March 27, 2018

To: A. S. Chambers, Manager, US DOE Nuclear Criticality Safety Program (NCSP)

From: D. K. Hayes, Deputy-Chair, US DOE NCSP Criticality Safety Support Group (CSSG)

David Kirk Hayes

Digitally signed by David Kirk Hayes
Date: 2018.03.27 07:40:04 -06'00'

Subject: CSSG Tasking 2017-05 Response

The CSSG has completed Tasking 2017-05, *CSSG Assessment of SRNS NCS Program*. As specified in the tasking, the final report is being provided to the NCSP Manager for transmittal to SRNS.

This report, while developed by a subteam of the CSSG, has been reviewed by the entire CSSG and their comments incorporated. Views presented in the report are the consensus opinion of the CSSG.

cc: CSSG Members
D. G. Bowen
L. Scott

Attachment 1: Response to CSSG Tasking 2017-05

CSSG ASSESSMENT OF SRNS NCS

Executive Summary:

In 2017 the Department of Energy (DOE) Criticality Safety Support Group (CSSG) was tasked to perform an independent assessment of the Savannah River Nuclear Solutions (SRNS) Nuclear Criticality Safety Program as outlined in Consent Order NCO-2016-01. This Tasking Report provides the conclusions and recommendations regarding the current SRNS Nuclear Criticality Safety Program. Because this review is an advisory review and not a compliance assessment, there are no findings. The assessment was conducted through program, operations, and oversight interviews, document reviews, and field observations.

The report addresses seven objectives which were tied directly to the areas of the consent order. The key conclusions and recommendations for each objective are summarized below with supporting details provided in Appendix A.

Overall the SRNS Criticality Safety Program was found to be healthy and functioning well. Those issues which led to the compliance order have been evaluated and understood by Site management and corrective actions have been developed, and in some cases completed, which should preclude similar events from occurring. While the extent of condition review for these events appears very thorough, a similar common cause analysis would provide assurance that other potential vulnerabilities are also uncovered. The CSSG team was also concerned that the current corrective actions did not appear to address changes in the underlying programs (e.g., Training & Qualification, Hazard Assessment process, etc.) that would help ensure sustainability of the improvements that have been made.

As in most programs, there is still room for improvement in the program, implementation, and in the quest to become a learning organization. These improvements are captured in the recommendations provided by the team.

The CSSG team commends the Site for the level of openness and support demonstrated during the review. The "pre-CSSG" self-assessment that was performed and provided to the CSSG team was also very helpful in limiting the scope of the CSSG to a manageable one and an exercise which the team feels added value to and ownership by the Site.

<u>Objective 1: Assess common mode failure (CMF) analyses as they relate to NCS Program implementation</u>

Common Mode Failure discussions are evident in most analyses (including those affected directly by the Consent Order). Although the NCS Program requires an evaluation of CMF, no formal process is in place to identify CMF, or address CMF between controls and/or scenarios. Regardless, CMF as it relates to the Consent Order has been addressed by SRNS.

Recommendations:

- Additional guidance and training associated with the evaluation of common mode failure should be instituted.
- Roles and Responsibilities should be defined and promulgated regarding the evaluation of CMF.

<u>Objective 2: Assess Organizational and facility interfaces as they relate to NCS Program implementation</u>

The NCSRC is not being utilized to take full advantage of the committee's expertise and the effectiveness and perceived significance of the committee has diminished. The NCSRC Charter (Manual 1-01) is not consistent with the recommendations of CSSG Tasking Response 2009-01.

The dispersion of facilities and staff presents a geographical and organizational challenge. Co-location of NCS staff and the facilities they support is a good practice. However, the opportunity to interact with peers in the Program Group and NCS Staff at other facilities is diminished. Thus, lessons-learned and consistency across facilities are more difficult to communicate/implement.

Interfaces between NCS staff and management appeared good based on observed staff and management discussions with both CSEs and Senior Management.

Interface between NCS and Operations supervision and Engineering appeared good based on observed interactions and interviews in the various Consolidated Hazards Analysis Process and assessment meetings attended.

Interface between NCS and Operators is not evident. The Team found no evidence of ad-hoc discussions/training between NCS and operators, meeting in small groups with operators to discuss evaluations, participation in safety meetings, informal interactions, etc.

Organizational and facility interfaces as they relate to NCS Program implementation are effective and address the Consent Order.

Recommendations:

- The scope and visibility of, as well as the response to, the Nuclear Criticality Safety Review Committee (NCSRC) should be brought into line with the recommendations of the CSSG Tasking Response 2009-01 on the role of Criticality Safety Review Committees.
- Informal interactions between criticality safety and the on-the-floor operators should be encouraged and supported in order to strengthen the relationship between them.

<u>Objective 3: Assess NCS control selection and implementation</u>

NCS control implementation was a focus of this assessment, given the events that precipitated the Consent Order. While assessment of NCS was a major focus of the Consent Order, Conduct of Operations (CONOPs) underpins implementation and execution of NCS controls. Without effective CONOPs, there can be no effective criticality safety program.

Control implementation and particularly verification varies depending upon the control designation (facility/procedural (considered defense-in-depth) or credited criticality safety control). There are instances where a control is deemed a facility control for one scenario and a credited control for another scenario. Once a control is credited for a process, it should be credited similarly for all scenarios.

Like-Kind redundant controls (e.g., Independent verification, and duplicate instruments) are often cited as independent controls. The CSSG views these as highly susceptible to CMF, perhaps increasing the system reliability but not as independent controls.

Formalized Hazards Analysis and subsequent control selection occur via the CHAP process. With the exception of the preceding bullet, controls appear independent and effective in preventing a critical configuration. Importantly, the controls are implementable by operations.

NCS control selection and implementation effectively addresses the Consent Order.

Recommendations:

- A communications method should be developed to ensure that failure of any NCSE controls that are part of the safety argument (credited or defense in depth) are identified and communicated to NCS for tracking and trending. This also has applicability to the NCS Assessment Process.
- As a part of the CHAP, a review of the entire suite of controls from the NCSE including CMF would strengthen the control selection process.

Objective 4: Assess Laboratory analysis process as it relates to NCS controls

It was noted that the self-assessment in preparation for the CSSG assessment (SA-005770) did not discuss results from F/H Laboratories. Upon further discussion with the review leader, it was ascertained that the write-up inadvertently omitted the F/H Laboratory discussion. The report should be revised to include the F/H Laboratory discussion. Regardless, the CSSG conducted interviews with the laboratory and concluded that the corrective actions resulting from prior incidents have been implemented and deemed effective.

The Laboratory analysis process, as it relates to NCS controls effectively addresses the Consent Order.

Objective 5: Assess the NCS assessment process

Self-Assessment is very evident.

Interviews indicate that deviations of facility/procedural controls are not reported, investigated, tracked or trended by NCS. Such deviations are indicators of the erosion of criticality safety controls. See related topic in Objective 3: NCS control selection and implementation.

The Nuclear Criticality Safety Review Committee (NCSRC) reports appear to simply be filed. The NCSRC Charter does not direct engagement by Senior Management. Implementation of the NCSRC is not consistent with the recommendations of CSSG Tasking 2009-01.

Current processes for annual operations reviews may not meet the intent that all operations are reviewed annually.

Periodic external assessments are valuable to ensure internal assessments are providing an objective review of the program. This assessment is the first external assessment of the NCSP in at least a decade.

The NCS assessment process effectively addresses the Consent Order.

Recommendations:

- Clear expectations and guidance should be developed and institutionalized to strengthen implementation of the annual operational review requirement and to ensure that all operations are reviewed annually.

Objective 6: Assess NCS Training and Qualification

Hazards Assessment training for Criticality Safety Engineers needs significant improvement in light of ANS-8.26, Section 7.7.1. This weakness is somewhat mitigated by the use of CHAP leads appropriately trained in the various methods.

There was not a consistent use or expectation of the role of the CHAP leads between the areas, nor did there appear to be a consistent knowledge of the resources available for determining criticality contingencies.

Lessons-Learned were not being shared amongst CHAP Leads.

Recommendations:

- The NCST&Q program should be modified to ensure that, as a minimum, the CSEs receive a formal overview (pros/cons/limitations) of the methodologies available for hazards assessment. If NCS staff serve as CHAP leads, they should receive the CHAP lead Hazard Assessment training. In the longer term, at least one CSE in each area should become CHAP lead trained in order to help drive the practice as it relates to the criticality safety specialty.
- Expectation for their formal role in the CHAP/Double Contingency Analysis (DCA) meetings and sharing of best practices between themselves should be reinforced with the CHAP leads.

NCS Training and Qualification effectively addresses the Consent Order.

Objective 7: Assess NCS staffing

Staffing is currently adequate to support operations. However, staffing exhibits a bimodal distribution when examined from an experience basis. The distribution shows minimal experience and extensive experience. Little to no staff have what would be considered mid-career experience.

Staffing should be reviewed in terms of distribution according to facility risk and succession planning.

The Engineering Leadership and Development Program (ELDP) is noted as a very good practice, providing early career staff. The NCS Program recognizes the need to transfer knowledge from their most experienced staff to the newer staff.

NCS Staffing effectively addresses the Consent Order.

