Office of Enterprise Assessments Review of the Nevada National Security Site Fire Protection Program

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Acronyms

AHJ	Authority Having Jurisdiction
ASTM	American Society for Testing and Materials
BNA	Baseline Needs Assessment
CD	Company Directive
CFR	Code of Federal Regulations
CRAD	Criteria, Review, and Approach Document
CWCS	Contaminated Waste Collection System
DAF	Device Assembly Facility
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
FHA	Fire Hazards Analysis
FPE	Fire Protection Engineer
FPP	Fire Protection Program
FSS	Fire Suppression System
ITM	Inspection, Testing, and Maintenance
LHD	Load-Haul-Dump
NFO	Nevada Field Office
NFPA	National Fire Protection Association
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NFO	Nevada Field Office
NSTec	National Security Technologies, LLC
OFI	Opportunity for Improvement
PD	Program Description
PIV	Post Indicator Valve
SR	Surveillance Requirement
SC	Safety Class
SS	Safety Significant
SSC	Structures, Systems, and Components
SSO	Safety System Oversight
SSOR	Safety System Oversight Representative
TSR	Technical Safety Requirement

Office of Enterprise Assessments Review of the Nevada National Security Site
Fire Protection Program

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) independent Office of Enterprise Assessments (EA) conducted an oversight review of the Nevada National Security Site (NNSS) fire protection program (FPP), managed by National Security Technologies, LLC (NSTec). This review was part of a targeted assessment of fire protection programs at nuclear facilities across the DOE complex.

Fire protection was identified as a targeted review area in a memorandum entitled Independent Oversight of Nuclear Safety – Targeted Review Areas Starting in FY 2013, dated November 6, 2012. Pursuant to this memorandum, EA reviewed and assessed the effectiveness of the NSTec FPP, with specific attention to program implementation at the Device Assembly Facility and the U1a Complex. The review included an evaluation of key program elements, including the adequacy and integration of the fire hazards analysis with the safety basis controls; the baseline needs assessments; fire pre-plans; the exemption and equivalency process; combustible controls; technical safety requirements surveillance and testing; and the inspection, testing, and maintenance of safety structures, systems, and components and supporting infrastructure. The review also evaluated the NNSS oversight processes (contractor and DOE) that are intended to verify the adequacy of its FPP.

The FPP implemented at NNSS is adequately meeting DOE objectives for minimizing the potential for a fire or related event that could cause unacceptable onsite or offsite release of hazardous or radiological material, property loss, or damage of critical process controls. NSTec fire protection engineers and staff are qualified, knowledgeable and actively engaged in evaluating and maintaining facility fire systems and supporting the FPP. The two fire stations at NNSS are appropriately staffed and equipped to respond to the emergency events described in the safety basis, in the facility fire hazard analyses, and as evaluated in the baseline needs assessments, with the exception of meeting DOE's expected response times because of the vast size of the reservation. EA considered the fire extinguisher maintenance and refurbishment shop at Fire Station 1 as a best practice.

EA identified some weaknesses with the NSTec FPP, many of which were also self-identified by NSTec. Many of these weaknesses present vulnerabilities to DOE worker safety and are primarily associated with incomplete FPP description documents, the exemption and equivalency process, diesel powered equipment and dry chemical fire suppression systems at the U1a Complex underground, and lack of baseline standards and controls for managing combustible material. In addition, like many sites across the DOE complex, NNSS has aging infrastructure and component degradation issues that challenge the reliability and adequacy of the fire water supplies. Areas for improvements were noted for maintaining the safety class fire suppression system and addressing the vulnerabilities with the single source fire water supply at the Device Assembly Facility. Contributing to theses vulnerabilities are concerns related to controls and operability requirements necessary to ensure a minimum available fire water supply and static pressure. Project work to address many of these vulnerabilities, specifically for the fire water lead-in lines, was ongoing and being monitored by knowledgeable fire protection engineers and cognizant system engineers.

The Nevada Field Office (NFO) oversight processes adequately conform to DOE Order 226.1B expectations. The NFO line oversight program includes written plans and schedules for planned assessments, focus areas for operational oversight, and reviews of the contractor's self-assessment of processes and systems. For fire protection, NFO has been adequately performing triennial self-assessments and functional area reviews.

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Fire Protection Program

1.0 PURPOSE

The U.S. Department of Energy (DOE) independent Office of Enterprise Assessments (EA) conducted a review of the fire protection program (FPP) at the Nevada National Security Site (NNSS). The purpose of the EA targeted review was to evaluate the implementation of program requirements and the adequacy of controls designed to reduce the risk resulting from a fire or explosion at nuclear facilities. This targeted review was designed to evaluate the selected core fire protection elements and to provide information to the site and responsible DOE line management organizations for benchmarking the program's effectiveness. This review was conducted within the broader context of an ongoing program of targeted assessments of FPPs across the DOE complex at hazard category 1, 2, and 3 nuclear facilities. EA performed the on-site review at NNSS from April 13-16, 2015. Additional data gathering and observations were performed from May 11-14, 2015.

2.0 SCOPE

EA reviewed and assessed the effectiveness and implementation of selected elements of the FPP at NNSS, with specific attention to program implementation at the Device Assembly Facility (DAF) and the U1a Complex. EA evaluated key elements of the NSTec FPP and the individual FPPs at the DAF and U1a Complex, including: program documentation; authority having jurisdiction (AHJ) determinations and exemption and equivalency processes; baseline needs assessments (BNAs); life safety assessments; pre-fire plans; ignition source and combustibles controls; fire system impairment process; inspection, testing, and maintenance (ITM) of suppression and alarm systems; and ITM of supporting infrastructure. EA also evaluated the integration of the fire hazards analysis (FHA) and the documented safety analysis (DSA), as well as the flow down of the safety basis requirements into the FPP. EA also considered the NSTec self-assessment program and the DOE field element's oversight of the FPP.

3.0 BACKGROUND

The NNSS is a massive outdoor laboratory and national experimental center, originally established by the Atomic Energy Commission as the Nevada Test Site in 1951 for nuclear weapons testing. Since 1992, test site use has diversified into many other programs such as hazardous chemical spill testing, emergency response training, conventional weapons testing, and waste management and environmental technology studies. The DAF supports work on special nuclear material, radiation test objects, and high-explosives in support of experiments for Stockpile Stewardship and other programs. The U1a Complex is an underground laboratory used for subcritical experiments and physics experiments that obtain technical information about the nation's nuclear weapons stockpile. NNSS is located about 65 miles northwest of Las Vegas, Nevada, covers approximately 1,375 square miles, and is managed and operated by NSTec with some 2,450 employees.

The EA independent assessment program is designed to enhance DOE safety and security programs by providing DOE and contractor managers, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements, as well as the effectiveness of DOE and contractor line management performance in safety and security and other critical functions as directed by the Secretary of Energy. The EA independent assessment program is described in and governed by DOE Order 227.1, *Independent Oversight Program*, and a comprehensive set of internal protocols and criteria,

review, and approach documents (CRADs).

The primary FPP functions at NNSS are managed by National Security Technologies, LLC (NSTec) for the National Nuclear Security Administration (NNSA)/Nevada Field Office (NFO). EA selected the DAF and U1a Complex for this targeted review as an example of implementation of the NNSS FPP, comprised of CD-2120.017, *National Security Technologies, LLC, Fire Protection Program*, DAF-PLN-SF-08, *Device Assembly Facility Fire Protection Program*, and PLN-U1a.001, *U1a Complex Fire Protection Program*.

4.0 METHODOLOGY

As identified in the review plan, EA reviewed FPP documentation, including the FHA, the safety analysis report, procedures, and records; conducted interviews with personnel responsible for program implementation and oversight; performed facility and system walkdowns; and observed performance of ITM activities and combustible loading weekly rounds. The review considered the requirements of Title 10 Code of Federal Regulations (CFR) Part 830, *Nuclear Safety Management*; 10 CFR 851, *Worker Safety and Health Program*; DOE Order 420.1C, *Facility Safety*; DOE-STD-1066-2012, *Fire Protection*; and various National Fire Protection Association (NFPA) codes and standards.

EA assessed the FPP in seven areas: FPP programmatic aspects; fire and related safety hazards analyses; fire prevention and protection structures, systems, and components (SSCs) and controls; FHA/DSA integration; technical safety requirement (TSR) surveillance and testing and ITM; the fire protection self-assessment program; and DOE oversight. The assessment in each area used criteria based on program elements from DOE Orders 420.1C and 226.1B.

