not integrated into the post-maintenance test for the fire water pumps after corrective maintenance. Both work packages required additional corrective maintenance beyond the initial scope of work, which addressed replacement of the pump packing due to excessive leaking. In each case, the work scope was expanded to include the removal of the top half of the pump casing. NFPA 25 (Table 8.6.1 – Summary of Component Replacement Testing Requirements) requires that an acceptance test be performed after repair of the casing. Removal and reinstallation of the top half of the casing of the pump is considered repair work in that it involves breaking the pump pressure boundary. However, the post-maintenance testing consisted only of performing the weekly pump test, which was not adequate for the type of work performed. The reason for the NFPA requirement is to provide sufficient run-in time for the pump to reseat the new casing gasket, but the weekly pump test runs the pump for only ten minutes, which does not allow the pump to generate enough heat to adequately seat the new gasket. (See deficiency **DEF-5**.)

Independent Oversight communicated several additional weaknesses to SRNL for follow-up or inclusion in lessons learned: (1) The work packages provided incomplete directions for conducting the packing adjustment. Although personnel performed the maintenance correctly, including the missing steps of adjusting the packing and checking the packing housing for excessive heatup, there was no indication the work planners were informed that these steps were missing from the procedure. (2) The activity hazards analyses for the work packages incorrectly stated that the work did not have the potential to negatively impact fire water supplies and fire suppression systems/equipment. (3) The packing follower bolts on one pump were replaced with bolts classified as general service, with no technical evaluation as required by SRS E7 Manual, *Conduct of Engineering*, procedure 3.4.6, *Replacement Item Evaluation/Commercial Grade Dedication*. As a result of this observation, SRNL issued nonconformance report 2011-NCR-33-0010. (See deficiency **DEF-5**.)

Objective 3: Contractor IVR or similar processes and site office oversight activities are sufficient to verify that safety SSCs and design features are installed, inspected, and maintained as described in the safety basis documentation.

Independent Oversight reviewed the configuration control processes associated with the safety basis changes in revision 9 to verify that the safety significant systems match the design documents, including system descriptions in the analyses and drawings. Safety basis (TSR)-defined surveillance tests and inspections necessary to ensure continued operability of the safety SSCs were assessed to determine whether they are executable, adequately performed, and appropriately documented. The review also determined whether the criteria are consistent with the safety basis and are adequately documented in approved instructions. Finally, DOE-SR oversight activities were reviewed briefly to ensure that they adequately verify that safety basis hazard controls are effectively implemented.

SRNL completed a significant effort to determine the system functional requirements, identify the system classifications and system boundaries, evaluate the systems' ability to perform the expected functions, and establish configuration control for the upgraded fire suppression system. The effort also included developing documentation, including calculations, drawings and reports, to address the classification change. Revised drawings indicated the line of demarcation and boundaries between systems such as the general service water system. Overall, most of these documents were accurate and clearly reflected the technical assertions documented in the backfit analysis. In two instances, however, weaknesses were observed in the establishment and maintenance of the service water system boundary.

First, the fire water supply system's ability to support the fire sprinkler systems is based on fire water supply tank levels (controlled by the TSRs) that inherently depend on the passive physical integrity of the service water system, which is classified as general service rather than safety significant. This functional interdependence was not identified and fully analyzed in the backfit analysis, functional classification report, or system boundary drawings to ensure passive interconnected portions of the service water system are appropriately classified. For example, the available water in the tank is dependent on the physical integrity of the service water system suction piping (part of the physical boundary of the system when the water level is above service water nozzle), which is not classified safety significant. In addition, in the portion of the service water discharge piping connected to the fire water supply system, a service water valve (V-029) is installed to prevent backflow into the service water system during fire system operations, but the need to maintain and test this feature is not discussed. (See deficiency **DEF-2**.)

Second, all of the fire suppression system valves are identified in the fire water system alignment procedures, which maintain operational configuration control of the fire suppression system. However, three service water valves (V-028, V-030, and V-230) are not included in the fire water system alignment procedures, even though the MOA between SRNL and IS identifies them as safety significant. Procedure TO-07-009 and procedure SP-15, *Building 784-A Electric Driven Fire Pump Exercise and Alignment*, require proper valve alignment for the 773-A fire water tank, fire pumps, and eastern leg of the OSUG fire water supply safety significant system loop. Only one of the three service water valves is identified on these alignment procedures. As a result, the operational configuration of these safety significant valves is not currently being controlled. (See deficiency **DEF-2** and observation **OBS-3**.)

The fire hazards analysis (FHA) is intended to serve as an input to the DSA and describe the protection of essential safety class and safety significant systems. DOE Order 420.1B requires that the FHA be revised when changes resulting from the annual DSA updates impact the contents of the FHA. In addition, the SRS 2Q Manual, procedure 2.14, *Fire Hazards Analysis Documentation Administration*, requires that the FHA be revised when a facility modification impacts the content of the FHA. SRNL used a design change form (DCF), F-DCF-A-00200, to address the classification change of the fire water systems from general support to safety significant and to address the flashing spray hazard analysis. Although the procedure allows a DCF to be used to revise the FHA, such a DCF is required to address a specific FHA section. In this case, the DCF did not specify which section(s) of the FHA would be impacted by this change; the relevant sections would include Section 3.3 Water Supply and Manual Attack, Section 3.5

Fire Exposure Analysis (for safety significant equipment) and Section 3.9 Fire Loss Analysis. (See observation **OBS-4**.)