Conclusion:

The NCS Program is effective and has addressed the events leading to the Consent Order. Improvements in both the NCS Program and Operations are comprehensive and will likely preclude recurrence of those events. However, without changes to the underlying programs that allowed the issues identified in the consent order there is less certainty on the sustainability of these improvements. As with all programs, improvements can be made and vigilance must be maintained to avoid slipping into complacency.

1.0 Introduction and Purpose:

The CSSG was tasked to conduct an independent assessment of the SRNS Nuclear Criticality Safety Program as outlined in Consent Order NCO-2016-01. The CSSG shall provide assessment results/findings/recommendations for use by SRNS to ensure the contractor NCS program has effectively addressed weaknesses identified in the causal analysis and as stated in the consent order.

2.0 Scope:

The CSSG assessed the SRNS Nuclear Criticality Safety Program and the implementation thereof in SRNS facilities. Consistent with the Consent Order, the following facilities (in priority order) were considered in scope for this assessment.

1. H-Canyon/HB-Line and F/H Laboratory
2. K-Area, L-Area
3. Savannah River National Laboratory (SRNL) and Solid Waste Management Facility (SWMF)
4. F-Area

3.0 Approach:

Personnel interviews, documents and in-field performance were evaluated to the extent practicable commensurate with the assessment time-frame. The primary focus of this assessment was implementation, consequently the approach is more towards field interviews and observations rather than document reviews.

Objectives and Criteria for the assessment are provided in Appendix A. The Objectives were taken directly from the Consent Order. Criteria were obtained from ANSI/ANS-8.19-2014, *Administrative Practices for Nuclear Criticality Safety*.

The following documents, along with others identified during the assessment, were reviewed:

1. NCS Program Description Document
2. NCS Methods Manual
3. Nuclear Criticality Safety Manual
4. Organization Charts: NCS, Operations, Engineering, Analytical Laboratory, DOE
5. Training and Qualification Program: NCS Analysts, CSOs, Operations
6. Self-Assessments: NCS, Facility Implementation, DOE
7. Selected Criticality safety evaluations for operations in H, L, and F/H
8. ORPS and Root Cause Reports
9. Procedures.

A list of the documents reviewed and personnel interviewed is provided in Appendix B.

4.0 Assessment Team Members

David K. Hayes was the Team Lead. Jerry Hicks, Tom McLaughlin, Fitz Trumble, and Bob Wilson were the Team Members. Biographies can be found on the US DOE NCSP Website (https://ncsp.llnl.gov/cssg.php).

5.0 Results:

The consent order specifies the following program areas for assessment: 1) NCS control selection and implementation, 2) Common Mode Failure (CMF) analysis in CSEs, 3) Organizational and facility Interfaces as they relate to NCS control implementation, 4) Laboratory analysis process as it relates to NCS controls, 5) NCS Assessments, 6) NCS training and qualification, and 7) NCS Staffing

In order to determine if other program areas had potential weaknesses that could influence criticality safety program effectiveness, the team critiqued a selection of criticality safety related incidents from 2015 to the present and rendered a judgement on programs that could have prevented the incident.

Recent SRS Incidents Affecting Criticality Safety and Site Programs That Might Have Prevented Them

Incident Date	AREA	Equipment	NCS Implementation	Supervision	Training	Oversight	System change	NCSE		Engineering	Laboratory
								Hazard Assessment	Rest of NCSE		
2/13/15	HBLine	*	*		*			*		*	
3/23/15	L Area							*		*	
5/11/15	H-Can		*	*		*					
6/24/15	CPWM		*	*		*					
9/8/15	HBLine			*		*					
10/7/15	CPWM		*			*				*	
1/20/16	SRNL		*	*	*	*		*			*
9/5/17	H-Can		*	*		*					
11/16/17	HBLine	*					*	*		*	

The NCS Implementation column includes such processes as procedures and Conduct of Operations. Supervision is the first level manager. Oversight includes the higher level managing structure and programs such as QA. Hazard Assessment relates most strongly to the Consolidated Hazard Assessment Process (CHAP). The programs that showed up prominently in the table (highlighted above) were:

- NCS Implementation
- Supervision
- Oversight
- Hazard assessment
- Engineering

Given these results, the last four of these programs were also evaluated during the assessment. While the role of Engineering was not specifically covered in the consent order, the team considered it as part of Objective 2. The other areas were clearly addressed by the consent order.

APPENDIX A
OBJECTIVES AND CRITERIA

Objective: 1 Date: January 22, 2018	OBJECTIVE MET	
	YES	~~NO~~

OBJECTIVE:
Assess common mode failure (CMF) analyses as they relate to NCS Program implementation

DISCUSSION:
Criticality Safety Methods Manual (SRNS-IM-2009-00035, Rev. 5), Chapter 4.2, section 3.2.9, provides the expectation for Nuclear Criticality Safety evaluations to *Address common mode failure potential between the barriers/controls and identify compensatory measures to prevent or mitigate.* N-NCS-H-00243, H-CANYON DOUBLE CONTINGENCY ANALYSIS (U) Rev. 11, (5/31/2016) and N-NCS-H-00177, Rev. 6, NCSE for HB-Line PHASE II Pu OXIDE OPERATION both specifically address common mode failure. S-CHA-L-00003, Rev. 0, HAZARD ANALYSIS FOR PHASE II L-AREA TO H-AREA TRANSFERS OF 70-TON CASKS (U) (March 2011) does not specifically address common mode failure. It is noted that the operations and the number of criticality scenarios are well described.

The Nuclear Criticality Safety Manual, SCD-3, addresses common mode failure in 3.2.1 “when implementing DCP contingencies shall be independent and not the result of common mode failure”. The NCS Methods Manual addresses common mode in Chapter 4.1 of the Technical Verification sheet but not within the text of the chapter. Chapter 4.2 states in 3.2.7 that common mode failure should have been addressed during the contingency analysis. While this section does give some examples, it does not provide guidance on how to determine the extent or potential for common mode failure. While the potential for common mode between controls within a scenario is well developed, common mode associated across scenarios and common mode associated with analysis are not as generally considered.

In H-area each scenario does include a discussion of common mode failure. In discussions with CSEs, there does not appear to be a formal method of determining common mode failure, nor any training associated with identifying it. Two examples are:

- HB line flush plan. The approach used during the CHAP discusses using sample results and liquid level to determine starting mass value then adding masses to determine the maximum fissile mass and subsequent concentration. This same control was the one that failed recently in both HB Line and the canyon (once by incorrect liquid level and once by failure to agitate leading to a non-representative sample). Failure mechanisms associated with the determination of those masses during the CHAP did not appear to be considered.

- The second example is in N-NCS-H-0277, R6 scenario 5.4.2 dealing with high Pu to 11.1 during Decon step. Controls selected use a redundant control on a single parameter using the same type instrument and common valves being interlocked. The CMF discussion acknowledges the potential for CMF but relies on “reliability of calibration and functional tests of the instruments based on the functional classification of the instrument”. Section 10 of the NCSE documents in the discussion of functional classification of these instruments a note that they are NR (none required). Facility controls associated with Decon make up and tank 11.1 agitation are discussed but not credited. The Criticality Safety Program Description Document (CSPDD) (N-NCS-G-00136) states that "multiple controls on a single parameter is acceptable to meet the DCP with justification. However in those cases it shall be documented that multiple controls are sufficiently robust and common mode failure is addressed." In this case it appears that controls which may have been on different parameters or with lesser common mode potential were not chosen.

In L-area there was no discussion of common mode failure in the CHAP document or in the specific-fuel-type NCSEs. However, the L area DCA does contain good discussions of various common mode failures with emphasis on administrative controls. Consideration is given to human performance failings which could be common in the execution of the controls. However, common analysis potential failure was not documented associated with the use (in L-area) of reference calculations against which fuels are compared (and controls selected). Since many fuels are compared against this reference calculation, an error here could affect proper control selection for many fuel types (including storage and transport). There also seemed to be an over-reliance on the presence of procedural controls to stop further evaluation of scenarios. In some cases, failure to perform a control may be important enough that it should be considered for elevation beyond the NCS program.

CONCLUSION:
Common Mode Failure discussions are evident in most analyses (including those affected directly by the Consent Order). Although the NCS Program requires an evaluation of CMF, no formal process is in place to identify CMF, or address CMF between controls and/or scenarios.

Regardless, CMF as it relates to the Consent Order has been addressed by SRNS.

RECOMMENDATIONS:

- Additional guidance and training associated with the evaluation of common mode failure should be instituted.

- Roles and Responsibilities should be defined and promulgated regarding the evaluation of CMF.

Objective: 2 Date: January 22, 2018	OBJECTIVE MET	
	YES	~~NO~~

OBJECTIVE:
Assess Organizational and facility interfaces as they relate to NCS Program implementation

DISCUSSION:
Interfaces between NCS staff and management appeared good based on observed interactions between staff and management and discussions with both CSEs and Sr. Management.

Interface between NCS and Operations supervision and Engineering appeared good based on observed interactions in the various CHAP and assessment meetings attended.

