22 December 2020

To: Angela Chambers, Manager, US DOE Nuclear Criticality Safety Program (NCSP)

From: David Hayes, Deputy Chairman, US DOE NCSP Criticality Safety Support Group (CSSG)

David Kirk Hayes Digitally signed by David Kirk Hayes Date: 2020.12.23 09:17:01 -07'00'

Subject: CSSG Tasking 2020-04 Response

The CSSG has completed its action on Tasking 2020-04. The attached report describes the review process, documents included in the review, observations and recommendations to address the observations. Please note that David Erickson, US DOE NCSP CSSG Chairman, recused himself from this tasking based on his direct involvement in the Savannah River Plutonium Processing Facility (SRPPF) project.

Overall, the opinion of the CSSG is that the current state of criticality safety documentation should be improved to more effectively support proceeding to preliminary design and are not yet sufficient to support CD-1. There are areas of both risk and opportunity that could be more clearly identified and communicated with the management and design organizations. The most significant areas to be addressed are: providing evidence that design alternatives have been considered for criticality safety control; additional integration with other disciplines including process engineering, fire safety, safeguards and security, and seismic events; and the identification of safety function and functional criteria for items important to criticality safety. The Hazard Evaluation Tables (HET) and Fire Scenario Document (FSD) appear to be well developed but the information is not pulled through into criticality safety documents. The criticality safety documents provided for review do not include sufficient discussion of control philosophy or design alternatives and do not demonstrate significant engagement within DOE criticality safety community for lessons learned. These insufficiencies represent unknown project and design risk which should be identified at CD-1. The CSSG proposes that vigorous implementation of the recommendations within this report would provide the most efficient method of addressing the insufficiencies and avoid significant project performance risk or project failure.

The drafting team consisted of the following CSSG members:

Michaele (Mikey) Brady Raap (PNNL retired, CSSG member and review team lead)
David P. Heinrichs (LLNL, CSSG member)
Thomas P. McLaughlin (LANL ret., CSSG member)
Kevin Kimball (Y-12/Pantex ret., CSSG member)
Fitz Trumble (Amentum, CSSG member)
Doug Bowen (ORNL, NCSP Task Manager)

The draft response was reviewed by the members of the CSSG. Comments from that review were considered for the enclosed final version of the response that is attached to this memo. This version represents a consensus position by the entire CSSG.

cc: CSSG Members

Response to CSSG Tasking 2020-04

CSSG Review of SRPPF Conceptual Design Documents

December 22, 2020

Table of Contents

Executive Summary

The Criticality Safety Support Group (CCSG) was requested to provide technical guidance for the implementation of criticality safety for the Savannah River Plutonium Processing Facility (SRPPF) in support of the National Nuclear Security Administration, Savannah River Office (NNSA-SR). The CSSG was tasked to review criticality safety and other related documents provided by NNSA-SR that support the SRPPF Critical Decision Level 1 (CD-1). The review covered twelve topic areas as specified in the CSSG Tasking 2020-04 (See Attachment A), and each area is individually addressed in the report. The review did not evaluate the design itself, but only the documentation supporting the integration of criticality safety into the design.

This review is a technical assist, and as such only observations and recommendations are made. In some cases, observations and recommendations are made to facilitate transitioning from conceptual design to preliminary and final design. That is, some recommendations are not required by regulatory documents to meet CD-1, but the implementation of them during conceptual design will help to prevent re-work and schedule impacts in the early design phases as intended by DOE-STD-1189-2016, *Integration of Safety into the Design Process*. The recommendations are based on either DOE regulatory documents or the extensive experience of the review team on similar projects performed under DOE-STD-1189.

The performance of the review identified three overarching observations regarding the process of integrating safety into design. First, DOE-STD-1189-2016, Section 4.3, makes clear that the conceptual design phase is to consider alternatives for meeting the mission need, and those alternatives often involve different safety strategies to be employed. The Conceptual Safety Design Report (CSDR) is to contain a more detailed facility-level hazards analysis for the preferred alternative. The documentation submitted to the CSSG did not include an alternatives analysis, so the CSSG is unable to comment on any evaluation of the best alternative from a criticality safety perspective. It was noted during the review that the criticality accident alarm system apparently selected may not be the best alternative for a new facility. If an alternative analysis has been performed, including a process flow and the alternatives considered along with the logic for selecting the chosen alternative would bolster the case for adequate safety in design.

Second, the Safety Design Strategy (SDS) and the CSDR are heavily focused on the Structures, Systems, and Components (SSCs) that have a preliminary functional classification of safety class and safety significant. This is understandable given the focus of DOE-STD-1189-2016. The CSSG concurs that the majority of SSCs important to nuclear criticality safety (NCS) would not be functionally classified as a safety SSC (i.e., safety significant or safety class) and that the NCS Program would provide appropriate quality assurance requirements to ensure meeting performance criteria. However, NCS SSCs are still subject to requirements of DOE-STD-1020-2016 as expanded upon in DOE-STD-3007-2017. Furthermore, CSSG Tasking 2016-05, *Regulatory Impediments to Effective Operational Criticality Safety*, highlights that NCS SSCs and the associated safety strategies may be a significant driver to the design, cost, schedule, and implementation of a project.

Therefore, the CSSG evaluated the submitted documentation in the spirit of DOE-STD-1189-2016 for NCS SSCs at the conceptual design phase. Namely, the review is to confirm that the preliminary safety positions adopted during conceptual design constitute an appropriate, conservative basis for proceeding to preliminary design for NCS SSCs, regardless of functional classification. Such an approach is supported by Section 4.8 of DOE-STD-1189-2016.

Third, there appears to be confusion in the documentation as to what information should be provided for the conceptual design with respect to criticality safety. As noted above, the focus of the CSDR is on safety SSCs, and this focus appears to have left SSCs important to NCS out of the CSDR. DOE-STD-1189-2016 sections 4.3.3, 4.3.4, and 4.3.7 identifies the following elements needed at conceptual design:

- Consequences associated with design basis accidents (DBAs)
- Hazard control strategies for significant hazard scenarios and DBAs
- Facility level safety functions, including major safety SSCs
- Initial classification of major safety SSCs
- Preliminary assessment of Natural Phenomena Hazard (NPH) design categories for major SSCs.

Generic consequence analyses were provided and reviewed; however, a specific type of accident consequence (e.g., a metal event and a solution event) associated with criticality safety hazard scenarios and SSCs was not presented. This is important because the consequences of a criticality hazard scenario determine the NPH design category for the major SSCs that have an NPH safety function. The lack of this information could lead to an excessive NPH design category for SSCs that only have a criticality safety function. The criticality safety documentation did not identify any NPH design categories associated with major NCS SSCs. This could impact cost and project risk. Furthermore, neither the hazard control strategies nor the facility level safety functions for criticality safety SSCs were identified. These strategies may conflict with other disciplines such as fire protection. At the conceptual design phase, the potential conflicts should be identified as a project risk in the CSDR.

The Preliminary Consolidated Hazard Analysis (PCHA) appeared to be an analysis involving an integrated team including experienced personnel from Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL). The CSSG believes that there could be some advantage to also engaging the Atomic Weapons Establishment (AWE). The Hazard Evaluation Tables for postulated criticality safety events include a number of specific design features that should be developed further. Not all of these features are needed at conceptual design, but the identification of safety functions and functional requirements is necessary early in the design process to avoid costly rework during preliminary design.

As the process and documentation extended away from the PCHA, much of this integration and information appears to be lost. Documentation developed within the criticality safety group appears to be particularly stove-piped (e.g., improvements are needed in integration with SDS, interface with fire suppression, interface with non-destructive assay, interface with seismic, lack of engagement of operations-knowledgeable staff during preliminary nuclear criticality safety evaluation (PNCSE) development). This is consistent with an observation made in the CSSG Assessment of Savannah River

Nuclear Solutions (SRNS) Nuclear Criticality Safety Program (NCS) performed under CSSG Tasking 2017-05. This may result in key project risks not being identified in the Conceptual Safety Design Report (CSDR). For example, CSSG Taskings 2013-01 and 2016-05 identify areas of conflict between fire protection and nuclear criticality safety strategies. The Uranium Processing Facility (UPF) project experienced these conflicts and they required significant effort to bring to resolution.

The reviewers observed that the NCS group does not appear to be well engaged with LANL and LLNL with respect to potential upset conditions and design options at this time. Multiple examples are discussed in the individual topic sections in this report. The maturity level of analyses performed for UPF and the Chemistry and Metallurgy Research Replacement (CMRR) facility could be highly beneficial to mitigate design risk, identify engineered features in lieu of administrative controls, etc. Use of these lessons learned was suggested as part of the Chief, Defense Nuclear Safety (CDNS) comments provided to the project as part of the SDS approval.

Furthermore, inconsistencies between the Safety Design Strategy, the Conceptual Safety Design Report, and the general treatment of nuclear criticality safety lead to the conclusion that significant project risks may exist that have not been adequately identified or addressed.

The Safety Design Strategy and the Conceptual Safety Design Report clearly state that NCS "evaluations" are to be performed late in the design process, which misses the point that NCS engineers need to be intimately engaged by establishing specific design requirements early in design; not following the design with subsequent analysis. Unlike other design disciplines that have pre-established design standards for safety significant or safety class SSCs, the NCS engineers have to determine the functional requirements and performance criteria for most, if not all of the NCS SSCs.

The current state of criticality safety documentation is too vague or too indefinite to support preliminary design, even though much of the PNCSEs go beyond conceptual design into the preliminary design phase. The generalities in the criticality safety documents do not prescribe specific criteria. While this assessment focuses on supporting conceptual design, a recommendation is made for criticality safety to follow the same criteria that facility safety must follow for safety SSCs, namely identify the safety function, functional requirements, and performance criteria as design proceeds. The safety functions are required to be part of conceptual design, the functional requirements should be identified early in preliminary design, and the performance criteria developed as preliminary design proceeds to final design. Implementing this recommendation will integrate the safety disciplines and provide a common means to convey safety requirements into the design.

A summary of the CSSG recommendations to improve the integration of nuclear criticality safety in the design process are given below. The bases for these recommendations are presented in the body of the report.

1. Document a nuclear criticality safety (NCS) strategy for each process. At CD-1, it would be appropriate to include control strategy options. These should be consistent with the PCHA, preliminary fire hazards analysis (PFHA) and SDS.

2. Document the safety functions, functional requirements, and performance criteria for potential major NCS SSCs, similarly to the requirements for safety SSCs as design proceeds through the various phases. Conceptual design should have safety functions identified as required by DOE-STD-1189-2016. Functional requirements should be identified as early as practical in preliminary design along with a listing of what performance criteria will be developed during preliminary design. This is needed to support an integrated project schedule and to identify project risks and opportunities as early as possible.
3. Identify conflicts between the NCS strategies and other safety management programs and security to identify areas of risk to the project in the conceptual design phase. Specifically reference scenarios identified in the Fire Scenario Document (FSD) when there is a potential for fire suppression water to impact the process analysis.
4. Supplement the NCS Design Criteria Document to include guidance developed through closure of the first three recommendations and the inclusion of fissile material accumulation control requirements. Examples can be found by reviewing the UPF NCS Design Guide.
5. The PNCSEs should be revised, incorporating the information available in the HET tables and PCHA event descriptions as design proceeds into preliminary design. This should be done in consultation with operators/NCS engineers who operate similar processes at other facilities (e.g., LANL, Y-12, AWE, LLNL). Specific recommendations citing revision of the PNCSEs include:
    a. Determine what the various container dimensions, masses and materials of construction are planned for various non-solution transportation and storage operations
    b. Collectively discuss options for fissile solution handling and storage both internal and external to gloveboxes
    c. Review containers, birdcages, carts, trolleys, etc., used at other sites as part of consideration of design alternatives
    d. Include descriptions of the design features identified in the PFHA
6. Review the unmitigated dose calculations to ensure they address appropriate types and magnitudes of criticality accidents, that appropriate conservatisms are applied, and that any mitigating initial conditions are identified appropriately in the CSDR. This is needed to support NPH design criteria for NCS SSCs.
7. Contact LLNL, LANL and UPF regarding commercially available criticality accident alarm systems and compare the advantages and disadvantages of these systems with the planned SRS NIMS. Ideally, this is done in conceptual design as part of an evaluation of alternatives, but can be performed early in preliminary design.
8. Delete the statement in S-CHA-F-00024 requiring NCS SSCs with a seismic safety function to be at the same SDC as the facility. NCS SSCs are assigned NDCs based on the unmitigated consequences of a criticality accident.
9. Update the Safety Design Strategy, as required by DOE-STD-1189-2016, to be consistent with the approaches presented in the CSDR.
10. Evaluate the CSSG Tasking 2020-03 response when responding to the CTA position memorandum regarding revising the SDS. This needs to be part of conceptual design because establishing NPH design criteria in preliminary design has historically resulted in high-cost impacts on other similar projects.

