DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700 Washington, D.C. 20004-2901
(202) 694-7000

January 27, 2010

The Honorable Thomas P. D'Agostino
Administrator
National Nuclear Security Administration
U. S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0701

Dear Mr. D'Agostino:

The staff of the Defense Nuclear Facilities Safety Board (Board) observed the readiness assessment (RA) led by the National Nuclear Security Administration (NNSA) for startup of the Tritium Process Station (TPS) at Lawrence Livermore National Laboratory (LLNL) and reviewed related aspects of the Tritium Facility's safety basis and operational activities. NNSA authorized startup of TPS based on the RA, but the Board is concerned that the hazard analysis for TPS may not have adequately characterized the consequences of fire scenarios involving tritium nor identified the appropriate safety-significant controls to protect facility workers. Some of these issues stem from weaknesses in the existing safety basis for the Tritium Facility.

The NNSA RA team identified two findings, both of which were categorized as post-start issues: (1) designating the TPS glovebox as a safety-significant control without appropriate justification has led to confusion about the functional requirements and controls for the glovebox, and (2) the operating guidance for the glovebox did not meet the intent of Department of Energy (DOE) Order 5480.19, *Conduct of Operations Requirements for DOE Facilities.* The Board's staff independently identified a number of other issues and expanded on the two issues identified by the RA team. Overall, the staff concluded that a number of significant open issues related to hazard analysis, selection of controls, and conduct of operations existed at TPS. The details of the staffs review are included in the enclosed report.

Therefore, pursuant to 42 U.S.C. § 2286b(d), the Board requests a report and briefing within 60 days of receipt of this letter on actions to be taken to address the deficiencies identified by the Board's staff and the NNSA RA team regarding the analysis and control of hazards both for TPS and more broadly in the Tritium Facility safety basis, as well as the deficiencies

identified in the conduct of operations for TPS. The Board notes that the Livermore Site Office recently directed the contractor to resolve a number of issues with the Tritium Facility safety basis, including those identified with TPS.

Sincerely,

John E. Mansfield, Ph.D.
Vice Chairman

Enclosure

c: Ms. Alice C. Williams
Mr. Mark B. Whitaker, Jr.

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

November 24, 2009

MEMORANDUM FOR: T. J. Dwyer, Technical Director

COPIES: Board Members

FROM: J. Shackelford

SUBJECT: Review of the Tritium Process Station at Lawrence Livermore National Laboratory

This report documents a review of selected aspects of the safety basis, conduct of operations, and readiness activities associated with the startup of the Tritium Process Station (TPS) at Lawrence Livermore National Laboratory (LLNL) as well as related aspects of the Tritium Facility's safety basis. The staff of the Defense Nuclear Facilities Safety Board (Board) observed the Livermore Site Office's (LSO) readiness assessment (RA) of TPS in Building 331 during September 14–18, 2009. The staff also conducted additional independent reviews of the TPS design, safety basis, and conduct of operations and held a follow-up discussion with LSO on November 2, 2009.

Background. TPS is intended to provide enhanced tritium-handling capability for a variety of customers, including the National Ignition Facility. Basic TPS services include supply, storage, assay, purification, mixing, initial pressurization, and processing of tritiated gas. TPS is a general-purpose glovebox system comprising a main glovebox and a ventilated enclosure that provide gas-handling services. In addition, an external off-gas collection system and mass spectrometer support TPS.

Readiness Activities. The RA team was composed of a team leader from LSO and team members from the Albuquerque Service Center and the Savannah River Site Office. The RA team observed an evolution and drill set, conducted interviews, and reviewed documents. The RA resulted in two findings, both of which were categorized as post-start issues: (1) designating the TPS glovebox as a safety-significant control without an established basis has led to confusion on what the functional requirements for the glovebox are and how they should be controlled and maintained, and (2) the operating guidance for TPS did not meet the intent of Department of Energy (DOE) Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*. These issues are discussed in detail below.

Safety Basis. Based on its review of the safety basis for TPS, the staff is concerned that the hazard analysis may not have adequately characterized the consequences of fire scenarios

involving tritium nor identified appropriate safety-significant controls to protect the facility workers.

Hazard Analysis—The safety function of the TPS glovebox is described in the LSO-approved documented safety analysis (DSA) as providing a safety-significant passive barrier when processing involves 600 curies (Ci) or more of tritium. This designation results from the DSA's facility-wide requirement to provide a safety-significant barrier for operations involving 600 Ci or more of tritium. This threshold is based on a hazard analysis that makes the qualitative assertion that the consequences of a tritium release smaller than 600 Ci would be low for the facility worker. There is not a fully developed technical basis associated with this limit, so it has not been demonstrated that allowing the processing of tritium up to this threshold without a credited barrier provides adequate protection for facility workers.

Further, it does not appear that the hazards associated with the maximum inventory of the TPS glovebox of 30 grams of tritium (approximately 290,000 Ci) have been adequately assessed. It is not clear that it is legitimate for the safety basis to exclude the full 30 gram inventory from consideration for glovebox operational events.

Overall, the staff questions whether the hazard analysis adequately characterizes the consequences of tritium release scenarios and identifies the appropriate safety-significant control to protect the facility workers. In particular, the accident scenario involving a fire with the potential to fully oxidize and release the 30 gram inventory appears to be inappropriately controlled. The DSA acknowledges that workers who remain in a room containing tritium during a fire could receive significant inhalation doses and skin contamination. The analysis discounts the likelihood of this scenario on the basis that the tritium storage vessels within the glovebox would limit the consequences long enough for workers to evacuate. However, there are no credited (safety-significant) controls to either prevent or mitigate this scenario. DOE Standard 3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, specifies that safety-significant controls be developed and implemented for scenarios that can result in significant radiological exposure to the involved facility workers.