Independent Oversight reviewed completed daily round sheets (including the Control Area Operator Round Sheet, the A-Area Fire Water Shift Operator Daily Round Sheet, and the Facility Operator Round Sheet) and surveillance tests to verify that they adequately address the continued operability of the safety significant fire suppression systems. The Control Area Operator Round Sheet, which records the daily tank level reading relayed from the A-Area operator, includes a note indicating that LCO 3.1.1, Condition A, should be entered if the tank level is < 25 feet. The A-Area Fire Water Shift Operator Daily Round Sheet includes instructions to notify SRNL if the water tank level is below 25 feet (per the compensatory measure) and sets the minimum tank level at "≥ 25 ft." The tank level reading is recorded twice a day (day and night shift), and a copy of the round sheet is sent by facsimile to SRNL when closed out on Sunday. The round sheet also includes a daily electrical lineup for the fire water pumps. The Facility Operator Round Sheet implements the daily surveillance requirements for the fire sprinkler system components in Building 773-A. All the round sheets use the "$" sign to denote TSR-related readings, including readings to support LCO requirements and readings indicating a potential operability problem with safety significant equipment or equipment important to safety. The round sheets were found to adequately implement not only the TSR-required surveillance, but also the compensatory measures identified in PI-2011-0022, *Minimum Required Fire Water Capacity for a 2 Hour Demand*, (September 15, 2011).

Facility procedure TO-07-012, *Verification of Annual Functional Test of 784-A Fire Pumps*, provides a means for tracking and controlling the performance of the annual electric fire pump test. It includes processes for coordinating activities with IS, entering the LCO before beginning the test, reviewing the results, verifying that independent verification was completed for valves manipulated during the testing, and confirming that the system was returned to operating condition before exiting the LCO. An attachment to the procedure records whether the test was acceptable or not. This procedure is typical of several procedures that the facility has implemented to control the conduct of surveillance tests, including those performed by outside organizations.

Independent Oversight reviewed completed copies of SP-16A-784-FP-ANN-TEST, 784-A Fire Pumps Annual Fire Pump Flow Test, including two interim procedure changes. TSR requirements are appropriately marked with a "$" sign, and acceptance criteria are based on NFPA 25 requirements. The procedure has detailed steps for performance, including a valve lineup to set up test flow path and verification that measuring and test equipment are within the calibration due dates. The procedure steps include recording readings for target differential pressure readings across the test line orifice, which are then analyzed by the design authority engineer to determine whether the acceptance criteria are met. The annual test procedure is an acceptable pump test per NFPA 25. However, it is not a functional test as defined in the facility TSRs and required by the LCO surveillance requirement, because it does not functionally test the pump start capability. In addition, the test procedure is run with the system isolated from the service water system, which is an abnormal configuration. (See deficiency **DEF-4**.)

Although the annual pump flow test does not functionally test the pump start capability, SP-15, A-784-720-023, *Building 784-A Electric Driven Fire Pump Exercise and Alignment*, does include appropriate instructions for a functional test of the fire pump start. The scope of the test, which is performed to meet NFPA requirements, is well defined, and the procedure incorporates the "$" sign marking for the steps "that implement a TSR requirement." The instructions provide for automatic start of the pumps by bleeding the pressure off the pump start pressure switches and recording the pump starting pressure against a calibrated gauge. Acceptance criteria are clearly specified for each pump and are labeled as TSR-related. The procedure includes appropriate data and restoration steps for aTSR surveillance, but it is not designated as a TSR surveillance test (in the TSR and management systems). Although this test is

performed with the service water supply header cross-connected to the fire water header (normal lineup), the test does not take data to verify that the service water check valve operates as designed (to prevent backflow from the fire water header to the service water header). In addition, the pressure switches, which have been recently calibrated and are identified as installed process instrumentation, are not identified in the TSRs as requiring periodic calibration, even though they perform a critical function in the fire water supply system. (See deficiency **DEF-4** and observation **OBS-5**.)

Independent Oversight also reviewed procedure TO-07-011, *Annual Surveillance of Building 773-A. Fire Sprinkler Systems Main Drain Flow, Inspector's Valve Test Flow, and Antifreeze Solution Testing*. This procedure provides the overall instructions for control of the annual main drain and inspector's flow tests, which are performed by the Fire Systems Testing and Maintenance Group. The procedure includes a number of TSR and NFPA required actions, including the annual system inspection of the valve house system valves, main drain test (TSR-related acceptance criteria), lubrication, cycling of the sectional isolation valve, inspection and test of the supervisory tamper switch, and conduct of the inspector's test. Although the procedure is mostly complete, the acceptance criterion for the main drain portion of the test addresses only the flushing of the system and does not include steps (and acceptance criteria) to compare the pressure readings with those made either at the time of the original acceptance tests or at the time of the last test to determine whether there has been any deterioration of the water supply, as required by NFPA 25. This test requirement is also not included in the TSR Bases for this surveillance requirement (Surveillance Requirement 4.1.1.5). (See deficiency **DEF-4**.)

