

June 5, 2017

Angele Chambers

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

From: D. G. Erickson, Chair, US DOE NCSP Criticality Safety Support Group (CSSG)

Subject: CSSG Tasking 2017-01 Rev. 1 Response

In Tasking 2017-01 a subgroup of the CSSG was tasked to review and comment on a January 24, 2017 Department of Energy (DOE) letter to the DNFSB, and documenting any discrepancies between those conclusions and the documented results of the most recent CSSG review.

For Rev. 1, based on the comments from the Office of River of Protection (ORP), and the CSSG's discussion with the ORP staff on April 18, 2017, it was noted that some technical issues remain open and the letter to the DNFSB is documenting progress to date. As discussed with the CSSG, the ORP has determined that enough progress has been made to consider the issues "resolved" meaning that a path forward has been identified. It was acknowledged by ORP that the issues would not be "closed" until the final design and licensing is complete. This revision is modifying the CSSG Tasking response to be consistent with this additional understanding of the scope and intent of the letter.

The Tasking 2017-01 CSSG Review Team consisted of the following:

Robert Wilson (Team Leader)
David Erickson
Michaele Brady-Raap

The draft report was provided to the entire CSSG for review. The Review Team addressed all comments received as they deemed appropriate.

The Review Team is available to answer any questions that may arise in working with the provided report.

The report from the review, which includes a copy of approved Tasking 2017-01, is included as an attachment to this transmittal.

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

Attachment: Response to CSSG Tasking 2017-01, Rev. 1.

Response to CSSG Tasking 2017-01, Rev. 1

05 June 2017

Executive Summary

The Criticality Safety Support Group (CSSG) reviewed a January 24, 2017 letter from DOE to the Defense Nuclear Facilities Safety Board (DNFSB). The letter addressed various issues raised by the Board regarding the safety basis for the Waste Treatment Plant (WTP) at the Hanford Site and concluded the issues, including Criticality Safety, were resolved to the extent that safety development studies and documentation could resume. The Board's concern relative to criticality safety was focused on the presence of heavy plutonium particulate (HPP) in the WTP Pretreatment Facility.

The CSSG reviewers in their Tasking 2016-03 response were primarily focused on a review of the preliminary criticality safety evaluation report (PCSER) for co-precipitated plutonium waste which is the only waste form in the current WTP design/ safety basis scope. In addition to the preliminary CSER, the CSSG reviewers also evaluated an engineering study that included a proposed control strategy for potentially processing wastes containing HPP in the WTP Pretreatment Facility – the subject of the Board's concerns. The reviewers noted the various options available to deal with the HPP and did not have sufficient information to judge if the Board's technical issues have been sufficiently resolved to permit resumption of construction but assumed safety basis development would continue. Specifically, the CSSG recommended that the WTP project consider several other control strategies for the processing of this material such as addition of soluble poisons due to concerns about the practicality of implementing the proposed criticality control strategy included in the engineering study.

The CSSG currently concludes that the WTP nuclear criticality safety (NCS) position, as described in the PCSER, requires considerable revision to support applicable fully compliant NCS documentation requirements to support final plant design and construction.

Introduction

In Tasking 2017-01, Rev. 1 (included as Appendix A) the CSSG was tasked to review and comment on a January 24, 2017 Department of Energy (DOE) letter to the DNFSB with the understanding, different from the Rev 0 Tasking, that the scope of the DOE EM letter was intended to relate to advancing the design and development of the safety basis only. The letter addressed various issues raised by the Board regarding the safety basis for the WTP with the hope that the information provided would permit the Board to agree that the safety basis development/design should proceed.

CSSG Tasking 2016-03 was developed and conducted at the request of the Office of River Protection (ORP). The scope of the request included review of the WTP contractor's plans to address the many Recommendations and Opportunities for Improvement (OFI) from prior CSSG reviews in 2008, 2009, and, in particular the Independent Review Team review in 2012. In addition they requested a review of the PCSER on the treatment of Tank Farm material from those tanks which did not contain HPP (e.g., containing only co-precipitated plutonium) and to hear a presentation on a plan for the other tanks

(e.g., those containing HPP). Tasking 2016-03 was to determine if issues identified in the various prior assessments had been adequately resolved and to receive a briefing on a proposal for further actions. The CSSG team did not address whether the remaining issues identified from past reviews, the ORP proposal presented, or the CSSG options recommended, would impact WTP design.

