Office of Enterprise Assessments
Assessment of the
Idaho National Laboratory
Criticality Safety Controls Implementation

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Acronyms

ANS	American Nuclear Society
ANSI	American National Standards Institute
ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance, LLC
CCA	Criticality Control Area
CFR	Code of Federal Regulations
CRAD	Criteria and Review Approach Document
CSE	Criticality Safety Evaluation
CSO	Criticality Safety Officer
CSP	Criticality Safety Program
DCP	Double Contingency Principle
DOE	U.S. Department of Energy
DOE-ID	Idaho Operations Office
EA	DOE Office of Enterprise Assessments
EM	DOE Office of Environmental Management
FCF	Fuel Conditioning Facility
FMF	Fuel Manufacturing Facility
FR	Facility Representative
HFEF	Hot Fuel Examination Facility
ICP	Idaho Cleanup Project
INL	Idaho National Laboratory
LRD	Laboratory Requirements Document
LWP	Laboratory-Wide Procedure
MCP	Management Control Procedure
MTG	Material Tracking System
NE	DOE Office of Nuclear Energy
NMIS	Nuclear Material Inspection and Storage
RSWF	Radioactive Scrap and Waste Facility
SAC	Specific Administrative Control
SAR	Safety Analysis Report
SME	Subject Matter Expert
SNM	Special Nuclear Material
TEV	Technical Evaluation
TSR	Technical Safety Requirement

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), assessed the implementation of criticality safety controls at the Idaho National Laboratory (INL). The purpose of this EA assessment was to evaluate the effectiveness of the laboratory contractor, Battelle Energy Alliance, LLC (BEA), in implementing the DOE-approved facility criticality safety program and criticality safety controls that are selected to provide preventive and/or mitigative functions for a potential criticality accident. DOE Idaho Operations Office (DOE-ID) oversight of criticality safety was also evaluated. This assessment focused on implementation at the Fuel Conditioning Facility, the Fuel Manufacturing Facility, and the Nuclear Material Inspection and Storage Facility. EA performed this assessment from September 10 through September 20, 2018.

EA's observations of multiple activities at the INL facilities showed effective implementation of the criticality safety program. BEA adequately establishes limits and controls that ensure conservative safety margins for fissionable material activities. Criticality safety engineers have a diverse background in criticality safety and a broad understanding of fissionable material activities at INL. The reviewed facility-specific samples of criticality safety limits and controls were appropriately simplified to allow straightforward implementation by the facility operators. The use of criticality safety officers to interface between the operations and criticality safety organizations ensures timely evaluation of changes in fissionable material activities, thorough identification of limits and controls, and close monitoring of implementation of criticality safety requirements. BEA adequately identifies and addresses issues related to criticality safety.

DOE-ID maintains sufficient knowledge of criticality safety activities to make informed decisions about risk. DOE-ID adequately implements its oversight processes for criticality safety, and effectively evaluates contractor performance.

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1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), assessed the implementation of criticality safety controls at the Idaho National Laboratory (INL). The purpose of this EA assessment was to evaluate the effectiveness of Battelle Energy Alliance, LLC (BEA), in implementing the DOE-approved facility criticality safety program (CSP) and criticality safety controls that are selected to provide preventive and/or mitigative functions for a potential criticality accident.

EA performed this assessment at INL from September 10 through September 20, 2018.

2.0 SCOPE

EA assessed the effectiveness of the CSP and the implementation of selected criticality safety controls at the Fuel Conditioning Facility (FCF), the Fuel Manufacturing Facility (FMF), and the Nuclear Material Inspection and Storage (NMIS) Facility. EA also reviewed the DOE Idaho Operations Office (DOE-ID) processes for criticality safety oversight. This review scope was in accordance with the *Plan for the Office of Enterprise Assessments Assessment of Criticality Safety Controls Implementation at the Idaho National Laboratory Site, September 2018*.

3.0 BACKGROUND

The Idaho Site includes INL and the Idaho Cleanup Project (ICP) Core. DOE-ID provides direction and oversight for the design and operation of the Idaho Site nuclear facilities for the DOE Offices of Nuclear Energy (NE) and Environmental Management (EM). NE is responsible for INL facilities and general laboratory operations, and EM is responsible for ICP Core facilities. BEA is the operating contractor for INL and is responsible for the management and operation of its facilities.

DOE-ID oversees BEA and is responsible for administering the contract, executing assigned DOE programs, and conducting oversight of work performed at INL in support of DOE and NE requirements and priorities. INL's mission is to lead and integrate U.S. nuclear energy research, development, demonstration, and deployment efforts, and to ensure the nation's energy security with safe, competitive, and sustainable energy systems and unique national and homeland security capabilities. INL includes 15 nuclear facilities and 19 radiological facilities that contain fissionable material. This assessment focused on three of the nuclear facilities. BEA maintains 1 CSP that is applicable to all 34 facilities. Much of the work involving fissionable material at INL is experimental, so the CSP must take into account the need for frequent changes in processes involving fissionable material.

NMIS, located in the Advanced Test Reactor (ATR) Complex, primarily stores new fuel for ATR and irradiated fuel reading less than 200 mR/h on contact. The fuel is stored in metal and wooden racks inside the vault. Some additional fissionable material may be appropriately stored either in the vault or in the staging area inside the secured building.

FMF, located in the Materials and Fuels Complex, includes a material storage vault that contains a variety of fissionable material stored in racks, drums, and other packages. It also has several gloveboxes for experimental work.

FCF, also located in the Materials and Fuels Complex, is a shielded hot cell facility with an air-atmosphere hot cell and an argon-atmosphere hot cell. The primary mission at FCF is processing used sodium-bonded metal driver and blanket fuel from Experimental Breeder Reactor-II to separate the uranium from fission products and other components of the fuel.