During operator interviews in H-area, one operator stated that they did not know who was the local criticality safety representative. While this is not a specific regulatory deficiency, it surprised the review team. Subsequent discussions were held with both operations and criticality safety management about potential benefits of reinforcing this interaction between the CSEs and the operating staff on the floor and ways to accomplish this. It is common at other DOE sites to have CSEs be on the floor chatting with operations staff, attending pre-operational meetings and explaining the rationale for the controls, informally soliciting feedback as to understanding of, and ease of following, criticality safety steps in procedures, providing short talks during occasional safety meetings such as on past accident or incident experience, etc.

Two meetings between DOE and contractor staff were attended by the team. In both cases there was a good flow of information and a respectful attitude. The working relationship between the NCS staff and management and NCS oversight appeared to be good. Discussions with DOE NCS oversight personnel after the meeting confirmed that they believed the relationship to be working well and they had no outstanding issues that had not been communicated with the contractor. The NCS program interface meeting provided grading from the DOE to the contractor on a number of attributes of criticality safety. These were discussed and understanding was reached on the basis for the grading. Upcoming deliverables were also discussed in these meetings which helped set the appropriate priorities for documents and activities. DOE is concerned about the "late career" cliff in NCS.

Assessment Summary for Assessment No. 2017-SA-005770 has an extensive discussion of the site Nuclear Criticality Safety Review Committee (NCSRC) and subsidiary committees, some of which is quoted below. The recommended improvement actions are not repeated as part of this report. The assessment team recommends that the committee charter and reporting be elevated such that the committee is under the direct purview of the contractor site manager.

The role and effectiveness of the site NCSRC has been limited for at least the last year. The committee has met twice, as required by the charter; but the meeting minutes indicated that one meeting was for a required annual presentation by the area CSCs and only a single topic was discussed at the second.

The effectiveness of area CSCs is varied. Three of the five committees meet regularly and appear to have plenty of issues to address. Two other committees indicate that their role is largely addressed by other committees or organizations and do not believe their committee is needed.

The charter also defines committee membership, requirements for being on the committee, minimum frequency of meetings (at least twice a year of which one meeting must consist of an annual review of the area CSCs and the NIM committees), how meetings are to be conducted, and includes an attachment with suggested meeting topics for facility reviews. This aligns well with the role of a CSC as suggested by the Criticality Safety Support Group (Purpose, Structure and Operation of Criticality Safety Committees, June 30, 2009) in Tasking 2009-1. However, evidence suggests that the NCSRC is not being utilized to take full advantage of the committee's expertise in these areas and that the effectiveness and perceived significance of the committee has diminished.

For example:

- Review of the NCSRC meeting minutes noted that although the committee has met twice within the last year (recently reduced from three to two meetings per year) as required, the scope of the meetings was quite limited. The June 2017 meeting was focused on annual facility reviews as required in addition to some discussion of areas of concern/issues pertaining to L-Area and HB-Line. Meeting minutes also mentioned several topics to be assessed during the next meeting. However, the minutes from the next meeting (August 2017) noted that the meeting was focused solely on new criticality safety guidance for ORPS reportability. In addition:
- No findings had been issued by the committee in at least 2 years. There was no evidence that the committee was touring facilities on a regular basis as was once practiced and as encouraged by this review team.
- Although the N&CSE website provided for posting of meeting minutes, the minutes from the last two meetings had not been posted (the last meeting minutes to be posted were from September 2016).
- Although the NCSRC charter requires meeting minutes to be issued in a timely manner, the minutes from the June 2017 meeting were not issued until October 2017.

Interviews with the NCS Manager and Senior Executive Vice President identified that although a 2017 NCSRC annual assessment was produced there was never any reply from Sr. Management on the report. The Sr. Executive VP was not aware if he received the report, and did state that he felt that there should be a response “otherwise why do it”. This seems to point to a gap in Sr. Management engagement on the health of the NCS program. It was noted that in March of 2018 there is a schedule for NCS to present the health of their program to the Senior Management Review Board.

CONCLUSION:

The dispersion of facilities and staff presents a geographical and organizational challenge. Co-location of NCS staff and the facilities they support is a good practice. However, the opportunity to interact with peers in the Program Group and NCS Staff at other facilities is diminished. Thus, lessons-learned and consistency across facilities are more difficult to communicate/implement.

Interfaces between NCS staff and management appeared good based on observed staff and management discussions with both CSEs and Senior Management.

Interface between NCS and Operations supervision and Engineering appeared good based on observed interactions and interviews in the various CHAP and assessment meetings attended.

Interface between NCS and Operators does not appear to be as robust as desired. No evidence of ad-hoc discussions/training between NCS and operators, meeting in small groups with operators to discuss evaluations, participation in safety meetings, informal interactions, etc.

Organizational and facility interfaces as they relate to NCS Program implementation are effective and address the Consent Order.

RECOMMENDATIONS:

- The scope and visibility of, as well as the response to, the Nuclear Criticality Safety Review Committee (NCSRC) should be brought into line with the recommendations of the CSSG Tasking Response 2009-01 on the role of Criticality Safety Review Committees.

- Informal interactions between criticality safety and the on-the-floor operators should be encouraged and supported in order to strengthen the relationship between them.

Objective: 3 Date: January 22, 2018	OBJECTIVE MET	
	YES	~~NO~~

OBJECTIVE:
Assess NCS control selection and implementation

DISCUSSION:

> **Criteria:** The staff shall maintain familiarity with all operations within the organization requiring nuclear criticality safety controls. This shall be accomplished by individual staff members maintaining familiarity with operations for which they provide guidance. [6.4]

Based on discussions and interviews, the staff is knowledgeable of the operations for which they have support responsibility. We did not see evidence that any of the staff are thoroughly knowledgeable of all operations on the site, which might be expected of senior staff.

> **Criteria:** The staff should periodically review nuclear criticality safety evaluations to determine their continued applicability and validity. This should include a review of elements of the evaluation such as scope, assumptions, normal conditions, credible abnormal conditions, controls, and limits. [6.8]

Section 3.2.10 of SCD-3 states “process and operational conditions and assumptions used in an NCSE shall be periodically reviewed to assure their continued applicability and validity.” The team reviewed 2017-SA-002793 “periodic review of H-Canyon Facility NCSEs” as representative of the assessment on NCSEs performed at each facility. This is done on a three-year frequency and covers the information in section 3.2.10 adequately.

ANSI/ANS 8.19 § 8.6 also requires that the operations be reviewed at least annually to assure that the operation performed is the operation evaluated, and the NCS staff participate in this review. This is discussed in Objective 5.

> **Criteria:** Before a new operation with fissile material is begun, or before an existing operation is changed, it shall be determined and documented that the entire process will be subcritical for both normal and credible abnormal conditions. [7.1]

> **Criteria:** Normal and credible abnormal conditions shall be determined with input from operations or other knowledgeable individuals. [7.1.1]

This appears to be happening in accordance with SCD-3. The primary mechanism to provide this function is the Consolidated Hazard Assessment Process (CHAP). Based on interviews and observations of meetings, operations staff is involved in the development of the normal and abnormal conditions. This may be limited to a few select operations staff in some areas. It was observed in a meeting later stated to actually be a preliminary meeting, before the formal Consolidated Hazards Analysis Process (CHAP) meeting, that the normal and credible abnormal conditions for potential use in an upcoming criticality safety analysis were raised in some cases and lowered in others to avoid conflict with other regulatory analyses. The formal CHAP activity requires a qualified Lead who has been trained in various Hazard assessment methods. In practice, the Hazard Assessment session related to NCS is largely produced by NCS engineers, usually with oversight from a qualified lead. Without a CHAP lead present, the practice is to call a preliminary session a Pre-CHAP.

Following the categorizing of the credible criticality accident scenarios, the CHA process discusses control methods to mitigate the risks. A recommended set of controls are identified to be developed by Engineering and Operations. The full CHAP team is required to participate.

A formal NCS CHAP requires the presence of staff from at least:

- Facility Operations;
- Facility Engineering; and
- Nuclear and Criticality Safety.

Other expertise would be expected to be present as required for the operation being evaluated.

Control selection occurs as part of the CHAP process in conjunction with involvement from Operations and Engineering. Chapter 4.2 section 3.2.7 of the NCS Methods Manual provides guidance for the identification and selection of controls. According to discussions with CSEs, existing controls currently in place are discussed along with potential new controls. Justifications for control selection are provided for some scenarios and often point to other controls not being cost effective or not being judged necessary in order to meet an agreed upon level of risk. Actions being performed by the facility but not credited as controls are listed for each scenario as “facility controls” and are listed to provide an indication of defense-in-depth beyond the selected controls.

With the exception of the redundant, like-kind controls selected in HB Line 5.4.2, the controls selected appear independent and effective in preventing a critical configuration. Implementation of those controls is a responsibility of operations and is controlled via an implementation plan and confirmed by IVR. Discussions with the IVR lead and review of several IVR reports demonstrated a rigorous method of ensuring implementation before operation. Maintenance of these controls by “annual operational reviews” required by 8.19 could be strengthened as noted in Objective 5 of this assessment.

