

## DEFENSE NUCLEAR FACILITIES SAFETY BOARD

January 31, 1994

**MEMORANDUM FOR:** G. W. Cunningham, Technical Director

**COPIES:** Board Members

**FROM:** C. H. Keilers, Technical Staff

**SUBJECT:** Y-12 - Safety Analyses/Criticality/Chemical Safety Review  
(November 3-5, 1993)

1. **Purpose:** This trip report documents the Defense Nuclear Facilities Safety Board (DNFSB) technical staff review of the Y-12 plant safety analysis report (SAR) upgrade program, criticality safety, and chemical safety. F. Bamdad, J. Roarty, and C. Keilers conducted this review at Y-12 on November 3-5, 1993.
2. **Summary:** The inventories of enriched uranium and lithium at Y-12 are increasing.
  - a. For enriched uranium, the amount on site will exceed the historic maximum level reported under the National Environmental Policy Act (NEPA) possibly by May 1994. DOE is reviewing a Martin Marietta Energy Systems (MMES) draft Environmental Assessment on this.
  - b. MMES has also developed a cost effective modular design to safely increase enriched uranium storage capacity. This concept is considered just as safe as the existing approach based on design similarities.
  - c. For lithium metal and hydrides, an assessment team has recommended that existing material be converted into innocuous chemical forms, a process estimated to take five years.

The DNFSB staff is concerned that a valid Unreviewed Safety Question Determination (USQD) at Y-12 is difficult to perform since the authorization bases are continuously changing as SARs are updated. Also, Y-12 management needs to consider implementing independent reviews of criticality analyses, preferably using alternate analytical approaches. These concerns are discussed further below and in the attachment.

3. **Background:** This trip followed up on questions and concerns from previous DNFSB staff trips in the areas of the SAR update program (9/28-30/92 and 5/18-20/93) and chemical safety (3/10-12/93).

4. **Discussion:** The Department of Energy (DOE) site office and the Y-12 plant Managing and Operating (M&O) contractor, MMES, made the following key points during their briefings:
- a. A number of Y-12 facilities are being consolidated or decommissioned such that by the year 2000 the size of the Y-12 exclusion area could be reduced by roughly half.
  - b. The MMES hazard screening process predates the applicable DOE standard (DOE-STD-1027-92). MMES presented a facility-by-facility comparison using the two approaches and indicated that its methodology meets or exceeds the hazard categorization of the standard.
  - c. As part of the SAR upgrade program, Y-12 facilities have been screened for hazards and prioritized. Justification for Continued Operations (JCOs) have been prepared, and SARs are being updated over a three- to four-year period, which is consistent with the schedule at other facilities in the defense complex.
  - d. An investigation into the causes of a hydrofluoric acid (HF) spill in January 1992, has led to the design of system upgrades for building 9212 to prevent recurrence. MMES plans to perform an operational readiness review (ORR) for the HF facility before restart. Subsequent to the trip, DOE indefinitely postponed restart.

The DNFSB staff has the following concerns:

- a. The DNFSB staff considers the Y-12 personnel performing criticality analyses well-qualified but also very focused on using one methodology. An independent review of Y-12 criticality analyses and methodology, preferably using alternate analytical approaches, could enhance confidence in their results. Y-12 management should consider implementing such independent reviews, perhaps using the capabilities of Oak Ridge National Laboratory.
- b. Unreviewed Safety Question Determination (USQD) at Y-12 is made based on the authorization basis documentation available, which includes old SARs and JCOs, as well as new documents prepared as part of the SAR Update Program and, in some cases, not yet approved. Since the authorization bases are continuously changing as SARs are updated, a valid USQD is difficult to perform.

The attachment to this trip report provides further details.

5. **Future Planned Activities:** The DNFSB staff will continue to follow Y-12 progress in updating safety analysis reports, in obtaining independent reviews of criticality analyses, and in addressing the increasing inventories of enriched uranium and lithium. The staff will also closely follow progress on restarting the HF facility.