In addition, the portion of the triennial dry pipe trip test conducted by the facility in 2009 (in accordance with procedure SRT-773004A-D Wing – AN, 773-*000A D Wing & 773-004A Valve House Fire System Test – Annual* (step 6.4.28)) did not satisfy the NFPA 25 requirement for ensuring the flow of water to the inspector's test connection within a specified time limit. As noted previously, this test requirement is also not included in the TSR Bases for this surveillance (Surveillance Requirement 4.1.1.5). (See deficiency **DEF-4**)

Procedures TO-07-014 and TO-07-015 were found to provide appropriately for calibration of pressure gauges and tank level indication, respectively, to satisfy the TSR surveillance requirements. TO-07-014 contains a table in an attachment to record the completion of the calibration for each of the instruments. Pressure gauges were calibrated appropriately per the procedure using standard calibration procedures. The tank 782-A level indicator was calibrated by removing the instrument and performing the calibration check in the shop. However, the loop calibration was incomplete because the height of the instrument above the bottom of the tank is not known and no instrument loop calculation has been performed to ensure that the instrument readings accurately reflect the tank water level. A work order to measure the mounting details of the ultrasonic probe was generated during the Independent Oversight review. Currently, the level reading appears to be conservatively low, based on a comparison of the indicated level to the level of the overflow on the tank drawing. (See deficiency **DEF-4**.)

Independent Oversight's review of selected aspects of the implementation of the facility's fire protection program found that SRNL's procedures and guidance provide for fire patrol personnel to readily support compensatory measures for impairment of the sprinkler system within Building 773-A. Fire inspectors were found to be knowledgeable and well trained in understanding the operation of a sprinkler system (for example, the potential compromise of system performance by missing ceiling tiles). The facility's guidelines facilitate the decision process for determining whether a system is impaired and applying that process during facility fire inspections.

The facility has a number of administrative procedures to implement the fire protection program, including a procedure to implement controls on combustibles. Although the facility had adequate controls for managing designated storage areas for combustibles, weaknesses were observed with

managing transient combustibles. Facility procedure TO-07-006, *Annual Accounting of Flammable/ Combustible Liquids and Storage Areas*, requires monthly and quarterly fire prevention and life-safety walkdowns; however, with the exception of designated combustible storage areas, it does not address transient combustible loading limitations within Building 773-A. In addition, personnel observed a significant amount of combustibles, subsequently shown to exceed the sprinkler system design capacity, during a facility walkdown in Building 773-A, Room D-1176, which is a designated transient combustible storage area. The facility promptly responded to this deficiency by removing plastic sheeting from the area and reducing the quantity of insulated electrical cable. Further, although specific combustible loading limits for the facility were evaluated in the past and documented by an approved calculation (F-CLC-A-0002, *Transient Combustible Loading Estimate for Building 773-A*), this information has not been incorporated into the facility's safety significant fire program. Additionally, the fire inspectors performing these facility walkdowns were not trained to determine the acceptable quantities of combustibles. (See deficiency **DEF-6**.)

Fire patrols for Building 773-A are performed as required to satisfy compensatory measures in case of a fire water system impairment. Independent Oversight observed the fire patrols and noted that although the fire patrol was conducted using a disciplined approach, the fire inspector did not visually inspect some areas as required by site procedures. SRS 2Q Manual procedure 5.3, *Fire Watch and Fire Patrol*, states "the fire patrol visually inspects specific areas to detect conditions likely to result in fire." Currently, the facility fire patrol touches the exterior doors of rooms that cannot be accessed during the inspection to determine whether any door is hot. SRNL indicated that there are four rooms that are routinely inaccessible, but during the rounds this practice was observed to be used at more than four rooms. A fire patrol is intended to identify incipient fires so they do not develop into fully involved fires. If the fire patrol can detect the heat from a fire on the outside of a door, the fire producing that heat would likely be beyond the incipient stage (depending on the size and configuration of the room). Consequently, this method is not equivalent to a visual inspection, and it is not documented as an exception to the site requirements or in facility procedures or training. (See deficiency **DEF-6**.)

The Building 773-A fire control pre-plan was found to be generally satisfactory. However, it had not been updated to reflect the current design information for the fire water supply storage tank or the sprinkler systems so that the Fire Department could have the most current, correct information to facilitate appropriate emergency response actions. (See observation **OBS-6**.)

SRNL TSRs identify the radionuclide inventory control as a SAC to ensure that accident consequence values remain below the DSA analyzed consequences. The radionuclide inventory control process for Building 773-A is implemented using the RI-AC computer program, an accredited program, to reduce the risk from the flashing spray phenomenon. Daily RI-AC inventory surveillances, quarterly fissionable material inventory surveillances, biannual physical and liquid inventory surveillances, and yearly total inventory assessments are conducted. The risk from fire-related events is further reduced by the implementation of dose consequence limits via the radionuclide inventory control process. RI-AC calculations are run to determine the dose consequences before all proposed material transactions to ensure that the dose consequence limits will not be exceeded. (See good practice **GP-1**.)