The 2012 Independent Review Team (IRT) cited many concerns with the provided WTP CSER but focused on the possibility of the Pu separating from the various chemical and thermal processes in the WTP. The 2012 IRT was also concerned about the identified possibility of the HPP causing a criticality safety concern in the Pulse Jet Mixer (PJM). **A path forward to deal with the HPP issue was not provided by the WTP contractor at the time of the IRT review.** The IRT was aware that the HPP surrogate material in the test PJM did segregate; however, they were not convinced that the problem particles from the actual tank farm waste would also separate to the extent that they would pose a criticality concern during PJM operations. The IRT drafted a laboratory test plan to show if, or how much, separation would occur in the actual operation of the PJM. Based on review of results from similar settling tests conducted in prior years, the IRT was reasonably sure that following the proposed test plan would provide a technical basis for resolution of the issue of the HPP at the WTP. The test plan was socialized with a dozen hydrodynamic experts around the nation and received concurrence that it should succeed in dispositioning the issue of potential criticality due to settling of HPP. The proposed tests have not been conducted and it is not believed that they are currently planned to be performed.

ORP Rationale for Resolution of DNFSB Concerns Related to Criticality Safety

The DOE Letter, in its' Attachment 2, identified seven actions (provided in italics below) that, in total, were judged by ORP to resolve the Board's criticality safety concerns. It is the understanding of the CSSG that the term "resolved" in the letter, as used by DOE EM, means have a strategy and path forward to support ongoing design, and is not considered "closed" until final design. The following are the CSSG judgments for each action (in the following, the use of the term "resolved" by the CSSG indicates that the issue/concern will be adequately addressed but has not yet been "closed"):

- *Assessments to estimate the mass, particle size and location of HPP in the Hanford tank farm (HTF).*
This has been completed and appears appropriate for this stage of the process development.
- *Chemistry studies, criticality calculations, and hazards analyses, demonstrating that the co-precipitated plutonium waste form can be safely processed in WTP.*
This has been completed and documented in the PSCSER. However, there are still concerns about the adequacy of the criticality analysis also noted in the ORP Conditions of Approval of the PSCER. (See **Assessment of Corrective Actions from Prior Reviews**, below).
- *Engineering study with supporting analyses identifying proposed controls for treatment of waste containing HPP in the Pretreatment Facility.*
Though treatment of most of the tanks containing HPP appears acceptable (with the caveat that a control scheme to effectively control mass throughout the quasi-batch process has yet to be identified) it is not understood how the tank potentially containing more than

2,700 g of HPP will be treated. It is anticipated that additional analysis and design efforts are necessary to resolve this concern.

- *Identification of proposed controls identified in the WTP Criticality Safety Evaluation Report (CSER) and the Criticality Safety Evaluation Engineering Study (CSE-ES) for management of tank wastes containing fissile material, considering both uranium and plutonium.*

These appear acceptable for the co-precipitated fissile materials, but as indicated previously, there are still questions regarding the HPP that require additional analysis and design efforts and the development of criticality safety controls that can be realistically implemented.

- *Independent review by the DOE Nuclear Criticality Safety Program CSSG on the proposed control strategy for treatment of HPP containing wastes.*

See **Assessment of Corrective Actions from Prior Reviews**, and **Conclusions**, below.

- *Commitment to deliver waste feed to the WTP complying with the design basis.*

Without implementing the 'proposed' Tank Waste Characterization and Staging Facility (TWCSF), including a rigorous sampling process, it is unknown how this will be accomplished. Chemistry studies have addressed how the waste characteristics may change through the Pretreatment Facility that, if relied on for criticality safety control, may require validation. Additional analysis and design efforts are needed to resolve this concern.

- *Evaluation of an improved PJM vessel design that will improve mixing performance and the ability to effectively remove heavy solids.*

It appears this study is underway and should resolve the related concerns including reducing holdup and thereby improving the ability to effectively remove heavy solids between batches.

Review of PCSER for Co-Precipitated Plutonium

Though the scope of the DOE EM letter was focused on the Board's concerns about HPP, there are still concerns that impact both co-precipitated and HPP. In Tasking 2016-03 the ORP specifically requested that the CSSG review the *Preliminary Co-Precipitated Plutonium Critically Evaluation Report for the WTP Project* (24590-WTP-CSER-ENS-08-0001, Rev. 1) This review resulted in many suggestions to strengthen the Hazard Assessment part as well as the presentation of the proposed criticality safety limits.

Although many of these suggestions were consistent with the Conditions of Approval cited by ORP, the concern was that the four general COAs may not convey the extent of revisions necessary to produce a quality CSER. Much of the concern expressed in Tasking 2016-03 was directed at the rigor of validating the computer code used to develop the limits. Use of the required Industry standard for validation (ANSI/ANS 8.24) is required to resolve these concerns.