11. The results of the updated PNCSEs should be flowed into N-NCS-F-0147 with definitive guidance as to the NCS design criteria that design will need to adhere to during the preliminary design. The UPF project developed a detailed NCS design criteria document which should be reviewed for format, content and applicability.
12. Revise the PNCSE Desktop Instruction, SRNS-IM-2019-0013, to include discussions on:
    a. the purpose of the PNCSE as well as further expectations about the proper determination and flow of design constraints/requirements associated with NCS, and
    b. expectations for implementation of the ANS-8.1 process analysis requirement and double contingency principal (DCP) recommendation. As the PNCSEs mature, full evaluation of the process to meet the process analysis requirement and DCP recommendation should be added, including evaluation of common mode failures and effects.
13. Prior to revising PNCSEs, consideration should be given to developing a SRPPF NCS input document which will standardize the input information for NCS evaluations. The UPF project developed an NCS analysis guide that should be reviewed for format, content and applicability.
14. If there are plans to exclude stored/staged plutonium from the MAR inventory and from release considerations based on contained robustness, then this strategy should be documented and evaluated as part of the criticality design strategy.
15. Identify integration of fire hazard scenarios and the collection of fire suppression water into the PNCSEs as an open item in the PFHA and a risk in the CSDR.

The CSSG believes that following these recommendations will help to ensure: (1) basic contingencies for operations have been considered to determine if the design will need to be constrained as part of integration of safety into design, (2) that the preferred hierarchy of engineered features (passive and active) are considered before administrative controls, (3) that lessons learned associated with operations/design are considered during the evaluation, and (4) that project risks and opportunities are identified early in the project. Overall, the opinion of the CSSG is that the current state of criticality safety documentation should be improved to more effectively support proceeding to preliminary design.

1.0 Introduction

The CSSG was tasked to provide a technical assist in the review of nuclear criticality safety documents supporting the conceptual design review for the SRPPF. Consistent with the procedures of the CSSG, a formal tasking statement was developed and, reviewed by NCSP management in consultation with the National Nuclear Security Administration (NNSA) and then by the full CSSG. The approved tasking is provided in Attachment A.

The goal of this review was to bring the significant design integration experience of members of the CSSG to bear on the SRPPF project early enough to help ensure success of the project by conducting a documentation review and assessing the “sufficiency” of current analysis/documentation and to provide assistance in the form of recommendations and discussions to support the Conceptual Design Review, CD-1The review did not evaluate the design itself, but only the documentation supporting the integration of criticality safety into the design.

The primary expectations framing this review are based on DOE standards and orders. DOE-STD-1189-2008, -2016, *Integration of Safety into the Design Process*, were developed to fulfill the project management objectives established by the Deputy Secretary of Energy in 2005. These objectives are: to fully integrate safety early into the design and, by the start of preliminary design, establish the safety requirements. The project is at the end of the Conceptual Design Phase with the submittal of the SDS and the CSDR. Preliminary NCSEs have been generated for a number of the processes to be used by SRPPF.

2.0 Review Team Members and Methods

The review was focused on the conceptual design phase as the benchmark, and not the preliminary design. The members of the review team have considerable experience with DOE projects in both the conceptual and preliminary design phases. These facilities and projects include: UPF (Y-12), CMRR (LANL), Applied Research in Earth Science (ARIES) Oxide Production Program (LANL), Pit Disassembly and Conversion Facility (URS/PNNL), KAMS/CSSC/KIS (SRS), Isotek U-233 Project (ORNL), High Enriched Uranium Facility (HEUMF) and several other major modifications at DOE facilities. The recommendations provided are specific and try to point to the appropriate level of detail for conceptual design based on the experience of the team.

Documents provided by SRNS for the review and those requested and received throughout the review are identified in Attachment B. Due to COVID-19 travel restrictions, no onsite work or onsite interviews were performed as part of the team’s review.

In the process of developing this report, key members of the writing team focused on specific topics and conducted weekly phone calls to describe progress and observations and have group discussions. The completed report was distributed to the entire CSSG for review. The CSSG members provided comments which were resolved by revision to the report. Final review and approval of the report is provided by the US DOE NCSP Manager, Dr. Angela Chambers.

The review team members are:

- Michaele (Mikey) Brady Raap (PNNL retired, CSSG member and review team lead)
- David P. Heinrichs (LLNL, CSSG member)
- Thomas P. McLaughlin (LANL ret., CSSG member)
- Kevin Kimball (Y-12/Pantex ret., CSSG member)
- Fitz Trumble (Amentum, CSSG member)
- Doug Bowen (ORNL, NCSP Task Manager)

3.0 Review Topics

The formal tasking identified thirteen areas to be assessed:

- SRPPF strategy for addressing criticality for NPH events, including the SDS, the CDNS Safety Advice Memo and the Conceptual Safety Design Report (CSDR)
- EA-31 comments and SRPPF responses, if available, on the SDS regarding criticality safety
- Material handling approaches, including any interaction vulnerabilities-both within and in-between process modules
- Proposed Criticality Accident Alarm System (CAAS)
- Preliminary Nuclear Criticality Safety Evaluations (PNSCEs)
- Overall criticality safety program as it pertains to SRPPF
- Waste Management System (WMS) related to material handling, assay and waste storage configurations
- Material-At-Risk (MAR) documents
- Dose assessment evaluation and ensuing shielding related to criticality safety
- Criticality accident dose consequence to the maximally-exposed offsite individual (MOI) and collocated worker (if available)
- Interaction between criticality safety and fire suppression
- Implementation of the Process Analysis requirement vs the Double Contingency Principle (DCP) recommendation
- CD-1 and the SDS/CSDR as a sufficient "design of record"

In two cases, EA-31 comments and the question of sufficiency, the design team made clarifications to the scope. Based on the documentation received, the review focused the EA-31 task on criticality comments cited in the Letter Dan Sigg to D. Alldridge and Scott Cannon; *Advice on approval of SDS for the SRPPF*; August 7, 2019. As a point of clarification on the final area, this report addresses the sufficiency of the provided criticality safety documents to support CD-1 keeping with the expertise and qualifications of the CSSG. The "sufficiency" area was addressed as the overall objective of the review rather than an individual area.

In addition, the NCS staff on the project were provided informal, specific comments on the individual documents for their consideration. This was done in order to keep the CSSG report at a higher level and not get bogged down in details.

3.1 SRPPF Strategy Review

The SRPPF strategy was reviewed with emphasis on the treatment of criticality safety for NPH events and consistency with the SDS and CSDR. The overall NCS safety philosophy documented in the Safety Design Strategy (N-SCD-F-00001) is consistent with DOE-STD-3007-2017, *Preparing Criticality Safety Evaluations at Department of Energy Nonreactor Nuclear Facilities*, and with ANSI/ANS-8.1-2014, *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*. However, the guidance identified in the CSDR for a criticality accident initiated by a design basis event is lacking information related to assigning a Natural Phenomena Hazard (NPH) Design Criteria (NDC) or to assigning an appropriate limit state for NCS SSCs per the requirements of DOE-STD-1189-2016, Section 4.3.4 and DOE-STD-3007-2017, Section 4.2.

Background

DOE-STD-1189-2008, -2016, *Integration of Safety into the Design Process*, were developed to fulfill the project management objectives established by the Deputy Secretary of Energy in 2005. These objectives are to fully integrate safety early into the design and by the start of preliminary design the safety requirements for the design be established.

The project is at the end of the Conceptual Design Phase with the submittal of the Safety Design Strategy (SDS) and the Conceptual Safety Design Report (CSDR). DOE-STD-1189-2016 states that the CSDR "(a) describes the initial major hazards and other risk areas that could affect project cost and schedule and (b) identifies significant hazard scenarios and the initial suite of facility design basis accidents (DBAs)."

Furthermore, DOE-STD-1189-2016 calls for the purpose of the Department of Energy review of the CSDR "to confirm that the preliminary safety positions adopted during conceptual design constitute an appropriately conservative basis for preliminary design."

This section of the report evaluates the overall strategy of addressing a criticality accident hazard and the inclusion of Nuclear Criticality Safety (NCS) as documented in the SDS and CSDR.

Documents Reviewed (see Attachment B)

- N-NCS-G-00136 Rev. 5,
- N-SDS-F-00001, Rev. 0
- S-CSDR-F-00001, Rev. 0
- N-NCS-F-00143, Rev. 1

Review Results

Observation 1: The overall NCS safety philosophy documented in the Safety Design Strategy (N-SDS-F-00001) is consistent with DOE-STD-3007-2017, *Preparing Criticality Safety Evaluations at Department of Energy Nonreactor Nuclear Facilities*, and with ANSI/ANS-8.1-2014, *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*. However, the guidance identified in the CSDR for a criticality accident initiated by a design basis event is lacking information related to assigning a Natural Phenomena Hazard (NPH) Design Criteria (NDC) or to assigning an appropriate limit state for NCS SSCs per the requirements of DOE-STD-1189-2016, Section 4.3.4, and DOE-STD-3007-2017, Section 4.2.

Basis: Section 7.0 of the SDS states that prevention of a criticality accident is expected to be provided primarily by inherently safe designs such as geometrically favorable designs, neutrons absorbers, spacing, and minimization of moderation. This is consistent with DOE-STD-3007-2017, Section 3.5, which provides a preferred hierarchy of controls being passive engineered features, active engineered features, and last administrative controls. The SDS also states that "whenever possible" the double contingency principle defined in ANS-8.1 will be met.

S-CSDR-F-00001, Section 7.2 provides guidance regarding the application of design basis events as a possible initiator to a criticality accident. This information appropriately summarizes the DOE guidance from various standards when evaluating a design basis event as an upset condition that affects changes in parameters.

However, the guidance is silent on the establishment of a natural phenomena hazard design criteria (NDC) for NCS SSCs. The overarching requirement is in DOE Order 420.1C, as supplemented by a National Nuclear Security Administration (NNSA) memorandum (dated July 15, 2019). This requirement is that fissionable material operations remain subcritical under normal and credible abnormal conditions, including those initiated by design basis events. There are two methods by which this can be demonstrated: through analysis or through design. At this point in design (i.e., conceptual design phase), analyses supporting the position that a design basis event will not result in a criticality accident are not expected to exist. Therefore, according to DOE-STD-1189-2016, Section 4.1.5, a conservative approach is called for by establishing the NDC for NCS SSCs.

DOE-STD-3007-2017, Section 4, provides a methodology for addressing a design basis event through design. The methodology employs DOE-STD-1020-2016, which is mandated by DOE Order 420.1C for NPH events.

Although the scope of DOE-STD-1020-2016 mandates the establishment of NPH design categories for safety SSCs, it is not limited to safety SSCs, or Table 2-1 of that standard would not contain consequence criteria for NDC-2 that are below the threshold of safety classification. (Something that should be clarified in DOE-STD-1020.) Furthermore, Footnote 2 of that table explains that no consequence thresholds are provided in the table to protect in-facility workers. This is because it is recognized that a radiological event resulting in 5 to 100 rem to the co-located worker would also result in a significant dose to the facility worker, therefore appropriate design criteria are already provided. Furthermore, Footnote 2 also states that “A determination should be made whether additional protection measures are warranted for facility workers, especially to protect against potential loss of life from an anticipated NPH event.” That determination is effectively met by DOE Order 420.1C and DOE-STD-3007-2017. For these reasons, DOE-STD-1020-2016 is an appropriate method for addressing NCS SSCs.

The CAAS is an SSC that does not prevent a criticality accident. DOE-STD-3009-2014 recognizes the importance of the mitigating safety function of a CAAS, and requires that it must be considered for safety functional classification. The CSDR identifies the CAAS as a safety significant SSC. Therefore, it must perform under the environment associated with the criticality accident. If the accident is initiated by a design basis event, the CAAS must function during and after that event. This is something that requires compliance through design, unless it can be shown that an NPH event cannot initiate a change in process condition resulting in a criticality accident or that some other credited SSC accomplishes the same safety function. An NDC is not specified in the CSDR for the CAAS.

Observation 2: The NCS input is too generalized to meet the intent of DOE-STD-1189-2016 for CD-1 and fails to identify potential safety significant design features with their functional requirements as prescribed by N-NCS-G-00136.

Basis: The SDS and CSDR are focused on Structures, Systems, and Components (SSCs) that may be classified as Safety Class or Safety Significant. N-NCS-G-00136 provides criteria for functionally classifying SSCs important to NCS as Safety Significant. One criterion, is the classification of passive design features required by NCS analysis to ensure subcriticality. Although this criterion is more conservative than the guidance provided in DOE-STD-3007-2017, NCS related SSCs have shown to be a significant driver to the design, and subsequently the cost of the project. S-CHA-F-00024, Section 5.2.3.5 identified eight potential engineered features as potentially being safety significant, yet none of these potential design features had any functional requirements identified in the CSDR and in fact, the evaluation of these features appears to be put off until NCSEs are done at CD-4.

Establishing the design requirements for NCS SSCs is necessary regardless of the safety classification of the SSC. DOE-STD-1189-2016, Section 4.8.1, Safety Management Programs, states: "Such programs shall be evaluated in light of the proposed design to assure that the design supports program implementation. In some cases, design requirements need to be defined that support SMP implementation." Add to this that N-NCS-G-00136 calls for NCS SSCs with passive design features important to ensuring subcriticality be Safety Significant, a significant number of SSCs would be expected to be identified in the CSDR.

Design requirements of NCS SSCs will have facility level impacts. DOE-STD-1020-2016 and DOE-STD-3007-2017 address Natural Phenomena Hazard evaluations for NCS to meet the requirement of DOE Order 420.1C, Facility Safety, Attachment 2, Chapter III, Section 3.f. These requirements call for the establishment of NPH Design Categories (NDC) and seismic limit states of NCS SSCs. Typically, the NDC for a NCS SSC will be NDC 1 or 2 depending on the consequence analysis. There should be sufficient information at the conceptual design for NCS to identify where, for example, a seismic event may be an initiator to a criticality accident. This was found to be true in several SSCs, e.g., casting equipment, during the Uranium Processing Facility design and should be easily determined as a potential vulnerability from LANL's design and analysis.

