Department of Energy
National Nuclear Security Administration
Washington, DC 20585

May 18, 2009

OFFICE OF THE ADMINISTRATOR

The Honorable A. J. Eggenberger
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W., Suite 700
Washington, D.C. 20004-2901

Dear Mr. Chairman:

This is response to your letter to the Secretary of Energy, dated April 7, 2009, requesting a report describing the compensatory measures and actions taken by the National Nuclear Security Administration (NNSA) and Los Alamos National Laboratory (LANL) personnel to improve the safety posture of non-safety class containers of plutonium-238 (Pu-238) stored in the Plutonium Facility vault water baths. The enclosed report provides the requested information, and also provides the strategy for improving the robustness of containerization of Pu-238.

The NNSA had similar concerns to those discussed in your letter when NNSA reviewed the draft Plutonium Facility Documented Safety Analysis and revised Technical Safety Requirements (TSR). As a result, the NNSA safety evaluation report, issued on December 22, 2008, included direction to LANL to modify the Plutonium Facility TSR to eliminate or minimize uncovering of non-safety class containers of Pu-238 and to identify actions to be taken in the event of failure of the vault water baths.

The essential actions taken include checking vault water bath level daily and correcting the water level when necessary to ensure that it is maintained at least one inch above the tallest non-safety class Pu-238 container. An updated thermal analysis demonstrated that the temperature transient upon loss of cooling is sufficiently slow to justify a daily surveillance. During the week of April 27, 2009, LANL personnel installed a camera to facilitate remote daily inspection of the water level, which is a new TSR that was approved in December 2008 and has been implemented by standing order. By June 2010, NNSA and LANL intend to either disposition, repack, overpack, or analytically demonstrate that all the Pu-238 containers meet safety class pedigree and do not require water cooling. At that time, downgrading the Vault Water Bath Cooling System from safety class may be technically acceptable. The enclosure provides more detailed information on the Plutonium Facility vault water baths and the plan for the non-safety class Pu-238 containers.

If you have any questions, please contact Mr. James McConnell, Director, Office of Safety, at (202) 586-4379.

Sincerely,

Thomas P. D'Agostino
Administrator

Enclosure

cc: Mark Whitaker, Jr., HS-1.1
D. Winchell, LASO

UNITED STATES GOVERNMENT | DEPARTMENT OF ENERGY

memorandum

National Nuclear Security Administration
Los Alamos Site Office
Los Alamos, New Mexico 87544

DATE: APR 27 2009
REPLY TO
ATTN OF: FO:16CK-50092
SUBJECT: Los Alamos National Laboratory – Plutonium-238 Vault Water Baths

TO: Thomas P. D'Agostino, Administrator, NA-1, HQ/FOR
THRU: Brigadier General Garrett Harencak, Deputy Administrator for Defense Programs, NA-10, HQ/FORS
THRU: Gerald L. Talbot, Assistant Deputy Administrator for Nuclear Safety and Operations, NA-17, HQ/FOR

In a letter to the Secretary of Energy dated April 7, 2009, the Defense Nuclear Facilities Safety Board (DNFSB) stated that the safety-class vault water bath system at the Plutonium Facility is unable to fulfill its safety function in a reliable manner and that significant unresolved issues with this safety-class system are unaddressed, leaving it in an indeterminate and degraded state with respect to operability, reliability, and effectiveness.

The attached describes actions that the National Nuclear Security Administration (NNSA) and Los Alamos National Security, LLC, (LANS) have taken to improve the safety posture of non-safety-class plutonium-238 containers stored in the vault water baths, as well as the strategy for improving containerization. This constitutes the NNSA reporting requirement response requested by the DNFSB.