EA also used selected applicable sections of CRAD 45-34, *Fire Protection*, Revision 1, for this targeted assessment, with particular emphasis on the following programmatic elements:

- Section I, Programmatic Elements, FP-1, Program Documentation.
- Section I, Programmatic Elements, FP-2, Program Implementation – Fire and Related Safety Hazards and Self-Assessments.
- Section I, Programmatic Elements, FP-3, Program Implementation – Fire Prevention and Protection.
- Section II, FHA/DSA Integration, FP-4.
- Section III, Engineered System Design Features.
- Section IV, TSR Surveillance and Testing.
- Section V, Configuration Management.

EA also used selected elements of CRAD 45-21, *Feedback and Continuous Improvement Inspection Criteria and Approach – DOE Field Element*, Revision 1, to collect and analyze data on NFO oversight activities for the FPP. The members of the EA review team, the Quality Review Board, and EA management responsible for this review are listed in Appendix A. A detailed list of the documents reviewed, personnel interviewed, and observations made during this review, relevant to the findings and conclusions of this report is provided in Appendix B.

5.0 RESULTS

5.1 Fire Protection Program

Criteria:
A documented fire safety program exists as required by applicable safety criteria. (DOE Order 420.1C, DOE-STD-1066-2012)

A baseline needs assessment (BNA) of the fire protection emergency response organization has been documented and updated every 3 years. The plan should describe in sufficient detail fire-fighting operations for the respective facilities. (10 CFR 851, DOE Order 420.1C, DOE-STD-1066-2012)

Program Documentation

NSTec has implemented a FPP designed to provide a level of fire protection consistent with industrial risks as required by DOE Order 420.1C, *Facility Safety*, and Title 10 CFR Part 851, *Worker Safety and Health Program*, Appendix A. The FPP includes fire protection policies, requirements, technical criteria, analyses, administrative procedures, systems and hardware, apparatus and equipment, plans, and personnel who ensure the program achieves DOE objectives relating to fire safety. EA considered the fire extinguisher maintenance and refurbishment shop at Fire Station 1 as a best practice. This shop was very well organized and included procedures, manuals, and updated equipment for technicians to perform required maintenance and hydrostatic testing on all types of portable fire extinguishers present at the site. The FPP, as implemented in the DAF and U1a Complex, is intended to provide a level of fire protection that is sufficient to fulfill the requirements for the best-protected class of industrial risks (i.e., "Highly Protected Risk" or "Improved Risk"). Accordingly, the NSTec FPP includes both active and passive fire protection safety-related SSCs classified as safety class (SC) and safety significant (SS) in the DAF and SSCs classified as SS and "defense-in-depth" in the U1a Complex, as well as administrative controls designed to limit the material at risk and combustible loading in the facilities.

Many groups are responsible for implementing the NSTec FPP. Key roles are held by the fire chief, assistant fire chief, fire marshal, principal fire protection engineer (FPE), cognizant systems engineer, facility managers, ITM supervisor, water department supervisor, work planning manager, and the fire support group. The NNSA/NFO has delegated limited fire protection AHJ responsibilities to the NSTec fire chief for fire and rescue, the fire marshal for fire prevention, and the principal FPE for implementation of NFPA codes and standards.

NSTec has an FPP company directive (CD), CD-2120.017, *National Security Technologies, LLC Fire Protection Program*, which describes the overall FPP for the entire NNSS site. Additionally, NSTec has supplemental FPP description documents specific to the DAF facility (DAF-PLN-SF-08, *Device Assembly Facility Fire Protection Program*) and the U1a Complex (PLN-U1a.001, *U1a Complex Fire Protection Program*).

The three FPP description documents incorporate the requirements in DOE Order 420.1C, Attachment 2, Chapter II, Fire Protection, and DOE-STD-1066-2012, but they are not complete. FPP description documents do not require critical characteristics of SC and SS systems, including support systems, to be identified and documented in a configuration-controlled system design document. Critical characteristics typically include hydraulic performance requirements, system construction materials, fire pump performance, standby and fire pump startup criteria, availability and reliability requirements, component design lifetimes and environmental limitations, seismic requirements, level of DOE control, design for future planned expansion, design to accommodate the potential for multiple fires, and water supply and distribution systems. Additionally, PLN-U1a.001, *U1a Complex Fire Protection Program*, does not

address dry chemical fire suppression systems (FSSs) installed on diesel powered equipment used in the underground. Finally, contrary to DOE Order 420.1C (sections 3.a, 3.b, 3.c and 3.h), DOE-STD-1066-2012 (section 3.1, 4.2), and NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*, NSTec FPP description documents do not include all elements and requirements associated with the design and operation of a DOE compliant FPP. (See **OFI-NSTec-1**)

Exemption and Equivalency Process

The FPP description document CD-2120.017 defines the process for requesting an exemption or an equivalency. Additionally, Appendix G, Table 2, provides a list of approved equivalencies and exemptions for specific facilities at NNSS. FHAs for the DAF facility and U1a Complex discuss each applicable exemption and equivalency that has been submitted and approved for fire protection and life safety features. EA confirmed that exemptions and equivalencies specific to the DAF facility and U1a Complex are being reviewed during each FHA update to verify that conditions have not changed and the justifications are still valid, as required by DOE-STD-1066-2012. However, NSTec has not requested DOE approval for continued occupancy of the U1a underground because of the lack of required fire barriers and life safety requirements for refuge areas. Although deficiencies of fire-rated barriers and refuge areas were self-identified in PLN-U1a.001 and the U1a long term fire protection strategy, NSTec continues to occupy the U1a underground without having documented concurrence from the appropriate authorities for not meeting life safety, FHA and FPP requirements. (See **OFI-NSTec-2**)

An NFO assessment identified a lack of consistent approach for fire protection for underground facilities. NSTec submitted to NNSA/NFO a *Request for Permanent Exemption from Fire Protection Requirements Designated in DOE O 420.1B and DOE-STD-1066-99 for the U1a Complex in Area 1 of the NNSS.* This request was approved by NNSA headquarters with comments that included the requirement to develop an approved long term fire protection strategy for the U1a Complex provided in PEP-DESS-1020, *NSTec Underground Safety and Health Project Execution Plan*, and implemented through PD-P200.002, *NNSS Underground Facility Safety and Health Program Description*. NSTec, using the Delphi Group, Inc., developed a gap analysis for this program description against current conditions. The analysis identified numerous gaps and NSTec developed appropriate corrective action plans. Many of the corrective actions have been completed while others are in progress.

The PD-P200.002 program description applies portions of NFPA 520, *Standard on Subterranean Spaces*, for many features of escapeways and refuge areas underground. NSTec has identified several aspects of this standard that are not currently met and has developed corrective action plans. The corrective actions identified are appropriate, but the implementation schedule for completion of these actions is dependent upon funding and will extend over several years. Although NSTec has self-identified several issues of noncompliance, many issues remain that present vulnerabilities to DOE worker safety. (See **OFI-NSTec-2**)

NFPA 520 section 5.8.2.2 requires a refuge area to have an engineered fresh air system. The system installed at U1a consists of Ingersoll Rand oil-lubricated compressors that provide compressed air to the underground. The PD-P200.002 program description document provides requirements applicable to the compressed air system in NFPA 520, section 10. The relevant requirements include:

- Section 10.1 requires that compressed air equipment meet the following codes and standards:
    - 29 CFR 1910, Subpart M – air receiver requirements.
    - NAC 455C – Nevada Pressure Vessel Code.
    - 42 CFR 84.141 – Breathing Gas; minimum requirements.

    - American National Standards Institute/Compressed Gas Association Commodity Specification for Air, G-7.1-198.
- Section 10.4 requires the compressed air to meet minimum grade requirements for Type 1 gaseous air set forth in the Compressed Gas Association Commodity Specification for Air, G-7.1, 1966 (Grade D or higher quality) and the air compressor to be constructed and situated in accordance with 29 CFR 1910.134(i)(5); although this (i)(5) requirement specifically pertains to respirators, it should also be considered generally applicable to any breathing air supplied by compressors.

NSTec has operated the U1a compressed air system as specified in the applicable parts of PD-P200.002. However, the provisions adopted from 29 CFR 1910 do not sufficiently address the safety and health concerns with breathing air from air compressors. The selected portions of 29 CFR 1910 relative to breathing air from air compressors are limited to the prevention of contaminated air into the system, limitation of moisture, inclusion of sorbent beds, and tagging of filters. Critical protection features for compressors supplying breathing air are included in 29 CFR 1910.134(i)(7), which addresses the hazards of oil-lubricated compressors, by requiring the use of a high-temperature or carbon monoxide alarm, or both, to monitor carbon monoxide levels. Although NSTec Industrial Hygiene personnel routinely monitor underground air quality at U1a, there are no protective in-line alarms. If only high-temperature alarms are used, the air supply must be monitored at intervals sufficient to prevent carbon monoxide in the breathing air from exceeding 10 parts per million.

