Department of Energy
National Nuclear Security Administration
Washington, DC 20585

December 7, 2011

The Honorable Peter S. Winokur
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004

Dear Mr. Chairman:

Based on past interest of the Defense Nuclear Facilities Safety Board (DNFSB) with Building 331 Tritium operations at the Lawrence Livermore National Laboratory (LLNL), this letter provides information related to a clarification of an issue related in the Building 331 (B331) Documented Safety Analysis (DSA).

On June 14, 2011, as requested by the DNFSB report regarding *Review of Safety Basis for Tritium Facility, LLNL,* the National Nuclear Security Administration (NNSA) transmitted the Livermore Site Office (LSO) response to the DNFSB. The NNSA transmittal memo indicated that LSO was preparing a Safety Evaluation Report (SER) that included a number of Conditions of Approval (COAs) that LLNL would implement through re-submittal of the B331 DSA and Technical Safety Requirements (TSRs). One COA limited "the total hydrogen species that can be introduced into the Tritium Processing Station (TPS) and Tritium Science Station (TSS) gloveboxes to 2% by volume."

Subsequently, LLNL requested clarification on the COA since (1) the LSO SER stated that a four percent by volume limit for total hydrogen species in a glovebox would prevent a deflagration when the hydrogen mixture was at equilibrium; (2) the National Ignition Facility target production operations to-date have exceeded the two percent limit for total glovebox inventory; and (3) the total inventory within or connected to the gloveboxes was not capped.

On October 7, 2011, LSO clarified the COA as follows:

> *"LLNL shall revise the B331 TSR [Specific Administrative Control] SAC to limit the total hydrogen species within or connected to the TPS and TSS gloveboxes to less than 4% by volume. In addition, LLNL shall implement a TSR programmatic administrative control limiting hydrogen species in TPS and TSS to 2% volume in any continuous un-isolated volume."*

The revised COA ensures the TPS and TSS gloveboxes will be operated in a manner that protects worker safety while meeting programmatic needs. The LSO letter and the enclosure transmit the revised COA and the justification.

Additionally, LSO will brief the DNFSB on this topic when they visit LLNL the week of December 12, 2011. If you have any questions concerning this letter, please contact me at (202) 586-2179 or have your staff contact Ms. Sharon Steele at (202) 586-9554.

Sincerely,

DONALD L. COOK
Deputy Administrator
for Defense Programs

Enclosure

cc: M. Campagnone, HS-1.1
A. Williams, LSO
T. D'Agostino, NA-1

U. S. Department of Energy
National Nuclear Security Administration
Livermore Site Office
PO Box 808, L-293
7000 East Avenue
Livermore, California 94551-0808

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COR-DP-9/27/2011-382276

Dr. Bruce T. Goodwin
Principal Associate Director
Weapons and Complex Integration
Lawrence Livermore National Security, LLC
Lawrence Livermore National Laboratory
7000 East Avenue, L-160
Livermore, CA 94551

Subject: Clarification of Building 331 Hydrogen Species Condition of Approval to Address Programmatic Needs (DP:110080)

References: (1) COR-NSI-12/10/2011-307760 (A. Williams/B. Goodwin), *Conditional Approval of the Documented Safety Analysis and Technical Safety Requirements for the Tritium Facility – Building 331 (TS:110045)*, dated July 12, 2011

(2) NMTP11-077 (R. Rocha/A. Williams), *Request for Clarification on B331 Hydrogen Limit Conditional Approval to Address Programmatic Needs,* dated September 27, 2011

Dear Dr. Goodwin:

In Reference 1 the Livermore Site Office (LSO) directed the Lawrence Livermore National Laboratory (LLNL) to comply with six Conditions of Approval (COAs) through re-submittal of the Building 331 (B331) Documented Safety Analysis (DSA) and Technical Safety Requirements (TSR). One of the COAs directed the following concerning the hydrogen species limit for the B331Tritium Processing Station (TPS) and the Tritium Science Station (TSS).

> **LLNL shall revise the TSR Specific Administrative Controls (SACs) to limit the total hydrogen species that can be introduced into the TPS and TSS gloveboxes to 2% by volume.**

LLNL requested in Reference 2 that the above COA be amended, presenting information related to the programmatic need to amend the COA and frequency analysis concerning the potential to release hydrogen species in the TPS and TSS gloveboxes. LSO agrees with the analysis presented in Reference 2 and directs the subject COA be revised to the following:

LLNL shall revise the B331 TSR SACs to limit the total hydrogen species within or connected to the TPS and TSS gloveboxes to less than 4% by volume. In addition, LLNL shall implement a TSR programmatic administrative control limiting hydrogen species in TPS and TSS to 2% by volume in any continuous un-isolated volume.