Essentially, vault water bath operability is checked daily, and water-level is corrected when necessary. If the cooling system is operational, the evaporation rate is about 4 inches per month, providing ample time for operator response. If the cooling system is non-operational, rate of temperature rise of the baths under current loading is less than 4°F per hour; daily verification is sufficient to detect a loss of water level and initiate operator intervention before a safety concern arises. Also, preliminary analysis indicates that the most limiting containers, when exposed to air, will maintain integrity for at least the next 18 months. By June 2010, NNSA and LANS intend to either disposition, over-pack, or analytically demonstrate that all the plutonium-238 containers meet safety-class pedigree and do not require water-cooling. At that point, down-grading the vault water baths from safety-class may be technically acceptable. The NNSA Los Alamos Site Office (LASO) and LANS is available to brief or support a brief to the DNFSB on the vault water baths and on the site's other vital safety systems by May 22, 2009, as requested by the DNFSB.

Please refer any questions to C.H. Keilers at (505) 665-6352.

Donald L. Winchell, Jr.
Manager

NNSA/DOE
Los Alamos Site Office
3747 West Jemez Road
Los Alamos, NM 87544-2201

Material transmitted is Unclassified and contains no Unclassified Controlled Nuclear Information

DC Winchell 4-23-09

NNSA/DOE
Headquarters
1000 Independence Avenue, SW
Washington, DC 20585-1290

Attachment

cc w/attachment:
D. Nichols, NA-1/FORS
G. Talbot, NA-17/FORS
J. McConnell, NA-1/FORS
K. Loll, NA-173/FORS
C. Keilers, AMFO, LASO
J. Vozella, AMSO, LASO
J. Griego, AMNSM, LASO
B. Broderick, DNFSB, LASO
R. T. Davis, DNFSB, LASO
Records Center, LASO

Plutonium Facility – Plutonium-238 Vault Water Baths
April 23, 2009

ISSUE

In a letter to the Secretary of Energy dated April 7, 2009, the Defense Nuclear Facilities Safety Board (DNFSB) stated that the safety-class vault water bath system at the Los Alamos National Laboratory (LANL) Plutonium Facility is unable to fulfill its safety function in a reliable manner and that significant unresolved issues with this safety-class system are unaddressed, leaving it in an indeterminate and degraded state with respect to operability, reliability, and effectiveness.

The DNFSB requested a report and briefing within 45 days describing immediate actions, compensatory measures, and the strategy for fully characterizing and correcting vault water bath deficiencies or improving container robustness. Within 60 days, the DNFSB also requested a briefing describing plans, milestones, and completion dates to improve assessments for other vital safety systems. This report addresses the former request, focused on the vault water baths.

BACKGROUND

Heat-source plutonium (HS-Pu) is up to 90 % enriched in plutonium-238, which decays at a rate of about 0.9 % per year and emits about 0.5 watts per gram. The LANL Technical Area 55 (TA-55) Plutonium Facility normally stores, transfers, and stages HS-Pu containers submerged in water to provide radiation shielding and to control temperature. As plutonium-238 decays, heat generation decreases and helium pressure increases. Increasing temperature would further increase vapor space gas pressure, stressing the container.

Much of LANL's plutonium-238 is appropriately stored in safety-class containers (i.e., the EP-61s). However, the reliability of approximately 200 non-safety-class containers in air is still being determined. Preliminary analysis indicates that about 160 of these containers, the Russian Product Containers (RPCs), have adequate pressure-integrity margin when in air for at least the next 18 months. Six other containers (K2s) have sufficiently low loading and high volume to provide indefinite protection. The pressure-integrity margin for the remaining containers is still being determined, but appears at this time to be bounded by the RPC case.

In December 2008, the National Nuclear Security Administration (NNSA) Los Alamos Site Office (LASO) issued a safety evaluation report (SER) and approved a new safety basis for the Plutonium Facility. The calculated unmitigated dose for the maximally exposed off-site individual for a worst-case container failure exceeds the Department of Energy (DOE) evaluation guideline by about a factor of 20 (i.e., the 500 rem, cited in the DNFSB letter); therefore, the safety basis designates the building passive confinement system, the containers, and the vault water baths as safety-class features and the active confinement system as safety significant.