As noted in Objective 6, use of a formalized process for hazards identification may be hampered by a lack of training in formal methods. SCD-11 in Appendix 8.20 reiterates the DOE-STD 3007 recommendation that a disciplined method be used. It states the CHAP methodology may be used to aid in this evaluation. Although there is additional information on the assessment process available in the NCS Methods Manual it is not referenced from this Appendix. There is a reference to Appendix A of ANSI 8.1. Given that the definitions of credible and incredible in Appendix 8.20 are not the same as that in the SCD-3 (where it was purportedly taken from) it is not clear that consistency or coordination is frequent between the two manuals.

The team observed a Pre-CHAP meeting on flushing HB-Line vessels to H-Canyon Tank 11.1. The meeting had about a dozen participants from the various required organizations and disciplines. This was a first meeting and largely focused on defining and understanding the full scope of the proposed operation.

Criteria: During development of the nuclear criticality safety evaluation, the staff performing the evaluation should personally observe relevant existing equipment, activities, and processes. [7.1.2]

Our evidence indicates that this is occurring routinely. Several of the staff are very knowledgeable of the operations, and multiple walkdowns to gather process and surrounding conditions are used by the criticality safety staff.

Criteria: The nuclear criticality safety evaluation shall be documented with sufficient detail, clarity, and lack of ambiguity to allow independent judgment of results by personnel familiar with the physics of nuclear criticality, the facility operations, and the associated nuclear criticality safety practices. [7.3]

In many cases, the dependence of the controls on the excursion scenario that they were placed to prevent could not be made. In some of those cases we could infer how the control related to the scenario and the controlled parameters, but in others we could not. We did find it positive that the controls required were the types of controls that operating staff could implement in order to affect the necessary criticality safety parameters.

We did not attempt to find and check subcritical calculations as part of this review. The team members are not intensely familiar with canyon solvent dissolution and solvent extraction operations, nor the history of site practices. Therefore, we would not purport to do an independent review of the evaluations, nor was it in our scope.

Criteria: Before the start of operation, there shall be an independent review that confirms the adequacy of the nuclear criticality safety evaluation. The reviewer shall be familiar with the physics of nuclear criticality, the facility operations, and the associated nuclear criticality safety practices. [7.4]

Our evidence indicates that the technical review process is being executed in accordance with local guidance. However, we would have anticipated that some of the senior staff would have pushed the program and evaluations to more rigorous compliance with the ANSI/ANS-8 Standards. See discussion below regarding specification of control values.

NCSE-H-0299 derives mass limits for Pu in tank 9.6 based on Gadolinium. It is assumed that suspended solids form an optimum geometry in the optimum concentration for criticality in the tank. This would normally deal with any potential for other contingent conditions in this scenario. However, the limits were derived from regression analysis of parameter study data, and it is stated in the evaluation that a regression curve for K-effective vs mass could not be estimated. The fact is that a simple transformation of the independent mass parameter to the natural log of the mass parameter allows a regression curve to be developed, and regression values estimated against the non-transformed variable. When this was done, it was found that the stated mass limit was about 12% high, since the regression variances were not considered in setting the limit. The validation offsets taken put the maximum upper limit on a very steep portion of the curve, and the variance from the regression fit is not included in setting the limit. This led to a check of the other curves where gadolinium is counted for keeping the particulate solids subcritical. It was found that the limits from regression analysis should be 3% to 10% lower than those stated in the evaluation.

> **Criteria:** Nuclear criticality safety controls shall be implemented and maintained to provide subcriticality for fissile material operations under both normal and credible abnormal conditions. [8.1]

The evaluations appear to be weak in this area, especially with the focus on a facility wide "Double Contingency Analysis". At least one of the major evaluations reviewed had controls that were probably tied to the process conditions and parameters being controlled, but the logic of the ties required a lot of external knowledge. A reviewer knowledgeable of the types of processes could very easily draw the wrong conclusions, and a reviewer without specific knowledge of the unit operations being evaluated should refuse to draw conclusions at all. However, there were multiple instances where a specific control value was stated in the procedures, but not in the governing evaluation the procedure referenced. The presence of the control was required, but the value of the control parameter was frequently not. ANS-8.19 § 7.2 and ANS-8.1 § 4.2.1 require that these parameters and their limits be identified and stated. These requirements may be inappropriately overshadowed by the emphasis placed on complying with the "recommended" Double Contingency Principle. (For example, Section 6.1.4.5 of SCD-3 states: "Compliance with the DCP (see Section 3.2) and the **recommendation** [Emphasis added. Note that this excerpt from the standard is a requirement, not a recommendation] that the entire process is subcritical under both normal and credible abnormal conditions shall be demonstrated in this section of the evaluation."

The team reviewed an evaluation for transfer from favorable geometry tanks with potential fissile particulate suspension into an unfavorable geometry tank containing neutron poisons. The process description indicated a slow flow from the favorable geometry tank. The postulated worst-case process condition is that the particulate would form a sphere of un-poisoned pseudo-solution in the large tank before mixing, with a critical mass of a few hundred grams. The only control placed is a mass limit for various poison concentrations in the tank. There were several opportunities to assure that the postulated process condition remained subcritical.

- The maximum mass in any individual transfer is normally less than 200 grams.
- The receiving tank can be well mixed.
- The receiving tank concentration is expected to be below the subcritical concentration limit from ANS-8.1. The sending tank concentrations are also expected to be low, but this is not stated as a normal condition.

These all should have been placed as controls or protected assumptions. This would thoroughly forestall the potential scenario, and further, if one of these controls failed, it would be internally reportable (ANSI/ANS-8.19, § 8.7) rather than an ORPS report with undue DOE HQ pressure.

The CSSG recommends the site adopt a practice of "crediting" or using all the controls that are readily available, especially those that would aid in the efficient conduct of the process operations. In coarser language, take cheap safety where you can get it. This will provide earlier indications of potential process drift or program weakness, enhance the real defenses against criticality, and avoid high visibility reporting when it is not necessary.

> **Criteria:** Before the start of operation, the supervisor responsible for the operation should confirm that the nuclear criticality safety evaluation adequately identifies normal and credible abnormal conditions and establishes requirements that are verifiable and compatible with the planned operation. [7.5]

Criteria: Before the start of operation, proper implementation of nuclear criticality safety controls shall be verified. [8.2]

S-OSA-G-00007 Rev. 9, Onsite Safety Assessment of the 70-Ton Nuclear Fuel Element Cask
Section 4 contains the "Controls and Programmatic Attributes for 70-Ton Cask Transfers." The controls are labeled with [C] or [P] for Control and Programmatic Attribute respectively. NCS controls for HFIR fuel transport are included in Section 4.1.3. The controls listed do not carry forward all controls identified in referenced documents. In some instances, stated controls do not match the cited document.

For example:
"4.1.3.6 [C] Transfers of HFIR fuel shall be dry-loaded. For dry-loaded transfers, residual water remaining in the fuel assemblies is acceptable. [N-NCS-G-00133, 7.3.5]"

7.3.5 of N-NCS-G-00133 states: "A 70-ton cask (CD-3) with the HFIR insert installed is limited to up to four each of HFIR inner fuel elements and up to four each of HFIR outer fuel elements each of which is in its respectively sized carrier and water has been drained from the cask such that the level of residual water is no higher than the bottom of the grate of the insert. (Normal condition and CSc #1 through CSc #3)

Perhaps there is an operational understanding implicit in the OSA document but there is no explicit equivalence between the implementing document and the NCSE control. After a thorough reading of the evaluation and its references there is no single, concise listing of controls. For example, the "…residual water remaining in the fuel assemblies is acceptable" statement is found in the Scope Section of the NCSE as "Water is assumed to remain in the fuel assemblies, and residual water may be present in the fuel bundles." Again, there is not a one for one correlation between the two.

Section 7.2.1 of N-NCS-L-00130 states: "70-ton casks shall be loaded with clean, resin-free fuel per the loading limits outlined in Table 16." This control is translated neither to N-NCS-G-00133 nor the OSA. It is not clear whether this control is a credited control or a procedural control. Regardless, it is an example of implementation not as intended by the NCSE.

Criteria: The purpose of operating procedures is to facilitate and to document the safe and efficient conduct of operations. [8.5]

Criteria: Procedures should be organized for convenient use by operators and be conveniently available. They should be free of extraneous material. [8.5.1]

Criteria: Procedures shall include those administrative controls and limits significant to the nuclear criticality safety of the operation. [8.5.2]

Several procedures we reviewed included limits and controls to maintain the operation subcritical. Traceability of the specific values in the procedure to the criticality safety evaluation was not always possible. We observed a demonstration of tracing an identified criticality safety control from the H-Canyon DCA to the appropriate implementing procedures. However, when an attempt was made as part of the demonstration to trace a control identified as a "facility control" to the procedures, the ability to do so was not nearly as facile. Granted, the LDD is not utilized to trace other than elevated controls or in some cases credited controls. However, a similar process (or the same) could be utilized to trace “facility” controls providing a clear implementation trail for those DID controls. “Facility controls”, as identified in the Double Contingency Analysis or Nuclear Criticality Safety Evaluation are important for criticality safety (i.e., defense-in-depth), but are not part of the “credited” controls.

> **Criteria:** New or revised procedures that have an impact upon nuclear criticality safety shall be reviewed by the nuclear criticality safety staff. [8.5.3]

Interviews and inspection of procedures indicates that the criticality safety staff reviews procedures and procedure changes.