NSTec has not sufficiently covered the potential hazards associated with the use of oil-lubricated air compressors to provide breathing air to the underground refuge areas in the PD-P200.002 program description by requiring a high temperature and/or carbon monoxide alarm. NSTec also did not follow the FPP process for requesting the DOE head of field element's concurrence, with appropriate justification, on fire safety program requirements that are not being met. (See **OFI-NSTec-2**)

Pre-Incident Plans

NFPA 1620, *Standard for Pre-Incident Planning*, requires pre-incident strategies and plans to be established to enhance the effectiveness of manual firefighting efforts. NNSS fire inspectors, emergency planning and preparedness, and fire department personnel are responsible for developing pre-incident plans. Pre-incident plans are in place for the DAF facility and U1a Complex and are reviewed regularly to ensure that facility information remains current. These plans are carried on emergency command vehicles, which are typically used as the incident command post. EA observed a DAF facility pre-plan table top exercise that included players from the fire department, emergency preparedness organization, and DAF. Although the requirements from NFPA 1620 are covered on the pre-incident plans, discussions during the table top exercise identified additional pertinent information that could be of value to emergency response groups; e.g., the non-compliant low level fire water tank monitor and associated alarm reporting features in particular. (See **OFI-NSTec-3**)

Hot Work Program

CD-2120.017 refers to CD-P280.030, *Hot Work*, which is the required document for performing all hot work activities. The DAF facility FPP description document, DAF-PLN-SF-08, *Device Assembly Facility Fire Protection Program*, requires hot work to be performed in accordance with CD-2120.017 and lists CD-P280.030 as a reference. However, the reference to CD-P280.030 is titled *Compressed Gas Cylinders* rather than *Hot Work*. (See **OFI-NSTec-4**)

PLN-U1a.001, *U1a Complex Fire Protection Program*, section 4.3.20, references the hot work program but does not discuss requirements for performing hot work nor reference CD-P280.030 or PD-P200.002,

NNSS Underground Facility Safety and Health Program. PD-P200.002 section 15.0 requires U1a hot work to be performed in accordance with 29 CFR 1910.252 and 29 CFR 1926.800. EA observed hot work activities in the U1a drift 100 area where the project was using a drop down flexible exhaust/ventilation duct, placed in close proximity to welding operations, to draw in smoke and exhaust out through the shaft. The drop down duct did not have markings indicating that the flexible duct material was fire resistant and the opening of the drop down duct, connected directly to the main shaft ventilation duct, has no means in place to prevent hot slag/sparks from entering the exhaust channel. This poses a potential risk for igniting fine dusts and lint that typically line the inner walls of ventilation ducts and carry sparks/slag to distant combustibles. NSTec has not evaluated the hot work program to ensure adequate flowdown into all FPP documents. NSTec has yet to determine if requirements for drop down exhaust ventilation equipment are appropriately addressed. (See **OFI-NSTec-5**)

U1a Dry Chemical Fire Suppression Systems

DOE 420.1C requires FPP description documents to include the elements and requirements for the performance and assessment of fire protection systems. PLN-U1a.001, *U1a Complex Fire Protection Program*, does not address the dry chemical FSSs installed on the diesel powered equipment used in the underground. (See **OFI-NSTec-1**) Additionally, PD-P200.002, *Nevada National Security Site Underground Facility Safety and Health Program Description*, October 15, 2013, section 9.12.3.2 requires that appropriate codes and standards be identified and followed for FSSs. FHA-U1a.001, *Fire Hazards Analysis for the U1a Complex*, May 2014, section 8.8.1 briefly discusses the diesel powered equipment, and associated portable fire extinguishers, and indicates that the Type ABC dry chemical FSSs are provided as required by 30 CFR 57.4230 and NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*, section 7.

NSTec identified and included the minimum requirements for safeguarding life against fire and related hazards associated with nonmetal underground mining by incorporating NFPA 122. NFPA 122 requires that diesel-powered equipment shall be protected by a fixed fire suppression system to suppress the largest anticipated fires in the protected areas, and that systems shall have the following characteristics (partial list):

- Be listed or approved for the purpose.
- Be automatically actuated by a fire detection system.
- Have one manual actuator in the operator's compartment and at least one additional actuator accessible from the ground.
- Be installed to ensure that the system actuation causes shut- down of the protected equipment.

The *U1a Complex Ventilation Plan* (01119-RPT-1) lists the underground diesel equipment as required by the PD-P200.002. This equipment consists of three load-haul-dump (LHD) units, a Hyster forklift, and a Tamrock jumbo drill. With the exception of one of the LHDs, EA observed all the diesel-powered equipment. All units were equipped with appropriate portable fire extinguishers that had current inspection and test dates. The LHDs and Tamrock drill are also equipped with manually actuated dry chemical FSSs that do not have features to automatically shut down the equipment upon actuation. The LHDs and Tamrock drill include manual actuators in the operator's compartment as well as an additional actuator in the path of egress operable from ground level. Another LHD was equipped with a single manual actuator in the operator's compartment. The Hyster forklift was not protected with a fixed FSS.

NSTec has also not fully incorporated NFPA 122 requirements for FSSs, as noted by the following examples: (See **OFI-NSTec-1**)

- Hyster diesel-powered forklift was not equipped with a fixed FSS.
- Fixed FSSs installed on the three LHDs and Tamrock drill are not automatically actuated by a fire detection system.
- Fixed FSSs are not installed so that system actuation causes shut-down of the protected equipment.
- One LHD is not equipped with at least one additional manual actuator accessible from the ground.

5.2 Fire and Related Safety Hazards Analyses

Criteria:
Fire Hazard Analyses (FHA) have been prepared for each nuclear facility and the results coordinated and integrated into the Documented Safety Analysis as required. (DOE Order 420.1C, DOE-STD-1066-2012, DOE-HDBK-1163, NFPA 801)

Fire and related safety hazards on site (or within the facility) have been identified and evaluated in conjunction with a current and comprehensive FHA. (DOE Order 420.1C)

The FHA and self-assessments address all essential elements for a complete analysis as delineated in DOE Order 420.1. (DOE Order 420.1C)

The information contained in the FHA and assessment is accurate, as required by applicable fire safety criteria. (DOE Order 420.1C)

NSTec has a company directive, CD-EN22.002, *Fire Hazards Analysis*, for preparing FHAs. FHAs for the DAF facility and the U1a Complex are current and are reviewed and updated every three years as required by DOE Order 420.1C, and CD-EN22.002. EA reviewed FHA-U1a.001, *Fire Hazards Analysis for the U1a Complex*, May 2014, and DAF-RPT-35, *Fire Hazards Analysis for the Device Assembly Facility at the Nevada National Security Site*. The FHAs are generally adequate and the results integrated into the safety bases; however, EA identified the following inconsistencies and omissions in the U1a FHA:

- Section 6.8.1, *U1a Complex Surface Fire Areas*, discusses portable fire extinguishers located outside of buildings that are installed in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. NFPA 10-6.1.3.7 requires "Fire extinguishers installed under conditions where they are subject to physical damage (e.g., from impact, vibration, the environment) shall be protected against damage." Extinguishers mounted outdoors at the U1a surface area buildings are not protected from environmental elements (i.e., direct sunlight/ultraviolet radiation) as required by NFPA 10. (See **OFI-NSTec-6**)
- Photoluminescent exit signs installed on walls and on mobile stanchions in several areas of the underground lack adequate and continuous face lighting to properly charge the photoluminescent cells. Section 8.6 of the FHA specifies that life safety requirements for the U1a Complex underground areas as they pertain to means of egress are as identified in Chapter 6 of PD-P200.002. PD-P200.002, section 6.1.3.4, requires each exit sign to be sufficiently illuminated. (See **OFI-NSTec-7**)
- Section 8.5.4 discusses diesel-fueled equipment used in the U1a underground and associated dry chemical FSSs installed on the EJC61 LHDs and Tamrock drill, but does not address areas that do not fully comply with NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities.* (See **OFI-NSTec-8**)

EA identified the following inconsistencies and omissions in the DAF FHA:

- The FHA does not discuss the low water level tank alarm installed on the 250,000 gallon fire water storage tank. This alarm system does not fully comply with DOE-STD-1066-2012, section 4.2.8. Additionally, the facility fire alarm system(s) is not described in the FHA as required by DOE Order 420.1C, section 3.b(1). (See **OFI-NSTec-9**)
- Section 6.7 of the FHA adequately describes the life safety systems installed throughout the DAF. However, requirements for the ITM of emergency lighting and exit signs are not discussed to ensure these systems operate as designed and perform as required in DAF-DSA-01, section 4.4.3. (See **OFI-NSTec-10**)
- The FHA does not adequately describe the attributes of the FSS SSCs or their respective boundaries in accordance with the guidance of DOE-STD-1066-2012, Appendix B. (See **OFI-NSTec-11**)

5.3 Fire Prevention and Protection SSCs and Controls

Criteria:
A complete spectrum of fire prevention controls and procedures are in existence and have been implemented as required by applicable fire safety criteria. (DOE Order 420.1C, Site & Facility DSA)

Technical, functional, and performance requirements for the systems are specified in (or referenced in) the facility authorization basis documents consistent with the facility fire hazards analysis. Safety/authorization basis documents identify and describe the system safety functions, and these criteria are translated into design calculations and procedures.