When reviewing the new safety basis, the NNSA Site Office considered that additional actions were required. In SER Condition of Approval #13, NNSA directed LANL to modify the TSRs to eliminate or minimize uncovering of the non-safety-class containers and to identify actions to be taken in the event of failure of the vault water baths. NNSA also directed LANL to provide a basis for how long non-safety-class containers would maintain their integrity when uncovered and to provide a schedule for repackaging the material into safety-class containers. These actions are underway and are discussed below.

SAFETY FUNCTION

The vault water bath safety-class function is to keep non-safety-class containers submerged. The new Technical Safety Requirements (TSRs) include a Limiting Condition of Operation (LCO 3.5.1) that specifies a minimum water level, based on operating experience considering normal evaporative losses. A daily surveillance requirement is implemented now via standing order.

NEW SAFETY CONCERN

On March 24, 2009, the DNFSB site representatives at Los Alamos informed LASO that four non-safety-class containers with undetermined pressure-integrity could extend above the minimum water-level specified in the safety basis; seven other containers with undetermined pressure-integrity would immediately begin to uncover if water-level fell below the minimum specification.

The site representatives also observed that, while the new TSRs require daily surveillance, the new TSRs have not been implemented, and the currently credited surveillance is monthly. Other improvements were also suggested, such as strengthening configuration control of the containers within the vault water bath baskets and pursuing back-up power for the heat-exchanger pump.

IMMEDIATE ACTIONS

LANL increased the vault water bath water-level, to increase margin to evaporative losses, and strengthen the current standing order for daily monitoring the vault water bath operation. For some time, operators have been checking the water-level daily when the vault is open (typically 4 days per week) and checking temperature drop across the heat exchanger confirming its operation; operating experience has been that the water baths evaporate at a rate of about 4 inches per month if the heat exchanger is operating, which allows ample time to respond.

LANL has proposed a TSR change to require not only daily surveillance of water-level but also refilling if water-level is found to be less than 1 inch above the top of the non-safety class containers during daily surveillance (i.e., establishing a margin equivalent to one-week's normal evaporative losses). A TSR change was directed by SER Condition of Approval #13. The NNSA Site Office is reviewing the proposed TSR change.

The DNFSB site representative line-of-inquiry was focused on the containers in the vault water baths; however, LANL also considered transfer and staging practices for containers outside the vault water baths and declared a Potential Inadequacy in Safety Analysis (PISA) on non-safety-class containers outside the vault water baths or glove-box lines. Within one day, LANL returned to the vault water baths all but two containers that are oversized. These two containers are submerged elsewhere in the facility and are also receiving daily surveillance.

SUPPLEMENTARY ACTIONS AND COMPENSATORY MEAURES

LANL expects to complete the following actions within the next few weeks:

- Install a camera in the vault water bath room to allow daily visual checks from the TA-55 Operations Center, whether the vault is open or not. This is a key element in achieving early implementation of the new TSRs.
- Develop alarm response procedures for the existing Facility Control System alarms for heat exchanger cooling loop flow and temperature. These alarms are monitored in the TA-55 Operations Center.
- Re-perform the vital safety system assessment for the vault water baths using the new LANL vital safety system assessment procedure.
- Refine the vault water bath thermal calculations using more realistic but still conservative assumptions.

In particular, if heat exchanger cooling is lost and if the vault water baths contain the maximum permitted HS-Pu loading, the thermal calculation cited in the DNFSB letter predicted 18 hours to boiling and 30 hours to beginning to uncover RPCs; however, this calculation unrealistically assumed the water baths have full adiabatic boundary conditions. This calculation has been updated. The revised calculation assumes the room boundary is adiabatic and predicts 33 hours to boiling and 52 hours to start uncovering containers at the full heat load; the predicted rate of temperature rise of the water baths is about 4 °F per hour. NNSA and LANL will consider changes to the TSRs based on the revised calculation.