## ATTACHMENT

**Y-12 - Safety Analyses/Criticality/Chemical Safety Review  
November 3-5, 1993**

The DOE site office and the Y-12 plant M&O contractor, Martin Marietta Energy Systems (MMES), briefed the DNFSB staff on site consolidation efforts, the safety analysis report (SAR) upgrade program, the unreviewed safety question determination (USQD) process, criticality safety, uranium and lithium storage issues, and planned restart of the HF facility for the enriched uranium processing building (9212).

a. Y-12 Consolidation Status:

A number of Y-12 facilities are being consolidated or decommissioned such that by the year 2000 the size of the Y-12 exclusion area could be reduced by roughly half. Moderate hazard facilities slated for decommissioning include an enriched uranium processing building (9206), the "Fogbank" facility (9404-11), and the quality evaluation and reclamation building (9204-4). Several low hazard facilities associated with deuterium and depleted uranium operations are also scheduled to be shutdown. MMES plans safety reviews as part of decommissioning process to reduce risks.

b. Hazard Screening Methodology:

The MMES hazard screening process predates DOE-STD-1027-92 and uses a "high/moderate/low" rating system instead of categories "1/2/3" in the DOE standard. MMES considers its process superior to that in the standard since its process evaluates not only nuclear hazards but also unique Y-12 chemical hazards.

The Y-12 screening process begins by dividing each facility into systems and subsystems. "Facility safety evaluation teams" then identify credible hazards on a process level. Each team develops a matrix of bounding accidents and initiating events. Health consequences are then determined considering the specific hazardous material and the administrative controls that limit the material at risk. No credit is taken for mitigating systems.

Hazard classifications are next assigned based on the health effects and the number of people affected. This methodology is similar to that defined in DOE Order 5480.23 "Nuclear Safety Analysis Reports" but different from the DOE-STD-1027-92 approach, which classifies facilities based on the total nuclear material inventory. MMES presented a facility-by-facility comparison using the two approaches and indicated that its methodology meets or exceeds the hazard categorization of the standard.

c. Safety Analysis Report (SAR) Upgrade Program:

MMES initiated a SAR upgrade program in mid-1989. SARs document the adequacy of a facility's safety basis and provide assurance that the facility can be operated, maintained, and shut down safely and be in compliance with applicable laws and regulations. In accordance with DOE Order 5480.23, "Nuclear Safety Analysis Reports," SARs play a key role in documenting and controlling a facility's authorization basis for continued operations.

To date, MMES has surveyed its facilities to identify hazards and classify risks, prepared justification for continued operation (JCOs), and performed hazard screening (discussed above). Based on this screening, MMES concluded that Y-12 has no high hazard facilities but has nine (9) moderate and twenty (20) low hazard facilities. For the moderate hazard facilities, MMES has invoked configuration management requirements on candidate safety class items and has developed interim operational safety requirements.

Over the next four years, MMES plans to perform detailed safety analyses, develop operational safety requirements (OSRs), and prepare final safety analysis reports (FSARs) for all the moderate hazard facilities. OSRs and FSARs will be submitted to DOE for approval as each such document becomes available. For low hazard facilities, safety evaluations will also be documented, but these will be approved by the contractor instead of DOE.

According to the MMES schedule, the first SAR will be completed in about one year (i.e., by mid FY 95) and will cover the "Blue Goose" on-site uranium transport vehicle. This will provide experience useful in preparing subsequent SARs. The remaining moderate hazard facility SARs will be completed in three to four years (i.e., in FY 97/FY 98).

In summary, Y-12 facilities have been screened for hazards and prioritized. JCOs have been prepared, and SARs are being updated over a three- to four-year period, which is consistent with the schedule at other facilities in the defense complex.

d. USQD Process:

Unreviewed Safety Question Determination (USQD) at Y-12 is made based on the authorization basis documentation available. These documents include old SARs as well as new documents prepared as part of the SAR Update Program, including justifications for continued operation (JCOs). However, not all the new documentation has been reviewed and approved by DOE.

The DNFSB staff believes that a valid USQD is difficult to perform due to the fact that the authorization bases are continuously changing as SARs are updated. For example, the criticality alarm system was identified as a safety related system using the 1980's definition and documentation. Recently, MMES identified lack of compliance of this system with the redundancy requirements for safety related systems. However, this was not identified as a USQD nor was an investigation performed because the criticality alarm system would not be considered as a safety class item under recent DOE standards, some still in draft form.

e. Criticality Safety:

The DNFSB staff reviewed the on-going criticality safety analysis activities for various process operations. The personnel assigned to this work are well qualified in both performing criticality analyses and reviewing day-to-day operations of chemical processes for criticality safety concerns.

During its visit in September 1992, the DNFSB staff identified a need for an independent review of criticality analyses and methodology at Y-12. This was due to the fact that the criticality safety department has focused on Monte Carlo methods. An independent review based on alternate methods could improve safety. Oak Ridge National Laboratory has the capability to perform such reviews. The DNFSB staff was informed that such independent reviews have not been done because of higher priority activities.