All fixed fire protection features (appropriate construction types, fire barriers, fire alarm and signaling systems, manual and automatic fire suppression systems, etc.), that are required by authorization basis documents and fire hazards analyses, have been installed and are tested and maintained, as required by applicable fire safety criteria. (DOE Order 420.1C, Site & Facility DSA)

A reliable and adequate water supply and distribution system must be provided for fire suppression, as documented through appropriate analysis. (DOE Order 420.1C)

A means for collecting and containing a credible quantity of fire suppression water for a minimum of 30 minutes is provided to avoid the spread or release of radioactive material during a fire. (DOE-STD-1066-2012, NFPA 801)

EA reviewed fire protection systems at the DAF to confirm, in part, that they are appropriate for the facility fire hazards as described in the FHA and the safety basis design basis accident scenarios; that they are designed and installed in compliance with required DOE orders, DOE standards, and consensus industry codes and standards; and that an appropriate ITM program for fire protection features is in place and is being conducted. The EA review of the FSS focused on the safety related SSCs that provide fire suppression in DAF. EA also reviewed the adequacy of the water supply to DAF. In addition, EA reviewed the contaminated waste collection system (CWCS) to ensure that the SC SSCs that are part of this system are designed to mitigate radioactive material releases associated with fire or explosion in assembly cells. In many cases, the systems are adequately designed, installed, maintained, and tested. However, EA identified several inadequacies, some of which have been long standing issues, as discussed in the following sections.

Seismic Analyses

DAF-JCO-09-01, addresses the justification for continued operation of the FSS system with reference to seismic vulnerabilities. The JCO credits 080277-CAL-S-001, Rev 0, *Seismic Analysis of FSS Buried Water Pipe*, as demonstrating compliance with seismic PC-3 criteria. However, the calculation design inputs used for the steel lead-in piping wall thickness were not in compliance with American National Standards Institute B31.3 or American Society for Testing and Materials (ASTM) standards that require consideration of the pipe manufacturer's permitted fabrication tolerance. The lead-in piping is ASTM SA-106 Grade B seamless extruded pipe. Pipe wall thickness can vary up to 12.5% of the nominal wall thickness because of the manufacturing process. Calculation CAL-S-001 did not consider the permitted manufacturer's fabrication tolerance in determining the seismic loading acceptability for the lead-in piping; therefore, the calculation may inadequately demonstrate the ability of this piping to withstand PC-3 loading and may require further evaluation as a potential inadequacy of the DSA. (See **OFI-NSTec-12**)

DAF-JCO-09-01, concludes that the as-is FSS, including an inoperable FSS in operational buildings combined with a continuous fire watch, is acceptable. This would not be an accurate assessment for some work performed in some DAF buildings during a postulated seismically induced fire. For this accident scenario, one of the major preventive credited controls is that the structure and structure appurtenances stay in place; however, the seismic PC-3 qualification for this control strategy is incomplete. In the absence of this control and because of the nature of the work being performed, a fire watch would be ineffective. (See **OFI-NSTec-13**)

Other long-standing seismic non-compliance issues at the DAF recognized by NSTec still exist: (See **OFI-NSTec-14**)

- The DAF Water Storage Tank is not seismic PC-3 qualified. The storage tank as part of the FSS system has a functional requirement to remain operational during and after a seismic PC-3 design basis earthquake. Additionally, the tank water supply automatic fill valve (altitude valve) is classified as SC but not qualified to seismic PC-3 criteria.
- Water supply to non-seismic "support buildings" compromises the ability of the SC FSS to support the design basis seismically induced fire accident scenario. The safety function of the FSS is to prevent depleting the fire water supply, thereby disabling the FSS in other buildings. However, the SC portions of the FSS system are not isolated from defense in depth and non-safety system areas and are not provided with an alternate SC water supply. There is no assurance that a seismically induced pipe break would not occur upstream of the flow restriction orifice plate installed in the piping for non-safety domestic use. As a result, the function of the SC portions of the system may be adversely affected and compromised. The SC portions of the FSS system are directly connected with an open flow path to the non-safety portions of the system and therefore the capability of the complete FSS to withstand a seismic event is uncertain, and the time durations cited in the hydraulic calculations may not be accurate.

Contaminated Waste Collection System

The CWCS receiver tank is inadequately sized to receive potentially radioactive water from deluge system activation from some DAF building cells. The CWCS system is designated SS only for the assembly cells. The safety function of the CWCS is to mitigate the release of waterborne radioactive material following a high explosive violent reaction event in the assembly cells. Additionally, the CWCS is provided for fire protection water runoff in the assembly cells and for the decontamination showers in two DAF buildings. If the FSS activates in a cell, large quantities of contaminated water will be released with a direct flow path to the 20,000 gallon waste collection tank. Based on 2-hour accident duration and the associated FSS water discharge, the total water discharge significantly exceeds the holding capacity of

the CWCS tank. Additionally, shower drains for both buildings connect directly to the CWCS piping to the receiver tank, creating a potential bypass flow path for contaminated water and gaseous vapors. These deficiencies were previously identified by EA in 2007 and NSTec addressed them in analyses completed in 2009 and 2010, but EA questions the adequacy of these analyses to fulfill the requirements of NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, and be fully incorporated into the DAF safety basis. (See **OFI-NSTec-15**)

Fire Water Storage Tank

The SC fire water storage tank for the DAF is gravity fed by an 8-inch diameter line from the two water tanks in Area 6. The water tanks have 500,000 gallon and 300,000 gallon capacities and a base elevation approximately 400 feet higher than the fire water storage tank, providing sufficient static head to fill the tank when the storage tank altitude valve opens.

The fire water storage tank level is automatically controlled by an 8-inch diameter altitude valve in an adjacent concrete vault along the tank's fill piping from the water tanks and wells 4 and 4A. The vault also contains two 8-inch diameter gate valves to isolate the altitude valve, and an 8-inch diameter bypass line with bypass valve. The altitude valve senses water "altitude" (i.e., pressure) in the tank via the level sensing line and opens and closes the storage tank's fill valve to maintain the tank's level. The fire water supply from the storage tank to the DAF perimeter fire water loop is supplied via a 12-inch diameter reinforced thermoplastic pipe water main. The perimeter loop and connecting lines are cement-lined ductile iron. The supply main and connecting lines join in two concrete vaults with three isolation valves each. A cross-connect between the storage tank fill and supply lines is fitted with a normally closed valve, which when opened, can supply the DAF perimeter loop directly from the fill piping should the tank be out of service.

NSTec has self-identified significant degraded conditions in the DAF water supply and distribution system. For example, table 3C-0-3, *Safety SSC Vulnerabilities Device Assembly Facility (DAF),* describes fire water storage tank deficiencies (e.g., pitting and corrosion) that could impact the capability of the tank to provide a reliable water supply to the DAF FSS. NSTEC had an inspection performed in 2010, *Water Tank Inspection Report for National Security Technologies of the 250 K Welded Steel DAF Tank Nevada Test Site,* that indicated that the interior coating is blistering and failing across the roof, shell and floor. The following recommendations have not been implemented: (See **OFI-NSTec-16**)

- Blast and paint the interior of the tank in the next 1-2 years to prevent the formation of deep pits and metal loss on the roof rafters.
- Install a cathodic protection system to prolong the life of any new coating, allowing for a 5-year inspection under current NFPA 25 requirements.