4.0 METHODOLOGY

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

As identified in the assessment plan, this assessment considered requirements related to criticality safety listed in 10 CFR 830, *Nuclear Safety Management*; DOE Order 420.1C, *Facility Safety*; and American National Standards Institute/American Nuclear Society (ANSI/ANS) Eight Series standards. Key aspects of these requirements are included in the criteria and lines of inquiry within the criteria and review approach documents (CRADs) EA used for this assessment.

EA used the following sections of EA CRAD 31-30, Revision 2, *Criticality Safety Program and Criticality Safety Controls Implementation Criteria and Review Approach Document*, for this assessment:

- CS.1: A fully compliant CSP has been implemented at the site.
- CS.2: Criticality safety controls have supporting criticality safety analysis basis and are sufficiently reliable to ensure that a change in process conditions necessary for a criticality accident is at least "unlikely."
- CS.3: Criticality safety controls are implemented using documented and approved processes, and implementation is effective.

EA also used elements of HSS CRAD 45-21, Revision 1, *Feedback and Continuous Improvement Assessment Criteria and Approach – DOE Field Element*, to collect and analyze data on DOE-ID oversight activities related to the implementation of criticality safety controls.

EA examined key documents, such as criticality safety evaluations (CSEs), work packages, procedures, documented safety analyses, policies, and training and qualification records. EA also conducted interviews with key personnel responsible for developing and implementing criticality safety controls; observed fissionable material handling activities; and walked down criticality control areas (CCAs). The members of the EA assessment team, the Quality Review Board, and EA management responsible for this assessment are listed in Appendix A. A detailed list of the documents reviewed, personnel interviewed, and observations conducted during this assessment, relevant to the findings and conclusions of this report, is provided in Appendix B.

EA has not performed a recent assessment of INL criticality safety controls implementation, so there were no previously-identified items for EA follow-up during this assessment.

5.0 RESULTS

5.1 Criticality Safety Program

This section discusses EA's assessment of BEA's CSP. The objective of this portion of the assessment was to verify that BEA has implemented a fully compliant CSP at INL.

Criteria:

- *BEA has prepared and submitted a CSP description document that has been approved by the Site Office Manager or designee. The CSP description document is current and consistent with the commitments in the applicable documented safety analysis. (DOE Order 420.1C)*
- *BEA has prepared implementing mechanisms for the CSP that meet the requirements of DOE Order 420.1C and the commitments in each facility's documented safety analysis and technical safety requirements. (10 CFR 830; DOE Order 420.1C)*
- *Procedures and mechanisms ensure that nuclear facility operations covered by the CSP are conducted in accordance with CSP implementing mechanisms requirements. (10 CFR 830; DOE Order 420.1C)*
- *Issues identified during previous 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, Implementation of Department of Energy Oversight Policy)*

Criticality Safety Program Documentation

BEA has prepared a CSP description that is captured in Chapter 6 of the INL sitewide safety analysis report (SAR), SAR-400, *INL Standardized SAR*, which has been approved by DOE-ID. The CSP description, along with referenced supporting documentation, adequately meets the requirements of DOE Order 420.1C. The program documentation contains a comprehensive crosswalk of ANSI/ANS Eight Series standards to link the applicable standards with the appropriate CSP requirements. BEA has prepared a series of plans, lists, and procedures that implement the requirements of the CSP to prevent criticality accidents and ensure that the risks from handling fissionable materials are acceptably controlled. EA reviewed a sample of these documents and determined that they adequately describe the requirements and the implementing mechanisms for different elements of the CSP.

Program Requirements for Criticality Safety Evaluations and Control Implementation

The INL CSP, as described in PDD-18200, *INL Criticality Safety Program*, requires that all fissionable material activities be evaluated to identify the limits and controls that will ensure the activities are subcritical under both normal and credible abnormal conditions. CSEs are performed in accordance with Management Control Procedure (MCP)-18202, *Performing Criticality Safety Evaluations*, to evaluate the consequences of criticality accidents and derive criticality safety controls for processes and equipment used in fissionable material handling and storage. MCP-18202 specifies that CSEs be performed in accordance with DOE-STD-3007-2007, *Guidelines for Preparing CSEs at DOE Nonreactor Nuclear*

Facilities. EA reviewed 27 CSEs covering a variety of fissionable material handling activities, including some that were developed more than 30 years ago. Most of the reviewed CSEs were prepared to meet the requirements of DOE-STD-3007-2007. The older CSEs were documented with reference to the formats and requirements in effect at the time of preparation and used a less complex process analysis. Annually, BEA reviews the CSEs that are five years old or older to ensure that the analysis remains valid for the associated fissionable material activity. If BEA identifies significant issues in a CSE documented to an earlier format, the CSE is revised to meet the latest standard specified in the CSP. For the older CSEs included in this assessment, EA verified that BEA had reviewed each of them and ensured that the documents establish an adequate set of limits and controls. All the CSEs that EA reviewed provide recommended limits and controls that are adequate for safe operations, given the conservative safety margins specified in the CSP.

EA determined that implementation of the CSP requirements establishes limits and controls that are appropriately conservative. For example, the CSP recommends that limits determined by computer modeling result in configurations with an effective multiplication factor of no greater than 0.95. In addition, for activities considered safe based solely on a mass limit, the CSP recommends limiting the allowed amount of fissionable material to 75% of the critical mass for the most reactive state. By keeping operations within these limits, BEA establishes acceptable safety margins for fissionable material activities.