ROLE OF THE VAULT WATER BATH COOLING SYSTEM

LASO considers that the safety system vulnerabilities lie more with the non-safety-class containers than with the vault water baths or cooling system. The DNFSB staff report, forwarded by a DNFSB letter dated October 16, 2007, stated that the vault water bath cooling system includes a non-credited heat exchanger, which is correct, and asserted that the safety function of the cooling system has not been adequately defined, documented, and assured. Until the December 2008 SER was issued, the safety function of the vault water baths was defined as shielding HS-Pu containers from convective and radiative heat transfer from fires in the vault room (Reference: TSR Revision 6.1, Section 6.1.11); the cooling system was not included. The new safety basis does not limit the safety function to thermal protection from fires but still does not include the cooling system. It states that the vault water bath ensures

that the water level is sufficient to prevent radiological release caused by internal over-heating and over-pressurization of containers in the water bath as a result of the loss-of-coolant accident; it explicitly identifies that active cooling of the containers in the baths is not part of the required safety function. Container pressure calculations are being performed with the assumption of boiling water (Reference: 2008 TA-55 Documented Safety Analysis, Section 3.4.25.5).

STRATEGY FOR IMPROVING CONTAINERS

The NNSA Site Office designated the vault water baths as safety-class in July 2005, as part of the response to the building confinement (i.e., leak path factor) issue raised in late 2004. The vault water baths were not constructed to safety-class requirements, particularly seismic requirements (i.e., Performance Category 3). The scope of the TA-55 Reinvestment Project, Phase 2, includes upgrading or replacing the vault water baths during the next five years.

More timely action is required. Consistent with the SER Condition of Approval #13, NNSA and LANL intend to either disposition, over-pack, or analytically demonstrate that all the HS-Pu storage containers meet safety-class pedigree and not require water-cooling. At that point, down-grading the vault water baths from safety-class may be technically acceptable. Other factors also need to be considered, such as TA-55's ability to receive non-safety-class containers from off-site sources and stage them until they can be over-packed.

Near-term actions include the following:

- Review new pressure buildup calculations for non-safety-class containers when available.

  Analysis of two of the ten types have been completed, including the Russian Product Containers (RPC), which is the most numerous (~160) and the most limiting type. Tentatively, results indicate air-exposed RPCs would maintain pressure integrity for at least the next 18 months. The other type analyzed (K2) has pressure integrity indefinitely.

- Complete radiography of the eight remaining types to obtain dimensions for pressure analysis; this could be done within the span of days once the PISA discussed above is resolved.

- Complete qualification of first-generation safety-class fuel storage containers that can be used to over-pack non-safety-class containers. LANL anticipates being able to begin to over-pack the most limiting non-safety class containers in July and August 2009.

Longer-term actions include the following:

- Complete pressure analysis of the eight remaining container types in about 5 months following PISA resolution.

- Complete qualification of second-generation fuel storage containers by August 2009. Repackage remaining non-safety-class containers, as necessary, by June 2010, and then consider downgrading vault water baths from safety-class.

CONCLUSIONS

LASO considers that the safety system vulnerabilities lie more with the non-safety-class containers than with the vault water baths. Preliminary analysis indicates that the most limiting containers (RPCs), when exposed to air, will maintain integrity for at least the next 18 months. By June 2010, NNSA and LANS intend to either disposition, over-pack, or analytically demonstrate that all the HS-Pu containers meet safety-class pedigree. At that point, down-grading the vault water baths from safety-class may be technically acceptable.

Considering the vault water baths, operating experience indicates that, if the cooling system is operational, the evaporation rate is about 4 inches per month, providing ample time for operator response. If the cooling system is non-operational, an updated conservative analysis predicts a rate of temperature rise for the water baths of about 4 ^{o}F per hour, a time to boiling of 33 hours, and a time to beginning to uncover the most limiting containers (RPCs) of about 52 hours at full heat load. Vault water bath operability is being checked daily, either visually or by confirming heat exchanger operability, and water-level is being corrected when necessary. The updated analysis shows that a daily check of the water baths is sufficient to detect and correct a problem with the vault water baths before a safety concern develops.