> **Criteria:** Procedures should be supplemented by posted nuclear criticality safety limits or limits incorporated in operating checklists, flow sheets, or inventory control systems. Where these supplements are used, they shall be kept in good repair, legible, and consistent with current controls and limits. [8.5.4]

The procedures reviewed were supplemented by the use of checklists and tables. It is also typical to have the limits programmed into the control system where remote operation is used.

> **Criteria:** Deviations from procedures and unintended alterations in process conditions that affect nuclear criticality safety shall be reported to management, investigated promptly, corrected as appropriate, and documented. Action to correct such deviations or alterations shall be taken in accordance with procedure requirements or with guidance obtained from the nuclear criticality safety staff. Action shall be taken to prevent recurrence. [8.7]

While SCD-3 section 2.4.17 has the requirement that NCS staff shall examine reports of procedure violations and other deficiencies related to NCS, it does not appear that this is being done for all deficiencies or procedure violations. The typical evaluation protocol is to derive or cite a maximum acceptable value, which is frequently below well-known subcritical limits. From this, a lower operating limit is developed, and then an even lower procedural control is developed outside the evaluation process. It is frequently these procedural controls that support the safety of the operation. However, interviews indicate that deviations of these procedural controls would not be reported or investigated, and thus they are not tracked or trended. Without such notification, there is no clear way for CHAP team members or NCSE authors to be aware of instances of DID failure in the same manner that they can for credited controls. DID is a real part of the risk management process.

There is a large tendency to develop two controls, usually cited as “credited” controls for each potential criticality scenario, and call that double contingency. These controls frequently address only one potential change in process conditions, contrary to the double contingency principle. Controls that help maintain the system below the control limits, or serve to make the control of the process parameter more reliable than it would be with the credited controls alone are implemented as defense in depth. These are frequently called “facility controls”. Our interview evidence overwhelmingly indicates that violation of theses lesser controls is not reported, tracked or trended. This leads to undue emphasis on the main controls alone, and increases the necessary reporting level if one fails. This reporting level gives the indication that the system is much less safe than it is. The missed opportunity to detect and correct errors in the contributing or buttressing controls makes the system less safe than it should be.

> **Criteria:** Personnel should be encouraged to provide feed-back on the nuclear criticality safety program, including identification of concerns or circumstances that could adversely impact

nuclear criticality safety, practices that favorably impact nuclear criticality safety, and identification of potential improvements. [8.8]

It is not clear that the operating staff feels they have the opportunity to suggest improvements to controls and procedures, and development of procedures and methods is left to only a few senior operators. There was some sense of operations providing input to the NCS process because they 'have to'.

Criteria: Management shall establish and maintain a configuration management system that identifies, and controls changes to, facilities, equipment, and processes important to nuclear criticality safety. [4.9]

Criteria: The facility configuration management system shall include those engineered controls significant to the nuclear criticality safety of the operation. [8.4]

F/H Lab faulted themselves for software QA configuration control in the following assessment.
Assessment Summary, Assessment No. 2017-SA-002009, *F/H Laboratory SAR/TSR Rev. 16 IVR*, 12/5/2017.

***2017 SWMF FA-15 Program Manager Facility Assessment*, 02/27/17**
Are procedures in place to verify that changes to process equipment over time have not degraded compliance with criticality safety controls?

Results: Yes. The assessor verified by document review that changes to process equipment are governed by the Configuration Control Program. This is a TSR level program and is implemented in the U-SBIP-E-00014, Rev. 1, Safety Basis Implementation Plan for SWMF DSA, Rev. 25, and TSR, Rev. 26. The plan identifies and documents the technical baseline of Structures, Systems, Components and computer software. It ensures that changes to the technical baseline are properly developed, assessed, approved, issued, and implemented.

Surveillance No. 2016-SUR-34-0010 *Independent Implementation Verification Review (IVR) for H-Canyon DSA Rev.10/TSR Rev. 10 (Non-TRM)*, 5/26/2016
Finding (Pre-implementation): Discrepancies were identified in multiple LDD records involving installed process instrumentation (IPI), STD records, and requirement statement wording versus DSA Rev. 10 and TSR Rev. 10 wording. [Criteria 1.1, LOI 2], Reqt: Manual 11Q, Procedure 1.06, Section 5.2, "LD Configuration Control"

2016-SA-003288, H-Canyon 2016 Facility Self-Assessment Criterion 15-01-01- 09, Evaluation Dates: 4/25/2016 – 5/10/2016
Assessment of the H-Canyon and H-Outside Facilities configuration management. No Findings or OFIs were noted.

2016-SA-004236, HB-Line 2016 Facility Self-Assessment Criterion 15-01-01-09, Evaluation Dates 6/27/2016 – 6/30/2016. This evaluation of HB-Line's configuration management program confirmed that programs are in place to control changes which may affect criticality safety. This assessment did not involve field work, but instead discussed methods. No Findings or OFIs were noted, and the results of the assessment were satisfactory.

2016 KAC Facility N&CSE Self-Assessment of the Nuclear Criticality Safety (Functional Area 15, or FA-15) criterion for Configuration Management (CM).
This assessment is based on U-PP-G-00006, Rev. 1, which defines the FA-15 assessment bases, criteria, and suggested lines of inquiry. The assessment elements, performance objectives, and criteria (EPO&C) are drawn from American National Standards Institute (ANSI) standards addressing criticality safety and DOE-STD-1158, Self- Assessment Standard for DOE Contractor Criticality Safety Programs. The specific criterion assessed here is 15-01-01-09, which states: "Management shall establish and maintain a configuration management system that identifies and controls changes to facility and process conditions important to nuclear criticality safety."

Assessment Results: The results of this assessment were satisfactory, with no findings or OFIs.

Topic: Is a configuration management system clearly established for K Area Complex (KAC)?

The SRS Site Policy for Configuration Management (CM) is defined in Site Manual 1-01, Procedure 5.39. Among other things, this states: It is Savannah River Site (SRS) policy that Configuration Management be used in development, design, construction, start-up, maintenance, operation, and dispositioning of all operating nuclear facilities and nuclear facilities postured for Disassembly and Removal (D&R). It also states that CM includes processes to create valid technical baseline documents and databases that provide safety, environmental, health protection, and mission critical requirements of SSCs, and process software.

KAC Documented Safety Analysis (DSA), WSRC-SA-2005-00005, Rev. 11, Chapter 5 (Derivation of TSRs) addresses CM as follows in Section 5.5.5.7.5 (page 5.5-63):
"The SRS Configuration Control Program is based on the requirements of DOE Order 420.1C and establishes a business method that maintains consistency among design requirements, physical configuration, and facility documentation (Ref. 56). DOE O 420.1C refers to DOE-STD-1073-2003, Configuration Management (Ref. 57). A Configuration Control Program is implemented for the KAC that identifies and documents the technical baseline of Systems, Structures, and Components (SSCs), including the Assembly Area non-hardened structure footprint, and computer software and ensures that changes to the technical baseline are properly developed, assessed, approved, issued, and implemented. It also maintains a system for recording, safeguarding, and indicating the status of technical baseline documentation on a current basis."

N-ESR-K-00008, Rev. 6, documents the Configuration Management Implementation Plan (CMIP) for Nuclear Materials Management KAC Facilities.
The CMIP Executive Summary states, in part: "The objective of the K-Area Complex CM Program is to establish and maintain the Technical Baseline (TB) for selected Structures, Systems, and Components (SSCs) that support the facility mission and to control changes to that baseline." The CMIP addresses reconstruction of the technical baseline because the historical documentation available for some SSCs was not in accordance with the current requirements of the Site CM Program. Although this reconstruction is still ongoing, as shown in Table 3, that does not present a significant concern for criticality safety. CMIP Section 4.2.6, KAC Facility Modification Document Approval Requirements, states: "All documents associated with a modification to a KAC Facility including design input and output documents ... shall be reviewed/approved by a designated representative from each of the following organizations prior to being implemented in the field: Criticality Safety Engineering, Fire Protection Engineering, Structures and Buildings (SAB) Design Authority Engineer, Area Configuration Management."

Site Manual E7
E7 includes numerous procedures that govern a host of activities that collectively constitute Configuration Control. Key procedures addressing change control are: 1. E7, 2.05, Modification Traveler, 2. E7, 2.06, Temporary Modification Traveler, 3. E7, 2.37, Design Change Form, 4. E7, 2.38, Design Change Package. Procedures E7, 2.37 and 2.38 require that all modifications be subject to the Unreviewed Safety Question (USQ) procedure defined in Manual 11Q, 1.05. This procedure requires review of proposed activities, or modifications, against the existing facility Safety Basis documents, which include the process descriptions and controls for criticality safety. In aggregate, the E7 procedures address details of establishing, documenting and controlling the Technical Baseline. Overall the documents discussed under this LOI provide ample evidence that a CM system is established for SRNS facilities, including KAC. This CM system also provides for criticality safety reviews of changes to SSCs.

CONCLUSION:
NCS control implementation was a focus of this assessment, given the events that precipitated the Consent Order. While assessment of NCS was a major focus of the Consent Order, Conduct of Operations (CONOPs) underpins implementation and execution of NCS controls. Without effective CONOPs, there can be no effective criticality safety program.