EA identified three areas requiring clarification in the requirements crosswalk in Laboratory Requirements Document (LRD)-18001, *INL Criticality Safety Program Requirements Manual*:

- Paragraph 3.4.1.1 does not describe or reference the INL interpretation or implementation strategy concerning process analysis for situations where the activity cannot be shown to be subcritical under credible abnormal conditions.

- Paragraph 3.7.3.7 does not clearly establish the ANSI/ANS 8.7, *Guide for Nuclear Criticality Safety in the Storage of Fissionable Materials,* expectation that storage areas (e.g., vaults) shall have mass limits posted. In addition, it does not describe the INL implementation strategy for storage areas that will not have postings for limits. Despite that shortcoming, in all cases that EA reviewed, procedures provided adequate guidance for determining storage area limits.

- Section 3.2.4 describes an annual review that line management shall perform to ascertain that the limits and controls are effectively implemented and procedures are followed. Section 3.5 describes performance of an annual review by the Criticality Safety Engineering Department that shall be performed, in consultation with Operations, to ascertain that process conditions have not been altered in a way that affects the CSEs. Interviews with criticality safety and facility staff provided various interpretations of how they meet these requirements. LRD-18001 is not clear as to whether the requirements of the two sections may be satisfied with a single annual review or whether two reviews must be conducted separately.

Additionally, the definition of "fissionable material" is not consistent within the CSP documentation. Some documents – e.g., Laboratory-Wide Procedure (LWP)-18201, *Establishing, Operating, and Deleting Criticality Control Areas (CCAs)*; MCP-18203, *Criticality Safety Assessments*; and LRD-18001 – provide a broad (traditional) definition that includes all fissionable isotopes. However, multiple criticality control lists explicitly identify a subset of fissionable transuranic isotopes. EA noted at least one example of a fissionable radionuclide, curium, that is handled and stored at INL but is not included in the criticality control list definition of "fissionable material." Omitting curium from the criticality control list definition removes a control that prevents an operator from adding a sufficiently large quantity of curium to an otherwise critically safe configuration of fissionable material and creating a potentially critical configuration. BEA verified that the known amounts of fissionable isotopes of curium are gram quantities and adequately concluded that the small amount of material is not currently a concern for criticality safety, so no control is necessary.

Program Requirements and Performance of Assessments and Inspections

The CSP program documentation requires periodic assessments and inspections to evaluate its continued effectiveness. Assessments are formally scheduled at the beginning of each fiscal year and focus on program effectiveness, while inspections focus on implementation of limits and controls for a CCA. BEA annually submits a summary report on CSP performance to DOE-ID. The report provides assessment results, status of issues and corrective actions, any criticality infractions that have occurred, CSP funding, and the Defense Nuclear Facilities Safety Board CSP data call (information compiled annually by DOE in response to Recommendation 1997-2). The Defense Nuclear Facilities Safety Board CSP data call information is included in the summary report even though it is not required.

The assessment documentation and summary reports for the past three fiscal years generally meet CSP requirements for assessment and inspection activities. Specifically, EA's review of the CCA inspection documentation indicated that inspections are conducted in a timely fashion, meet CSP requirements, and successfully identify areas of less than adequate implementation. The CSP also requires periodic program effectiveness assessments performed in accordance with DOE-STD-1158-2010, *Self-assessment Standard for DOE Contractor CSPs*. EA's review of three years' worth of assessment reports noted that BEA did not explicitly reference DOE-STD-1158 in those reports, although they adequately covered most of the criteria.

EA also reviewed the CCA annual inspection process defined in MCP-18203 and implemented using Form 431.03, *Criticality Control Area (CCA) Inspection Checklist*. The Criticality Safety Engineering staff is responsible for this inspection, which is conducted in concert with the Operations staff. The process includes reviews of criticality safety boundaries and procedures for assurance that criticality safety limits and controls have not been removed or altered, as well as a review of the resolution of previous issues. However, the inspection approach focuses largely on compliance because MCP-18203 suggests, rather than requires, observing a fissionable material-based activity. Of the 16 CCA inspections from 2017 that EA reviewed, only 4 included observations of a fissionable material-related activity. This inspection approach represents a missed opportunity to fully review performance in implementing criticality safety limits and controls.

Issue Resolution

During review of the assessment documentation, EA observed that issues identified by CSP assessments and inspections are being properly placed into LabWay, the INL issues management system, for resolution. In the past 3 years, assessments and other processes have identified 37 criticality safety-related issues. At the time of this EA assessment, 11 issues remained open, with 2 issues past due by up to 2 months. EA determined that the two past-due issues were minor and that BEA had adequately addressed the issues that had been closed.

BEA's actions in response to one issue were particularly thorough. An oil leak in a shield window in the Hot Fuel Examination Facility (HFEF) resulted in untracked moderator material entering a moderator-limited criticality hazard control zone and subsequent declaration of a potential inadequacy of the safety analysis. The Criticality Safety Engineering staff's questioning attitude and use of the issues management process were evident in its extent-of-condition review. Although the SAR for FCF does not explicitly discuss the introduction of moderator material from a shield window leak, the staff appropriately used the unreviewed safety question process to document why the condition was not a concern.

Criticality Safety Program Conclusions

Overall, BEA's CSP description document is current and consistent with the commitments in SAR-400 and the requirements of DOE Order 420.1C. Although EA identified a few minor issues in implementation of the CSP, the program has resulted in conservative limits and controls and acceptable safety margins for fissionable material activities. BEA's assessments and inspections generally meet the CSP requirements and successfully identify areas of less than adequate implementation. BEA adequately identifies and addresses issues related to criticality safety.

5.2 Criticality Safety Controls Basis

This section discusses EA's assessment of BEA's development of criticality safety controls. The objective of this portion of the assessment was to verify that criticality safety controls have a supporting criticality safety analysis basis and are sufficiently reliable to ensure that a change in process conditions necessary for a criticality accident is at least "unlikely."