The CHA and DSA analyses for flashing spray release identify the need to establish a Building 773-A liquid inventory surveillance as a additional SAC. *Savannah River National Laboratory Liquid Radionuclide Inventory Surveillance*, Manual L1, Procedure 4.01 provides direction to determine the percentage of the Building 773-A radioactive liquids that are in containers susceptible to flashing spray releases. The procedure establishes clear roles and responsibilities and provides directions that clearly describe all the steps required to fill out the attached liquid inventory surveillance data sheets. The surveillance is required to be conducted semiannually to meet the TSR surveillance requirement.

Independent Oversight's review of the completed surveillance determined that it has been effectively implemented.

OLO has continued to provide oversight of TSR implementation at SRNL, including the fire suppression system. In September, OLO identified a number of deficiencies, including an error in the TSR Bases for the tank water level surveillance, the lack of a functional test requirement for the fire pump automatic start feature, and failure to identify the fire pump automatic start components as safety significant, and failure to revise the FHA when the DSA and TSR were revised for flashing spray. OLO facility representatives also identified that the facility failed to track the status of the fire water system valves that were operated to isolate the pumps during the September maintenance activities and that both pumps were removed from service simultaneously (an observation). OLO transmitted these deficiencies and the observation, which are similar to several issues discussed above, to SRNL on October 20.

5.0 CONCLUSIONS

Following the identification of the potential for events involving a flashing spray release, SRNL addressed the issue appropriately using its established procedures and processes. SRNL conducted a thorough hazard analysis, developed technically sound ARF and RF values for this type of release, and performed well-documented radiation dose consequence calculations. Because the analyses led to the conclusion that additional hazard controls were necessary to protect the facility workers, SRNL appropriately upgraded the classification of two systems (the building fire sprinkler system and portions of the OSUG fire water supply system) from general service to safety significant and established an additional SAC to control the liquid inventory susceptible to flashing spray. The principal engineering support for the DSA revision was provided by two backfit analyses addressing the upgrade of the fire suppression system, which were found to provide an acceptable means of evaluating the existing systems and determining their ability to meet the safety basis functional requirements. The analyses identified a number of system vulnerabilities; these were addressed by further analysis or corrected through maintenance or modification of the systems. The results of the backfit analyses were used to develop the subsequent revision of the DSA and supported the development of the TSR controls. As part of the DSA revision, SRNL developed and implemented a significant number of new procedures and surveillance tests and executed an MOA with IS in an effort to establish the necessary interactions to control the operation and maintenance of the upgraded portions of the fire water system.

Independent Oversight found that, in general, operating procedures and practices adequately support facility operations within the approved safety basis. Administrative programs for managing hazard controls are in place and mostly well executed. SRNL has implemented effective methods for scheduling, conducting, and documenting surveillance tests. Surveillance tests and facility operating procedures suitably manage the facility's status to ensure that operations remain within the established safety basis controls, including entry into and exit from LCO action statements. The facility developed and implemented a detailed procedure to maintain control over the status of the fire suppression system valves. The surveillance test procedures that Independent Oversight reviewed were generally adequate in confirming the operability of the safety system and their components and appear to have addressed many of the implementation problems identified by OLO in 2010. A sampling of fire protection program activities indicated that although the program is mostly sound, some improvements are needed in program execution. SRNL has developed and implemented an exemplary radionuclide inventory control system, which is supported by an appropriately accredited and maintained software program. Finally, the SAC to control liquid inventory is effectively implemented.

Notwithstanding the above positive aspects, Independent Oversight identified a number of deficiencies in the rigor and detail applied to the safety bases and supporting backfit analyses for the two upgraded

systems (the Building 773-A sprinkler system and the OSUG fire water supply system). The deficiencies include weaknesses in establishing the amount of water required to support sprinkler system operation, evaluating system hydraulic performance over the full range of operating conditions, accurately defining and describing the functions of associated support systems, and identifying precise system boundaries and interdependencies. The weaknesses led to problems identifying fully adequate safety system functional requirements in the DSA and translating those requirements into hazard controls in the TSRs. Also, in several cases, the expectations of the safety bases, codes, or standards were inadequately or incorrectly translated into facility procedures or practices; for example, the weaknesses discovered in establishing the sprinkler system pressure setpoints and performing and evaluating the sprinkler system functional tests. The Independent Oversight review also identified a problem in the implementation of the facility's transient combustible control program. Finally, although the site and facility took steps to compensate for a simultaneous outage of both fire water pumps, the outage revealed several weaknesses in safety system control. These include LCO compensatory measures that do not adequately address the risks associated with the full range of potential system outages, errors in classifying the impairment and specifying appropriate compensatory measures in the impairment permits, and simultaneous removal of both fire water pumps from service when this action might have been avoided.

DOE-SR and SRNL responded to the issues and problems identified during the review in an appropriate and timely manner. SRNL initiated a PISA for issues related to the tank water volume requirements during the review planning phase and revised the PISA as additional issues were identified during the Independent Oversight review. SRNS also began to address the underlying structural issues by establishing and implementing a broad improvement plan (with an assigned program manager) for the fire protection program. Overall, no instances were identified where the fire suppression system was rendered inoperable as a result of the engineering or safety basis weaknesses. However, SRNS should apply continued management attention to ensure that sufficient technical expertise and attention to detail are applied to the analysis of the PISA, fire protection program improvements, and development of the revised and upgraded facility DSA and TSRs.