In the Reference 1 Safety Evaluation Report (SER) LSO stated that a 4% by volume limit for total hydrogen species in a glovebox would prevent a deflagration when the hydrogen mixture was at equilibrium. The SER also stated that further limiting the total hydrogen species that can escape into the glovebox atmosphere to 2% provides a safety margin sufficient to protect against deflagration including a partial volume deflagration. LSO reviewed the additional data presented in Reference 2 and concluded that the revised COA is consistent with the Reference 1 SER for all credible hydrogen species release scenarios. Further details on the evaluation supporting this decision are provided in the enclosure to this letter. The revised COA ensures TPS and TSS gloveboxes will be operated in a manner that protects worker safety while meeting programmatic needs.

If you should have any comments or questions, please contact Tom Grim at (925) 422-0704.

Sincerely,

Alice C. Williams
Manager

Enclosure: Evaluation of the Adequacy of LLNL's Proposed Change to the COA on Hydrogen Species Inventory for B331 Tritium Gloveboxes

cc (w/encl.):
J. Plaue, DNFSB
M. Alcuran
T. Altenbach
M. Bronson
S. Browning
K. Cadwell
D. Chin
K. Foote
H. Holloway
J. Lewis
L. Lisle
J. Freeman
M. Martinez
M. Merritt
M. Mintz
M. Mitchell
D. Pinkston
R. Rocha
P. Schafer
D. Spencer
D. Squire
A. Warner
NMTP File

bcc (w/encl.):
D. Nichols, NA-2.1
C. Sykes, NA-2.1
M. Thompson, NA-17
A. De La Paz, NA-171.1
C. Johnson, NA-171.1
S. Steele, NA-171.1
A. Williams
S. Brinker
P. Hill
P. Rodrik
T. Grim
H. Larson
E. Begg
D. Corporandy
D. Damba
D. Eddy
A. Nichols
J. Retelle
R. Robb
R. Roses
Q. Tran
I. Tregub
D. Yee
M. Zulim
AMESH Files
AMDP Library

Evaluation of the Adequacy of LLNL's Proposed Change to the COA on Hydrogen Species Inventory For B331 Tritium Gloveboxes

Background and Approach

At an August 29, 2011 meeting, Lawrence Livermore National Laboratory (LLNL) staff expressed to the Livermore Site Office (LSO) serious concerns about the ability to meet programmatic deliverables under a Condition of Approval (COA) to limit the total amount of hydrogen isotopes within and connected to the Tritium Processing Station and Tritium Science Station gloveboxes at the Tritium Facility to 2% of total volume.

In reference (1), LLNL formally submitted its concerns, the following recommended change to the COA, and the basis for the recommended change.

> **LLNL shall revise the B331 TSR SACs to limit the total hydrogen species within or connected to the TPS and TSS gloveboxes to less than 4% by volume. In addition LLNL shall implement a TSR programmatic administrative control limiting hydrogen species in TPS and TSS to 2% by volume in any continuous un-isolated volume.**

The purpose of the COA was to provide a control to prevent a hydrogen deflagration in the tritium gloveboxes. The unmitigated consequence of a glovebox deflagration is estimated to be low to negligible for collocated workers and the general public but high for facility workers in the vicinity of the affected tritium glovebox. Accordingly, LSO's primary focus was on the adequacy of the proposed preventive control as applied to the safety of B331 facility workers.

Review Details

Attachment A of Reference (1) provided information on minimum required loads, practical operational load, and design full loads for each of the individual inventory sources to support programmatic needs. Subsequent meetings between LLNL and LSO discussed the low likelihood of simultaneously storing all the hydrogen sources identified in the proposed practical operational load as well as the challenge of projecting future needs associated with production of tritium/deuterium/protium targets for the National Ignition Facility (NIF). At these meetings, LLNL provided further details on optimal operating ranges and operational efficiencies (or more accurately inefficiencies) associated with extracting tritium from palladium beds and uranium beds as well as with operational support activities (e.g., lecture bottle change-out frequency). Additionally, information was provided regarding the derivation of minimum required loads from variables including NIF-requested parameters and equipment and piping volumes. This

information was useful in helping the LSO reviewers understand the bases for estimating practical operational loads and minimum required loads.