Criteria:

- *Technical, functional, and performance requirements for criticality safety controls are specified in criticality safety documents. These documents identify and describe the safety functions and are effectively translated into procedures. (DOE Order 420.1C)*

- *Criticality safety controls are robust and meet the Double Contingency Principle, or DOE has granted a specific exemption which incorporates the foregoing criteria. (DOE Order 420.1C)*

Development of Controls in Criticality Safety Evaluations and Supporting Lists

In the 27 CSEs that EA reviewed, BEA supported its determinations by using computer codes that were benchmarked against validated experiments, and when necessary, BEA benchmarked the CSE-specific models as well. EA's review of 27 CSEs did not indicate any model oversimplifications. In addition to diagrams used to illustrate actual dimensions, shapes, sizes, and layouts, some CSEs also made effective use of figures from the CSE analysis computer model. For example, ECAR-3706, *Criticality Safety Evaluation for Fissionable Material Processing in the SNM* [Special Nuclear Material] *Glovebox Oxidation Furnace within FMF*, provided figures that show the Oxidation Furnace trays as actually modeled, in addition to photographs and design diagrams. These additional figures aid CSE reviewers in evaluating the appropriateness of the model and the adequacy of the derived criticality safety control. EA observed that BEA adequately uses validated computer codes and industry-accepted computer models.

EA reviewed the implementation of the CCA process for NMIS. NMIS criticality safety documentation has not been updated to meet the latest requirements of the CSP for a CCA as outlined in LWP-18201, which was initially issued in October 2016. Instead, the limits and controls for criticality safety are contained in multiple documents, including the CSEs and Chapter 6 of the NMIS SAR. Taken together, the CSEs and NMIS SAR provide a comprehensive listing of criticality safety controls to be implemented by the NMIS procedures. Review of the two main NMIS fissionable material handling detailed operating procedures DOP-7.11.12, *Inspection of Advanced Test Reactor (ATR) Fuel Elements*, and DOP-7.11.13, *Performing Confirmatory Measurements, Inventories, or Inspections*, indicated that all criticality limits and controls were properly identified. EA determined that BEA is adequately maintaining the NMIS criticality safety documentation until BEA can update it to meet the latest requirements.

The CCA process outlined in LWP-18201 establishes a criticality control list of limits and controls from the CSEs for operations personnel to implement. Compliance with CCA criticality control lists is reinforced by the establishment of a specific administrative control (SAC) in the facility technical safety requirements (TSRs). The TSR SAC specifies that failure to comply with any control in the CCA control listing is a violation of the TSRs. For FCF and FMF, all criticality safety limits and controls are captured in LST-390, *Fuel Conditioning Facility (MFC-765) Criticality Control List*, and LST-386, *Fuel Manufacturing Facility Criticality Control List*, respectively. In general, the criticality safety limits in the lists reviewed were conservative.

Overall, the derived criticality safety controls are sufficiently conservative to provide an adequate safety margin to prevent inadvertent criticalities. The strategy used and margins employed by BEA in performing CSEs help ensure that the criticality safety limits established and captured in the list documents are robust, conservative, and readily implemented by the operations staff. When determining criticality safety limits and controls, BEA focuses on consistency. For example, at FCF, five Argon Cell zones have the same limits. These limits envelope the calculated individual zone limits and simplify the fuel handlers' implementation of limit controls, resulting in more straightforward implementation by operators. In reviewing a sample of procedures governing operations at FCF and FMF, EA determined that the derived criticality safety controls are captured in the applicable criticality control list documents and appropriately implemented in facility operating procedures. In some procedures, EA observed that these limits and controls are incorporated by reference and the operators successfully referenced and implemented the appropriate controls.

Double Contingency Principle Requirements

The CSP describes the double contingency principle (DCP) and its application to fissionable material activities. The CSP discussion of the DCP matches the description in Section 4.2.2 of ANSI/ANS 8.1, *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*, which defines the DCP as follows: "Process designs should incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible." However, the CSP states that the purpose of the DCP is to prevent an inadvertent criticality, which is actually the purpose of the process analysis requirement in Section 4.1.2 of ANSI/ANS 8.1. The DCP requirement is distinct from the process analysis requirement, and meeting one requirement does not ensure meeting the other. LRD-18001 presents the requirements for implementing the DCP, including the purpose of it, in an appropriate manner.

PDD-18200 establishes additional requirements to include controls in the TSRs and to obtain DOE-ID approval when applying the DCP only to a single parameter (e.g., mass) for a given fissionable material activity. Although some of the limits EA reviewed were based on a single parameter, all activities reviewed met DCP expectations. For example, CSE-INL/INT-09-15365, *CSE for the Generic Fissionable Material Limits in HFEF*, describes a criticality scenario that requires each of four adjacent zones to exceed the mass limit by more than 50%, with material placed in the very corner of each zone. Both the controls to prevent overbatch and the controls to prevent placing material in the very corner of the zones apply to mass, yet the DCP is still met because two changes in process conditions are needed to create a potential criticality. EA's review of multiple CSEs for fissionable material operations indicated that the DCP is applied appropriately as specified in DOE Order 420.1C and the CSP.

Criticality Safety Control Basis Conclusions

As implemented at INL, the CSP incorporates effective processes and procedures to ensure that adequate bases are established to support the derivation of criticality safety controls and that such controls are reliable. INL criticality safety documents identify criticality safety controls and effectively translate them into criticality control lists and procedures. Criticality safety controls are robust and meet the DCP.