Furthermore, S-CHA-F-00024, Rev. 2, Section 5.2.3.5 makes an erroneous statement regarding eight potential areas that may be as credited passive engineered features. It states: "At this stage, the above engineered features could be functionally classified at the highest as SS for criticality safety and would need to meet the appropriate seismic design category <u>for the facility</u>." {Emphasis added} This is not true. The seismic design category for NCS SSCs is assigned according to the consequences of a criticality accident. Making this commitment in the hazard analysis will needlessly elevate NCS SSCs to SDC-3, which through system interaction could elevate most of the non-safety SSCs in seismic design category.

The lack of maturity of the NCS design requirements seems to stem from the perspective that NCS analysts will perform their analyses after much of the design is developed. This is illustrated throughout the safety documents such as N-SDS-F-00001, Section 7.0, where it states "Detailed process analysis typical of an NCSE will be completed at a later stage of the project as the design matures when there are sufficient process details for this level of analyses." While it is true that the administrative controls may not be fully developed until later in the design, it is not true that NCS has insufficient information to develop specific design strategies and safety functions for the different parts of the process at a conceptual design level.

For example, N-NCS-F00143, evaluates potential spacing criteria for storage racks. The document goes through detail on determining item spacing within a rack. This level of detail is normally reserved for preliminary design performance criteria, and appropriately, is not carried forward into the CSDR. However, ANSI/ANS-8.7-1998 (R2017), Section 4.2.4 requires the storage of fissile materials in a manner that "accidental nuclear criticality resulting from fire or from flood, earthquake, or other natural calamities is not a concern." The preliminary NCSE treats NPH superficially. A postulated collapse or falling over of storage racks may result in a criticality accident. If so, that type of accident would result in a certain unmitigated dose. The consequence result would determine what building features and seismic design criteria (SDC) and limit states were applicable. Presently, the preliminary evaluation does not identify any passive design requirement for the storage racks or other alternative approaches to ensure a criticality accident is prevented. However, there is a recommendation in the PNCSE (but not requirement) that the racks be designed to the same seismic design criteria as the storage vault. The vault will likely be designated SDC-3 for other facility safety accidents. Therefore, if the recommendation is adopted, the racks would be SDC-3. This robust design may not make it possible to put enough racks into the existing vault that would be needed for production. It is likely, though, that the process in DOE-STD-3007-2017 would determine that NDC-1 or 2 is more applicable. Such a determination would save design and construction costs. Failure to correctly identify such criteria early in the design could also result in a lower inventory requirement (e.g., a mass control) to compensate for lack of seismic robustness, which may not meet operational needs.

Another example is the criticality accident alarm system. The CSDR states that a seismically qualified criticality accident alarm system is not needed based on an assumption that a seismically initiated event may not be credible based on a double contingency analysis in H Canyon. The CSDR further states that since it is only for facility worker protection, DOE-STD-1020-2016 states that the building code is sufficient so an SDC is not assigned. This is not compliant with the collective requirements in DOE-STD-1189, 1020, and 3009 that establish NPH criteria based on unmitigated dose. The CSDR states that the unmitigated dose from a criticality accident to the collocated worker will exceed 5 rem, which makes the requirement SDC-2. If a criticality accident is initiated by a seismic event, the criticality accident alarm system cannot be credited to mitigate the consequences to the facility worker. This should be determined at the conceptual design phase and identified in the CSDR per DOE-STD-1189 because a criticality accident initiated by a seismic event has not been demonstrated to be not credible. The cost implications for not making this determination may be significant.

A lesson learned from the Uranium Processing Facility design in Oak Ridge, TN was that the NCS staff did not realize early enough in the design that they were actually responsible for design criteria and not simply an analysis after the fact. When that was rectified, early safety functions associated with NCS SSCs were established, identified in the safety documents, and design requirements were established to meet those safety functions. The UPF NCS organization soon after adopted the concept from DOE-STD-3009-2014 to document the safety function, functional requirement, and performance criteria into the preliminary criticality safety evaluation. This facilitated complete integration between facility safety, criticality safety, and the design organizations. The final report for CSSG Tasking 2011-04 identified a noteworthy practice of the UPF project related to the development of a SSC table that included NCS SSCs.

Observation 3: There is no description of the NCS strategy to be employed for each part of the operation in either NCS documents or the CSDR.

Basis: It is important to establish the NCS strategies to be employed for each part of the operation by the end of the conceptual design. These strategies are not detailed limits, but rather are the philosophy that will be used to establish those limits and subsequently design criteria to be used in preliminary design. The focus of current NCS documents are sensitivity studies that will be more applicable to preliminary design. DOE-STD-1189-2016, Section 4.3.4 requires that hazard control strategies for significant hazard scenarios and DBAs be identified in the hazard analysis. NCS control strategies should be identified even if the result does not identify major NCS SSCs as safety NCS SSCs.

The lack of specific process strategies will often result in the need for administrative controls in lieu of design features because it will be too late to incorporate changes to design as design proceeds. The specific strategies would, at a high level, state anticipated nuclear parameters to be controlled, and the passive and active design features needed to control these parameters. In some cases, there will not be a cost effective engineered feature, so administrative controls will be necessary. For example, many mass upset conditions in glovebox operations rely on administrative controls. Yet, a simple engineering approach of limiting placement positions within a glovebox may eliminate the need for an administrative control.

No specific approach to ensure subcriticality in each operational process appears to have been decided upon, thereby making the preliminary evaluations and the subsequent NCS design criteria document too general to enable design. This supports the observation that NCS engineers are on the back end and not the front end of design as intended by DOE-STD-1189-2016.

Observation 4: Integration of NCS with other safety management programs such as fire protection and security appears to be lacking.

Basis: A review of the SDS and CSDR and hazard analysis tables gives strong indication that each discipline is analyzing their functional area without considering conflicting requirements or approaches. These conflicting approaches should be noted in the CSDR as a risk item. A couple of examples follow based on lessons learned from various projects that were documented in CSSG Tasking 2016-05, *Regulatory Impediments to Effective Operational Nuclear Criticality*, and Tasking 2013-01, *CSSG Position on Use of Water for Firefighting in Light of Criticality Constraints for DOE Facilities*.

Referring back to N-NCS-F00143, the evaluation states that flooding is not credible based on the size of the room and that automatic water suppression is assumed as a possibility. Fire protection requirements in DOE-STD-1066-2016 require the retention of water from sprinklers for a duration that is typically 30 minutes or more for a design basis fire. The amount of water discharged in 30 minutes is significant. Yet there are no functional requirements in the NCS evaluation requiring that the bottom positions be above the level of water collected by a sprinkler system or that drains have sufficient capacity to prevent flooding.

For areas with a significant amount of fissile solution, the requirement to collect fire water becomes a design conflict in that it competes with the NCS requirements to control geometry or volume. This was a particular problem with the UPF design.

NCS strategies should state what processes will be governed by moderation control so that fire protection can plan alternate fire protection strategies. At the conceptual stage of design, these strategies should be known and if any conflicts are identified, they should be listed as a risk.

There are also potential conflicts with security requirements and the requirements to evacuate during a criticality accident. Resolution of those conflicts impact design.

Observation 5: Lessons learned from other recent design projects do not appear to be integrated into the NCS evaluation of hazards or establishment of design criteria.

Basis: A significant portion of the design comes from the process at Los Alamos National Laboratory (LANL). The processes at LANL have been evaluated for a criticality accident, and the strategies associated with that evaluation should be reviewed and adopted as appropriate. There is no indication in the documentation reviewed that such strategies have been evaluated.

Furthermore, the processes for integrating criticality safety into design has been developed, refined, and thoroughly tested at the UPF project. The experience of the UPF project would have provided valuable knowledge to the SRPPF on integrating criticality safety into both the safety basis documents and the design.

Observation 6: Section 7.4 of the CSDR, Safety in Design Risks and Opportunities, may understate the risk associated with NCS impact on design.

Basis: There is only one risk identified in the CSDR associated with NCS. This risk is associated with NCS controls potentially limiting production. The risk is shown as has having all the mitigating actions completed with a low level of risk. Yet it is clear that this risk has yet to be realized and it is questionable that sufficient information has been presented for NNSA to determine that the risk has been addressed.

Experience with many other projects shows that there have been many project risks associated with NCS that adversely affected project costs and schedule. Several of these issues are documented in CSSG Tasking Report 2016-05. While it may be possible that many of the risks have been worked out based on the LANL design, the submitted documentation shows that NCS input is too immature to only have one risk.

Observation 7: The design strategy to meet the fissile material accumulation control requirement in DOE Order 420.1c, Facility Safety, Attachment 2, Chapter III, Section 3.e does not appear to be addressed.

Basis: DOE Order 420.1c, Facility Safety, Attachment 2, Chapter III, Section 3.e has a requirement to be able to detect and monitor inadvertent fissile material accumulation. The recent issues at the Y-12 facility highlight the importance of this requirement. The review did not identify this functional requirement in NCS documents. A control strategy and potential control alternatives would be expected to be identified at conceptual design.

Observation 8: Important and material inconsistencies remain between the SDS, the CSDR, and the implementing documents (PNCSE, PFHA, PCHAP) leading to potential confusion, design impacts, and cost impacts.

Basis: Descriptions of the ventilation system (HEPA vs Sand Filter), Fire Protection system (full water based vs moderation control) are inconsistent between the SDS and the CSDR. Assumptions made during Hazards Analysis, Fire Hazards, and PNCSEs reflect these different descriptions and call into question the completeness of the control strategies put forward. Inconsistent statements about the use or prohibition on water as a suppressant occur in Section 5 of the SDS, as compared to section 7.5.7 of the CSDR. The PFHA was developed assuming full water suppression in all rooms, while the PNCSEs appear to in some cases follow moderation control while in others assume full flooding from sprinklers.

As noted in Observation 4, it is suggested that these decisions be made by an integrated team, based on an informed understanding of the relative risk of the hazards being presented.

The recommendations are as follows:

Recommendation R1: Establish the NCS strategy for each process. The NCS strategies should be at a high level (e.g., nuclear parameters to be controlled) and should identify if the parameters are to be controlled by passive engineered features, active engineered features, or administrative control. Existing information from other sites regarding pit production (whether it is plutonium or uranium) will simplify this task and will capture lessons learned from the application of implemented strategies to design.

Recommendation R2: Document the safety function, functional requirement, and performance criteria for NCS SSCs. These elements are required per DOE-STD-1189-2016 for safety SSCs but should also be performed for major NCS SSCs regardless of classification. Safety functions will not typically change from conceptual design to final design, and the strategies established in Recommendation 1 will establish those safety functions. Functional requirements should be identified as early as possible in the preliminary design along with a listing of what performance criteria are to be developed during the preliminary design phase. These requirements may change as design progresses; however, for the most part they will remain unchanged. Performance criteria are quantitative criteria. In some cases, that information will be identified at the conceptual stage, particularly for NPH hazards. Often, the performance criteria are developed throughout the preliminary design phase. This is needed to support an integrated project schedule and to identify project risks and opportunities as early as possible. Waiting until the final design stage to establish performance criteria will have an adverse effect on the project cost and completion. An example for a hypothetical storage vault is provided in Attachment C.

Recommendation R3: Identify the conflicts between the NCS strategies and other safety management programs and security to identify areas of risk to the project. When functional requirements have been identified, they can be evaluated with other design and safety disciplines to determine potential functional classifications per N-NCS-G-00136 and conflicts with other design strategies. These conflicts can then be identified as risks to the project and addressed accordingly.

Recommendation R4: Supplement the NCS Design Criteria Document to include guidance developed through closure of the first three recommendations and the inclusion of fissile material accumulation control requirements. Examples can be found by reviewing the UPF NCS Design Guide.

Recommendation R5: Delete the statement in S-CHA-F-00024 requiring NCS SSCs with a seismic safety function to be at the same SDC as the facility. NCS SSCs are assigned NDCs based on the unmitigated consequences of a criticality accident.

Recommendation R6: Update the Safety Design Strategy, as required by DOE-STD-1189-2016, to be consistent with the approaches presented in the CSDR.

3.2 EA31 Comments

This section of the report addresses the two CDNS comments regarding NCS on the SDS submittal.

Documents Reviewed (see Attachment 2)

- N-SDS-F-00001, Rev. 0
- Letter Dan Sigg to D. Alldridge and Scott Cannon; *Advice on approval of SDS for the SRPPF*; August 7, 2019.
- NNSA-SRPPF-119-0004A, SRPPF Code of Record, Rev 0

Review Results

Observation 9: CDNS discusses SRPPF taking advantage of lessons learned from other DOE facility projects. The CSSG concurs with this recommendation.

Basis: This is discussed further in both the strategy section of the CSSG report as well as the PNCSE section of the CSSG report. The CSSG has stated in CSSG Tasking response 2016-05 that failure to observe some of these lessons learned from past DOE design projects has caused significant cost/schedule/scope issues with those projects. Several of these lessons (e.g., code of record changes, fire suppression vs criticality safety, application of NPH for seismic) are directly applicable to the SRPPF project. In addition, lessons learned from facilities which are operating similar processes, will aid in the determination of credible contingent conditions and ensure proper application of design features to prevent or mitigate these potential upsets. This information will be very important moving into preliminary design.