The staff communicated this issue to both LSO and LLNL. The LSO RA team documented a finding against LSO that mirrored the staff's concern regarding hazard analysis and selection of controls; this finding was characterized as a post-start issue. Of note, this same issue was previously identified during both the contractor's RA and the management self-assessment. The LSO-approved corrective action for this finding is to direct LLNL to either submit a safety basis modification that ensures the development of appropriate technical safety requirements from the hazard analysis or provides justification for not implementing safety-significant controls. This action is expected to coincide with the next annual update of the safety basis, expected in March 2010. This corrective action does not appear to address the global weaknesses associated with the hazard analysis or address the weaknesses in the LSO safety basis review and approval process that resulted in the finding against LSO.

Identification and Implementation of Controls—From an operational perspective, the DSA requirement to avoid inadvertently transferring more than 600 Ci of tritium outside the TPS glovebox is implemented through an informal calculation using a number of system operating and design parameters (e. g., pressures, pipe volumes), to determine the amount of tritium at risk for a given operation. The calculation drives a number of subsequent system alignments and process steps. The calculation is invoked by Attachment 2 of LLNL Operational Safety Plan (OSP) No. 331.099, step 5.12.2.8, by a direction to "determine required manifold pressure." The operators interpret this step of the general-use procedure as a direction to perform a MathCAD® calculation using an unverified algorithm that determines the amount of tritium to be transferred during the operation. Following this theoretical calculation, the operators perform the necessary valve and system alignments to conduct the transfer. However, since the actual system pressures may vary slightly from the theoretical values determined from the calculation, the operators must recheck that the 600 Ci limit was not exceeded by adjusting the values using a hand calculation. Neither the initial calculation nor the reverification steps are controlled by formal operating procedures. Further, it is not clear that the calculation adequately addresses whether additional tritium might be at risk by taking the credited control boundaries into consideration. As a result, no credited (safety-significant) systems, structures, and components (SSCs) or specific administrative controls are in place to ensure that the 600 Ci limit is not exceeded.

Essentially all TPS control functions, indications, and valve manipulations are accomplished remotely through the operation of a computer console and programmable logic controller (PLC) collocated with the glovebox. Failures of the PLC are not explicitly considered in the hazard analysis, likely because the hazard analysis was not derived from a process-specific approach for TPS. As a result, the consequences of a failure are not characterized, the PLC is not identified as a safety-significant SSC, and its associated software is subject to the lowest category of software quality assurance.

TPS is equipped with bubbler devices for both overpressure and underpressure protection. The system design description identifies the bubblers as safety devices, but they are not credited as safety-significant controls in the context of DOE Standard 3009. Rather, the bubblers are identified as a defense-in-depth feature in the hazard analysis. Each bubbler contains a reservoir and a graduated sight gage for the operator to measure the amount of oil inside each reservoir. At room ambient pressure, the sight gage also indicates the relief pressure for each bubbler. During system walkdowns, the staff noted that the bubbler assembly lacked permanent markings to indicate the appropriate oil levels for normal and abnormal conditions. Given the pressure protection function provided by the bubblers, it is not clear why they were not formally credited as a safety control.

Conduct of Operations. LLNL does not use a comprehensive set of formal operating procedures to govern the TPS system operations. Rather, facility operations are accomplished through a combination of general-use procedures in conjunction with operator aids. Operators interpret the needs of facility customers based on requirements outlined in "execution plans" and develop a conceptual idea of the most efficient transfer route and method. The transfer route is marked with a grease pencil on a laminated copy of the system diagram, and this operator aid is used to develop the tritium-at-risk calculation described above as well as to guide the necessary

system alignments. The staff noted that there were no formal review or approval mechanisms associated with the development of the required flow paths or system alignments. The staff questioned whether the observed operating practices were of sufficient rigor to control operations. This issue was also raised by the LSO RA team. The RA team found that "...The use of an OSP with attached operating guidance does not meet the intent of procedures as defined by DOE O 5480.19." However, the RA team characterized this issue as a post-start finding. LLNL's approved corrective action for this finding is to revise the procedure used to develop OSPs to address expectations for procedures that are appended to OSPs.

During a simulated emergency evolution, the staff noted a number of drill deficiencies. Specifically, the management-approved aids posted throughout the facility had inaccurate information related to the identification of various tritium alarms and the required personnel mustering locations in the event of an actual emergency. LLNL facility management indicated that these postings had been superseded, but had yet to be replaced by the current (presumably accurate) versions. The staff also observed that the public address system and the emergency alarms were difficult to hear inside the room housing TPS because of high background noise.

During system walkdowns, the staff made the following additional observations:

- The ventilation exhaust duct in the room had been partially covered with duct tape in an attempt to achieve air flow balance.

- The position indicators for the main (ventilation) isolation valves of the glovebox were difficult to read.

Summary. The staff reviewed conduct of operations and readiness activities associated with the startup of the TPS at LLNL as well as related aspects of the Tritium Facility's safety basis. The LSO RA identified two important issues: (1) designating the TPS glovebox as a safety-significant control without an established basis has led to confusion on what the functional requirements for the glovebox are and how they should be controlled and maintained, and (2) the operating guidance did not conform to the requirements of DOE Order 5480.19. Both of these issues were characterized as post-start findings.

The staff identified several other issues and further developed the two issues identified by the RA team. In particular, the staff is concerned that the hazard analysis may not properly characterize the consequences of all tritium release scenarios. Moreover, the observed operating practice of using a general-use procedure with operator aids may not apply sufficient rigor to control TPS operations. The staff concluded that the open issues related to hazard analysis, selection of controls, and conduct of operations at TPS warrant corrective actions.