5.3 Criticality Safety Control Implementation

This section discusses the implementation of the identified criticality safety controls during laboratory activities. The objective of this portion of the assessment was to verify that criticality safety controls are effectively implemented using documented and approved processes.

Criteria:

- *Management organizational structures and systems provide assurance that the criticality safety controls are implemented and are being maintained such that they will fully and reliably perform their safety functions over the life of the facility. (DOE Order 420.1C)*

- *The adequacy of criticality safety controls is confirmed by individuals or groups other than those who performed the work. Such confirmation, as well as activities ensuring that the technical basis for the controls is adequate, is completed before the start of operations. The adequacy determination considers that no single credible event or failure can result in a criticality. (DOE Order 420.1C)*

- *Criticality safety controls and how they are implemented are adequately communicated to workers via training, statements in procedures, workplace postings and other operator aids as appropriate. The need for materials labeling and other identifiers used to prevent criticality is understood and they are adequate. (DOE Order 420.1C)*

- *Cases where controls are discovered to be confusing or inadequately understood are resolved whether or not an actual non-adherence occurs. (DOE Order 420.1C)*

Criticality Safety Personnel Qualifications

EA reviewed program documentation and interviewed Criticality Safety Engineering staff and Operations personnel to verify that BEA has sufficient staff and funding for program implementation, and that personnel were knowledgeable of the CSP requirements. These interviews indicated there was sufficient funding and personnel with the requisite experience to ensure implementation of CSP requirements. The number of criticality safety personnel assigned to oversight of CCAs is sufficient to evaluate changes in fissionable material activities, identify limits and controls, and monitor implementation of criticality safety requirements. In interviews, criticality safety engineers demonstrated considerable knowledge and experience in evaluating and overseeing fissionable material activities, and sufficient knowledge of overall INL activities. In addition, BEA management ensures sufficient staffing through a balance of new and experienced personnel, and by filling vacancies when staff members leave.

The INL CSP incorporates a criticality safety officer (CSO) for each facility who is a member of the Operations organization at the facility and has responsibilities associated with deriving and changing criticality safety controls. Along with other members of the Operations staff, and in concert with Criticality Safety Engineering staff, the CSO is responsible for attending the round-table review meetings associated with CSEs under development or revision, and the CSO must concur with derived criticality controls. In addition, the CSO is responsible for communicating criticality control changes to facility training organizations to ensure that the training incorporates these changes. EA interviewed five CSOs and observed their interaction with criticality safety engineers, operators, and nuclear facility managers before, during, and after multiple operations. EA observed that CSOs have broad knowledge of operations practices and criticality safety control strategies.

The FCF, FMF, and NMIS operations staff are well versed on their responsibilities involving the implementation of criticality safety limits and controls. Interviews demonstrated that the operators are committed to and engaged in ensuring error-free operations. EA observed the FCF Nuclear Facility Manager conducting a morning start-of-shift brief, which focused on following procedures and learning from operating experience. The facility staff were attentive to the brief. EA also observed a training refresher taught by a criticality safety engineer for the operations staff and noted that it appropriately reinforced the criticality controls for that facility. Because of previous facility operator interactions, the criticality safety engineer for FCF determined that refresher training on criticality safety limits and controls basis would be beneficial. He recommended the refresher to the Nuclear Facility Manager, who supported the training and was present during the session that EA observed. EA noted that the routine engagement of the Criticality Safety Engineering staff with the Operations staff facilitates a positive relationship between the organizations and results in improved understanding of criticality safety controls.

Confirmation of Criticality Safety Control Adequacy

The review and approval process for CSEs is performed per the requirements of LWP-10106, *Engineering Verification*. At the discretion of the criticality safety manager, the process can include a group meeting/discussion to peer-check the CSE for technical adequacy, referred to as a "round-table review" in LWP-18201. EA observed a round-table review of a CSE regarding the storage of cladding hulls in process scrap containers at the Radioactive Scrap and Waste Facility (RSWF) and FCF. The criticality safety manager coordinated the round-table review meeting. The personnel present at the round-table review included the preparer of the evaluation and additional staff from the Criticality Safety Engineering, Safety Basis, and Facility Operations organizations. The meeting covered all sections of the CSE, and the group technical discussions challenged many of the assumptions and conclusions presented in the evaluation. Although not explicitly required by INL procedures, EA observed that this round-table review served as a useful peer check, demonstrated a thorough review process for the CSE, and adequately resulted in comments requiring resolution before the evaluation could proceed to final approval.

Communication of Criticality Safety Controls to Workers

EA observed and reviewed a sample of fissionable material handling and storage operations at multiple INL facilities to help evaluate the implementation of criticality safety controls. At FMF, EA observed an operation to convert pyrophoric uranium and uranium hydride to stable uranium oxide by using the oxidation furnace located in the SNM Glovebox. EA also reviewed documentation for the fissionable material transfer from the FMF Vault to the FMF Workroom, and then into the SNM Glovebox. The criticality safety controls for both these activities were contained in facility procedures and a separate handwritten form. The FMF operators implemented the controls adequately, and the use of the form identified and supported implementation of the appropriate criticality safety limits and controls; however, multiple Criticality Safety Engineering and Facility Operations staff acknowledged that there was room for improvement in how the handwritten forms are structured and implemented. For example, the Criticality Safety Engineering and Operations staff discussed incorporating an additional column to record the criticality safety limits for the transfer steps, instead of using the "COMMENTS" section to identify them.

At FCF, materials are tracked in the Material Tracking System (MTG), and the mass limits and controls from LST-390 are programmed into the MTG. MTG performs real-time tracking of mass movements within FCF and either concurs with or provides warnings that would prevent movement if the movement would violate a limit. At FMF, fissionable materials are tracked by hand using a system of forms that are identified within each procedure. For each step in a process at FMF that results in a movement of fissionable material, the mass is documented and tracked on a given form, which also references the applicable criticality safety limit from LST-386. EA observed operations and reviewed documentation that demonstrated the successful use of these systems. The incorporation of criticality control lists into facility operations helps ensure that all operators are aware of the criticality safety requirements prior to fissionable material handling.