Control implementation and, particularly, verification vary depending upon the control (facility/procedural or credited criticality safety control). There are instances where a control is deemed a facility control for one scenario and a credited control for another scenario. Once a control is credited for a process, it should be credited for all scenarios.

Like-Kind redundant controls (e.g., Independent verification, and duplicate instruments) are often cited as independent controls. The CSSG views these as highly susceptible to CMF. Redundancy will generally increase the reliability of a control but credit should not be taken for independence.

Formalized Hazards Analysis and subsequent control selection occurs via the CHAP process. With the exception of the preceding paragraph, controls appear independent and effective in preventing a critical configuration. Moreover, the controls are implementable by operations.

As a part of the CHAP, a review of the entire suite of controls from the NCSE including CMF would strengthen the control selection process.

NCS control selection and implementation effectively addresses the Consent Order.

RECOMMENDATIONS:

- A communications method should be developed to ensure that failure of any NCSE controls that are part of the safety argument (credited or DID) are identified and communicated to NCS for tracking and trending. This also has applicability to the NCS Assessment Process.

- As a part of the CHAP, a review of the entire suite of controls from the NCSE including CMF would strengthen the control selection process.

Objective: 4 Date: January 22, 2018	OBJECTIVE MET	
	YES	~~NO~~

OBJECTIVE:
Assess Laboratory analysis process as it relates to NCS controls

DISCUSSION:
F/H Laboratory Analysis Process as it relates to NCS controls:
In late January 2016 an incident occurred as the HB-line facility was preparing to transfer solution from a geometrically favorable tank to an H Canyon tank (H 9.6) which was not geometrically favorable. The criticality safety basis was that the transferred solution would have a Pu concentration less than 5.1 grams per liter. The control was that two samples would be taken from the sending vessel (NT-51). When the two samples arrived at the laboratory, the technician assigned to analyze both samples input the wrong dilution factor into the record for the first sample and it automatically transferred for the second sample. The two sample results roughly agreed and the concentrations reported were substantially less than what was actually transmitted to the HB line.

The subsequent investigation identified corrective actions. Now, when dual samples are received from HB area, two technicians analyze the material. Although the same device is used, the first technician must log out of the system before the second technician can log in and begin analysis. This deletes the input data for the prior sample. Quality control measures are performed before both analyses. The two technicians then evaluate each other's results for inconsistencies. It is expected that the results will be statistically the same but not identical. The laboratory staff is aided in this task by a spreadsheet that is validated and controlled per local laboratory procedures. Laboratory scientists periodically assess the sample results.

The sample request system now specifies the function requiring the data, such as nuclear criticality safety or MC&A.

A person in the laboratory is now assigned the responsibility of assuring communication between operations, the laboratory, and other groups requiring the data, such as nuclear criticality safety.

The enhancements to the F/H laboratory operations are positive and adequate.

CONCLUSION:
It was noted that SA-005770 did not discuss results from F/H Laboratories. Upon further discussion with the review leader, it was ascertained that the write-up inadvertently omitted the F/H Laboratory discussion. The report should be revised to include the F/H Laboratory discussion. Regardless, the CSSG conducted interviews with the laboratory and concluded that the corrective actions resulting from prior incidents have been implemented and deemed effective.

The Laboratory analysis process, as it relates to NCS controls effectively addresses the Consent Order.

Objective: 5 Date: January 22, 2018	OBJECTIVE MET	
	YES	~~NO~~

OBJECTIVE:
Assess the NCS assessment process

DISCUSSION:

> **Criteria:** Management shall establish a method to monitor the nuclear criticality safety program. [4.6]

Effectiveness of the Nuclear Criticality Safety Review Committee (NCSRC)

The Criticality Safety Support Group drafted a position paper on the purpose and function of a site Criticality Safety Committee. The report stipulated that the committee report to the senior contractor manager and advise such on the status and quality of their NCS program.

Other nuclear facilities have management level nuclear safety committees which monitor the effectiveness of the NCS program and report at least annually to the site manager to identify issues and recommended corrective actions.

The charter of the NCSRC specifies its purpose as providing a forum for "discussing and coordinating" the implementation of the NCS program at SRS. One could assume an implied function was to support the ANS-8.19 requirement to monitor the NCS program. It is not clear that "discussing and coordinating" will monitor the health of the NCS program. It is noted that the self-assessment 2017-SA-005770 asserts that even their charter function has limited effectiveness.

The team recommends that SRNS revise and strengthen the NCSRC to provide effective oversight and provide advice to assure the vector of the program is upward.

> **Criteria:** Management shall participate in auditing the overall effectiveness of the nuclear criticality safety program at least once every 3 years. [4.7]

> **Criteria:** The staff shall conduct or participate in audits of nuclear criticality safety practices, including compliance with procedures, as directed by management. [6.6]

> **Criteria:** The staff shall examine reports of procedural violations and other deficiencies for possible improvement of safety practices and procedural requirements. Findings shall be reported to management. [6.7]

Procedural violations are not reported or tracked unless they hit the credited controls in the DCA. Interviews indicate that deviations of these procedural controls would not be reported or investigated, and they are neither tracked nor trended. In some areas CSEs attend engineering turnover meetings where deviations (including failed procedural steps) are covered. While in most cases it appears that deviation meetings are attended by NCS staff, a review of the SRNL fact finding (STAR 2016-CTS-00968) on 1/26/2017 did not list a NCS presence at the fact finding.

Criteria: Operations shall be reviewed at least annually to verify that procedures are being followed and that process conditions have not been altered so as to affect the nuclear criticality safety evaluation. [8.6]

Criteria: These reviews shall be conducted, in consultation with operating personnel, by individuals who are knowledgeable in nuclear criticality safety and who, to the extent practicable, are not immediately responsible for the operation. [8.6.1]

Criteria: These reviews shall be documented. [8.6.2]

Section 9.1.7 of SCD-3 provides the requirement for operations to be reviewed at least annually. It credits the combination of annual facility self-assessments, DATRs and the USQ process, the NCSE change process, the procedure review process, management self-assessments, readiness assessments, and annual CSC reviews. Based on the self-assessment reports they credit 3 things for "operational reviews". The facility self-assessments, the NCS program assessments and CSO walkdowns. There does not appear to be specific guidance on what is evaluated for an operational review (they do review changes - hardware changes - to the system as they are requested), or any assurance that all operations are reviewed (only that there are reviews of operations - the organization and process - but not actual operations). Appendix F of SCD-3 states "a standard walk-down consists of three general steps; review the implementing documents, observe the work, document any findings or observations". Section 3.2.10 of SCD-3 states "process and operational conditions and assumptions used in an NCSE shall be periodically reviewed to assure their continued applicability and validity." The team reviewed 2017-SA-002793 "periodic review of H-Canyon Facility NCSEs) as representative of the assessment on NCSEs performed at each facility. This is done on a three-year frequency and covers the information in section 3.2.10 adequately. An assessment for F area (2016-SA-002105) was also reviewed, indicating that these requirements are being met.

Document N-NCS-H-00145, Rev. 0, 12 Rad Zone Analysis, was reviewed and found to be very conservative in both its determination of the credible locations and in the magnitudes and time evolution of the selected, credible criticality accident source terms. When this observation was discussed with NCS management it was stated that this now 15-year-old report is on the docket to be updated in the next few years as staff time and work priorities permit. It is noted that Appendix C of ANS-8.23 provides guidance based on criticality accident simulation experiments for the first spike yield and total fission yield for solution accident durations up to 10 minutes which should cover most, if not all, facility evacuation times. It is also noted that there is a new DOE Accident Analysis handbook in RevCom and it should provide significantly updated guidance compared to what is found in currently referenced DOE and NRC documents such as DOE HDBK 3010-94. We encourage this update be prioritized. It could also provide an important learning opportunity for newer staff to become familiar with a specialty technical area that is apparently familiar to few current staff.

CONCLUSION:
Self-Assessment is very evident.

Interviews indicate that deviations of facility/procedural controls are not reported, investigated, tracked or trended by NCS. Such deviations are indicators of the erosion of criticality safety controls. See related topic in Control Development and Implementation Objective.

NCSRC reports appear to simply be filed. The NCSRC Charter does not direct engagement by Senior Management. Implementation of the NCSRC is not consistent with the recommendations of CSSG Tasking 2009-01.

Current processes for annual operations reviews may not meet the intent that all operations are reviewed annually.

Periodic external assessments are valuable to ensure internal assessments are providing an objective review of the program. This assessment was the first external assessment of the NCSP in at least a decade.

The NCS assessment process effectively addresses the Consent Order.

RECOMMENDATION:

- Clear expectations and guidance should be developed and institutionalized to strengthen implementation of the annual operational review requirement and to ensure that all operations are reviewed annually.

Objective: 6 Date: January 22, 2018	OBJECTIVE MET	
	YES	~~NO~~

OBJECTIVE:
Assess NCS Training and Qualification

DISCUSSION:
The criticality staff interviewed while investigating implementation of criticality controls were knowledgeable in their subject areas. The breadth and depth of knowledge was variable, as would be expected with a bi-modal staff demographic. We interviewed several personnel with in-depth knowledge of their subject areas, whether process areas or site program. However, we did not find any one with a comprehensive knowledge of criticality safety at the entire site. It would be expected that there would be at least a few senior staff with this type of knowledge.