EA identified additional deficiencies with the fire water storage tank regarding compliance with the requirements of NFPA 22, *Water Tanks for Private Fire Protection*, 2008 edition. The associated ¾-inch piping and valves supplying the tank level gauge (ref. GAV-201-1) that are connected to the outside wall of the fire water storage tank are located in an insulated box exterior to the tank, but NFPA 22 requires exposed piping and gauges subject to freezing to be located to prevent freezing. There has been no analysis to demonstrate that this configuration will prevent freezing and eventual failure of the piping compromising the required volume of water in the fire storage tank, nor were there any records that the gauge had been tested or calibrated. Also, the fire water storage tank does not have a low level water alarm that meets the requirements of NFPA 22; e.g., the alarm and transmitting device are not hardwired or supervised, and do not provide a distinct fire alarm indicating a low water signal. Additionally, the currently installed low level alarm system is not discussed in the facility FHA or facility FPP documents. (See **Finding F-NSTec-1**) Finally, the fire water storage tank pressure transducer, wiring, and battery

power supply supporting the altitude valve are not classified as SC, nor was there any documentation to demonstrate that the equipment is adequately maintained. (See **OFI-NSTec-16**)

DAF Fire Supply System

The FSS is an active engineered control that mitigates the consequences of numerous postulated fire scenarios throughout the DAF. As a mitigative control, the FSS ensures that given a fire, the magnitude of the fire is greatly reduced to the extent that it prevents a high explosive violent reaction event, rupture of containers of radioactive material, significant barrier damage, damage to other safety systems, and also mitigates the consequences from a radioactive material release.

Flaking of the coal-tar epoxy that lines the steel lead-in piping has been observed at the DAF for many years. The coal-tar epoxy flaking problem was discovered during an NFPA required acceptance test of the installed piping, and was confirmed by a comprehensive flushing study and remote video camera inspection of the internal surfaces of affected lead-in piping. NSTec had a study performed to analyze the status and conditions for the DAF lead-in piping and to provide recommendations. This condition was determined to be the result of the welding process during initial construction that caused delamination of the coating in the vicinity of each welded joint. These liberated coal-tar flakes pose a clogging hazard to the sprinkler system served by each lead-in. Because of this condition, in-line strainers have been installed in each riser and periodic flushing of lead-in piping is conducted to reduce the potential of sprinkler clogging.

A reliability analysis, *Fire Suppression Reliability Analysis,* was completed in 2008 for the FSS. The report provides analysis and documentation of the operational reliability of the DAF FSS. EA reviewed this report and determined that several recommendations from this analysis have not been implemented: (See **OFI-NSTec-18**)

- For the DAF support buildings that are not seismically qualified, it is expected that the FSS lines to these buildings will rupture upon failure of these structures. Seismically (or motion) actuated valves should be installed on the post indicator valves (PIVs) to these buildings and other areas that are susceptible to seismic damage.
- To further reduce the damage caused by leaving valves closed after testing or maintenance activities, all PIVs and feed-in lines from the tank should be remotely monitored by independently trained, qualified personnel. Because of the potential single failures associated with the delivery of water supply from the fire water supply tank, including the closure or failure of valves in the supply line, the normally closed valve between the CP-9 supply line to the storage tank and the fire water cross-tie should be replaced by a remotely operated valve that could be opened in case the water supply from the storage tank fails. This will slightly add to the overall system reliability by eliminating single failures within this water supply tank/line.
- Considering the latest results about the degraded condition of the lead-in piping to DAF buildings, a program should be implemented that is geared to continuously and remotely monitor the level and make-up water to the DAF tank.

EA identified an additional concern with the fire water supply regarding compliance with the requirements of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. The DAF DSA does not evaluate the failure and subsequent effects of the altitude valve, FSS-ALTV-205-1, for the underground fire water supply system. The valve is not described as one of the SC boundaries for the FSS nor maintained in accordance with NFPA 25, section 9.5, requirements. (See **Finding F-NSTec-2**) Also, the mechanical boundaries for the FSS water supply including isolation valves have not been analyzed for failure and subsequent effects. These valves are not adequately controlled in the field to prevent inadvertent operation. (See **OFI-NSTec-19**)

Configuration Management

EA identified various inconsistencies, omissions, and outdated information in the facility's configuration management plan that could compromise the integrity of the safety basis and safety controls; specifically, the configuration management for the exterior SC FSS perimeter loop needs improvement. Examples include:

- The underground SC FSS drawings have not been updated to ensure that valve and air vent locations are accurate and appropriately labeled. The latest drawing is dated February 1999. NSTec is contracting for these drawing to be updated, with work expected to begin in January 2016.
- The boundaries of the SC FSS are not clear. For example, DSA figure 2-47, *NNSS Water Supply Connections to the DAF*, does not reflect the actual SC FSS boundaries, nor match the DAF FHA or system design document. The SC boundary as depicted on figure 2-47 is shown as the system side flange on the PIV (ref. SCV-205-1), but this boundary does not include the altitude valve, bypass piping and associated valves.
- A 12-inch SS FSS gate valve that provides a cross-connect between the storage tank fill and supply lines is normally closed. This valve, when opened, could supply the DAF perimeter loop directly from the fill piping should the fire water storage tank be rendered out of service, but this information is not documented.
- There is no documentation to support the fire water storage tank pressure transducer, wiring, and battery power supply supporting the altitude valve. This non-credited instrumentation is connected to the SC fire water storage tank.

On November 10, 2013, the DAF FSS was rendered inoperable because of a pipe failure in the FSS underground supply piping. Corrective actions for the occurrence report (ref. ORPS NA-NVSO-NST-NTS-2013-0011- tank drain) and subsequent lessons learned have not addressed all of the specific actions such as implementing a plan to isolate leaks and potential pipe failures. The exterior piping system drawing has not been updated since 1999. A mitigation plan to address one of the several recommendations has been initiated but not completed. (See **OFI-NSTec-20**)

5.4 FHA/DSA Integration

Criteria:
Within the scope of the review, the FHA conclusions shall be incorporated into the safety authorization (preliminary safety design review, preliminary DSA, or DSA, as appropriate) and demonstrate the adequacy of controls provided by the system to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the controls and controlling their use. (DOE Order 420.1C, DOE-STD-1066-2012)

The safety authorization basis is consistent with the fire hazards analysis; demonstrates the adequacy of controls provided by the system to eliminate, limit, or mitigate identified hazards; and defines the processes for maintaining the controls current at all times and controlling their use. (DOE Order 420.1C, DOE-STD-1066-2012)

Overall, the FHAs for the DAF and U1a (ref. FHA-U1a.001 and DAF-RPT-35) comprehensively and qualitatively described facility operations, identified the fire hazards, assessed the risk from fire within individual fire areas in the facility, concisely described building construction, and the conclusions are incorporated into the nuclear facility safety authorization basis documents. However, EA identified several deficiencies associated with the FSS design requirements that were omitted in the FHA and

inconsistencies with supporting documentation.
EA identified initial project design requirements that were not implemented for the DAF FSS, specifically the requirements addressing secondary water supplies. The DAF DSA section 2.7.1.3, *Fire Suppression System*, states that "the water-based fire suppression system was designed in accordance with DOE Order 6430.1, *General Design Criteria Manual*, and DOE Order 5480.7, *Fire Protection*." The FHA also references these orders but does not identify the requirement for or exemption to a redundant water supply. DOE Order 6430.1A requires redundant water supplies based on the maximum permissible financial loss value of the facility, as evaluated per DOE Order 5480.7A, section 9.b(8). This requirement for DAF had not been implemented. (See **Finding F-NSTec-3**)

Additionally, EA identified other inconsistencies with supporting documentation associated with the risk of a single loop design. For example, the DAF FSS reliability analysis completed in 2008 states, "an SC FSS should have a redundant loop, but the DAF FSS has only a single loop, which is an inherent vulnerability." However, the DAF DSA, Table 3C-0-3, *Safety SSC Vulnerabilities*, identifies the vulnerability risk associated with a single water source but concluded that there was no effect on the process hazards analysis. (See **OFI-NSTec-18**)

5.5 TSR Surveillance and Testing and ITM

Criteria:
Surveillance and testing of the system demonstrates that the system is capable of accomplishing its safety functions and continues to meet applicable system requirements and performance criteria. (DOE-STD-1066-2012, DOE-STD-3009-94, DOE-STD-3011-94)

Surveillance and test procedures confirm that key operating parameters for the overall system and its major components remain within safety basis, NFPA, and applicable consensus standards operating limits. (DOE-STD-1066-2012, DOE-STD-3009-94, DOE-STD-3011-94)

The acceptance criteria from the surveillance tests used to confirm system operability are consistent with the safety basis. (DOE-STD-1066-2012, DOE-STD-3009-94, DOE-STD-3011-94)

Instrumentation and test equipment for the system are calibrated and maintained. (DOE-STD-1066-2012, DOE-STD-3009-94, DOE-STD-3011-94)

Technical Bases and Controls for the FSS

EA evaluated the FSS and the associated surveillance and testing documents to ensure that the system is capable of accomplishing its safety functions as described in the safety basis. TSR surveillance testing for the DAF fire protection safety system confirms that key operating parameters for the system and its components are capable of accomplishing their safety functions, and that the performance of credited controls was in accordance with applicable system requirements, standards, and performance criteria. EA observed in most cases that applicable ITM provisions of NFPA code requirements were appropriately integrated into the facility TSR surveillance testing procedures, and the TSRs were developed such that FSS systems and components credited to perform a safety function were tested and inspected on an acceptable periodic basis.

