

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

August 19, 1996

MEMORANDUM

FOR:

G. W. Cunningham, Technical Director

COPIES:

Board Members

FROM:

Dermot Winters

SUBJECT:

Trip Report - Subcritical Experiments REBOUND-1 and HOLOG

1. **Purpose:** This report documents observations made by the Defense Nuclear Facilities Safety Board (Board) staff member Dermot Winters during a trip to the Department of Energy (DOE) Nevada Operations Office (NVOO) and to the Nevada Test Site (NTS) on August 13-14, 1996. The primary objective of the trip was to meet with DOE, Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL) and Bechtel Nevada to discuss underground construction quality assurance (QA) in relation to subcritical experiment preparations. The trip also afforded the opportunity to observe the 207th meeting of the Containment Evaluation Panel (CEP).
2. **Summary:** On August 13, 1996, Mr. Winters attended the 207th meeting of the CEP for review of "Mexia," the pre-qualification of a hypothetical LANL sponsored underground nuclear test. The Mexia exercise appeared to be of value for maintaining CEP and laboratory readiness but of only limited value in qualifying the site chosen.

On August 14, Mr. Winters traveled to CP-1 and the LYNER complex at the NTS to discuss underground construction QA. As described below, documentation of the results of pressure grouting the alluvium surrounding the primary containment plug constructed for the LANL subcritical experiment REBOUND-1 is deficient. During a meeting held at CP-1, LANL officials indicated they also viewed the report documenting pressure grouting as deficient and committed to prepare an addendum to the report correcting its deficiencies. In addition, LANL officials noted that additional QA concerns had led them to hold a meeting with all personnel responsible for underground construction at LYNER. The necessity for attention to quality work, including accurate documentation, was re-emphasized at that meeting.

Following the CP-1 meeting a visit to underground work areas in LYNER provided the opportunity to confirm information given at the meeting concerning pressure grouting results for REBOUND-1 and to observe ongoing underground construction activities for LLNL's HOLOG experiment. HOLOG preparations reflect a significantly different philosophy for containment from that of REBOUND-1, with greater dependence placed on multiple barriers rather than on the primary barrier. Based on observations to date of KISMET, REBOUND-1,

HOLOG, and plans for additional experiments, variations from experiment to experiment will be significant enough to warrant a Board staff review of each experiment.

3. **Background:** REBOUND-1 and HOLOG are subcritical experiments to measure equation-of- state properties of weapons-grade plutonium. Safety concerns involve the potential for release of plutonium from the experiment zero rooms, since the quantities and configuration of the plutonium used in these experiments preclude any criticality hazard. Because the barriers utilized to seal the zero rooms are too well anchored to be moved by the force of the explosives to be employed, the concern is that plutonium dusts or fumes might pass through or around the barriers. An earlier LANL experiment, KISMET, had unexpectedly released carbon monoxide gas generated from the explosives used. Because the ground surrounding the KISMET barrier plug was not pressure grouted, the gas may have escaped either through the alluvium surrounding the plug or through an unintended void left at the top of the plug when it was filled with grout.
4. **Discussion/Observations:**
 - a. **207th CEP Meeting.** The 207th meeting of the CEP, a review of "Mexia," the pre- qualification of a hypothetical LANL sponsored underground nuclear test, for which no device or projected yield has been proposed, took place on August 13, 1996. The Mexia exercise appeared to primarily be of value for maintaining CEP and laboratory readiness. Because any future test at the Mexia site would require a significant re-review by the CEP to accommodate the addition of test details, the exercise appeared to be of limited value for qualifying the site chosen.
 - b. **Subcritical Experiments Construction QA.** Although the KISMET experiment leaked carbon monoxide gas around its 10-foot long plug, there was no detected leakage of either the depleted uranium used or of the tungsten fines used to simulate the potential airborne transport of plutonium. Post-experiment studies indicate that the uranium and tungsten materials failed to penetrate more than a few centimeters into the alluvium. Nevertheless, the REBOUND-1 plug has been constructed 20 feet in length to further increase the path length for gaseous transport through the alluvium. In addition, unlike KISMET, a shotcrete grout surface has been sprayed onto the walls and roof of the experiment room (except for the rear face opposite the plug) and then painted with a sealant mixture of Lucite paint and sodium silicate. It is believed that this covering will have the effect of increasing the gas travel path by an additional 20 feet.