Review of HPP Presentation

The proposed scheme for processing the 16 tanks known to contain HPP was presented in slide format. A mass control for each tank was postulated. Four of these tanks were considered to contain fewer than 450 g Pu, and these were proposed to be processed with no extra controls. The five tanks with an estimated HPP mass between 450 g and 2,700 g were to be processed with the addition of sufficient

nuclear poison (boron in the form of sodium pentaborate) to provide a safety basis feature in addition to a mass control protocol. The 2,700 g HPP mass limit was from a calculated geometry considered to be a worst case configuration developing from operation of the PJM. The configuration is referred to in safety documents as resembling a 'fluted horn'. No proposal was made for a safety basis for processing the three tanks with Pu mass considered to exceed 2,700 g. Nor was any specific control scheme to measure the mass of plutonium particulate independent of the co-precipitated plutonium identified for any of the HPP tanks. The possibility of using neutron poisons was discussed but no implementation plan/strategy was presented. Compliance with ANSI/ANS-8.14, the industry standard for the use of soluble neutron poisons, was not included in their discussions.

The CSSG team agreed that the proposal was better than no vision to handle the HPP issue and considered this welcome progress. However, they also noted that it, with a yet to be developed mass control scheme, might not succeed and even if successful would likely be complex to implement and expensive. The IRT report had provided a testing strategy, affirmed by the hydrodynamic community, which would have a high probability of providing technical support that that no additional controls beyond the Waste Acceptance Criteria would be needed. The CSSG Tasking 2016-03 report also recommended the IRT approach but noted that if this path was rejected, then other schemes/bases would have to be pursued.

Several proposed structural changes to the design were also included in the presentation but the review team was unable to factor these changes into the safety argument.

Assessment of Corrective Actions from Prior Reviews

The following summarizes the current known status of the open Recommendations and Opportunities for Improvement, identified in CSSG Tasking 2016-03 (provided here in italics), and judgment of which ones could be considered still open and still relevant.

Open co-precipitated plutonium Recommendations:

- *The CSER should identify required samples and location.*
Required sampling for criticality compliance (or confirmation) has not been fully addressed.
- *Move key information from the CSER to Authorization Basis (AB) documents and delete the CSER as a stand-alone AB document.*
This has not been addressed at this stage. The project requirement for the CSER to be an AB document appears to be a contractual requirement. ORP indicated that they were taking action to remove this requirement from the contract.

Open co-precipitated plutonium Opportunities for Improvement:

- *WTP should use guidance from the ANS 8 standards on nuclear poisons.*
There is no evidence this has been addressed. The applicable standard is ANSI/ANS-8.14-2004; R2011; R2016: *Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors.*
- *Update the validation documentation with currently available benchmark experiments.*
There is no evidence this has been addressed. This calls into question the adequacy of the calculational analyses performed to date.

- *Temperature effects on cross-sections and reactivity feedback coefficients should be evaluated and impacts considered for systems considerably different than room temperature.*
There is no evidence this has been addressed. As some of the processes at WTP will utilize high temperatures there is still a need for this to be addressed
- *Basis should be provided for the stated 30% “non-representativeness” and applicability of samples. (Value revised from 5% to 30%)*
There is no evidence this has been addressed. (See prior Recommendation, and CSSG Tasking 2016-03 report, regarding samples)
- *NCS staff should review technical basis for control schemes at other similar DOE facilities.*
No evidence was provided that this has been addressed.

New co-precipitated plutonium Recommendations from the 2013 review:

- *The WTP Contractor should address the applicability of ANS-8.14 on soluble neutron absorbers. (Revised from OFI, above)*
There is no evidence this has been addressed. (See prior OFI)
- *The basis needs to be provided for the stated 30% “non-representativeness” and applicability of the sample to other tanks. (Revised from OFI, above)*
There is no evidence this has been addressed. (See prior OFI)
- *There needs to be a process defined for tracking “open items” in the Hazards Analysis (HA) and how consistency will be maintained as both the HA and CSER are living documents.*
Though this should not impact the process at this stage, there is still no evidence this has been addressed.
- *Recommend that the use of sensitivity/uncertainty techniques be used to support the appropriateness of the selected benchmarks, particularly in cases where no additional margin for the Area of Applicability (AoA) is utilized.*
There is no evidence this has been addressed.
- *The CSSG review team concluded that the validation report as reviewed does not meet all the requirements of ANS-8.24 and should be revised.*
There is no evidence this has been addressed. With a less than adequate validation there are ongoing concerns about the adequacy of the results and proposed controls, based upon the calculations performed.
- *Recommend that additional effort is applied to ensure the assumptions are properly categorized, managed and controlled as applicable.*
Though this should not impact the process at this stage, there is no evidence this has been addressed.
- *Recommend the Criticality Safety Limits be restructured to support understanding of the safety margin and assist with response to potential abnormal events.*
There is no evidence this has been addressed.
- *Develop a CSER for the co-precipitated material that presents a better defined picture of the safety basis.*
There is no evidence this has been addressed.