EA identified that in some cases required ITM for the FSS was not being completed. The DAF DSA section 4.3.4.2 identifies the altitude valve (ref. ALTV-205-1) as the boundary between the SC water system and the non-safety make-up system, but it is not being maintained in accordance with NFPA 25, section 9.5, requirements. (See **Finding F-NSTec-4**) EA also reviewed the completed annual valve inspection report and identified the following concerns:

- The PIV valve (ref. SCV-205-1) on the supply side to the fire water storage tank, as well as the SC altitude valve and respective by-pass valves, were not included on this inspection. The cognizant system engineer and the utilities department did not know who was responsible for maintaining this equipment.
- The SC altitude valve and the tank pressure transducer, wiring, and battery power supply supporting the altitude valve are not maintained in accordance with NFPA 25, section 9.5, and NFPA 70, *National Electrical Code*. NSTec could not produce any documentation supporting the design, installation or maintenance of these SSCs.

EA also identified two weaknesses associated with several surveillance requirements (SRs). First, the TSRs (ref. DAF-TSR-01, *Device Assembly Facility Technical Safety Requirements,* and CEF-TSR-01, *Nevada Test Site Criticality Experiments Facility Technical Safety Requirements*) require an open flow path and unobstructed flow path for the FSS. SR 4.4.4 requires that a main drain test be performed on an annual basis to demonstrate the unobstructed flow path. An acceptance criterion requires the water pressure on the supply gauge to return within one second to original static pressure once the main drive valve is closed. The SR basis discusses that the time to return to static conditions needs to be comparable between tests, but the technical basis is not clear for establishing a predetermined time frame to restore pressure. Second, EA observed an annual system flush surveillance (ref. Fire Suppression System Flush Verification Surveillance) that was performed using the SOP-DAF-SP22 to verify completion of SR 4.4.6 and SR 4.8.7. The acceptance criteria associated with the annual system flush SRs require that material collected in a five-minute flush to be less than or equal to 20 grams of debris. Report DAF-RPT-55 covers the technical basis for these acceptance criteria but is not documented in the DSA. (See **OFI-NSTec-21**)

5.6 Fire Protection Self-Assessment Program

Criteria:
A documented comprehensive self-assessment of the fire protection program is performed by the DOE site office and the facility contractor at least every 3 years, or at a frequency with appropriate justification approved by the DOE head of field element. (DOE Order 420.1C)

Proper controls are incorporated to prioritize and monitor the status of the fire protection assessments and associated findings until final resolution. [DOE Order 420.1C, Chapter II, 3.b.(14)]

Processes are developed and implemented that prioritizes and monitors the status of fire protection assessment findings, recommendations, and corrective actions until final resolution. [(DOE Order 420.1C, CRD, Chapter II, 3.b.(15)]

Program issues identified during previous assessments or program reviews have been appropriately resolved, corrective actions have been completed, and are adequate, or a clear path to completion is indicated. (DOE Order 226.1B)

NSTec recently completed FPP self-assessment MA-14-EN22-003, *Management Assessment Report,* in January 2015. Requirements for performing programmatic self-assessments of the FPP are provided in CD-2120.017, *National Security Technologies, LLC Fire Protection Program*. Section 4.16.2 of this document requires fire protection engineering to ensure that FPP programmatic self-assessments are performed every three years using criteria from DOE-STD-1066-2012, section 3.2, *Program Self-Assessments*, and supplemental checklist FRM-2359, *Programmatic Fire Safety Assessment Checklist*.

NSTec has an established issues management tracking system (ref. CCD-QA03.001, *Issues Management*) that provides a consistent approach for issues management related to fire protection, as well as the

development, documentation, maintenance, and monitoring of a comprehensive, structured quality improvement program (PD-0001.002, *Quality Assurance Program*) for continual improvement of the FPP. Elements of the quality improvement program include issue identification, evaluation, investigation, analysis, data entry, tracking via the caWeb database, corrective actions, and post-closure activities for findings/recommendations, OFIs and any noncompliances regarding fire protection and life safety matters. The NSTec issues management program also includes unclassified data entry into caWeb for issues owned by DOE, NNSA/NFO, and other non-NSTec contractors. NNSA/NFO completed a triennial assessment of the NSTec FPP in April 2014 that identified NSTec was not performing documented comprehensive FPP self-assessments every three years (F-NSTec-FPP-14-07) as required by DOE Order 420.1 and the NSTec FPP. EA confirmed this issue was in the caWeb tracking system, which identified the corrective action as "closed" with reference to NSTec's self-assessment MA-14-EN22-003, *Management Assessment Report*; EA considers the closure appropriate.

5.7 DOE Oversight

Criteria:
DOE field element line management has established and implemented oversight processes that evaluate contractor and DOE programs and management systems, including site assurance systems, for effectiveness of performance (including compliance with requirements). [DOE Order 226.1B 4b.(1)]

DOE field element line oversight program includes written plans and schedules for planned assessments, focus areas for operational oversight, and reviews of the contractor's self-assessment of processes and systems. [DOE Order 226.1B 4b (2)]

Oversight processes are tailored according to the effectiveness of the laboratory assurance systems, the hazards at the site/activity, and the degree of risk, giving additional emphasis to potentially high consequence activities. [DOE Order 226.1.B 4b.(5)]

DOE field element staff are adequately trained and qualified to perform assigned oversight activities. (DOE Order 226.1B, DOE Order 360.1C, and DOE Order 426.1 Chg. 1)

EA reviewed NFO oversight related to the NSTec FPP. NFO performs line management oversight of the FPP and fire protection safety systems in accordance with NFO Order 226.X, *Line Oversight Program*, and NFO Order 420.X, *Fire Protection Program*. NFO has established a safety system oversight (SSO) program as defined in DOE Order 426.1, *Federal Technical Capability*, for qualifying staff to apply expertise in their oversight of assigned safety systems and safety management programs. NSO Order 426.XB, *Safety System Oversight Program*, identifies the roles and responsibilities for SSO personnel and associated management and also establishes the program requirements related to the oversight of safety systems and programs. NFO Order 226.X also assigns responsibilities for SSO personnel to monitor assigned facilities and systems and provide input to line management.

NFO has a trained and qualified FPE in accordance with NFO Order 426.1A, *Technical Qualification Program Plan*, and the *Safety System Oversight Representative (SSOR) Qualification Standard*. EA reviewed the qualification cards and training records for the primary and backup SSORs for the fire protection systems and FPP to verify compliance with requirements. The FPE meets the requirements and is technically competent, but does not have an NFO backup trained and qualified in fire protection. NFO acknowledged this SSO program weakness, which was challenged further at the end of 2014 with the retirement of one of its four SSORs. NFO is currently qualifying a new SSOR. (See **OFI-NFO-1**)

The Assistant Manager for Safety and Security is responsible for the schedule and performance of triennial self-assessments of the contractor FPPs and NNSS Fire and Rescue operations. NFO performs

periodic functional area reviews of the NSTec FPP and fire protection systems scheduled in accordance with its annual assessment implementation plan. Requirements for performing NNSA/NFO triennial assessments of the contractor FPP are documented in NFO Order 420.X, *Fire Protection Program*, section 4.d (2). NFO/NNSA recently completed FPP assessments in September 2013 and April 2014 to satisfy the triennial self-assessment requirement for DOE Order 420.1B. NNSA Headquarters provided a senior FPE, who provided additional expertise and technical competence to augment the NFO FPE, to participate in the assessments. Overall, this two-part assessment was comprehensive and identified 9 findings and five OFIs. NFO/NNSA also completed a scheduled assessment of the DAF wet-pipe FSS in December 2014. NFO is scheduled to perform a joint NFO/NSTec FPP assessment of NSTec's off-site facility at Lawrence Livermore National Laboratory later this year. Overall, NFO oversight for fire protection and its management of issues such as inspections of fire water storage tanks and resolution of deficiencies in facility fire safety assessments is generally adequate.