LWP-9201, *Briefings*, requires that the work group perform a pre-job brief before beginning an operation. Criticality limits were not discussed during the pre-job brief for the uranium conversion operation in the SNM Glovebox oxidation furnace that EA observed. In interviews with BEA Operations staff and managers, EA found that criticality safety limits and controls are not always discussed during the pre-job brief for a given operation because LWP-9201 does not explicitly require it. Not routinely discussing these hazards as part of a pre-job brief is contrary to the principles of work planning and control core functions.

Resolution of Confusing or Inadequately Understood Controls

During review of items entered in LabWay, EA noted that BEA effectively used its issues management process to resolve what initially seemed to be a pair of criticality limit infractions identified by MTG at FCF. In two events within a week of each other, MTG indicated that mass limits may have been exceeded. MTG uses a conservative mass process to prevent criticality limit violations for the Mark IV electrorefiner and cathode processer. Since the mass of fissionable material cannot be known with certainty until the product is sampled and/or weighed, MTG assigns conservative mass factors and assumptions to items in the electrorefiner and cathode processer and uses those factors to implement the criticality controls and provide a margin between the limit and actual mass. The criticality safety staff was able to demonstrate that the actual mass present was always below the mass limit. As a result of the events, they modified procedures, improved the MTG warning messages, developed a Technical Evaluation (TEV), and conducted operator training. These actions improved the staff's understanding of MTG and its imbedded conservatism.

Based on interviews and walkdowns in FCF, EA observed that BEA is adequately taking steps to address overcrowding of material in the argon hot cell. When interviewed, the FCF operations staff stated that their primary concerns were the quantity of fissionable material in the argon hot cell and the lack of organization. Contributing to the concerns was the number of manipulator arms that were out of service, reducing the ability to move materials and improve conditions in the hot cell. Although conditions in the FCF argon hot cell are less than optimal, the Nuclear Facility Manager is engaged in a number of initiatives to improve those conditions: installation of upgraded manipulator arms, ongoing efforts to reduce clutter, an engineering redesign of criticality zones and storage areas, and removal of transuranic wastes. In addition, BEA has already exceeded the goal for removal of waste boxes by 66%.

EA reviewed records showing the total amount of fissionable material in each criticality control zone of the hot cell. MTG calculates this information, but the FCF operations staff do not review the total quantity of fissionable material in each zone on a routine basis. The records showed that some zones were approaching the mass limits (at least two zones were within 1%), posing a challenge for the operators to maintain operations within criticality safety limits. During interviews, operators stated that they sometimes start a planned activity, only to discover – just before moving the material into a new zone – that they cannot make the move without exceeding the mass limit. Consequently, to complete their planned work, they must identify material to move out of yet another zone. Although FCF operators have adequately completed the material moves each time, the additional moves add risk to the original planned activity.

Criticality Safety Control Implementation Conclusions

Observations of multiple activities at the INL facilities, as well as interviews with Operations and Criticality Safety Engineering staff, indicate that organization structures and systems adequately support the implementation and maintenance of criticality safety controls. Staff members are well qualified to perform their functions and are actively engaged in all aspects of facility operations. The review process for criticality safety controls is thorough and ensures that controls are adequate. Training and procedures adequately communicate criticality safety control implementation to the workers. EA observed examples of BEA taking action to resolve confusing controls when identified. However, pre-job briefs in some cases do not discuss criticality safety limits and controls associated with the assigned work.

5.4 Idaho Operations Office Oversight

This section discusses EA's assessment of the adequacy of the oversight performed by DOE-ID to ensure that criticality safety controls are implemented properly. The objective of this portion of the assessment was to verify that DOE-ID has established and implemented effective oversight processes and that assurance system programs and processes are in accordance with the policy and key elements outlined in DOE Policy 226.1B, *Department of Energy Oversight Policy*, and applicable DOE directives.

Criteria:

- *The Operations Office has developed and implemented processes and procedures to effectively oversee contractor performance in this functional area. (DOE Order 226.1B)*

- *The Operations Office line oversight program includes written plans and schedules for planned assessments, focus areas for operational oversight, and reviews of the contractor's self-assessments. (DOE Order 226.1B)*

DOE-ID has established and implemented oversight processes that evaluate BEA's criticality safety program for effectiveness of performance and compliance with requirements. DOE-ID designates one person as the criticality safety subject matter expert (SME), responsible for oversight of criticality safety at both INL and ICP Core. That individual conducts routine monitoring of BEA's criticality safety group by reviewing the most significant CSE revisions and all new CSEs, which document the basis for the criticality safety controls. For all but two of the BEA CCAs, criticality controls are documented in a contractor-maintained list that is invoked by the TSRs and the documented safety analysis; DOE-ID does not need to approve changes to the criticality safety controls on the list. However, the DOE-ID criticality safety SME maintains cooperative relationships with BEA staff, resulting in strong communications and a high level of engagement in changes to criticality safety controls.

Facility Representatives (FRs) learn the basics of criticality safety as a part of general technical base training, and they learn the specifics of criticality safety controls at their facilities as they qualify for each facility. FRs become familiar with the TSRs, the lists of the criticality safety controls, and the way those controls are implemented in procedures. The criticality safety SME interfaces with the FRs on periodic visits to the facilities, and keeps open communications with them in order to address issues as they arise. Based on interviews, the FRs are sufficiently knowledgeable about criticality safety at their facilities.