Observation 10: CDNS recommends SRPPF reevaluate the SDS for inclusion of current DOE nuclear safety requirements (namely DOE O 420.1C chg 3 and DOE-STD-3007-2017). The CSSG agrees with this recommendation.

Basis: While the CSSG is very sensitive to the changing of the code of record during the design phase (see CSSG Tasking Response 2016-05), the CSSG agrees with this recommendation (and the direction provided in NNSA-SRPPF-119-0004A) as both DOE Order 420.1C chg 3 and DOE-STD-3007-2017 bring the code of record into consistency with approaches/assumptions in DOE-STD-3009-2014 which is being used for SRPPF. Use of DOE-STD-3009-2014 with the older DOE-STD-3007 may lead to inconsistencies in the approach for documentation of criticality safety and incorporation of NCS into the safety basis documents. The review team notes that the "Code of Record Document" reviewed does commit to these "current DOE NCS requirements documents". The CDNS recommendation goes on to state that the SRPPF project consider the CTA position memorandum regarding the consideration of evaluation basis events in criticality safety evaluations. The CSSG has recently issued a tasking response (2020-03) that provides a review of DOE Order 420.1C, Chapter III, 3.f and provides recommendations consistent with the CTA position paper. Tasking 2020-03 concludes that DOE-STD-3007-2017 provides sufficient guidance to address NPH events.

Recommendation R7: SRPPF should review and evaluate the CSSG tasking response provided in Tasking 2020-03 as they are reviewing the CTA position memorandum and should take appropriate action during the next revision of the SDS to reflect this approach.

3.3 Material Handling

The SRPPF operations are largely mirrored on those at the plutonium facility at Los Alamos National Laboratory. The various handling operations involve hand-carrying (small) items, transport of items between gloveboxes, rooms and modules on carts and on drum-handling conveyances as well as via an overhead trolley system. Within gloveboxes and for vault placement and retrieval, movements will generally be hands-on.

While not addressed in the reviewed documents, fissile bearing liquids will be required to be transferred in limited diameter piping between gloveboxes and rooms within the Aqueous Recovery modules and limited volume and limited dimension solution process vessels will also be required, unless neutron poisons are employed.

Documents Reviewed (see Attachment B)

- N-SDS-F-00001, Rev. 0
- S-CSDR-F-00001, Rev. 0
- S-CHA-F-00024, Rev. 2
- SRNS-IM-2019-00013, Rev. 0
- N-NCS-F-00141, Rev. 1
- N-NCS-F-00142, Rev. 1
- N-NCS-F-00143, Rev. 1
- N-NCS-F-00144, Rev. 0
- N-NCS-F-00145, Rev. 1
- N-NCS-F-00146, Rev. 1
- N-NCS-F-00147, Rev. 0
- N-NCS-F-00150, Rev. 0
- N-NCS-G-00136, Rev. 5
- S-CLC-G-00393, Rev. 0
- G-FRD-F 00001, Rev. 0
- F-PFHA-F-00045, Rev. 0
- S-CLC-F-00712, Rev. C

Review Results

Observation 11: There is little discussion or design guidance concerning material handling in the documents provided to the review team. In particular, there is no discussion of the various containers and vessels that are being considered for the various movement and storage operations. The only preliminary designs provided are a slab tank solution array and a single glovebox storage layout and a vault storage layout, but with no alternative storage options.

Basis: While the level of detail may be appropriate at the conceptual design phase of facility design, significant thought should be given to the efficient routing of the trolley consistent with glovebox placements and to the movement of fissionable materials between floors. Within gloveboxes, hands-on movement will be the norm and thus the locations of gloveboxes and the equipment therein will need significant ergonomic and material flow considerations. There is a recommendation to have fixed spacing arrangements in vault cubicles and to design glovebox and vault rack storage such that items will remain in place during a design seismic event. This may be excessively conservative. The containers themselves may assure subcriticality even for items falling to the floor during an earthquake and with or without flooding. Not requiring fixed spacing or seismic qualification might also provide valuable storage flexibility. Storage of loaded shipping containers (incoming and outgoing) according to the Criticality Index formalism will also be needed. These considerations may result in NCS safety functions affecting the conceptual design layout.

Observation 12: There are recommendations to have transport devices such as carts and trollies provide fixed spacing between items being transported and to maintain their payload during normal and credible abnormal conditions. These may be excessively conservative recommendations (with associated costs and operational flexibility implications). There were no alternative options provided.

Basis: The goal of criticality safety is to assist in the design of safe, efficient operations. There are many avenues to the goal of accident prevention and, for example, the containers holding the fissile items may themselves provide the robustness, separation, and neutron absorbing properties that preclude credible criticality accidents.

The following are recommendations to address the cited observations:

Recommendation R8: Coordinate with process operations staff, design engineers and others as needed to determine what the various container dimensions, masses and materials of construction are planned for use for the various non-solution transportation and storage operations. Apply this information to formulate various options for transportation and storage of fissile material throughout the building. Analyze these options neutronically and provide the results to operations staff for review and further iterations.

Recommendation R9: Coordinate with process operations staff, design engineers and others as needed to explore fissile solution handling and storage needs and options, both internal and external to gloveboxes. Analyze these options neutronically and provide the results to operations staff for review and further iterations.

Recommendation R10: Review containers, birdcages, carts, trolleys, etc., used at other sites as part of the consideration of design alternatives.

3.4 Criticality Accident Alarm System (CAAS)

The SRPPF documentation provided clearly identifies the intent to utilize the existing NIMs system in use at SRNS. These are gamma-only detectors. In the preliminary calculations for placement, a non-conservative direct path is used. Slant thicknesses should be used which can heavily impact the number and placement of detectors. A fast metal critical spectrum was used for the preliminary analysis when the more conservative long-moderated accident is more appropriate as is noted in the project documentation itself, but this is not identified as a design risk.

Reviewers also noted that there were additional big, picture items that were not addressed, but the detail of placement was. Some of these concerns were that the seismic qualifications for the CAAS were not addressed, and it was not clear that alternatives to the gamma-only system were considered. DOE-STD-1189-2016, Section 4.3, specifically states that during the conceptual design phase, alternatives for satisfying the mission need are evaluated in detail to identify the preferred alternative for preliminary design. There was no evidence in the documentation reviewed that this objective was met for the CAAS. Modern, commercially available systems could offer clear operational advantages. LLNL, LANL and UPF have all documented studies on this topic – none of which were identified or referenced.

Documents Reviewed (see Attachment B)

- N-SDS-F-00001, Rev. 0
- S-CSDR-F-00001, Rev. 0
- S-CHA-F-00024, Rev. 2
- SRNS-IM-2019-00013, Rev. 0
- N-NCS-F-00141, Rev. 1
- N-NCS-F-00142, Rev. 1
- N-NCS-F-00143, Rev. 1
- N-NCS-F-00144, Rev. 0
- N-NCS-F-00145, Rev. 1
- N-NCS-F-00146, Rev. 1
- N-NCS-F-00147, Rev. 0
- N-NCS-F-00150, Rev. 0
- N-NCS-G-00136, Rev. 5
- S-CLC-G-00393, Rev. 0
- G-FRD-F 00001, Rev. 0
- F-PFHA-F-00045, Rev. 0
- S-CLC-H-01168, Rev. 0

Review Results

Observation 13: The proposed, revised Minimum Accident of Concern (MAC) in an upcoming revision to ANSI/ANS-8.3 might enable spacings that are farther apart than the current MAC permits.

Basis: The current version of ANS-8.3, to which SRS must adhere, is under revision and will likely be finalized and approved by the ANS and adopted by the DOE within a year or two, long before a CAAS will need to be installed. SRS staff should be aware of potential changes to the MAC and other relevant sections of the standard.

Observation 14: Current System Design is to trip at >= 2 R/hr. Modern, off-the shelf CAAS designs, e.g., CIDAS installed at Y-12, trip at about 0.1R/hr. This is a factor of 20 increased sensitivity to a criticality accident and would seem to be able to increase the spacing between detector clusters (reduce the number of clusters) significantly. The CIDAS system also seems to have very high reliability, ease of installation, etc.

Basis: The selection of the NIMS does not seem consistent with the off-the-shelf preferences of DOE-STD-1189. No discussion of alternatives to this identified safety significant SSC is presented in the CSDR. The Design Authority review of available commercial systems and discussions with Y-12 and other sites seems appropriate.

Observation 15: N-NCS-F-00142 seems to indicate that accessibility and maintainability of the detector locations is a significant concern. If this is based on experience with current installed systems at SRS, then the newer systems such as CIDAS may alleviate this concern. While this document states: "Using detectors with a lower set point could reduce the number of detectors needed but could (Section 5.1; “would” is used in Section 7) also increase the likelihood of false alarms.”

Basis: The concern for false alarms with state-of-the-art systems seems to be unwarranted. To the contrary, they seem to have a much less likelihood of false alarms than systems from past decades.

This document also states in Section 4.2: "For the purposes of this study the example fast criticality spectrum from SRNS-IM-2009-00035 will be used.”

It also acknowledges that “In some cases, a thermal criticality is more conservative (i.e., results in a smaller effective detector range) and could require more detectors to provide adequate coverage.”

Indeed, a solution or solution-like (e.g., flooded plutonium powders or fines) criticality accident has historically shown itself to be much more likely in the US and worldwide than a fast spectrum criticality accident. Relatedly, a non-solution-like criticality accident (e.g., plutonium metals or dry powders) has only been reported once and that accident occurred under operational conditions that are considered to be extremely unlikely to be found in any US facility today. Thus a solution or solution-like criticality accident may be the only credible criticality accident, and this could limit the facility locations where CAAS coverage is deemed to be warranted. This could then further impact evacuation requirements, muster locations, etc.

Observation 16: If prior MOX Facility designs evaluated CAAS requirements, designs, detector placements, etc., then the reports may be useful to current designers.

Basis: No MOX Facility documentation was directly referenced or provided to reviewers.

Recommendation R11: Review reports by LLNL, LANL and UPF regarding commercially available criticality accident alarm systems and compare the advantages of these commercial, off the shelf systems with the SRS NIMS. These systems include, but are not limited to: CIDAS Mk XI (Cavendish Nuclear), IS820 CIDS (Ultra Electronics), CAAS-3S (Mirion Technologies), EDAC 21 (Mirion Technologies), GA-6/7M (Nuclear Measurements Corporation).

3.5 Preliminary Nuclear Criticality Safety Evaluations (PNCSEs)

DOE-STD-1189-2008 and 2016, *Integration of Safety into the Design Process*, were developed to fulfill the project management objectives established by the Deputy Secretary of Energy in 2005. These objectives are to fully integrate safety early into the design and by the start of preliminary design the safety requirements for the design be established.

DOE Order 420.1 requires the adoption of the ANSI/ANS standards on Criticality Safety, including ANSI 8.1, *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors* and ANSI 8.19 A*dministrative Practices for Nuclear Criticality Safety*. ANSI 8.1 further requires in section 4.1.2 that before a new operation is begun…it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions. ANSI 8.19 restates this requirement in section 7.1 and further amplifies this with requirements during the evaluation for input from operators and other knowledgeable individuals. Preliminary NCSEs fulfill the role of documenting the performance of these evaluations in a manner such that controlled parameters and their limits can be provided to the design agency to integrate safety into the design and minimize later rework in the project.

This section of the report evaluates the process used to generate the PNCSEs, as well as an overall evaluation of the potential for a criticality event via the requirement for process analysis of all normal and credible abnormal conditions. Furthermore, this section addresses the flow of the results of those evaluations into design space/requirements for the facility.

Documents Reviewed (see Attachment B)

- N-NCS-F-00147 Rev. 2,
- N-NCS-F-00145, Rev. 1,
- N-NCS-F-00144, Rev. 0,
- N-NCS-F-00143, Rev 1,
- N-NCS-F-00141, Rev. 1,
- N-NCS-F-00150, Rev. 0,
- N-NCS-F-00146, Rev. 1,
- SRNS-IM-2019-0013, Rev. 0

Review Results

<u>Observation Regarding the PNCSE Process.</u>

Observation 17: SRNS-IM-2019-0013 provides information as to the expected format of the PNCSEs, however it does not provide enough guidance on content or philosophy to generate acceptable PNCSEs.

Basis: SRNS-IM-2019-0013, while providing a format for the PNCSEs, does not provide the reasoning for the PNCSE as an aid to design for the facility/processes. It also does not require the interaction with operators or "knowledgeable individuals" during its development. The document is also silent as to how to flow the results of the PNCSEs into documents that the designers will use during the preliminary design process. The Desktop instruction provides the capability to perform parameter studies which require less process analysis. However, these are to be numbered differently from a PNCSE. Some of the PNCSEs appear to be more closely related to parameter studies, however, are numbered as if they are PNCSEs.

<u>Observations Regarding the PNCSE Results.</u>

Observation 18: The current PNCSEs do not provide enough guidance to the design agency to integrate NCS into the design in a way to ensure project success.