6.0 GOOD PRACTICES, ISSUES, AND OPPORTUNITIES FOR IMPROVEMENT

During the review, Independent Oversight identified a number of issues. These issues are characterized in accordance with the DOE-SR manual for integrated performance assurance and are annotated in the report by characterization and number (for example, DEF-1 would be the first identified deficiency). DOE-SR categorizes issues identified in assessments according to instructions provided in DOE-SR procedure SRIM 226.11.D, *Integrated Performance Assurance Manual*. Section 3.2.4 of the manual discusses assessment results and categorizes the identified issues as follows:

- Concern - an indication of a programmatic breakdown or widespread problem supported by several findings or adverse trend.
- Deficiency - an inadequacy or variance of an activity from established requirements, policies, procedures, standards, criteria, or expectations requiring corrective action.
- Observation - an identified aspect of performance that is compliant but in need of quality or productivity improvement.

The performance assurance manual also identifies a Good Practice as "an activity that is performed in a manner warranting emulation, commendation, or application to other problems or facilities." Observations closely approximate opportunities for improvement (OFIs), which according to Independent Oversight protocols (*Office of Independent Oversight Appraisal Process Protocols*, July 2009) "are suggestions offered by the Independent Oversight appraisal team that may assist line management in identifying options and potential solutions to various issues identified during the conduct of the appraisal."

The good practices, issues (deficiencies and observations), and opportunities for improvement are summarized below and are provided to OLO for evaluation, follow-up, and correction in accordance with DOE-SR procedures and processes.
Independent Oversight identified one good practice:

GP-1: SRNL has developed an excellent, real-time radionuclide inventory control system to ensure that Building 773-A does not exceed the analyzed radioactive material inventory limits.

Independent Oversight identified six deficiencies:

DEF-1: The DSA contains unstated assumptions and ambiguities in the discussion of flammable and process flammable gas explosion events in the facility and does not clearly describe the fire sprinkler functional requirements necessary to control these events, as required by DOE-STD-3009, *Preparation Guide for U.S Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, page 55. Specifically, although the DSA credits the ability of the fire sprinkler system to mitigate a flammable or process flammable gas explosion, neither the DSA nor its supporting documents contain a qualitative or quantitative analysis to demonstrate that the system will be operable after these types of explosions. The DSA does not fully describe the sprinkler system's functional requirements necessary to mitigate the accidents for which it is currently credited and does not address the system's ability to function after an initiating event.

DEF-2: The revised SRNL DSA and its supporting documents do not provide clear descriptions and technically accurate calculations for required and available water volume and system hydraulic performance for the full range of conditions needed to support operability of the Building 773-A sprinkler systems as required by DOE-STD-3009, page 61, section 4.4.X.4.Additionally, the dependence of the fire water supply system on the passive physical integrity of service water system components is not adequately addressed in the engineering analyses that supported the fire suppression system upgrade, including the fire water supply system backfit analysis, functional classification report, and system boundary drawings, as required by DOE-STD-3009, page 60, chapter 4, paragraph 4.4.X.2.

DEF-3: The electrical supply system for the fire water pumps has not been fully analyzed in the applicable backfit analysis and functional classification report to ensure that the electrical supply to the pumps is appropriately classified, operated, and maintained, as required by DOE Order 420.1B, *Facility Safety*, page II-1, paragraph 3.a and page II-4, paragraph 3.c., and discussed in the guidelines established in DOE Guide 420.1-3, *Implementation Guide for DOE Fire Protection and Emergency Services Programs for Use with DOE O 420.1B*, page 29, paragraph 4.21.

DEF-4: The TSR surveillance requirements, TSR Bases, and implementing surveillance test procedures for the fire sprinkler system are not sufficiently defined and implemented, as required by DOE-STD-3009, page 65, Chapter 5. Specific examples (e.g., technical Bases for greater than 60 psig at each wet pipe sprinkler control valve; for an orifice located in a system-to-system cross connect between the service water system and the fire water supply system; and, the bases for the TSR requirement of a water supply pressure greater than or equal to 60 psig and an air supply pressure less than or equal to 65 psig at each dry pipe valve sprinkler control valve) are discussed on page 8 of this report. A fire pump start functional test deficiency is discussed on the bottom of page 14 of this report.

DEF-5: An acceptance test of the fire water pumps was not performed after significant corrective maintenance activities, and in one instance, commercial grade dedication procedures were not properly implemented to evaluate installed spare parts, in accordance with NFPA 25, *Standard for the Inspection,*

Testing, and Maintenance of Water-Based Fire Protection Systems, and the SRS E7 Manual, *Conduct of Engineering*, Procedure 3.4.6, *Replacement Item Evaluation/Commercial Grade Dedication*.

DEF-6: The fire protection program has not implemented effective control of transient combustibles within the facility, and the method used by fire patrols for conducting inspections is not documented in facility procedures or training, in accordance with SRS 2Q Manual Procedure 5.5, *Control of Transient Combustibles*, and Procedure 5.3, *Fire Watch and Fire Patrol*.

Independent Oversight also identified seven observations:

OBS-1: An important DSA assumption (that SRS Road 1 can be controlled in an emergency) is not protected by explicit documentation in the DSA and inclusion in the SRNL TSR linking document.