Attachment B of Reference (1) provided a volume analysis of inadvertent mixing potentials and a frequency analysis of inadvertent mixing and leakage. In the recent annual update to the B331 documented safety analysis (DSA) (Reference 2), hazards analysis event TGO-9 addresses a release from an overheated bed. One of the reviewers requested additional information on the uranium bed vessel and palladium bed vessel design in order to verify that LLNL had provided beds with sufficient design margin. LLNL provided information from Engineering Safety Notes MESN09-500022-AA and 500023-AA (Reference 3) asserting maximum operating pressures of 600 psig and 140 psig respectively for the palladium bed vessel and uranium bed vessel with corresponding design pressures of 2374 psig and 857 psig respectively. During the discussions, LLNL provided additional information on the pressure relief devices for these systems and high temperature interlocks that automatically secure the bed heaters to prevent overheat/overpressure. LSO used this information in evaluating the adequacy of Reference (1) estimates for leakage.

Another concern the reviewers expressed was potential for common mode failures that would bring multiple volumes together from natural phenomena hazards such as earthquakes. Discussions on this topic also included the potential for a failure of the Program Logic Controller (PLC) to bring together multiple volumes. LLNL provided the following information:

The mechanical and electrical systems involved are physically discrete. There are no common cause failure modes apart from human error and hypothetical misprogramming of the PLC.

Human error is already addressed in the submittal. The PLC was extensively reviewed by LLNL as part of the DSA preparation effort. This included a Failure Modes and Effects Analysis (FMEA) that specifically reviewed the ladder logic programmed into the PLC. It was assessed as appropriate, consistent with LLNL's extensive testing results to date.

PLC-associated equipment can fail in one of two ways: The PLC monitored individual process components (i.e., field devices and sensors) can develop their own internal faults. As noted above, these failures are by definition discrete. The PLC can also lose power or have logic faults. Loss of power does not spuriously activate process components. PLC logic faults are generally discrete due to PLC programming. Process sensors feed input modules tied to output modules by individual logic trains.

One does not historically see PLC faults causing a wide variety of different systems to function inappropriately. The only way to do that is to fundamentally and grossly misprogram the logic. That level of misprogramming cannot be overlooked as it precludes proper operation to begin with. In sum, the likelihood of undetected, major misprogramming bringing multiple sources together is less likely than the frequencies already reported.

The LSO reviewers concluded that the LLNL had adequately reviewed the potential for the occurrence of common mode failures and associated consequences.

Conclusion

The level of protection provided by the revised COA is consistent with the safety margin (to the Lower Flammability Limit [LFL] – i.e. 2% by volume maximum concentration allowed compared to 4% [conservatively selected as the LFL of hydrogen]) proposed in the Safety Evaluation Report (SER) (Reference 4) for the B331 DSA/TSR Annual Update for all credible hydrogen species release scenarios. The revised COA as shown below ensures TPS and TSS gloveboxes will be operated in a manner that protects worker safety while meeting programmatic needs.

LLNL shall revise the B331 TSR SACs to limit the total hydrogen species within or connected to the TPS and TSS gloveboxes to less than 4% by volume. In addition LLNL shall implement a TSR programmatic administrative control limiting hydrogen species in TPS and TSS to 2% by volume in any continuous un-isolated volume.

References

1. NMTP11-077 (R. Rocha/A. Williams), *Request for Clarification on B331 Hydrogen Limit Conditional Approval to Address Programmatic Needs*, dated September 27, 2011

2. UCRL-AR-114203-08, *Weapons and Complex Integration, Tritium Facility – Building 331, Documented Safety Analyses*, dated June 2010

3. Mechanical Engineering Safety Note MESN09-500022-AA, *Tritium Process Station Palladium Hydride Storage Bed,* approved May 21, 2009

   Mechanical Engineering Safety Note MESN09-500023-AA *Tritium Process Station Uranium Hydride Storage Bed,* approved May 21, 2009

4. COR-NSI-12/10/2011-307760 (A. Williams/B. Goodwin), *Conditional Approval of the Documented Safety Analysis and Technical Safety Requirements for the Tritium Facility – Building 331 (TS:110045,* dated July 12, 2011