> **Criteria:** Management shall establish a training and qualification program for nuclear criticality safety staff. Guidance for establishing that program may be obtained from ANSI/ANS-8.26-2007 (R2012) [3]. [4.5]

Training and qualification has been the subject of multiple self-assessments at the facilities, the program level and most recently at the "pre-CSSG" review level. Results from the facility self-assessment and program assessment have been routinely satisfactory as has been the program assessment. Based on this the CSSG has limited its review to focus on results of the "pre-CSSG" review and a limited set of areas identified in our review of other areas of the program. The finding from the "pre-CSSG" associated with maintenance of facility specific training is noted, as is the issue of CSE requalification.

In addition, the CSSG has determined that the ANS-8.26 section 7.7.1 (SCD-3 4.3.6.8) that CSEs have knowledge of hazards analysis techniques can be significantly strengthened. Review of the ETS91011STH0000100 class slides indicates that the only training provided is on the name of methods that are available. Discussions with the CSEs identified that they did not remember receiving any further training nor were they familiar with the pros and cons of the various methods. CHAP leads, who have had greater training on the methods, are typically available as part of the CHAP meeting. CHAP leads may be viewed as a compensatory measure, given their training. However, this does not obviate the requirement for CSE training. In L-area "pre-CHAP" meetings are held to evaluate NCS related scenarios - these typically will not involve a CHAP lead, however a CHAP lead is present at all full CHAP meetings in L-area. In H-area CHAP meetings are replaced with DCA meetings where a similar group is convened to address scenario development and control selection. The CSSG witnessed a DCA meeting for HB Line which included the CHAP lead, however at least in the case we witnessed he was not leading the meeting or directing the process. In discussion with H-Area CSEs this was explained as usual (for safety basis CHAPs the lead was the CHAP lead, but for NCS/DCA meetings the lead was NCS). This lack of familiarity by the CSEs on formal hazard analysis processes coupled with the potential for a CHAP lead to not drive a formal process can lead to inadequate identification of events and incomplete evaluation of controls.

Discussions with CHAP leads and with CSEs from various areas identified that, although the CHAP process has an expectation that the CHAP team will travel to the location of the process being evaluated, that step is seldom used within the CHAP process – instead it is typical that paper reviews using P&IDs or drawings are used instead. This can lead to different perceptions of the actual layout, process and operations between CHAP participants and thus potentially errors in the CHAP output. This step should be part of the CHAP lead responsibilities/expectations.

> **Criteria:** Each supervisor shall be knowledgeable in those aspects of nuclear criticality safety relevant to operations under his or her control. Training and assistance should be obtained from the nuclear criticality safety staff. [5.2]

> **Criteria:** Each supervisor shall ensure that nuclear criticality safety training is provided to the personnel under his or her supervision. [5.3]

> **Criteria:** Each supervisor shall require that the personnel under his or her supervision understand procedures, limits, controls, and other nuclear criticality safety considerations such that personnel can be expected to perform their functions without undue risk. [5.3.1]

Staff understanding of controls, basis of controls, and the need for ConOps regardless of the apparent need for controls may be an area where improvements could be made. Our observations indicated that operations staff have very limited ownership of controls. We saw no evidence indicating an understanding of the occasional need for the implementation of overly conservative controls to facilitate time sensitive operations. As noted in Objective 1, opportunities to enhance this understanding have been missed (via small group interactions and training opportunities between operations and criticality safety staff). This is a vulnerability as it could lead to rote compliance with controls/limits.

> **Criteria:** Records of training activities and verification of personnel understanding shall be maintained. [5.3.2]

This item was reviewed as part of the pre-CSSG assessment and was not re-reviewed by the CSSG.

> **Criteria:** General guidance for a nuclear criticality safety training program may be obtained from ANSI/ ANS-8.20-1991 (R2005) [4]. [5.3.3]

This item was reviewed as part of the pre-CSSG assessment and was not re-reviewed by the CSSG.

> **Criteria:** The staff shall assist supervision, on request, in training personnel. [6.5]

Discussions with CSEs and with SB &NCS training manager show that CSEs review NCS training slides/presentations and are available to assist in the training as requested. In practice CSEs seldom provide NCS training and are only sporadically present when training is conducted. This presents a missed opportunity and should be considered in light of the recommendation in Objective 2 associated with the NCS engineer/operator relationship.

CONCLUSION:
Hazards Assessment training for Criticality Safety Engineers needs significant improvement in light of ANS-8.26, Section 7.7.1. This weakness is somewhat mitigated by the use of CHAP leads appropriately trained in the various methods.

There was not a consistent use or expectation of the role of the CHAP leads between the areas, nor did there appear to be a consistent knowledge of the resources available for determining criticality contingencies.

Lessons-Learned were not being shared amongst CHAP Leads.

NCS Training and Qualification effectively addresses the Consent Order.

RECOMMENDATIONS:

- The NCST&Q program should be modified to ensure that, as a minimum, the CSEs receive a formal overview (pros/cons/limitations) of the methodologies available for hazards assessment. If NCS staff serve as CHAP leads, they should receive the CHAP lead Hazard Assessment training. In the longer term, at least one CSE in each area should become CHAP lead trained in order to help drive the practice as it relates to the criticality safety specialty.

- Expectations for their formal role in the CHAP/DCA meetings and sharing of best practices between themselves should be reinforced with the CHAP leads.

Objective: 7 Date: January 22, 2018	OBJECTIVE MET	
	YES	~~NO~~

OBJECTIVE:
Assess NCS staffing

DISCUSSION:

> **Criteria:** Management shall provide personnel familiar with the physics of nuclear criticality and with associated safety practices to furnish technical guidance appropriate to the scope of operations. This function should, to the extent practicable, be administratively independent of operations. [4.4]

"There are sufficiently trained and assigned Criticality Safety Engineers (CSEs) and Criticality Safety Officers (CSOs) to address facility criticality safety issues and sustain facility mission objectives. SRNS staffing level is sufficient to meet current needs but has no surge capacity. Staff experience level is still dominated by late-career Senior Criticality Safety Engineers (SCSEs)." [2017-SA-004278]

NCS staffing was reported by NCS personnel to be adequate, but with little surge capacity. However, the site-wide, new staff development program appears to be making 2 new staff available within the next year and potentially others in the future. It was also noted that the site-wide criticality safety review committee, NCSRC, does not have in its charter the mandate to monitor NCS staffing adequacy. This seems to be an anomaly compared to similar committees at other DOE sites nationwide. Management might benefit from having an independent analysis of this staffing situation and the NCSRC would seem to be the logical organization to provide such. Operations and Engineering supervisory folks who were interviewed were generally positive about the support they received from CSEs. Staff at all levels were generally optimistic and satisfied with their jobs.

CONCLUSION:
Staffing is currently adequate to support operations. However, staffing exhibits a bimodal distribution when examined from an experience basis. The distribution shows minimal experience and extensive experience. Little to no staff have what would be considered mid-career experience.

Staffing should be reviewed in terms of distribution according to facility risk and succession planning.

The ELDP is noted as a very good practice, providing early career staff. The NCS Program recognizes the need to transfer knowledge from their most experienced staff to the newer staff.

NCS Staffing effectively addresses the Consent Order.

APPENDIX B
Meetings Observed, Personnel interviewed, and Documents Reviewed

Meetings Observed:
CHAP and Pre-CHAP meetings
Criticality Safety Colloquium
HB Line Flush CHAP kickoff meeting 1/16/2017
L-Area Pre-CHAP meeting 1/17/2017
HB Line FA-15 Program Assessment Kick off meeting 1/16/2017
NCS Interface Meeting (H-area) 1/16/2017
N&CSE/DOE Interface Meeting 1/17/2017

Personnel interviewed:
First line managers of operating areas
Fissile material handlers and operators
Shift Operations Managers
H-Area Facility and Operations Managers
Training Mangers & Coordinators
F/H Laboratory Lead
L-Area NCS Lead
L -Area CSEs/CSOs (5)
H-Area NCS Lead
H-Area CSEs/CSOs (3)
K-Area CSE (1)
H-Area CHAP Lead
SB and NCS Training Manager
SRNS Chief Engineer
SRNS Executive Vice President
SRNS NCS Program Manager
IVR Manager and “pre-CSSG” assessment lead

Documents Reviewed:
Qual Cards for ACSE
Qual Cards for CHAP

DOC Number	Title
22-04-16	Signed SRNS Consent Order (NCO-2016-01)
2015-CTS-001892	Loss of Tank NT-51 Agitation Results in Criticality Control Violation
2015-CTS-010106	HB-Line Phase III TSR-NCSE Violation
2016-CTS-000968	F-H Lab & TIDAS
2016-SA-002152	
2016-SA-002155	
2016-SA-003288	H-Canyon 2016 Facility Self-Assessment Criterion 15-01-01- 09
2016-SA-004236	HB-Line 2016 Facility Self-Assessment Criterion 15-01-01-09
2016-SA-005007	
2016-SA-005746	KAC FA-15 Self-Assessment for Configuration Management