Basis: A review of the PNCSEs (Results, Design Features) and the NCS Design criteria document show that a number of design features and/or engineered features which were discussed/credited in the PCHA tables have not been included nor have events, discussed in those tables, been evaluated in the PNCSEs. This leads to the condition where the safety basis documents have one set of assumed controls, while the PNCSEs are not consistent and therefore do not flow the proper controls/features to the designers to be incorporated into the preliminary design. This may be an artifact of the approach in the SDS that NCSEs will be developed to support CD-4 (which is too late to be effective in integrating safety in design – see recommendations in the strategy section of this report).

Observation 19: The PNCSEs emphasize calculations and provide little information related to how the hazard analysis was performed, who was involved in identifying hazards, scenarios and likelihoods.

Basis: The methodology described in the PNCSEs is focused on the calculational methodology and validation as are the results. ANS-8.1 clearly requires process analysis. DOE STD-3007 strongly suggests the team approach for hazards analysis supporting NCS to include operators or other knowledgeable individuals. Several PNCSEs do not appear to capture lessons learned from other similar processes/designs around the complex.

Observation 20: Validation/Methodology sections within the PNCSEs are not consistent between the PNCSEs, have incorrect or misleading statements, and do not credit all the available benchmarks that are available to cover the discussed Area of Applicability.

Basis: The PNCSEs inconsistently list ANSI 8.24 or 8.3 as the reference for the validation requirements, the generation of the MSM varies between the PNCSEs. For example, several complex processes involving melting, salt transfer and solidification are listed as "simple; effects of chlorine on the reactivity of the system are incorrectly accounted for (discussion of Cl reducing reactivity once Pu becomes "molten"); not applying available Pu benchmarks that cover the area of applicability (Pu in the intermediate range not being covered by Pu-Tex experiments currently in the ICSBEP Handbook). Some PNCSEs using keff + 2*sigma while others are using keff + 1.65*sigma to compare against Ksafe. The NCS Methods Manuals states keff+2*sigma will be used. AOA discussion does not take temperature into effect, even for those configurations where molten Pu is being evaluated, nor is Pu dispersed in salt considered in the AOA discussion.

Observation 21: All contingencies which could impact design have not been considered during the process analysis for each PNCSE.

Basis: A review of the PCHA events, and knowledge of similar events at other facilities, would lead to scenarios/contingencies not being fully evaluated. Credible water sources and effects of NPH events, are just two that consistently are not fully evaluated within the PNCSEs. Dry machining, where the fines are assumed to be "dispersed evenly" does not provide design guidance on the need for filtration at the glovebox/ventilation interface in a way that facilitates inspection and limits accumulation. Reference is made to adopting LANL ER limits that may have been significantly lowered since their development based on further contingency analysis. ANSI 8.1 requires that all processes undergo process analysis prior to operation. Full evaluation of these events could lead to further design considerations that would need to be shared with the designers for consideration during preliminary design. PNCSEs evaluations are not always consistent with the design strategy listed in the SDS (e.g., use of firefighting water in various parts of the facility).

Observation 22: There is no discussion or determination as to the "likelihood or credibility" of a criticality accident which would be required to properly scope the CAAS evaluation and set appropriate SDC levels.

Basis: DOE STD 3007 and SCD-3 suggest that each NCSE provide a determination of the credibility of a criticality accident for the process being evaluated. This credibility determination plays into the need/magnitude of controls necessary for seismic design as well as the need/classification of the CAAS. Design guidance that the gloveboxes and internals be designed to the same SDC level as the facility may result in severe over conservatism and cost to the project. The SDC level should be based on criticality potential for credible events. This could impact the gloveboxes, staging and the vault design.

Observation 23: The formatting from the Desktop instruction has not been carried into the PNCSEs.

Basis: The Desktop instruction states there should be a section 7.4 which contains any open data needed to complete the NCSE. This is a good place to capture information (leading to an assumption, or missing data needed) that should be tracked to ensure the information is obtained and factored into the PNCSE. A review of all the PNCSEs showed none of them contained this section or any indication of open items which need to be carried forward.

<u>Observations Regarding Flow of PNCSE results to Design</u>

Observation 24: Controlled parameters and design features from the PCHA event tables have not been flowed into the PNCSEs or the NCS Design Criteria document.

Basis: A review of the PCHA tables shows where design features were discussed in the PCHA tables, however these design features are not listed in the PNCSEs for the similar process. These design features were also not carried forward into the NCS design criteria document. The lack of this consistency could result in preliminary designs being generated that are found to either not be satisfactorily protected from an NCS standpoint, or that later become a bounding NCS event. There are also cases where PNCSE results show scenarios which exceed ksafe without changes to the design or design parameters being controlled.

The primary recommendations regarding the PNCSEs are**:**

Recommendation R12: SRNS-IM-2019-0013 should be revised to include a discussion on the purpose of the PNCSE as well as further expectations about the proper determination and flow of design constraints/requirements associated with NCS.

Recommendation R13: Using the results of the evaluation of each portion of the process and determination of the safety philosophy to be used (see Strategy section recommendation, Attachment 3), the PNCSEs should be revised taking into account the information available in the PCHA tables and event descriptions. This should be done in consultation with operators/NCS which operate similar processes at other facilities (e.g., LANL, Y-12, AWE, LLNL). This consultation will aid in ensuring: (1) basic contingencies for that operation have been considered to determine if design will need to be constrained as part of integration of safety into design, (2) that the preferred hierarchy of engineered features (passive and active) are considered before administrative controls, and (3) that lessons learned associated with those operations/design are considered during the evaluatio**n.**

Recommendation R14: The results of the updated PNCSEs should be flowed into N-NCS-F-0147 with definitive guidance as to the NCS design criteria that design will need to adhere to during the preliminary design. The UPF project developed a very useful and detailed NCS design criteria document which should be reviewed for format, content and applicability.

Recommendation R15: Prior to revising PNCSEs, consideration should be given to developing a SRPPF NCS input document which will standardize the input information for NCS evaluations. This document could cover the approach for: validation (including updating the benchmarks to cover the area of applicability where available), the materials input (same material input values for concrete, steel, and other materials used in the PNCSEs), expectations for NPH and fire suppression and other common areas of the PNCSEs. The UPF project developed an NCS analysis guide that establishes parameters to be used when performing modeling of the systems (e.g., material properties) to ensure consistency in the resultant design criteria from one analyst to another. This guide should be reviewed for format, content and applicability.

3.6 Nuclear Criticality Safety (NCS) Program

This section of the report addresses the NCS Program to support the SRPPF project. CSSG Tasking 2017-05 evaluated the Savannah River Nuclear Solutions (SRNS) Nuclear Criticality Safety Program. This review does not duplicate that review. Rather, it reviews the program ability to support a major design effort. The staffing and NCS organization are not described in the submitted documents, so the review is unable to provide a position regarding the adequacy of staffing. The review did look at NCS documents made available and whether any areas of improvement from the Tasking 2017-05 report have been addressed. Any observations in this area are limited to what was provided.

Documents Reviewed (see Attachment B)

- N-SDS-F-00001, Rev. 0
- S-CSDR-F-00001, Rev. 0
- S-CHA-F-00024, Rev. 2
- SRNS-IM-2019-00013, Rev. 0
- N-NCS-F-00141, Rev. 1
- N-NCS-F-00142, Rev 1
- N-NCS-F-00143, Rev. 1
- N-NCS-F-00144, Rev. 0
- N-NCS-F-00145, Rev. 1
- N-NCS-F-00146, Rev. 1
- N-NCS-F-00147, Rev. 1
- N-NCS-F-00150, Rev. 0
- N-NCS-G-00136, Rev. 5
- S-CLC-G-00393, Rev. 0
- SRNS-P0000-2020-00026

Review Results

Observation 25: The NCS processes appear to follow, rather than lead/fully participate in design. They are structured to support an already operating process and not a new process yet to be developed.

Basis: N-NCS-F-00147 provides the following note in the purpose statement {emphasis added}:

"Note: At this stage, the criticality safety design criteria provided in this document are based on criticality safety engineering staff expertise, lessons learned from current and past fissile material operations, and preliminary analysis {sic} that are scoping in nature. Consequently, the criticality safety design criteria should not be construed as requirements and limits but design recommendations. They can be refined with more detail and specific analyses. Limits and requirements will be defined at a later stage of the project, as the design matures, when there are sufficient process details for formal nuclear criticality safety evaluations."

The UPF project adopted a similar approach of waiting for design to "mature" in order to perform analyses. This was soon discovered to cause schedule slippage and rework. The Safety Design Strategy and the Conceptual Safety Design Report clearly state that NCS "evaluations" are to be performed late in the design process, which misses the point that NCS engineers need to be fully participating in the design; not following the design. Unlike other design disciplines that have pre-established design standards for safety significant or safety class SSCs, the NCS engineers have to determine the functional requirements and performance criteria for most, if not all of the NCS SSCs. The NCS engineers involved in design should be no different than other disciplines involved in design. They should be establishing the design requirements to be applied. National handbooks, ANSI/ANS-8 standards, existing analyses from other organizations, process hazards analyses, and NCS analyses can all be used to establish design criteria. The criteria is expected to evolve as the design evolves.

Observation 26: The design criteria presented in N-NCS-F-00147 do not give other designers sufficient information to incorporate NCS requirements into the design.

Basis: The design criteria document contains generalities and permissives that do not define the design requirements. Three simple examples follow.

N-NCS-F-00147, Section 2.1.1 states that "It is desirable, from a nuclear criticality safety perspective, that the facility be designed such that it will maintain integrity during DBAs." No specific portion of the facility is defined to need to "maintain integrity", nor is the quoted phrase sufficient to design to. In the absence of a criteria, the structural designers will design all equipment to SDC-3, Limit State D because that is the most conservative approach to follow per guidance in DOE-SDT-1189-2016. Such an approach will likely be irreversible because of the length of time to revise seismic and structural analyses and will result in excessive cost.

Section 2.1.2 of that same document regarding the building fire suppression system states: " … it is recommended that the building fire suppression system be designed to ensure that rooms cannot flood to the level of any plutonium handling operations (thereby avoiding full reflection of the fissile material and potential water mixing with the fissile material)." The fire protection strategy for this facility calls for use of sprinkler water throughout, and sprinkler systems are designed to NFPA-13. The concept described above is not applicable to the sprinkler system itself, but rather to the building and internal equipment design. No functional requirements are specified that limit the distance from fissile material for the purpose of reflection control. If the distance from fissile material has not been established, the design criteria should state clear functional requirements for the applicable processes, with performance (design) criteria noted as "to be determined". That allows the other design organizations the ability to specify when that information is needed to establish a critical path schedule to proceed with design.

Section 2.1.3 refers to "geometrically favorable drains and sumps" that may be required for "some process areas". This does not give direction to other design engineers and may have a significant impact on an existing building.

Observation 27: SRNS-IM-2019-00013 is the desktop guide for developing preliminary NCSEs, and this guide does not address a recommendation by the CSSG regarding common mode failure as documented in the tasking report for CSSG Tasking 2017-05.

Basis: A review of the NCS program by the CSSG identified a need for establishing a formal method of determining common mode failure. The desktop guide does not address common mode failure, nor reference where this guidance may be documented. A common mode failure may drive NPH design criteria that would have to be specified in the CSDR.

Observation 28: Changes in process conditions from upset contingencies may not be protected by the NCS design criteria.

Basis: The CSSG Tasking 2017-05 report noted that evaluations appeared to be weak in the area of addressing normal and credible abnormal conditions. The various NCS documentation provided made it clear that full contingency analyses were not performed due to maturity of design. Some "traditional" changes in process conditions were considered such as fissile mass upsets, but these upsets are not tied to the actual operating process.

The recommendations presented in Section 3.1, SRPPF Strategy Review, and those presented in Section 3.5, Preliminary Nuclear Criticality Safety Evaluations, will also address these observations.

3.7 Waste Management System (WMS)

This section of the report evaluates the strategy of addressing a criticality accident hazard associated with the Waste Management System as documented in the SDS and CSDR. The primary activities associated with waste handling in Building 226-F are to move, package, stage, and characterize solid waste. Liquid wastes are solidified through the Aqueous Recovery/Recycle system or are treated at the Effluent Treatment Facility.

Documents Reviewed (see Attachment B)

- N-SDS-F-00001, Rev. 0
- S-CSDR-F-00001, Rev. 0
- S-CHA-F-00024, Rev. 2

Review Results

Observation 29: A review of the hazard analysis shows a potential for a criticality accident with the only potential design feature as a Type B container. None of the preliminary NCS evaluations address the Waste Management System.

Basis: The activities of moving, packaging, staging and characterizing waste may not need facility level design requirements to be identified in the CSDR, so this level of information related to NCS may be appropriate for the Waste Management System. The preliminary hazard analysis may be sufficient to support this hazard.

Given that no NCS strategy is provided for Waste Management, a more detailed review is not possible. No specific recommendations are provided. It was noted that the Fire Scenario Document acknowledged a change to design to support a strategy of "package at risk" and therefore removed a glovebox for waste packaging and replacing in with a room to repack drums. Criticality safety should address these design options. No other specific details were observed.

3.8 Material at Risk (MAR) Calculations

Material-at-Risk values associated with the various processing modules are presented in document N-ESR-F-00043, Rev. 2 and S-CLC-F-00712 Rev C. The MAR values are driven primarily by the Pu-239 isotope and the MAR quantities are far in excess of minimum critical mass values. However, possible MAR limits on specific process operations and locations are not provided.