OBS-2: The TSR linking document does not include the TSR implementing procedures maintained by outside organizations, such as procedures for IS surveillance tests.

OBS-3: Some service water system boundary valves are not included in procedure TO-07-009 to ensure that operational configuration control of the fire water supply is established and maintained.

OBS-4: The FHA for Buildings 773-A and 773-43A (F-FHA-A-00010) has not been revised to include the information documented in the CHA, DSA, and updated backfit analyses for flashing spray releases.

OBS-5: The weekly fire pump exercise test does not verify that the service water check valve operates as designed.

OBS-6: The Building 773-A fire pre-plan has not been revised to address changes resulting from the analyses of a potential flashing spray release to ensure that the SRS Fire Department has the correct information to facilitate appropriate emergency response actions.

OBS-7: The LCO action statements and their Bases do not adequately analyze the associated risks and identify appropriate compensatory measures for fire pump outages, as required by DOE-STD-3009 and DOE Guide 423.1-1A, *Implementation Guide for Use in Developing Technical Safety Requirements*.

Independent Oversight identified 13 OFIs:

OFI-1: To ensure that the DSA assumption for control of Road 1 is protected, consider including implementing emergency and security procedures in the linking document and identifying the linkage between the SRNL safety basis assumption and planned actions by emergency operations center and Wackenhut Services, Inc. responders during emergency events.

OFI-2: To reinforce the justifications for taking credit for fire water tank volume accessible by the non-safety service water system and for tank makeup from the non-safety well water system, institute emergency operating procedures to limit service water usage and to provide additional assurance of the well water makeup capability in the event of a fire.

OFI-3: Evaluate the following actions that could enhance the ability to respond to a sprinkler system actuation: have an IS operator respond to 784-A and vicinity to monitor tank level; start a second electric driven fire pump or diesel driven fire pump; increase well water supply; and start a second well water supply pump.

OFI-4: Consider testing the fire water supply system using the Number 3 fire water pump alone to

determine its capability (or limitation) with respect to meeting the DSA-required hydraulic performance over the bottom of the range of available fire water tank levels; existing tests of the Number 1 fire water pump indicate that it cannot meet these criteria for the hydraulically most remote area. If confirmed, establish the Number 3 pump as the lead pump.

OFI-5: Evaluate whether to perform additional analyses of the Number 1 fire pump's capabilities to meet DSA performance requirements with respect to the second and third most hydraulically remote areas. If it can fully meet the requirements for one or both of these areas (and assuming that the Number 3 pump alone is verified to be fully capable), revise the TSRs, LCOs, and Bases accordingly.

OFI-6: Explore possible ways to reduce the required hydraulic performance in zones where existing performance is inadequate, such as mandating tighter limits on combustible materials in all or parts of the zones.

OFI-7: Through testing and/or analyses, determine the overall system performance capabilities of the existing non-safety diesel-powered fire pump to determine its suitability for serving as a recognized compensatory measure for inoperable fire pumps.

OFI-8: Consider replacing the existing flow orifice between the service water system and the fire water supply system with a gate or butterfly valve with the appropriate sized orifice drilled in the disk. This replacement would provide additional pumping capability to the fire water supply system whenever a fire pump is out of service; the cross-connect valve could be opened to provide the additional pumping capability if the hydraulics of the connecting piping and the service water pumps are suitable (suitability would have to be verified by analyses and tests).

OFI-9: The fire suppression system LCO action statements do not assure that reasonably equivalent alternative protective measures, such as limitations on "hot" work, verification that alternative pumps are operable, provision for alternative water sources, or heightened availability of fire fighting assets, are required and implemented for a range of system outages representing increased risk to the facility.

OFI-10: Consider establishing a senior-level engineering/safety basis review board (populated with individuals with demonstrated specific expertise, including design expertise, in the technical disciplines associated with the systems, areas, and subjects being reviewed) to provide design engineering expertise for review of DSA and TSR submittals.

OFI-11: Assess whether the instructions and training for safety basis reviewers should include guidance for the reviewers to challenge statements about the performance capabilities of safety SSCs in order to assure that there are documented, verified, and validated demonstrations of such capabilities.

OFI-12: Consider conducting an extent-of-condition review as part of the upgrade of the existing TSRs and their Bases to identify any additional areas where action statements for inoperable SSCs do not provide defensible levels of compensatory protection reasonably equivalent to that provided by the LCO.

OFI-13: Consider the need to perform extent-of-condition self-assessments of the engineering and safety bases related to other Building 773-A safety systems to identify possible technical issues and concerns similar to those that were identified in this review.

7.0 FOLLOW-UP ITEMS

Independent Oversight will continue to follow SRNS actions to address the issues identified in this report and to upgrade and implement the SRNL DSA and TSRs.