DOE-ID uses work instruction 03.WI.04.01, *Oversight Planning and Scheduling,* to develop an oversight schedule that includes oversight of the criticality safety program. The oversight schedule is planned for three years at a time. The criticality safety SME proposes input to the schedule, and the supervisor and manager approve it. EA's review of the schedule showed that it contains an appropriate level of oversight of criticality safety activities at INL. The SME assesses criticality safety at INL quarterly, using criteria selected from the ANSI/ANS Eight Series standards, and documents the results in written assessment reports that are approved by the supervisor. In reviewing the written assessment reports from the eight scheduled assessments for fiscal years 2017 and 2018, EA found that they adequately capture the details of the assessment performed by the SME. The assessments cover all areas specified by the oversight schedule and adequately focuses on current activities and recent document revisions.

One of the SME assessment reports referred to a criticality-safety-related finding from an assessment performed by the FRs. When findings are identified, both the supervisor and the responsible division director give their approval. Once approved, they are communicated to the contractor, and DOE-ID monitors the corrective action process. If DOE-ID believes the contractor needs to improve the corrective actions to properly address the finding, they inform the contractor. In this case, DOE-ID appropriately provided feedback that BEA needed to provide training to address the finding, so BEA added a corrective action to provide training.

The oversight schedule specifies conduct of a focused facility walkdown as a part of the quarterly assessment, but the choice of facility is at the SME's discretion. EA noted that each quarterly assessment included a focused facility walkdown, but some facilities were assessed more often than others. For example, FCF was covered in the quarterly focused facility walkdowns three times in two years, while FMF and NMIS were not covered. Although EA was not able to observe a focused facility walkdown, the information contained in the reports, combined with the SME's knowledge of the facilities displayed during the tours of FCF and the Fuels and Applied Science Building, demonstrated that the SME has conducted thorough walkdowns.

Idaho Operations Office Oversight Conclusions

Line management oversight processes allow DOE-ID to maintain sufficient knowledge of criticality safety activities to make an informed decision about risks. DOE-ID adequately implements its oversight processes, effectively evaluates contractor performance, completes assessments as scheduled, and appropriately documents the results. Although the quarterly focused facility walkdowns are thorough, they do not cover all facilities on a regular basis.

6.0 FINDINGS

EA did not identify any findings during this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA did not identify any opportunities for improvement during this assessment.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Assessment: September 10-20, 2018

Office of Enterprise Assessments (EA) Management

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

Quality Review Board

Steven C. Simonson
John S. Boulden III
Michael A. Kilpatrick

EA Site Lead for INL

Rosemary B. Reeves

EA Assessors

Sarah C. Rich – Lead
Aleem E. Boatright
Jimmy S. Dyke
Frank A. Inzirillo

Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

- 03.WI.04.01, *Oversight Planning and Scheduling,* Revision 6, 11/16/2016
- 03.WI.04.02, *Conduct of Oversight Activities,* Revision 18, 08/01/2017
- *2015 Annual Criticality Safety Program Performance Summary*, 12/08/2015
- *2016 Annual Criticality Safety Program Performance Summary*, 12/12/2016
- *2017 Annual Criticality Safety Program Performance Summary*, 12/12/2017
- AST-2016.10.24-371586, *Materials and Fuels Complex Transmittal of Issue for Operational Oversight: Finding: Fuel Conditioning Facility LST-390 (and its implementing procedures) does not specify the MTG data set which is used to verify facility zone masses are maintained below criticality control limits*
- DOP-7.11.12, *Inspection of Advanced Test Reactor (ATR) Fuel Elements,* Revision 24, 03/27/2018
- DOP-7.11.13, *Performance Confirmatory Measurements, Inventories, or Inspections,* Revision 26, 08/10/2017
- ECAR-1610, *Criticality Safety Evaluation for the TREAT Reactor Building*, Revision 2, 09/12/2017
- ECAR-1722, *Criticality Safety Evaluation for the Handling and Processing of SNL Debris Bed Experiments within FMF*, Revision 1, 09/01/2016
- ECAR-2189, *Criticality Safety Evaluation for Determination of Fissionable Material Limits for Operating Zones in FCF*, Revision 3, 08/17/2017
- ECAR-2277, *Criticality Safety Evaluation for the Processing of Sodium Bonded Fuel Elements in the SNM Glovebox within FMF*, Revision 1, 08/2014
- ECAR-3706, *Criticality Safety Evaluation for Fissionable Material Processing in the SNM Glovebox Oxidation Furnace within FMF*, Revision 0, 03/13/2018
- ECAR-4245, *Criticality Safety Evaluation for the Transfer and Storage of Cladding Hulls in Process Scrap Containers at the RSWF and FCF*, Revision 0, 09/2018
- EDF-6478, *Criticality Dose Evaluation for the Fuel Manufacturing Facility*, Revision 5, 02/13/2017
- EDF-6670, *Criticality Safety Evaluation for Handling EBR II Fuel Elements and Subassemblies in FMF and ZPPR*, Revision 2, 04/03/2018
- EDF-6781, *Criticality Safety Evaluation for the FMF and ZPPR Storage Racks in the FMF and ZPPR Vaults*, Revision 8, 04/03/2018
- EDF-6824, *Criticality Safety Evaluation for Handling Fissionable Material Containers within FMF and ZPPR*, Revision 10, 08/15/2017
- EDF-7711, *Criticality Safety Evaluation for Unirradiated FFTF Fuel Elements in the Hot Fuel Examination Facility (HFEF), the Fuel Manufacturing Facility (FMF) and Transfer Between Facilities*, Revision 3, 09/21/2016
- EGG-SRE-9625, *Firewater System Inadvertent Actuation Frequency*, Revision 1, 08/1991
- Email, INL Criticality Safety Manager to DOE-EM Criticality Safety Specialist, *Interpretation of DOE Order Requirements for Criticality Safety Process Analysis, and Criticality Accident Alarm System Coverage*, 09/13/2018
- FCF-OI-1306, *Conservative Mass Review Procedure*, Revision 0, 06/20/2017
- Form 431.03, *Criticality Control Area (CCA) Inspection Checklist,* 2017
- INEEL/INT-2000-01525, *Criticality Safety Analysis of ATR Fuel Element Transfer Racks at TRA*, 03/2001
- INEEL/INT-98-01011, *Fuel Storage in ATR Racks in ATRC and NMIS*, 09/2000