Documents Reviewed (see Attachment B)

- N-SDS-F-00001, Rev 0
- S-CSDR-F-00001, Rev. 0
- S-CHA-F-00024, Rev. 2
- SRNS-IM-2019-00013, Rev. 0
- N-NCS-F-00141, Rev. 1
- N-NCS-F-00142, Rev. 1
- N-NCS-F-00143, Rev. 1
- N-NCS-F-00144, Rev. 0
- N-NCS-F-00145, Rev. 1
- N-NCS-F-00146, Rev. 1
- N-NCS-F-00147, Rev. 0
- N-NCS-F-00150, Rev. 0
- N-NCS-G-00136, Rev. 5
- S-CLC-G-00393, Rev. 0
- G-FRD-F 00001, Rev. 0
- F-PFHA-F-00045, Rev. 0
- N-ESR-F-00043, Rev. 2
- S-CLC-F-00712, Rev. C

Review Results:

Observation 30: MAR values throughout the various process modules are much greater than the critical masses of the plutonium being handled. Such high MAR values will generally not impact criticality safety considerations.

Basis: Minimum critical masses for credible criticality accident scenarios are likely to be far below MAR value limits for the isotopics of the plutonium to be processed. If credit for container robustness can preclude items from contributing to MAR inventories, then perhaps smaller, residual MAR values could assist in supporting criticality safety limits.

The following recommendation is provided to address the observation:

Recommendation R16: If there are plans to exclude stored/staged plutonium from the MAR inventory and release considerations based on container robustness, then this strategy should be documented and details provided as part of the criticality design strategy.

3.9 Dose/Shielding Calculations – combined with 3.10

This review topic, as it pertains to nuclear criticality safety, has been combined in the discussion presented in Section 3.10.

3.10 Accident Dose Analysis and Consequence

The unmitigated criticality accident scenario dose evaluations (document S-CLC-F-00712 Rev. C and references thereto) are based on a (seemingly) conservative assumption regarding fission yield but non-conservative assumption regarding accident duration. The results are modestly below DOE dose guidelines for both the occupationally exposed personnel (OEP) and the MOI.

Documents Reviewed (see Attachment B)

- N-SDS-F-00001, Rev. 0
- S-CSDR-F-00001, Rev. 0
- S-CHA-F-00024, Rev. 2
- SRNS-IM-2019-00013, Rev. 0
- N-NCS-F-00141, Rev. 1
- N-NCS-F-00142, Rev. 1
- N-NCS-F-00143, Rev. 1
- N-NCS-F-00144, Rev. 0
- N-NCS-F-00145, Rev. 1
- N-NCS-F-00146, Rev. 1
- N-NCS-F-00147, Rev. 0
- N-NCS-F-00150, Rev. 0
- N-NCS-G-00136, Rev. 5
- S-CLC-G-00393, Rev. 0
- G-FRD-F 00001, Rev. 0
- F-PFHA-F-00045, Rev. 0
- S-CLC-F-00012, Rev. C

Review Results

Observation 31: While references to specific sections of the referenced documents are not provided, it appears that a total fission yield of 1.0+19 fissions in a solution-like medium was the basis for determining both the fission product dose and the prompt neutron and gamma dose. An important aspect of this total yield, namely, the time evolution was not provided. Substantial shielding due to the thick concrete floors and walls was also assumed in the analyses. These assumptions appear to be conservative, but not unreasonable, particularly for initial design considerations. However, per DOE-STD-3009-2014, if shielding is assumed in the analysis, the shielding is considered an initial condition and must be declared as a safety SSC with shielding as the safety function. This is not identified in the CSDR.

No discussion is provided of possible operational volumes or solution collection locations that might support plausible criticality accidents.

Basis: A fission source term of this magnitude could credibly be associated with a solution medium criticality accident of modest volume and of many hours duration. It is not apparent that there are credible receptor vessels/locations for volumes of the order of many hundreds of liters (or more) that might support this large source term in a short time period, such as the 3 minutes noted.

Observation 32: S-CLC-F-00712 considers an accident scenario involving the evaporation of 100 liters of solution due to boiling in a 3 minute time span. This airborne source term is then analyzed and is the basis for the 62.5 rem dose to the OEP. The justification for the evaporation of 100 liters of solution is taken from DOE-HDBBK-3010-94, page 6-2. However, no discussions are provided as to where critical volumes of solution might collect to support or a criticality accident or the expected duration based on actual accident history. Be aware that a new Accident Analysis reference, DOE-HDBK-1224 is in progress which will require revision to DOE-HDBK-3010-94.

Basis: For a critical mass/volume to evaporate 100 liters of solution, the system would have to have reached far above the prompt critical state and yet not have shut down immediately due to liquid dispersal. Accidents such as UNC (Wood River Junction), JNC (Tokai-Mura) and several of the Russian accidents indicate that the likely consequence of rapidly exceeding the prompt critical state is either permanent shutdown subsequent to the first spike or steady state fissioning at such a low power level that no appreciable evaporation occurs, even over hours duration. The only accident that might remotely resemble the 100-liter evaporation scenario is the ICPP accident in 1959 which involved ~800 liters of solution and is estimated to have lasted for 15-20 minutes.

The following recommendation is provided to address the observations:

Recommendation R17: Review the unmitigated dose calculations to ensure they address appropriate types of criticality accidents, that appropriate conservatisms are applied, and that any mitigating initial conditions are identified appropriately in the CSDR.

3.11 Fire Suppression

In November 2013, the CSSG completed a tasking to establish a *CSSG Position on Use of Water for Firefighting in Light of Criticality Constraints for DOE Facilities*, CSSG Tasking 2013-01. The CSSG was directed to provide its professional judgment on the acceptable use of water as a firefighting medium in consideration of its potential for initiating a criticality accident. Three potential areas of conflict between fire protection and nuclear criticality safety have been identified and are addressed in this report: (1) moderation/reflection effects of sprinkler activation; (2) moderation/interaction effects and potential for redistribution of fissionable material from manual firefighting; and (3) requirements for the collection of fissile material in sprinkler water runoff drains/tanks. In the majority of cases, these conflicts can be managed using an integrated engineering approach and realistic upset scenarios in the design and licensing of a facility without unnecessary restrictions on the use of fire suppression water.

The detailed observations and the basis for each observation are given below. A key observation is that the Fire Scenario Document (FSD) purports to be the document to identify scenarios and assumptions that are to be referenced by *Fire Protection Engineering and Nuclear and Criticality Safety Engineering*. The PNCSEs do not reference/incorporate this information nor do the fire protection documents note possible nuclear criticality safety limitations or strategy (i.e. do not point to the PNCSEs). Unlike the PNCSEs, the preliminary fire hazards analysis (PFHA) does track closely with the PCHA.

Background

DOE-STD-1189-2008 and 2016, *Integration of Safety into the Design Process*, were developed to fulfill the project management objectives established by the Deputy Secretary of Energy in 2005. These objectives are to fully integrate safety early into the design and by the start of preliminary design, the safety requirements for the design be established. Based on experience over the past two decades, there have been issues integrating both Fire Protection Requirements and Criticality Safety Requirements early into design. The primary issue is that Fire Protection favors the use of water as a fire suppressant and water, being an excellent neutron moderator and reflector, poses a hazard that must be addressed in the criticality safety analyses. Early in the design process the two safety disciplines can be at an impasse regarding the prevalent use of fire suppression water.

In November 2013, the CSSG completed a tasking to establish a *CSSG Position on Use of Water for Firefighting in Light of Criticality Constraints for DOE Facilities*, CSSG Tasking 2013-01. The CSSG was directed to provide its professional judgment on the acceptable use of water as a firefighting medium in consideration of its potential for initiating a criticality accident. Three potential areas of conflict between fire protection and nuclear criticality safety have been identified and are addressed in this report: (1) moderation/reflection effects of sprinkler activation; (2) moderation/interaction effects and potential for redistribution of fissionable material from manual firefighting; and (3) requirements for the collection of fissile material in sprinkler water runoff drains/tanks. In the majority of cases, these conflicts can be managed using an integrated engineering approach and realistic upset scenarios in the design and licensing of a facility without unnecessary restrictions on the use of fire suppression water.

The 2013-01 Tasking report established that automatic fire suppression systems are mandated by DOE O 420.1C and generally involve water. For all process operations involving significant quantities of fissile materials, American National Standard ANSI/ANS-8.1 (also invoked by DOE O 420.1C) requires that unlikely and credible upset/accident conditions be analyzed for their potential to cause a criticality accident. Water from both sprinkler systems and from manual firefighting operations would always be a consideration and documented in the criticality safety evaluation or related facility safety documentation.

The fire protection documents (FSD and PFHA) appear to be very consistent with one another and to have been developed after the PCHA although they do not formally reference one another. Nuclear criticality safety (NCS) was clearly involved in the PCHA development along with experienced personnel from LANL and LLNL. The FSD and PFHA do not appear to have been coordinated with NCS personnel nor do the PNCSEs appear to have involved Fire Protection or the aforementioned fire safety documents.

This section of the report evaluates the interface between fire protection and criticality safety engineering at this point in the design of SRPPF.

Documents Reviewed (see Attachment B)

- S-CHA-F-00024, Rev. 2
- WSRC-TM-95-1, Rev. 7
- F-FSD-F-00001, Rev. 2
- F-PFHA-F-00045, Rev. 0
- S-CSDR-F-00001, Rev. 0
- G-FRD-F-0001, Rev. 0
- N-NCS-F-00141, Rev. 1
- N-NCS-F-00143, Rev. 1
- N-NCS-F-00144, Rev. 0
- N-NCS-F-00145, Rev. 1
- N-NCS-F-00147, Rev. 0
- N-NCS-F-00150, Rev. 0

Review Results

Observation 33: The FSD purports to be the document to identify scenarios and assumptions that are to be referenced by Fire Protection Engineering and Nuclear and Criticality Safety Engineering. The PNCSEs do not reference/incorporate this information nor do the fire protection documents note possible nuclear criticality safety limitations.

Basis:

FSD, Section 2.0

"This document examines the possible fire scenarios for the SRPPF in 226-F under the guidance of the Consolidated Hazard Analysis Process Program and Methods Manual SCD-11, Consolidated Hazard Analysis Process Program and Methods, and fire protection engineering resources. A qualitative approach is used to arrive at conclusions to be referenced in Fire Protection Engineering and Nuclear and Criticality Safety Engineering documentation in order to provide the necessary background for fire event development and fire protection controls for the Project and Facility."

F-PFHA-F-00045, Section 4.1.10 lists safety class and safety significant equipment from the CHA. However, there are several nuclear criticality safety passive design features listed as potentially safety significant noted in the pCHA that are not addressed in this section.

The PNCSEs do not clearly define if moderation control is relied upon for the areas analyzed.

Observation 34: Fire protection engineering clearly assumes that the building will be fully sprinklered with a water supply of 2 hours. There are options for the use of gaseous extinguishing systems. This should be identified in the PNCSEs as an **open item** if analyses cannot be performed at this stage of design to rule out risk of a criticality accident resulting from the presence of sprinklers. Particularly in the case of the seismic-induced fire.

Basis:

CSSG Tasking Report 2013-01

Section 4.4.1

The building is required to be fully-sprinklered per IBC [Sec 903.2.4(3) or IBC Sec 903.2.5], NFPA 101 [Chapter 40], and NFPA 801 [Sec 6.1.1]. 420.1C [Chapter II, Sections 3.c(2)(b) and 3.c(2)(c)] requires that the facility be provided with an automatic fire suppression system (e.g. sprinklers) and a water supply of at least 2-hours. The corridors and non-production areas are expected to be protected with a wet-type automatic sprinkler system. Production rooms may be protected by water-based fire suppression systems and gaseous extinguishing systems.

6.3.2 Seismically induced Fires

Seismically induced fires are possible and should be considered in 1) locations where molten metals/materials are created/used (furnaces, foundries, etc.) and where equipment (glovebox, furnace, electrical) is not seismically qualified to survive or designed to fail safe during such an event.

Observation 35: Although the Fire Protection Documents provide for the resolution of conflicts between NFPA codes and standards with DOE-specific safety requirements, the practicality may be challenging and would certainly require design changes. The potential changes represent design risk and are potentially costly to the project.

Basis:

WSRC-TM-95-1, section 3.5.2 "Where conflicts occur in applying NFPA codes and standards and DOE-specific safety or security requirements, they should be resolved by alternative designs that remove the conflict while assuring that an equivalent level of protection is maintained. [1066 2.2.6]"

In order to establish and justify an "equivalent level of protection" a DOE-Approved equivalency or exemption may be required. This is often not achievable.

Observation 36: The requirement for fire protection to collect fire suppression water where there is removeable contamination is clearly important to criticality safety but is not identified in the PNCSEs. The fire protection requirement is to collect 30 minutes of water but the system is designed to provide for 2 hours of fire suppression. The PNCSEs should identify as **open items** which process areas this poses a risk to and be evaluated for design impacts. Relative to the building floors, the requirement to collect contaminated fire suppression water will necessitate that the floors be flat and curbing be provided. This was not evident in the criticality or fire hazard documentation, nor was evaluation of the criticality potential of this contained fire-water. Even if the building to house operations is existing, it should be clear that any future modification must maintain curbing and flat floors.