Appendix A
Supplemental Information

Dates of Review

Offsite Planning	August – September, 2011
Onsite Review:	October 17- 27, 2011

Office of Health, Safety and Security Management

Glenn S. Podonsky, Chief Health, Safety and Security Officer
William A. Eckroade, Principal Deputy Chief for Mission Support Operations
John S. Boulden III, Director, Office of Enforcement and Oversight
Thomas R. Staker, Deputy Director for Oversight
William Miller, Deputy Director, Office of Safety and Emergency Management Oversight

Quality Review Board

William Eckroade
John Boulden
Thomas Staker
Michael Kilpatrick
Thomas Davis
George Armstrong
Robert Nelson

Independent Oversight Site Lead for SRS

Phil Aiken

Independent Oversight Reviewers

Phil Aiken – Team Lead
Deborah Johnson
David Odland
Don Prevatte
Jeffrey Robinson

Appendix B
Documents Reviewed, Interviews, and Observations

Documents Reviewed

- F-MOA-A-00001, Memorandum of Agreement to Supply Fire Water to Savannah River National Laboratory (SRNL), Rev. 1, 5/11
- PI-2009-0002, Potential for Flashing Spray Release, 1/30/09
- PI-2011-0022, Minimum Required Fire Water Capacity for a 2 Hour Demand, 9/15/11
- PI-2011-0022, Minimum Required Fire Water Capacity for a 2 Hour Demand, 10/20/11
- ROD-OPS-2002-003, Facility Operator Round Sheet, Rev. 73, 10/7/11
- ROD-OPS-2002-002, Control Area Operator Round Sheet, Rev. 27, 9/15/11
- FW-740-020-011-A, A-Area Fire Water Shift Operator Daily Round Sheet, Rev. 4, 9/15/11
- TSR Surveillance Matrix, 10/10/11
- SRNL Facility Operations Plan Of the Week, 10/19/11
- LCO Tracking # SRNL-2011-049, Building 773-A Sprinkler Systems are Inoperable, 10/13/11
- ROD-CHKLST-OPS-004, SRNL SOM Turnover Checklist
- TO-07-012, Verification of Annual Functional Test of 784-A Fire Pumps, Rev. 2, 9/15/11
- SP-16A-784-FP-ANN-TEST, 784-A Fire Pumps Annual Fire Pump Flow Test, Rev. 7, 3/28/11 (with IPC -1, 3/29/11)
- SP-16A-784-FP-ANN-TEST, 784-A Fire Pumps Annual Fire Pump Flow Test, Rev. 7, 3/28/11 (with IPC -2, 3/31/11)
- SP-15, A-784-720-023, Building 784-A Electric Driven Fire Pump Exercise and Alignment, Rev. 5, 1/12/11
- FW-740-020-002, M, & H Areas Fire Water Team Mech/Operator Weekly Inspection Rover Round Sheet, Rev. 10, 5/11
- SRT-773005A-EWING-AN, 773-000A E-Wing and 773-005A Valve House Fire System Test - Annual, Rev. 5 (completed 3/17/11)
- SRT-773004A-DWING-AN, 773-000A D Wing and 773-004A Valve House Fire System Test - Annual, Rev. 8 (completed 3/17/11)
- AD-00-027, TSR System Functional Acceptance Testing, Rev. 2, 10/25/10
- AD-00-028, Control of Fire System, Rev. 3, 6/24/10
- TO-07-009, Operation of 773-A Fire Protection Systems, Rev. 4, 9/15/11
- TO-07-011, Annual Surveillance of Building 773-A. Fire Sprinkler Systems Main Drain Flow, Inspector's Valve Test Flow, and Antifreeze Solution Testing, Rev. 2, 9/15/11
- AOP-07-001, Response to 773-A Fire Sprinkler Systems and Shielded Cells Halon Systems Impairments, Rev. 15, 12/19/10
- TO-07-014, Calibration Surveillance of Bldg. 773-A Fire Sprinkler Systems Pressure Indicator Reading of Wet and Dry Pipe Systems (5 Year), Rev. 2, 9/15/11
- TO-07-015, Bldg. 773-A Fire Water Supply Systems Tank 782-A Level Indicator 5-Year Calibration Surveillance, Rev. 2, 9/15/11
- S-CHA-A-00003, *Hazard Analysis for Flashing Spray Release in the Savannah River National Laboratory (SRNL) (U)*, Revision 1, February 2010
- WSRC-SA-2, *SRNL Technical Area Documented Safety Analysis*, Revision 10, September 2010
- SRNS-TR-09-00431, *Airborne Release and Respirable Fractions for Flashing Spray Releases for Laboratory Applications at SRNS*, Revision 0, December 2009
- SRNS-U1000-2011-00325, *Dispersion Modeling Issue Plan*, Revision 0, September 22, 2011
- S-CLC-A-00130, *Updated Source Term and Radiation Dose Calculations to Support SRNL Safety Basis Documentation (U)*, Revision 8, February 8, 2011