In a related area, MMES has prepared a facility safety procedure to capture the requirements of the ANSI/ANS standards for criticality control. Implementation of this procedure has resulted in annual replacement of Raschig Rings in tanks rather than inspection of the Raschig Rings. This approach was stated to enhance criticality safety.

f. Current and Planned Uranium Storage:

MMES briefed the DNFSB staff on safety analyses, plans, and the schedule for enriched uranium storage at Y-12.

Y-12 is the main storage location for highly enriched uranium in the DOE weapons complex. As more weapons are disassembled, the Y-12 enriched uranium inventory will increase and could exceed the maximum historic storage level by May 1994. Therefore, MMES has prepared, and DOE-ORO is reviewing, a draft Environmental Assessment (EA) to assess the impact on the public and workers of increased storage. This assessment includes the effects of bounding accidents involving shipping, receiving, storing, and processing material.

Y-12 will also need additional safe, secure, long-term, storage capacity for enriched uranium. To meet this need, MMES plans to insert the canned material into holes in new heavy concrete pallets, called "modular storage containers." The pallets can then be stacked in existing buildings in the Material Access Areas, thereby avoiding the cost of building new storage facilities. DOE, Sandia National Laboratory, and MMES have reviewed the modular storage container design from a criticality safety and safeguards/security standpoint and have found it acceptable. MMES has contracted for 300 pallets. About 75 pallets have been delivered, as of January 28, 1994. None are currently being used for storage.

Based on design similarities, the DNFSB staff believes that the modular storage containers will be as safe as the current, more expensive storage approach (i.e., "tube vaults"), considering such hazards as airplane crash, fire, and inadvertent criticality.

g. Lithium Storage:

The DNFSB staff reviewed the status of DOE developing a lithium metal/lithium compound storage standard. The last DNFSB review of Y-12 lithium storage was in March 1993.

The inventory of lithium hydride, lithium deuteride, and lithium metal at Y-12 is increasing as more weapons are disassembled. These materials are combustible and thereby could release toxic fumes. They can also react with water and thereby release hydrogen gas. Because of these concerns, lithium metal and hydride forms are considered unacceptable for long-term storage.

An assessment team, consisting of DOE, MMES, LANL, and LLNL personnel, has developed a draft DOE technical standard for storage of lithium metal and compounds. In addition, the team evaluated alternate lithium compounds for long-term storage and recommended that the existing inventory be converted into lithium chloride or lithium carbonate since these materials are stable, noncombustible, and pose no serious health or environmental threat. This conversion is estimated to take about five years. The DNFSB staff requested the draft standard as well as the Y-12 lithium storage action plan for its review.

Additionally, MMES discussed experimental results that indicate health consequences due to a lithium fire are not as significant as was previously suspected since the toxic combustion products react with carbon dioxide in the air to produce innocuous chemical forms (i.e., lithium carbonate). The DNFSB staff requested further information on these experiments for internal review.

h. HF Facility Improvements and Restart Planning:

MMES briefed the DNFSB staff on improvements being implemented prior to restarting the HF facility for the enriched uranium processing building (9212). A DNFSB staff member also toured the HF unloading station outside the building, which is the focus of the upgrades.

In January 1992, a system rupture disk failure, coupled with a valve inadvertently left open, resulted in a spill of hundreds of pounds of hydrofluoric acid (HF) onto the HF unloading dock outside building 9212. An investigation into the cause of the spill has led to the design of system upgrades to prevent recurrence. The upgrades include:

1. New HF piping and HF vapor detectors both on the dock and in the building at the fluidized beds.
2. New isolation valving for the HF shipping container and the piping manifold on the dock.
3. An emergency isolation switch on the dock that will isolate sections of the unloading system and minimize any release.
4. A refrigerated enclosure for the DOE HF shipping containers with a water deluge system to mitigate a catastrophic release.

In addition to facility improvements, the current DOE HF shipping containers are to be replaced with more robust containers commonly used for chlorine shipments.

During the DNFSB staff briefing, MMES stated that they would be ready to perform an ORR for the HF facility restart at the end of May 1994. Major milestones prior to the ORR included submitting a system safety analysis to DOE, performing an order compliance assessment, modifying hardware, upgrading operating procedures, and training operators.

Subsequent to the DNFSB staff trip, DOE and MMES indefinitely postponed the restart.

The DNFSB staff will continue to follow developments, such as these safety analyses and other preparations leading up to HF facility restart.