Open HPP Recommendations

- *Assure a Pu heel management system is available.*
Though it appears heel removal is considered, there is no evidence as to how this has been addressed.

New/Revised HPP Recommendations

- *Proceed with the HPP distribution test to provide a technical basis for including some of the distributed nuclear poison in the criticality safety basis.*
No evidence of intent to pursue these tests.
- *Consider potential management of HPP criticality safety concerns via addition of caustic boron.*
It appears that a Tank Waste Characterization and Staging Facility (TWCSF) is being proposed that may be able to address this.

Conclusion

The January 24, 2017 DOE EM letter to the DNFSB notes the *Independent review by the U.S. Department of Energy (DOE) Nuclear Criticality Safety Program Criticality Safety Support Group (CSSG) on the proposed control strategy for treatment of HPP containing waste.* ORP had requested input from the CSSG to support a potential future decision to incorporate HPP into the WTP design basis. As stated earlier, the engineering study for criticality safety of HPP was a minor objective of CSSG Tasking 2016-03.

The CSSG Tasking 2016-03 report with identified recommendations should provide a path forward which would support effective and safe treatment of HPP tank waste materials. The CSSG currently concludes that the WTP NCS safety basis documentation supporting the PCSER requires considerable revision before all NCS related technical issues can be considered resolved. An example of the concern is the need to address compliance with several ANSI/ANS-8 Standards.

Presuming that ORP directs the WTP contactor to address the issues identified above, proceeding with safety basis development/design only, seems warranted. The CSSG concurs with the recommendation of the January 24, 2017 letter to resume safety basis development/design in order to enable final closure of the DNFSB criticality safety issues and those identified in the CSSG Tasking 2016-03 report.

Appendix A
Approved Tasking 2017-01, Rev. 1

CSSG TASKING 2017-01, Rev. 1

Date Issued: May 17, 2017

Task Title: *Review of EM Letter to the DNFSB resolving Criticality Safety issues at the Waste Treatment Plant*

Background:

Per Tasking 2016-03 the Criticality Safety Support Group (CSSG) performed and documented a review of the most recent criticality safety basis for the Waste Treatment Plant (WTP) being built at Hanford. The results of the CSSG review indicated there were still a number of opportunities to improve the WTP operational criticality safety posture.

On January 24, 2017 DOE EM sent a letter to the DNFSB (included as the Attachment to Rev. 0 of this Tasking) indicating issues previously identified by the Board related to the presence of heavy plutonium particulate (HPP) and the operation of the pulse jet mixers (PJMs) had been adequately addressed. Enclosure 2 of that letter addresses the DNFSB's specific criticality safety issues.

Task Statement (for Rev. 1):

Per the CSSG's discussion with the Office of River of Protection staff on April 18, 2017, some technical issues remain open and the letter to the DNFSB documents progress to date. As discussed with the CSSG, the ORP has determined that enough progress has been made to consider the issues "resolved" meaning that a path forward has been identified. It was acknowledged by ORP that the issues would not be "closed" until the final design and licensing is complete. The January 24, 2017 letter seeks DNFSB agreement to resume design work and safety basis development for the WTP Pretreatment Facility (PTF). The resumption of construction of the WTP PTF was not addressed.

The CSSG is tasked with reviewing the DOE EM letter and documenting any discrepancies between those conclusions and the CSSG Tasking 2016-03 report. The CSSG should specifically identify issues, if any, that the CSSG recommends be resolved prior to the resumption of facility design or of safety basis development.

The CSSG should pay close attention to issues relating to the use of ANS-8.10, ANS-8.14, and ANS-8.24 as presented in the CSSG Tasking 2016-03 report, and the conclusions documented in the DOE EM letter.

Resources:

CSSG Task 2017-01 Team Members:

Robert Wilson (Team Leader)

David Erickson

Michaele Brady Raap

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

Task Deliverables:

1. CSSG Subgroup to revise Rev. 0 Tasking Response by April 24, 2017.
2. CSSG Subgroup to provide a draft of the review documentation to full CSSG and to ORP for factual accuracy review: April 25, 2017
3. Full CSSG and ORP to provide review comments to Task Team Leader: May 2, 2017
4. CSSG team to issue final report to NCSP Manager: June 1, 2017

Task Completion Date: June 1, 2017

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