6.0 CONCLUSIONS

The FPP implemented at NNSS is adequately meeting DOE objectives for minimizing the potential for a fire or related event that could cause unacceptable onsite or offsite release of hazardous or radiological material, property loss, or damage of critical process controls. NSTec FPEs and staff are qualified, knowledgeable and actively engaged in evaluating and maintaining facility fire systems and supporting the FPP. The two fire stations at NNSS are appropriately staffed and equipped to respond to the emergency events described in the safety basis, in the facility FHAs, and as evaluated in the BNA, with the exception of meeting DOE's expected response times because of the vast size of the reservation. EA considered the fire extinguisher maintenance and refurbishment shop at Fire Station 1 as a best practice.

EA identified some weaknesses with the NSTec FPP, many of which were also self-identified by NSTec. Many of these weaknesses present vulnerabilities to DOE worker safety and are primarily associated with incomplete FPP description documents, the exemption and equivalency process, diesel powered equipment and dry chemical fire suppression systems at the U1a Complex underground, and lack of baseline standards and controls for managing combustible material. In addition, like many sites across the DOE complex, NNSS has aging infrastructure and component degradation issues that challenge the reliability and adequacy of the fire water supplies. Areas for improvements were noted for maintaining the SC FSS and addressing the vulnerabilities with the single source fire water supply at the DAF. Contributing to theses vulnerabilities are concerns related to controls and operability requirements necessary to ensure a minimum available fire water supply and static pressure. Project work to address many of these vulnerabilities, specifically for the fire water lead-in lines, was ongoing and being monitored by knowledgeable FPEs and CSEs.

The NFO oversight process adequately conforms to DOE Order 226.1B expectations. The NFO line oversight program includes written plans and schedules for planned assessments, focus areas for operational oversight, and reviews of the contractor's self-assessment of processes and systems. For fire protection, NFO has been adequately performing triennial self-assessments and functional area reviews.

7.0 FINDINGS

As defined in DOE Order 227.1, *Independent Oversight Program*, findings are significant deficiencies or safety issues that warrant a high level of attention from management. If left uncorrected, findings could adversely affect the DOE mission, the environment, the safety or health of workers and the public, or national security. Findings may identify aspects of a program that do not meet the intent of DOE policy or Federal regulation. DOE line management and/or contractor organizations must develop and

implement corrective action plans for EA appraisal findings. Cognizant DOE managers must use site- and program-specific issues management processes and systems developed in accordance with DOE Order 227.1 to manage these corrective action plans and track them to completion.

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F-NSTec-1: NSTec did not comply with the requirements of NFPA 22, *Water Tanks for Private Fire Protection*, (invoked by DOE Order 420.1C and DOE-STD-1066-2012) that require exposed piping subject to freezing and a low level water gauge be located to prevent freezing.

F-NSTec-2: NSTec did not comply with the requirements of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, (invoked by DOE Order 420.1C and DOE-STD-1066-2012) to evaluate in the DAF DSA the failure and subsequent effects of the altitude valve FSS-ALTV-205-1 for the underground fire water supply system.

F-NSTec-3: NSTec did not adequately implement design requirements for the DAF FSS redundant water supply as described in the DAF DSA section 2.7.1.3, *Fire Suppression System*, to comply with DOE Orders 5480.7, *Fire Protection*, and 6430.1, *General Design Criteria Manual*. The FHA also references these orders but does not identify the requirement or exemption to a redundant water supply based on the maximum permissible financial loss value of the facility.

F-NSTec-4: NSTec did not complete required ITM for the DAF FSS in accordance with NFPA 25 and 72 requirements (invoked by DOE Order 420.1C and DOE-STD-1066-2012).

8.0 OPPORTUNITIES FOR IMPROVEMENT

This EA review identified 21 opportunities for improvement (OFIs). These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are suggestions offered by the EA review team that may assist site management in implementing best practices, or provide potential solutions to minor issues identified during the conduct of the review. In some cases, OFIs address areas where program or process improvements can be achieved through minimal effort. It is expected that the responsible line management organizations will evaluate these OFIs and accept, reject, or modify them as appropriate, in accordance with site-specific program objectives and priorities.

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OFI-NSTec-1: Consider identifying and documenting critical characteristics of SC and SS systems, and their support systems, in FPP description documents and in a configuration-controlled system design document. For example, PD P200.002, *NNSS Underground Facility Safety and Health Program Description*, and PLN-U1a.001, *U1a Complex Fire Protection Program*, could address the non-SC/SS dry chemical FSSs installed on diesel powered equipment used in the underground as stated in DOE Order 420.1C, DOE-STD-1066-2012 and NFPA 122.

OFI-NSTec-2: Consider formally documenting and requesting DOE approval for fire safety program vulnerabilities identified in PLN-U1a.001, *U1a Complex Fire Protection Program*, especially for life safety requirements.

OFI-NSTec-3: Consider improving the DAF pre-incident plans to add additional information that could be of value to emergency response groups; i.e., primarily the non-compliant low level fire water tank

monitoring and associated alarm reporting features. NFPA 1620, *Standard for Pre-Incident Planning*, requires pre-incident strategies and plans to be established to enhance the effectiveness of manual firefighting efforts.

OFI-NSTec-4: Consider correcting the title of CD-P280.030 to *Compressed Gas Cylinders* rather than *Hot Work*, as referenced in DAF-PLN-SF-08, *Device Assembly Facility Fire Protection Program.*

OFI-NSTec-5: Consider re-evaluating the hot work program to ensure adequate flow down into all FPP documents and ensure requirements for drop down exhaust ventilation equipment are appropriately addressed.

OFI-NSTec-6: Consider protection for exterior fire extinguishers at the U1a surface area buildings that are exposed to environmental elements; i.e., direct sunlight/ultraviolet radiation.

OFI-NSTec-7: Consider installing adequate and continuous face lighting for photoluminescent exit signs installed on walls and on mobile stanchions in several areas of the underground, in accordance with NFPA 101, *Life Safety Code*, requirements.

OFI-NSTec-8: Consider updating the U1a FHA, section 8.5.4, to address areas that do not fully comply with NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities.*

OFI-NSTec-9: Consider updating the DAF FHA, specifically section 5.8, to describe the low water level tank alarm installed on the 250,000 gallon fire water storage tank, and to provide a complete description of the facility fire alarm system(s).

OFI-NSTec-10: Consider updating the DAF FHA, specifically section 6.7, to provide requirements for the ITM of emergency lighting and exit signs to ensure these systems operate as designed and perform as required in DAF-DSA-01, section 4.4.3.

OFI-NSTec-11: Consider updating the DAF FHA to adequately describe the attributes of the FSS SSCs and their respective boundaries in accordance with the guidance of DOE-STD-1066-2012, Appendix B.

OFI-NSTec-12: Consider updating calculation CAL-S-001 to address the permitted manufacturer's fabrication tolerance in determining the seismic loading acceptability for the lead-in piping and demonstrate the ability of this piping to withstand PC-3 loading.

OFI-NSTec-13: Consider updating DAF-JCO-09-01, which concludes that the as-is FSS, including an inoperable FSS in operational buildings combined with a continuous fire watch, is acceptable during a postulated seismically induced fire. For this accident scenario, the seismic PC-3 qualification for the credited preventive controls (i.e., that the structure and structure appurtenances stay in place) is not complete, and a fire watch would be ineffective if the structure failed.

OFI-NSTec-14: Consider developing an action plan to address long-standing seismic non-compliance issues at DAF; e.g., the water storage tank is not seismic PC-3 qualified as required, the altitude valve is not qualified to seismic PC-3 criteria, and the SC portions of the FSS are not isolated from defense in depth and non-safety system areas and are not provided with an alternate SC water supply.

OFI-NSTec-15: Consider updating CWCS analyses supporting the DAF safety basis to fully comply with the requirements of NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials.* Consider addressing the following problems:

- The receiver tank is inadequately sized to receive potentially radioactive water from deluge system activation from building cells.
- Shower drains connecting directly from the CWCS piping to the receiver tank introduce a potential bypass flow path to buildings for contaminated water and gaseous vapors.