- INEEL/INT-98-01028, *CSE for the NMIS for Non-ATR Fissile Material Only*, 12/1998
- INEEL/INT-99-00881, *ATR Fuel Storage in ETR Racks of NMIS*, 01/2001
- INL Presentation, *INL CSP*, 09/10/2018
- INL/EXT-11-20876, *Passive and Active Radiation Measurements Capability at the INL ZPPR Facility*, 12/2010
- INL/INT-09-15363, *CSE for the Criticality Safety Index for the Storage of the Single Element ATR Fresh Fuel Shipping Containers*, Revision 0, 01/2009
- INL/INT-09-15365, *CSE for the Generic Fissionable Material Limit in HFEF,* Revision 2, 05/2015
- INL-INT-07-12985, *Criticality Safety Evaluation for Neptunium Oxide Storage in the Fuel Manufacturing Facility Vault*, Revision 1, 09/2009
- INL/INT-09-15665*, Criticality Safety Evaluation of the Uranium Holdup in the Equipment Filters at FMF*, Revision 3, 02/2011
- INL-INT-09-15698, *Criticality Safety Evaluation of 6M Packages Used for On-site Transfer and Storage*, Revision 0, 08/2009
- INL-INT-09-16401, *Criticality Safety Evaluation for Storage of EBR II and TRIGA in the LESR and for the Handling of TRIGA within FMF and ZPPR*, Revision 2, 09/20/2016
- INL-INT-09-16705, *Criticality Safety Evaluation – 55-Gallon Drum Storage Criticality Safety Index (CSI) Determination*, Revision 0, 09/2009
- INL/INT-10-19145, *CSE for the Active Interrogation Measurement Campaign in ZPPR*, 08/2010
- LRD-18001, *INL Criticality Safety Program Requirements Manual*, Revision 6, 06/25/2018
- LST-119, *INL Safety Basis List for the Nuclear Material Inspection and Storage (NMIS) Facility*, Revision 33, 03/22/2017
- LST-213, *NMIS Nuclear Safety Basis Implementation Matrix*, Revision 16, 03/22/2017
- LST-386, *Fuel Manufacturing Facility Criticality Control List*, Revision 14, 11/15/2017
- LST-387, *Criticality Safety Controls for TREAT*, Revision 2, 03/14/2018
- LST-390, *Fuel Conditioning Facility (MFC-765) Criticality Control List*, Revision 7, 11/01/2017
- LWP-10106, *Engineering Verification*, Revision 8, 08/20/2018
- LWP-18201, *Establishing, Operating, and Deleting Criticality Control Areas (CCAs)*, Revision 1, 02/21/2018
- LWP-9201, *Briefings,* Revision 2, 07/17/2014
- MCP 18202, *Performing Criticality Safety Evaluations*, Revision 1, 04/26/2018
- MCP 18203, *Criticality Safety Assessments,* Revision 0, 09/27/2016
- PDD-18200, *INL Criticality Safety Program*, Revision 1, 06/25/2018
- SAR-154, Chapter 6, *Prevention of Inadvertent Criticality – SAR for the NMIS Facility TRA 621*, Revision 13, 03/22/2017
- SAR-400, *INL Standardized SAR*, Revision 11, 03/28/2018
- TEV-3004, *Application of Conservative Mass in FCF*, Revision 0, 05/2017
- TREAT-OI-0106, *TREAT Experiment Assembly and Handling Operations*, Revision 0, 09/11/2018
- TREAT-OI-1015, *Nuclear Material Handling*, Revision 9, 03/14/2018

Interviews

- Criticality Safety Engineers (4)
- Criticality Safety Program Manager
- Criticality Safety Engineering Manager
- DOE-ID Criticality Safety Subject Matter Expert
- DOE-ID Senior Facility Representative
- DOE-ID Technical Safety Supervisor

- FCF Criticality Safety Officer
- FCF Criticality Safety Engineer
- FCF Nuclear Facility Manager
- FCF Operators (4)
- FCF Shift Supervisor
- FCF System Engineer
- FMF Criticality Safety Engineer
- FMF Criticality Safety Officer
- FMF Fissile Material Handlers (3)
- FMF Nuclear Facility Manager
- FMF Shift Supervisor/Fissile Material Handler Supervisor
- NMIS Building Manager
- NMIS Criticality Safety Officer
- TREAT Criticality Safety Officer
- ZPPR Criticality Safety Officer

Observations

- FCF
    - Walkdown
    - Cold jet operation walk through
    - Magazine to Magazine loading
    - Operator training
    - Scale Argon cell calibration check
    - Start of shift brief
    - TRU basket loading
- FMF
    - Walkdown
    - Fissionable Material Processing in the SNM Glovebox Oxidation Furnace
- NMIS
    - Walkdown
    - Storage vault opening
- Round-table review
- TREAT experiment pre-job brief
- CCA walkdown at TREAT
- Zero Power Physics Reactor Fissionable Material Inspection Items Operation Areas