- WSRC-TS-97-0014, SRNL Technical Area Technical Safety Requirements (TSR), Rev. 10, 9/10
- Manual L7.7, Procedure 1.07, *Receipt, Internal Movement, Onsite Transfer, Offsite Shipment, Discards, Physical Form Changes, or Confinement Changes of Nuclear Materials*, Revision 30, September 19, 2011
- Manual 6Q15.1, Procedure 103, *SRS Emergency Response Facility Procedures Manuals - Protective Actions*, Rev. 14, October 29, 2011
- Manual L1, Procedure 4.01, *Liquid Radionuclide Inventory Surveillance*, Rev. 3, September 21, 2011
- WSMS-SAE-09-0025, *Failure Modes for Containers in F&H Labs During a Fire*, March 4, 2009
- SRNS-E0000-2011-00014-ATT4, Hazard Analysis for Real Waste Testing to Support Enhanced Chemical Cleaning, Rev.0
- F-SYD-A-00001, Automatic Sprinkler System Building 773-A System Design Description, Rev. 7, 6/10
- *System Health Report – Fire Water Supply Systems*
- Vital Safety System (VSS) 773-A Automatic Sprinkler Systems (FPAS) System Health, 4/28/11
- Curve 2856680, Peerless Pump (Curve #1), 3/52
- Curve 2889648, Peerless Pump (Curve #3), 8/66
- F-PA-A-0001, Outside Underground A and M Areas Sheet 1, Rev. 19, 9/10
- M-MA-A-0113,Service Water System Ops Diagram, Rev. 1, 6/06
- M-MA-A-0105, Service Water System 784-A, Rev. 2, 2/04
- M-MA-A-0100, Operating Diagram Fire Protection System Buildings 782-A & 785-A, Rev. 4, 2/05
- P-PF-A-0025, OSUG Fire Water Loop for SRTC, Rev. 0, 3/97
- Fire Water Tank Drawing, 5/15/87
- F-CLC-A-00007,Building 773-A, A-Wing Fire Protection Hydraulic Analysis for Wet Pipe Systems, Rev. 3, 3/10
- F-CLC-A-00021, Transient Loading Estimate for Building 773-A, Rev. 0, 3/97
- F-CLC-A-00029, SRNL D-Wing Fab Lab Sprinkler Addition, Rev. 2, 12/07
- F-ESR-G-00104, Equivalency for PIV Testing, 7/22/03
- F-CLA-A-00034, Building 773-A, Hydraulic Calculations, Remote Areas D1, D2, D3, and D4, Rev. 0, 3/10
- Manual 2Q, Procedure 8.0, Fire Protection System Maintenance, Test, and Inspection, Rev. 11, 11/09
- Manual 2Q, Procedure 11.0, Alternative Implementation Method, Rev. 1, 2/07
- M-FCD-A-00007, Component Level Functional Classification Report for the Savannah River National Laboratory Technical Area: Fire Sprinkler Systems, Building 773-A and A&M OSUG Fire Water Supply System, Rev. 7, 10/10
- F-CLC-A-00043, Required Water Level in the 782-A Fire and Service Water Tank, Rev. 0, 9/11
- F-BFA-00002, Backfit Analysis for A&M Area Outside Underground Fire Water Supply System, Fire Pumps, and Fire Water Storage Tank, Rev. 0, 4/10
- F-BFA-00003, Backfit Analysis for Automatic Fire Protection Sprinkler Systems in Building 773-A, Rev. 0, 4/10
- WSRC-TR-96-0361, Final Functional Classification Report for the Savannah River National Laboratory Technical Area, Rev. 12, 4/11
- F-FHA-A-00010, Fire Hazards Analysis for Building 773-A and 773-43A, Rev. 6, 2/10
- SRNS-RP-2011-00957, Fire Department Emergency Response Baseline Needs Analysis, Rev. 7, 5/11
- FW-740-0020-015, A&M Area SRNL Backfit Fire Hydrant Water Flow Verification, Rev. 0, 2/10
- WSRC-IM-98-00025, SRNL Technical Area TSR Linking Document, Rev. 26, 4/11
- W/O 01040816, PM 480V Switchgear B1 in 784-A, 8/11
- W/O 01144574, PM 480V Bus 1 Transformer T1 and Disconnect 784-A, 9/11
- W/O 01065480, SS, Repair Packing Gland Leak, 8/11

- Impairment No. 2011-547, Water Supply/Fire Pumps, 9/11
- Impairment No. 2011-546, Water Supply/Fire Pumps, 9/11
- W/O 01065478, SS, Repair Packing Leak, 8/11
- Impairment No. 2011-539, Sprinkler/Wet Pipe, 9/11
- W/O 01027458, 773-A, Calibrate Designated TSR Fire Sprinkler Gauges, 6/10
- F-PI-A-0002, Building 773-ABC Headers Fire Protection System A-Wing Basement, Rev. 3, 4/08
- P-PF-A-0017, 773-A Section D Service Level Fire Protection, Rev. 13, 1/08
- F-CLC-A-00037, Building 773-A Area B, C, and E Sprinkler System, Hydraulic Calculations, Rev. 0, 4/10
- TO-07-006, Annual Accounting of Flammable/ Combustible Liquids and Storage Areas, Rev. 3, 2/10

Interviews

- SRNL Facility Operations Manager
- SRNL Lead Shift Operations Manager
- Site Nuclear and Criticality Safety Engineering (N&CSE) Manager
- SRNL N&CSE Manager
- SRNL N&CSE Lead
- IS and Fire Protection Engineering – Fire Protection Engineering Lead
- IS and Fire Protection Engineering – Fire Protection Engineer
- IS Operations Manager
- IS Fire Protection Engineer
- RI-AC Software Subject Matter Expert
- Engineering Calculations Developer

Observations

- Walk down fire water system and sprinkler system with cognizant engineers.
- Walk down SRNL (Building 773-A).