OFI-NSTec-16: Regarding the 2010 water tank inspection, consider blasting and painting the interior of the tank within the next 2 years to prevent the formation of deep pits and metal loss on the roof rafters; also consider installing a cathodic protection system to prolong the life of any new coating, allowing for a 5-year inspection under current NFPA 25 requirements.

OFI-NSTec-17: Consider reclassifying as SC the DAF fire water storage tank pressure transducer, wiring, and battery power supply supporting the altitude valve, and demonstrate that these support components are adequately maintained.

OFI-NSTec-18: Consider implementing the recommendations from the 2008 reliability analysis, *Fire Suppression Reliability Analysis*, for the DAF FSS.

OFI-NSTec-19: Consider analyzing the mechanical boundaries of the DAF FSS for failure and subsequent effects, including isolation valves adequately controlling these valves in the field to prevent inadvertent operation.

OFI-NSTec-20: Consider addressing remaining corrective actions to isolate DAF FSS leaks and potential pipe failures based on the November 2013 pipe failure occurrence report and subsequent lessons learned. The exterior piping system drawing should be updated and the mitigation plan that has been initiated should be completed.

OFI-NSTec-21: Consider updating the DAF FSS technical bases to support the SR 4.4.4 acceptance criteria that the time required for the water pressure on the supply gauge to return to original static pressure once the main drain valve is closed is no greater than one second, and also the SR 4.4.6 and SR 4.8.7 acceptance criteria that material collected in a five-minute flush is less than or equal to 20 grams.

Nevada Field Office

OFI-NFO-1: Consider additional training and qualification for backup SSORs for fire protection and other functional areas to better enhance and sustain the SSO program over the long term.

9.0 ITEMS FOR FOLLOW-UP

EA may include the project related work supporting the replacement to the fire water lead-in lines at DAF as part of a follow on assessment. EA will monitor corrective actions and follow-up responses through operational awareness activities.

Appendix A
Supplemental Information

Dates of Review

Onsite Review: April 13 – 16, 2015
Data Gathering and Observation Review: May 11–14, 2015

Office of Enterprise Assessments (EA) Management

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Director, Office of Nuclear Safety and Environmental Assessments
Patricia Williams, Director, Office of Worker Safety and Health Assessments

Quality Review Board

William A. Eckroade
Thomas R. Staker
John S. Boulden, III
William E. Miller
Michael A. Kilpatrick

EA Site Lead for Nevada National Security Site

William A. Macon, Jr.

EA Reviewers

William A. Macon, Jr. – Lead
Joe J. Panchison
Jeffrey L. Robinson
Barry L. Snook
Peter M. Turcic

Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

- AMSS-RPT-2013-014, *NNSS/NFO Fire Protection Program Assessment for the National Security Technologies, LLC's Nevada National Security Site Facilities*, September 2013
- AMSS-RPT-2014-006, *NNSS/NFO Fire Protection Program Assessment for the National Security Technologies, LLC's Facilities*, April 2014
- AMSS-RPT-2015-001, *NNSS/NFO Assessment Report for the Device Assembly Facility Wet-Pipe Fire Suppression System*, December 2014
- MA-14-EN22-003, *Management Assessment Report*, January 27, 2015
- NFO *FY2015 Assessment Implementation Plan*, 9/30/2014
- NFO O 420.X, Rev. 0, *Fire Protection Program*, 6/10/14
- NFO Order 226.X, Rev. 0, *Line Oversight Program*, 5/20/2013
- NFO Order 420.X, Rev. 0, *Fire Protection Program*, 6/10/2014
- NFO Order 426.XB, *Safety System Oversight Program*, 2/14/2011
- CCD-QA03.001, Rev. 6, *Issues Management*, January 1, 2014
- CD-EN22.001, Rev. 1, *Facility Fire Protection Assessments*, May 4, 2015
- CD-EN22.002, Rev. 0, *Fire Hazards Analysis*, August 11, 2014
- CD-2120.017, Rev. 3, *National Security Technologies, LLC Fire Protection Program*, August 29, 2014
- CD-2120.018, Rev. 2, *Portable Fire Extinguishers - Monthly Visual Inspections*, September 16, 2013
- CD-P280.028, Rev. 1, *Housekeeping and Fire Protection*, August 30, 2011
- CD-P280.030, Rev.2, *Hot Work*, June 30, 2001
- PLN-SF-08, Rev. 7, *Device Assembly Facility Fire Protection Program*, 4/14/2014
- PLN-U1a.001, Rev. 1, *U1a Complex Fire Protection Program*, 11/20/2014
- PD-P200.002, Rev. 0, *NNSS Underground Facility Safety and Health Program Description*, October 15, 2013
- OP-2120.040, Rev. 2, *Fire and Rescue Training*, April 2, 2014
- OP-2120.041, Rev. 2, *Fire and Rescue Pre-Incident Planning Process*, January 27, 2014
- OP-2120.067, Rev. 1, *Control of Fire Water Runoff*, April 1, 2013
- OP-2120.075, Rev. 2, *Fire Prevention Inspections*, October 14, 2013
- OP-U1a.044, Rev. 5, *U1a Complex Flammable and Combustible Materials Control (SBI)*, 01/09/2014
- OP-U1a.050, Rev. 1, *U1a Complex Roving Fire Monitor*, 08/19/14
- DAF-SDD-FSS, Rev. 0, *Device Assembly Facility System Design Description Fire Suppression System*, September 2011
- DAF-RPT-35, Rev. 6, *Fire Hazards Analysis for the Device Assembly Facility at the Nevada National Security Site*, February 7, 2013
- FHA-U1a.001, Rev. 0, *Fire Hazards Analysis for the U1a Complex*, May 2014
- PY-M610.001, Rev. 0, *Fire Protection Policy*, August 6, 2014
- PEP-DESS-1020, *NSTec Underground Safety and Health Project Execution Plan*
- U1a-FPA-01, Rev. 0, *U1a Complex Fire Protection Assessment*, February 2015
- U1a-SCE-DSA-001, Rev. 0, *U1a Complex Subcritical Experiments Documented Safety Analysis*, January 2012
- U1a-SCE-TSR-001, Rev. 0, *U1a Complex Subcritical Experiments Technical Safety Requirements*, January 2012
- U1a-COMPLEX-EPIP-01, Rev. 3, *Facility Emergency Response Actions*, June 20, 2011

- U1a-COMPLEX-EPIP-06, Rev. 3, *Underground Rescue*, 1/15/2013
- 01119-RPT-1, *U1a Complex Ventilation Plan*
- *Approval of the Request for Permanent Exemption from the Fire Protection Requirements Designated in DOE O 420.1B and DOE-STD-1066-99 for the U1a Complex in Area 1 of the Nevada National Security Site*, November 06, 2012
- AMSS-RPT-2013-014, *NNSS/NFO Fire Protection Program Assessment for the National Security Technologies, LLC's Nevada National Security Site Facilities*, September 2013
- AMSS-RPT-2014-006, *NNSS/NFO Fire Protection Program Assessment for the National Security Technologies, LLC's Facilities*, April 2014
- AMSS-RPT-2015-001, *NNSS/NFO Assessment Report for the Device Assembly Facility Wet-Pipe Fire Suppression System*, December 2014
- NFO *FY2015 Assessment Implementation Plan*, 9/30/2014
- NFO Order 226.X, Rev. 0, *Line Oversight Program*, 5/20/2013
- NFO Order 420.X, Rev. 0, *Fire Protection Program*, 6/10/2014
- NFO Order 426.XB, *Safety System Oversight Program*, 2/14/2011
- Fire Suppression Reliability Analysis, November 18, 2008
- CEF-TSR-01 *Nevada Test Site Criticality Experiments Facility Technical Safety Requirements*, Rev 1, April 2009

Interviews

- NFO SSORs (2)
- NFO FRs (2)
- Fire Chief
- Fire Marshal
- ITM Alarms
- DAF Facility Representative
- Nuclear Operations Directorate, FP SME
- Safety Basis Engineer
- Project Engineer
- NSTec CAS Representative
- Fire Protection AHJ/FPP POC
- FPWG Facilitator, Metrics
- IT&M Sprinklers
- Utilities Superintendent
- DAF ITM
- U1a Support Supervisor/Backup CSE
- U1a Facility Representative
- DOE FP Facility Representative

Observations

- Emergency Response Table Top Exercise
- U1a Hot Work activities
- Issues Management caWeb Tracking System
- Monthly Inspection of Portable Fire Extinguishers
- U1a Complex Tour (2)
- DAF Facility Tour