Basis:

CSSG Tasking Report 2013-01

WSRC-TM-95-1, section 5.10.2 "If a new facility is expected to have removable surface contamination, or a fire could result in the release of radioactive material, the fire suppression water shall be contained, monitored, and treated as necessary. The containment shall be capable of collecting fire suppression water released during an anticipated fire scenario for a minimum of 30 minutes. Major modifications to existing facilities with similar conditions should consider similar containment and monitoring, if possible. [1066 4.4.1.3]"

N-NCS-F-00141 and N-NCS-F-00143 evaluate spacing for storage racks. This preliminary nuclear criticality safety evaluation assumes that flooding is not credible. However, there is no analysis to show the amount of water collected from sprinkler system runoff in either the nuclear criticality safety or fire protection documents. Complying with the collection of water while preventing “flooding” via possible wall penetrations or gaps under doors or walls, creates disconnects between fire, NCS and RadCon which could impact facility design. This creates a potential project risk. There also does not appear to be an analysis of potential fire water accumulations for criticality potential as would be required by ANSI/ANS-8.7 (R2017), Section 4.2.8.

Observation 37: The purpose of this paragraph is not clear. It seems inappropriate for a Fire Safety document.

Basis:

FSD, page 12 of 28

"Radioactive material is the major hazard associated with the SRPPF project. Hazards to the public, the co-located worker (CW), and facility worker (FW), will mainly involve the potential dispersal of radioactive materials due to fires, explosions, or loss of confinement accident scenarios starting from various initiators. Criticality of this fissionable material is an additional hazard to the FW. Note fissile material is a subcategory of fissionable material, and fissile material is the predominant material of criticality concern for SRPPF; however, “fissionable material” is used to recognize the presence of fissionable isotopes such as americium."

Recommendations from the CSSG Tasking Response 2013-01 spoke to concerns related to including criticality safety-related text in fire protection documents. It may be appropriate to acknowledge here that the criticality hazard associated with fissionable material may be exacerbated by the use of fire suppression water so integration of fire water scenarios with criticality safety is important.

Observation 38: The PFHA identifies several design features/assumptions that are not carried over to the PNCSEs

Basis: The level of design detail should be consistent among the safety analyses, particularly regarding SS and SC components. Examples include features cited in the Table in PFHA Section 4.1.10:

(1) N-NCS-F-00141 does not acknowledge Glovebox Design is seismically qualified not to tip over in seismic event

(2) N-NCS-F-00150 does not acknowledge Catch Pan/Safety Can. No open item is identified in the PFHA to indicate that criticality safety may require specific dimensional controls (e.g. depth of pan, diameter of can, etc.) and/or limited volumes. In turn, did not see PFHA requirements identified in the PNCSE acknowledging a need to evaluate.

(3) N-NCS-F-00143 does not acknowledge Non-combustible Vault Construction. No open item was identified to indicate that criticality safety may prohibit automatic water suppression in the vault. There was no indication in the PNCSE that fire suppression water is to be evaluated in the vault.

The primary recommendations are as follows:

Recommendation R18: As appropriate, update the PNCSEs to reference scenarios identified in the FSD when there is a potential for fire suppression water to impact the process analysis documented in the PNCSE. The maturity of the design may not be sufficient to perform specific analyses at this time, but the evaluation of the scenarios may identify project risks that must be resolved.

Recommendation R19: Include descriptions of the design features identified in the PFHA in the PNCSEs. The PNCSEs need to establish that there is or is not a need to credit the design features identified in the PFHA for criticality safety. This will identify any NCS safety functions that should be applied to fire protection safety SSCs, which could drive functional requirements for design at the conceptual state (e.g., NPH design criteria).

Recommendation R20: Identify integration of fire hazard scenarios and the collection of fire suppression water into the PNCSEs as an open item in the PFHA.

3.12 Process Analysis vs Double Contingency Principle

The SDS provides guidance on the approach to criticality safety and directly provides information related to the ANSI 8.1 requirement for process analysis (PA) and recommendation for application of double contingency principle (DCP).

This section of the report evaluates the implementation of this guidance relating to PA and DCP within the PNCSEs reviewed to date.

Documents Reviewed (see Attachment B)

- N-SDS-F-00001, Rev. 0
- S-CSDR-F-00001, Rev. 0
- N-NCS-F-00143, Rev. 1
- N-NCS-F-00141, Rev. 1
- N-NCS-F-00146, Rev. 1
- N-NCS-F-00150, Rev. 0
- N-NCS-F-00144, Rev. 0
- N-NCS-F-00145, Rev. 1
- SRNS-IM-2019-0013, Rev. 0

Review Results

Observation 39: The Safety Design Strategy (N-SDS-F-00001) seems to be the only place where this issue is discussed (Section 6; pp 17-18). All the "right" words are there for when the NCSEs are developed including the commitment to meet the process analysis requirement and commitment to the double contingency principle "where possible". The requirement in ANS-8.1, 4.1.2, is stated more than once in S-CSDR-F-0001, Section 7.2, but without reference to the DCP.

Observation 40: None of the PNCSEs have been developed sufficiently to state whether 4.1.2 has been met, but there are numerous individual upset conditions considered. Thus, the Task Statement: "Implementation of the Process Analysis …." Cannot be verified at this time.

Observation 41: In several places it is "recommended" that "one" upset condition be made incredible – implying that the criticality accident could occur if this single event happened. GB flooding is a common one that is recommended to be prevented down to the incredible likelihood. Vault storage rack resistance to seismic is another. For these scenarios the process is not sufficiently well developed to be able to know if the criticality accident would occur or not.

Basis: DOE-STD-1189-2016 states "Inherently safety design concepts can allow facilities to be designed minimizing the need for complex layers of controls that can add project risk and increase operational complexity". Design alternatives should be considered to optimize project risk, cost and integration with other safety disciplines.

Observation 42: In the majority of the PNCSEs there is not a discussion of common mode failure, thus it is difficult to ascertain at this point if the DCP has been achieved. The PNCSE desktop instruction does not specifically mention the process analysis requirement or the DCP recommendation. The desktop instruction does discuss contingencies and evaluation of those contingencies as well as referring to DOE-STD-3007 which requires the process analysis and consideration of DCP.

Recommendation R21: As was noted in the recommendation for the NCS program, the PNCSE desktop instruction should be updated to include expectations on PA and DCP. As the PNCSEs mature, full evaluation of the process to meet the process analysis requirement and DCP recommendation should be added, including evaluation of common mode failures and effects.

4.0 Conceptual Design Review Sufficiency

DOE-STD-1189-2008, -2016, *Integration of Safety into the Design Process*, were developed to fulfill the project management objectives established by the Deputy Secretary of Energy in 2005. These objectives are to fully integrate safety early into the design, and by the start of preliminary design establish the safety requirements.

With the submittal of the SDS and the CSDR, the SRPPF project is at the end of the Conceptual Design Phase. DOE-STD-1189-2016 states that the CSDR "(a) describes the initial major hazards and other risk areas that could affect project cost and schedule and (b) identifies significant hazard scenarios and the initial suite of facility design basis accidents (DBAs)."

Furthermore, DOE-STD-1189-2016 states that the purpose of the Department of Energy review of the CSDR is "to confirm that the preliminary safety positions adopted during conceptual design constitute an appropriately conservative basis for preliminary design."

Overall, the opinion of the CSSG is that the current state of criticality safety documentation is too vague or too indefinite to support proceeding to preliminary design. Inconsistencies between the Safety Design Strategy, the Conceptual Safety Design Report, and the general treatment of nuclear criticality safety lead to the conclusion that significant project risks may exist that have not been adequately addressed. In addition, major NCS SSCs do not have the NPH design categories established as required by DOE-STD-1189-2016, Section 4.3.4. The Safety Design Strategy and the Conceptual Safety Design Report clearly state that NCS "evaluations" are to be performed late in the design process, which misses the point that NCS engineers need to be fully participating in the design; not following the design. Unlike other design disciplines that have pre-established design standards for safety significant or safety class SSCs, the NCS engineers must determine the functional requirements and performance criteria for most, if not all of the NCS SSCs.

5.0 Conclusions and Recommendations

The performance of the review identified three overarching observations regarding the process of integrating safety into design. First, DOE-STD-1189-2016, Section 4.3, makes clear that the conceptual design phase is to consider alternatives for meeting the mission need, and those alternatives often involve different safety strategies to be employed. The Conceptual Safety Design Report (CSDR) is to contain a more detailed facility-level hazards analysis for the preferred alternative. The documentation submitted to the CSSG did not include an alternatives analysis, so the CSSG is unable to comment on any evaluation of the best alternative from a criticality safety perspective. It was noted during the review that the criticality accident alarm system apparently selected may not be the best alternative for a new facility. If an alternative analysis has been performed, including a process flow and the alternatives considered along with the logic for selecting the chosen alternative, would bolster the case for adequate safety in design.

Second, the Safety Design Strategy (SDS) and the CSDR are heavily focused on the Structures, Systems, and Components (SSCs) that have a preliminary functional classification of safety class and safety significant. This is understandable given the focus of DOE-STD-1189-2016. The CSSG concurs that the majority of SSCs important to nuclear criticality safety (NCS) would not be functionally classified as a safety SSC (i.e., safety significant or safety class) and that the NCS Program would provide appropriate quality assurance requirements to ensure meeting performance criteria. However, NCS SSCs are still subject to requirements of DOE-STD-1020-2016 as expanded upon in DOE-STD-3007-2017. Furthermore, CSSG Tasking 2016-05, *Regulatory Impediments to Effective Operational Criticality Safety*, highlights that NCS SSCs and the associated safety strategies may be a significant driver to the design, cost, schedule, and implementation of a project.

Therefore, the CSSG evaluated the submitted documentation in the spirit of DOE-STD-1189-2016 for NCS SSCs at the conceptual design phase. Namely, the review is to confirm that the preliminary safety positions adopted during conceptual design constitute an appropriate conservative basis for proceeding to preliminary design for NCS SSCs, regardless of functional classification. Such an approach is supported by Section 4.8 of DOE-STD-1189-2016.

Third, there appears to be confusion in the documentation as to what information should be provided for the conceptual design with respect to criticality safety. As noted above, the focus of the CSDR is on safety SSCs and this focus appears to have left SSCs important to NCS out of the CSDR. DOE-STD-1189-2016 sections 4.3.3, 4.3.4, and 4.3.7 identifies the following elements needed at conceptual design:

- Consequences associated with design basis accidents (DBAs)
- Hazard control strategies for significant hazard scenarios and DBAs
- Facility level safety functions, including major safety SSCs
- Initial classification of major safety SSCs
- Preliminary assessment of Natural Phenomena Hazard (NPH) design categories for major SSCs.

Generic consequence analyses were provided and reviewed; however, a specific type of accident consequence (e.g., a metal event and a solution event) associated with criticality safety hazard scenarios and SSCs was not presented. This is important because the consequences of a criticality hazard scenario determine the NPH design category for the major SSCs that have an NPH safety function. The lack of this information could lead to an excessive NPH design category for SSCs that only have a criticality safety function. The criticality safety documentation did not identify any NPH design categories associated with major NCS SSCs. This could impact cost and project risk. Furthermore, neither the hazard control strategies nor the facility level safety functions for criticality safety SSCs were identified. These strategies may conflict with other disciplines such as fire protection. At the conceptual design phase, the potential conflicts should be identified as a project risk in the CSDR.

The CSSG recommends that the criticality safety documentation be more defined and matured to more accurately identify project risk. Inconsistencies between the Safety Design Strategy, the Conceptual Safety Design Report, and the general treatment of nuclear criticality safety lead to the conclusion that significant project risks may exist that have not been adequately addressed. In addition, major NCS SSCs do not have the NPH design categories established as required by DOE-STD-1189-2016, Section 4.3.4. The Safety Design Strategy and the Conceptual Safety Design Report clearly state that NCS "evaluations" are to be performed late in the design process, which misses the point that NCS engineers need to be leading the design; not following the design. Unlike other design disciplines that have pre-established design standards for safety significant or safety class SSCs, the NCS engineers have to determine the functional requirements and performance criteria for most, if not all of the NCS SSCs.

The most significant areas to be addressed are: a lack of evidence that design alternatives have been considered for criticality safety control; limited integration with other disciplines including process engineering, fire safety, safeguards and security, and seismic events; and the identification of safety function and functional criteria for items important to criticality safety. The Hazard Evaluation Tables and Fire Scenario Document appear to be well developed but the information is not pulled through into criticality safety documents. The criticality safety documents provided for review do not include sufficient discussion of control philosophy or design alternatives and do not demonstrate significant engagement within DOE criticality safety community for lessons learned. These insufficiencies represent unknown project and design risk that should be identified at CD-1. The CSSG proposes that vigorous implementation of the recommendations within this report would provide the most efficient method of addressing the insufficiencies and avoid significant project performance risk or project failure.

A summary of the CSSG recommendations to improve the integration of nuclear criticality safety in the design process are given below. The **bold** citation given in parentheses indicates the original location of the recommendation by the report section number and original recommendation number.