DOC Number	Title
2016-SA-006299	DOE-SR Criticality Safety Program 2016 Self-Assessment
2016-SA-006318	Capturing Criterion 4 from 2016-SA-001930
2016-SUR-34-0010	Independent Implementation Verification Review (IVR) for H-Canyon DSA Rev.10/TSR Rev. 10
2017-CTS-012553	Tank 9.5 Liquid Level Anomaly Affects Proper Implementation of Fissile Solution Interim Storage Requirements (U)
2017-SA-002009	F/H Laboratory SAAR/TSR R 16 IVR
2017-SA-002793	
2017-SA-004278	SME Self-Assessment of the Criticality Safety Program (JUN2017 Metrics Report)
2017-SA-005007	Assessment of Criticality Safety Evaluation of Facility Operations using Criterion 15-05-01-07 for HB-Line as part of the Annual Facility Functional Area 15 Self-Assessment
2017-SA-005405 Full Report	October 2017 NCSP Metrics Report
2017-SA-005405 STAR Entry	
2017-SA-005770	Internal Review of SRNS Nuclear Criticality Safety Program
221-H-1969	Unloading the 70-ton Cask Car and Charging Dissolver 6.4D
221-H-1987	Determining Fragment Height in Ten-Well Insert Using the Ten-Well Insert Probe
221-H-4101	Operation of 6.4D to Dissolve Used Nuclear Fuel (UNF)
221-H-4147	Adding Chemicals to 6.4D Dissolver
221-H-4149	Preparing Dissolver 6.4D for Used Nuclear Fuel Batch
ANSI/ANS 8.19-2014	Administrative Practices for Nuclear Criticality Safety
ANSI/ANS 8.26R2016	Criticality Safety Engineer Training and Qualification Program
ANSI/ANS-8.1-2014	Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors
ANSI/ANS-8.14R2016	Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors
CSSG TASKING 2017-05	CSSG Assessment of SRNS NCS Program
DNFSB Letter	4JAN18 Conduct of Operations Safety Management Program at SRS
EM-SR--SRNS-HBLINE-2015-0002	Loss of Tank NT-51 Agitation Results in a Criticality Control Violation (U) ORPS
EM-SR--SRNS-HBLINE-2015-0006	HB-Line Phase III TSR-NCSE Violation (U) ORPS
EM-SR-SRNS-HCAN-2017-0017	Tank 9.5 Liquid Level Anomaly Affects Proper Implementation of Fissile Solution Interim Storage Requirements (U) ORPS
EM-SR--SRNS-SRNL-2016-0001	Management Concern Relative to TIDAS Pu Data Entry Error Review (U) ORPS
EM-SR-SRNS-SRNL-2016-0001 FF	Management Concern Relative to TIDAS Pu Data Entry Error Review Fact Finding
ETS91011STH0000100	Training Package on Functional Classification, Hazards Analysis, and Safety Analysis
Manual 1-01	Nuclear Criticality Safety Review Committee
N-ESR-K-00008, Rev. 6	Configuration Management Implementation Plan (CMIP) for Nuclear Materials Management KAC Facilities

DOC Number	Title
N-NCS-G-00133 R8	NCSE: Safe Onsite transport of 70-Ton Casks
N-NCS-G-00135, R3	
N-NCS-G-00136 R3	Criticality Safety Program Description for the M&O Contractor (SRNS) and the Liquid Waste Contractor (SRR)
N-NCS-H-00243 R11	H-Canyon Double Contingency Analysis
N-NCS-H-00249 LDD records	
N-NCS-H-00249 R7	NCSE: Safety of Spent Nuclear Fuel Dissolution
N-NCS-H-00277 R6	NCSE HB-Line Phase II Pu Oxide Operations
N-NCS-H-00299	NCSE: Plutonium Solids Mass Limits for Solutions Containing Gadolinium Neutron Poison
N-NCS-H-00302 R1	NCSE: Receipt, Handling, Storage, and Dissolution of HFIR Fuel in H-Canyon
N-NCS-L-00014	NCSE: Deionizer Resin in L Basin (U)
N-NCS-L-00016	NCSE: Effects of Zeolite in L Basin HFIR Racks (U)
N-NCS-L-00130 R1	NCSE: Safe Storage and Handling Limits for HFIR Fuel in L-Area Disassembly Basin (U)
N-NCS-L-0018	L Area DCA
PROGPJCEPDES000103	SRS Criticality Safety Engineer Training and Qualification Program Description
SCD-3	Nuclear Criticality Safety Manual
SCD-11 R14	Consolidated Hazards Analysis Process (CHAP) Program and Methods Manual
S-CHA-L-00003	Hazard Analysis for Phase II L-Area to H-Area Transfers of 70-Ton Casks (U)
S-CHA-L-011	CHAP for HFIR Transport
SRNS-E2000-2017-00010	Nuclear and Criticality Safety Engineering (N&CSE) Criticality Safety Program Review Plan
SRNS-E2100-2017-0011	H Area Criticality Control IVR
SRNS-IM-2009-00035 R6	Criticality Safety Methods Manual
SRNS-N1000-2017-00042	Independent Effectiveness Review and Validation HB-Line Consent Order NCO-2016-01
SRNS-RP-2013-00818	L-Basin HFIR NCSE/DCA Team Meeting Minutes
SRNS-RP-2015-00788	SRNS Root Cause Analysis of HB Line Phase III TSR/NCSE Violation (U)
U-PP-G-00004 R5	Safety Documentation and Criticality Safety Annual Assessment Plan
U-PP-G-00006 R2	FA-15 Assessment bases, Criteria, and Suggested Lines of Inquiry
U-SBIP-L-00019	L Area Facility N-NCS-000018 Rev.12 NCSE Implementation Plan
WSRC-SA-2005-00005	KAC Documented Safety Analysis (DSA) Rev. 11, Chapter 5

Attachment 1
CSSG Tasking 2017-05

CSSG TASKING 2017-05

Date Issued: December 05, 2017

Task Title: ***CSSG Assessment of SRNS NCS Program***

Task Statement:

The CSSG is tasked to conduct an independent assessment of the SRNS Nuclear Criticality Safety Program as outlined in Consent Order NCO-2016-01.

The Consent Order states:

> *SRNS shall conduct an independent (outside of SRNS and its associated parent companies) assessment of its Nuclear Criticality Safety Program, including H-Area and the F/H analytical laboratories. The assessment will be performed by an independent group of assessors that is mutually agreeable to the Parties. The assessment will include, at a minimum: a review of*
>
> *i) common mode failure analyses as they relate to Nuclear Criticality Safety Evaluations,*
> *ii) organizational and facility interfaces as they relate to NCS program implementation,*
> *iii) NCS control selection and implementation,*
> *iv) the laboratory analysis process as it relates to NCS controls,*
> *v) the NCS assessment process,*
> *vi) NCS training and qualification, and*
> *vii) NCS staffing.*
>
> *Assessment areas v, vi, and vii may be reviewed through the use of any previously conducted evaluations, if the independent group determines that those evaluations effectively reviewed these areas.*

The CSSG shall provide assessment results/findings/recommendations for use by SRNS to ensure the contractor NCS program has effectively addressed weaknesses identified in the causal analysis and as stated in the consent order.

Lines of inquiry and specific review topics shall be developed by the CSSG. The DOE NCSP Manager and SRNS shall review and concur with the Review Plan.

Period of Performance:

The on-site assessment and review is scheduled for two weeks, January 8-18, 2018. The team will perform reviews as available prior to the onsite portion of the assessment and report writing after. An outbrief with draft results will be provided to SRNS management prior to site departure (January 18, 2018).

Resources:

Contractor CSSG members of the team will use their FY18 NCSP CSSG support funding as appropriate; DOE CSSG members of the team will utilize support from their site offices.

CSSG Tasking 2017-05 Review Team Members:

- David Hayes (LANL, CSSG Team Lead)
- Jerry Hicks
- Thomas McLaughlin
- Fitz Trumble
- Robert Wilson

The assessment team will visit the SRNS site and conduct reviews, interviews and walkdowns as necessary to understand the state of the contractor NCS program and effectiveness of their assessment and evaluation implementation programs. When a draft report is ready for review, the entire CSSG will be provided an opportunity to review the draft and provide comments to the CSSG Team Lead, who will address/resolve the comments and forward the resulting response to CSSG Chair for transmittal to the NCSP Manager.

Task Deliverables:

1. CSSG Subgroup to receive all necessary documentation prior to: December 15, 2017.
2. CSSG Subgroup to draft Review Plan for NCSP Manager and SRNS review: December 18, 2017.
3. NCSP Manager and SRNS review/concur with Review Plan: January 4, 2018.
4. CSSG Subgroup on-site: January 8-18, 2018.
5. CSSG Subgroup to provide draft document to full CSSG for review: February 2, 2018.
6. Full CSSG to provide review comments to Task Team Leader: February 16, 2018.
7. CSSG Subgroup to address comments and provide document to SRNS for factual accuracy review: February 23, 2018.
8. SRNS provide comments by: March 2, 2018.
9. CSSG Subgroup address comments, issue final report to NCSP Manager: March 16, 2018.
10. The NCSP Manager transmits the approved CSSG report to SRNS by March 23, 2018.

Task Due Date: March 23, 2018

Signed: Angela Chambers

Angela Chambers, Manager US DOE NCSP