1. Document an NCS strategy for each process. At CD-1, it would be appropriate to include control strategy options. These should be consistent with the PCHA, PFHA and SDS. **(Section 3.1, R1)**
2. Document the safety function, functional requirement, and performance criteria for potential major NCS SSCs, similarly to the requirements fo safety SSCs as design proceeds through the various phases. Conceptual design should have safety functions identified as required by DOE-STD-1189-2016. Functional requirements should be identified as early as practical in preliminary design along with a listing of what performance criteria will be developed during preliminary design. This is needed to support an integrated project schedule and to identify project risks and opportunities as early as possible. **(Section 3.1, R2)**

3. Identify conflicts between the NCS strategies and other safety management programs and security to identify areas of risk to the project in the conceptual design phase. **(Section 3.1, R3)** Specifically reference scenarios identified in the FSD when there is a potential for fire suppression water to impact the process analysis. **(Section 3.11, R18)**
4. Supplement the NCS Design Criteria Document to include guidance developed through closure of the first three strategy recommendations and the inclusion of fissile material accumulation control requirements. Examples can be found by reviewing the UPF NCS Design Guide. **(Section 3.1, R4)**
5. The PNCSEs should be revised, incorporating the information available in the HET tables and PCHA event descriptions as design proceeds into preliminary design. This should be done in consultation with operators/NCS engineers who operate similar processes at other facilities (e.g., LANL, Y-12, AWE, LLNL). **(Section 3.5, R13)** Specific recommendations citing revision of the PNCSEs include:
    a. Determine what the various container dimensions, masses and materials of construction are planned for various non-solution transportation and storage operations **(Section 3.3, R8)**
    b. Collectively discuss options for fissile solution handling and storage both internal and external to gloveboxes **(Section 3.3, R9)**
    c. Review containers, birdcages, carts, trolleys, etc., used at other sites as part of consideration of design alternatives **(Section 3.3, R10)**
    d. Include descriptions of the design features identified in the PFHA **(Section 3.11, R19)**
6. Review the unmitigated dose calculations to ensure they address appropriate types and magnitudes of criticality accidents, that appropriate conservatisms are applied, and that any mitigating initial conditions are identified appropriately in the CSDR. This is needed to support NPH design criteria for NCS SSCs. **(Section 3.10, R17)**
7. Contact LLNL, LANL and UPF regarding commercially available criticality accident alarm systems and compare the advantages and disadvantages of these systems with the planned SRS NIMS. Ideally, this is done in conceptual design as part of an evaluation of alternatives, but can be performed early in preliminary design. **(Section 3.4, R11)**
8. Delete the statement in S-CHA-F-00024 requiring NCS SSCs with a seismic safety function to be at the same SDC as the facility. NCS SSCs are assigned NDCs based on the unmitigated consequences of a criticality accident. **(Section 3.1, R5)**
9. Update the Safety Design Strategy, as required by DOE-STD-1189-2016, to be consistent with the approaches presented in the CSDR. **(Section 3.1, R6)**
10. Evaluate the CSSG Tasking 2020-03 response when responding to the CTA position memorandum regarding revising the SDS. This needs to be part of conceptual design because establishing NPH design criteria in preliminary design has historically resulted in high cost impacts on other similar projects. **(Section 3.2, R7)**
11. The results of the updated PNCSEs should be flowed into N-NCS-F-0147 with definitive guidance as to the NCS design criteria that design will need to adhere to during the preliminary design. The UPF project developed a detailed NCS design criteria document which should be reviewed for format, content and applicability. **(Section 3.5, R14)**

12. Revise the PNCSE Desktop Instruction, SRNS-IM-2019-0013, to include discussions on:
    a. the purpose of the PNCSE as well as further expectations about the proper determination and flow of design constraints/requirements associated with NCS **(Section 3.5, R12)** and
    b. expectations in implementation of the ANS-8.1 process analysis requirement and double contingency principal (DCP) recommendation. As the PNCSEs mature, full evaluation of the process to meet the process analysis requirement and DCP recommendation should be added, including evaluation of common mode failures and effects. **(Section 3.12, R21)**
13. Prior to revising PNCSEs, consideration should be given to developing a SRPPF NCS input document which will standardize the input information for NCS evaluations. The UPF project developed an NCS analysis guide that should be reviewed for format, content and applicability **(Section 3.5, R15)**
14. If there are plans to exclude stored/staged plutonium from the MAR inventory and from release considerations based on contained robustness, then this strategy should be documented and evaluated as part of the criticality design strategy. **(Section 3.8, R16)**
15. Identify integration of fire hazard scenarios and the collection of fire suppression water into the PNCSEs as an open item in the PFHA. **(Section 3.11, R20)**

The CSSG believes that following these recommendations will help to ensure: (1) basic contingencies for operations have been considered to determine if the design will need to be constrained as part of integration of safety into design, (2) that the preferred hierarchy of engineered features (passive and active) are considered before administrative controls, (3) that lessons learned associated with operations/design are considered during the evaluation, and (4) that project risks and opportunities are identified early in the project. Overall, the opinion of the CSSG is that the current state of criticality safety documentation should be improved to more effectively support proceeding to preliminary design.

ATTACHMENT A - CSSG Tasking 2020-04

CSSG TASKING 2020-04

Date Issued: September 21, 2020

Task Title:

- CSSG Technical Assistance to NNSA-SR Related to the SRPPF Project.

Task Statement:

The CSSG has been requested to provide technical guidance for the implementation of criticality safety for the Savannah River Plutonium Processing Facility (SRPPF) Project in support of NNSA-SR. Specific consideration should be given to reviewing criticality safety and other related documents that support the SRPPF CD-1 submittal. Guidance shall include recommendations to resolve identified issues and proposed alternative approaches as appropriate.

The following topics should be considered under this Tasking:

- SRPPF strategy for addressing criticality for NPH events, including the Safety Design Strategy (SDS), the CDNS Safety Advice Memo and the Conceptual Safety Design Report (CSDR).
- EA-31 comments, and SRPPF responses if available, on the SDS regarding criticality safety.
- Material handling approaches, including any interaction vulnerabilities – both within and in-between process modules.
- Proposed Criticality Accident Alarm System (CAAS).
- Preliminary Nuclear Criticality Safety Evaluations (PNCSEs).
- Overall criticality safety program as it pertains to SRPPF.
- Waste Management System related to material handling, assay and waste storage configurations.
- Material-At-Risk (MAR) documents.
- Dose assessment evaluation and ensuing shielding related to criticality safety.
- Criticality accident dose consequence to the MOI and collocated worker (if available).
- Interaction between criticality safety and fire suppression
- Implementation of the Process Analysis requirement vs the Double Contingency Principle recommendation.
- CD-1 and the SDS/CSDR as a sufficient "design of record"

Period of Performance:

- Based on the availability of the SRPPF Design Packages and applicable PNCSEs, the task effort should kick-off with the NNSA briefing telecon on September 17, 2020. Documents, including the CSDR, will be provided as they become available, and all should be available by October 30, 2020. The final CSSG review document, including all recommendation, etc., should be available for posting to the NCSP website by November 23, 2020.

Resources:

CSSG Task 2020-04 Team Members:

- M Brady-Raap (Team Lead)
- DP Heinrichs
- KD Kimball
- TP Mclaughlin
- DG Bowen (Ex-officio)

CSSG members will use their FY21 NCSP CSSG support funding as applicable. Emeritus and Ex-officio Members will receive NCSP funds

Task Deliverables: (All dates are Tentative)

1. The Task Team will participate in a kick-off/NNSA briefing on September 17, 2020. Documents will be provided as they become available.
2. Task Team prepare a draft for full CSSG review by November 9, 2020.
3. Full CSSG provide review comments by November 16, 2020.
4. Task Team provide final version of document to NCSP Manager for posting by November 23, 2020.

Task Completion Date: November 23, 2020

Signed: Angela Chambers

Angela Chambers, Manager US DOE NCSP
Office of the Chief of Defense Nuclear Safety, NA-511

ATTACHMENT B - List of Documents Reviewed

Document Number	Document Description
COR-SRFOMA-8.6.2019-847087, R0	Code of Record, dated 9/11/2019, SDS Safety Review Letter, Rev 0
F-DRR-F-0001, R1	ICCPC Implementation Plan and Proof of Concept, Rev 1
F-FPIP-F-00001, R0	ICC Performance Code (ICCPC) Implementation Plan for the SRPPF Project, Rev 0
F-FSD-F-00001, R2	Fire Scenario Document, Rev 2
F-PFHA-F-00045, R0	Preliminary Fire Hazards Assessment, Rev 0
G-FRD-F-00001, R0	Functional & Operational Requirements: SRPPF Project, Rev 0
N-ESR-F-00043, R2	SRPPF Preliminary Material-at-Risk, Rev 2
N-NCS-F-00141, R1	PNCSE: Internal Glovebox Staging and Glovebox Spacing, Rev 1
N-NCS-F-00142, R1	SRPPF Preliminary CAAS Analysis, Rev 1 **UCNI**
N-NCS-F-00143, R1	PNCSE: Vault Storage, Rev 1
N-NCS-F-00144, R0	PNCSE: Solution Tanks, Rev 0 (Erickson downloaded Rev 1 to max.gov on 11/2/20, not final approved document)
N-NCS-F-00145, R1	PNCSE: Machining and Fines, Rev 1
N-NCS-F-00146, R1	PNCSE: Effects of Shielding for Glovebox Staging and Vault Storage, Rev 1
N-NCS-F-00147, R0	Nuclear Criticality Safety Design Criteria for SRPPF, Rev 0
N-NCS-F-00150, R0	PNCSE: Electrorefining and Casting Furnaces, Rev 0

Document Number	Document Description
NNSA-SRPPF-19-00004	A Letter from S. Cannon to L. Olson re: Contract De-AC09-08SR22470, Work Authorization
NNSA-2019-001048-SRPPF PRD, R2	Program Requirements Document (PRD) SRPPF Project , Rev 2
N-SDS-F-00001	Safety Design Strategy for Savannah River Plutonium Process Facility
S-CHA-F-00024	Preliminary Consolidated Hazards Analysis for the SRPPF Project **UCNI**
S-CLC-F-00712	Preliminary Accident Analysis for SRPPF Project
S-CLC-F-00719	Aircraft Impact Frequency for Savannah River Plutonium Processing Facility (SRPPF) Waste Storage Pad(s)
S-CLC-F-00720	Chemical Consequence Analysis for the Savannah River Plutonium Processing Facility
S-CSDR-F-00001, R0	Conceptual Safety Design Report for SRPPF, Rev 0
SRNS-P0000-2020-00026	Preliminary Nuclear Criticality Safety Evaluations, N-NCS-F-00147
SRNS-RP-2019-00075	Safety Design Integration Team Charter
T-ESR-F-00028	Preliminary Structural Analysis Report for SRPPF Conceptual Design
WSRC-TM-95-1, R13	Engineering Standard No 01120, SRS Fire Protection Design Criteria, Rev 13
**the following requested by reviewers	
SRNS-E0000-2020-00049	Transmittal of the Savannah River Plutonium Process Facility (SRPPF) Conceptual Safety Design Report (CSDR), Rev 0
S-CLC-G-00393, R0	MACCS2 Analysis for Criticality Release of Airborne Fission Products to the Onsite Receptor (U), Rev 0
S-CLC-H-01168, R0	H-Canyon Consequence Analysis for Criticality Events (U), Rev 0

Document Number	Document Description
SRNS-IM-2019-00013, R0	PNCSE Desktop Instruction, Rev 0
SRNS-IM-2009-00035_R6	Criticality Safety Methods Manual, Rev 6
SCD-3, Rev 31	Nuclear Criticality Safety Manual SCD-3, Rev 31

ATTACHMENT C - Additional Detail for SRPPF Strategy Recommendations

Additional Detail for SRPPF Strategy Recommendations

The following table illustrates the concept of applying a safety function, functional requirements, and performance criteria to a hypothetical fissile material storage rack. The example illustrates that the NPH design category is specified as a performance criterion as required by DOE-STD-1020-2016. Other performance criteria are shown as “to be determined”. The undeveloped criteria are then assigned to a organizations in the integrated schedule. If there are options for the performance criteria, these can be identified until resolution is reached.

1.

Safety Function	Functional Requirement	Performance Criteria
To prevent a criticality accident through interaction control	The racks shall be designed to prevent collapse or falling from a seismic event per ANSI/ANS-8.7-1998	SDC-2, Limit State B
	The racks shall be designed to space fissile containers apart such that neutron interaction is insufficient to challenge subcriticality.	• Container spacing requirements to be established during preliminary design • Container retention devices shall be designed to hold fissile containers in a fixed position to the criteria of SDC-2, Limit State B and to ensure spacing requirements
	The design will preclude operator error from storing the wrong form of fissile material	(1) The rack spacing will be determined during preliminary design to accommodate both metal and solution fissile containers, or (2) Metal and solution containers will be separate unique designs and the racks will be designed to accommodate only one type of container, or (3) Analysis results will show that interspersing container of different fissile material form will not result in a criticality accident.

Safety Function	Functional Requirement	Performance Criteria
To prevent a criticality accident through moderation control	The racks shall be designed to preclude the bottom containers from flooding from a fire sprinkler activation	(1) The height of water from sprinkler activation will be determined during preliminary design, or (2) a drainage system will be installed in the storage vault, or (3) Sprinklers will not be installed in the storage vault.
	The design will preclude sprinkler water from impacting fissile containers.	(1) Shelving on racks shall be designed to prevent water impingement on fissile containers, or (2) Analysis shows that water film on containers will not result in a criticality accident.