As an additional precaution at REBOUND-1, three rings of holes were drilled 3-4 feet into the ground surrounding the plug and used to pressure grout the alluvium. This pressure grouting operation was intended to reduce the permeability of the alluvium and fill voids, if any, that might exist surrounding the plug. Upon completion of the pressure grouting operation, the staff obtained a copy of the post-grouting report. Review of the report raised construction and construction QA concerns. First, the report indicated that there had been significant grout takes in several of the drill holes, one of which was reported to have resulted in grout flowing out of the rib (wall) into the zero room. Second, the report seemed to show an unexplained deviation from the original pressure grouting plan. The original plan specified that the grout ring nearest the zero room was to receive cement grout and the other two rings sodium silicate grout. No sodium silicate was used. Cement was used to pressure grout all three rings. Although it can be inferred from the grout batching information included with

the post-grouting report that only cement grout was used, the text does not document that fact. Finally, the report does not explain why the sodium silicate grout was not used. The CP-1 meeting and LYNER visit were scheduled to address these questions.

Satisfactory explanations were obtained during the meeting and visit. Grout takes and leakage into the zero room had been concluded by the LANL construction supervisor to be the result of incomplete filling of the REBOUND-1 plug with grout resulting in a void space at the top of the plug between the grout infill and the alluvium. It was this zone which was filled during the pressure grouting operation. Also, the decision was made to proceed with cement grout in the other two rings instead of the sodium silicate in order to ensure the filling of the inferred void space at the top of the plug. The sodium silicate had been eliminated since it is suitable for penetrating narrow fissures and pore spaces but not for filling large voids. LANL officials recognized that the post-grouting report was deficient for not accurately documenting and explaining the plan deviations described. They indicated that the reporting deficiencies would be corrected by issuance of an addendum to the post-grouting report and that a copy of the addendum would be provided to the Board.

The pressure grouting discussions were broadened to the more generic issue of construction QA for all subcritical experiment containment work at LYNER. LANL officials admitted construction QA had deteriorated somewhat during the continuing delays in proceeding with the experiments. Citing at least one other example of a construction QA problem, LANL officials mentioned that a meeting had already been held with all underground construction personnel and the necessity for attention to quality work, including adequate documentation, had been re-emphasized.

- c. ***HOLOG Containment.*** The LYNER visit also afforded the opportunity to view construction activities for HOLOG experiment containment. The approach taken to containment by LLNL for HOLOG is significantly different from LANL's for REBOUND-1. Greater emphasis is placed on the utilization of multiple barriers (following the nested containment vessels concept used in the past for DNA tunnel tests) and less on the length and massiveness of the primary barrier. Thus, HOLOG containment does not involve the construction of a massive grout filled barrier plug. It utilizes a 2.5 feet thick steel barrier coated on the zero room side with grout and on the opposite side with a proprietary foam material, "Versi-Foam." The "Versi-Foam" acts as a further barrier for plutonium particulates. It will not crack during the dynamic phase and will serve to encapsulate any particles that might pass through the rigid barrier. Despite the barrier's thinness, it appears adequate given the specific requirements of the HOLOG experiment. As noted in the HOLOG prospectus, diagnostics required include the use of camera equipment which must be placed nearer the experiment than would be allowed by a plug such as that constructed for REBOUND-1. In addition, the explosive pressure generated by the HOLOG experiment will be so much less than REBOUND-1 that it will not severely challenge the thinner HOLOG barrier. Consequently, although LLNL believes there is little likelihood of

explosive gases passing the zero room barrier, they are prepared to accept some gas leakage through that barrier should it occur. In such an eventuality, the secondary barrier (second vessel) is more than capable of containing those gases. LLNL believes that the design of the HOLOG barrier is more than adequate to preclude the passage of radioactive materials from the zero room, even if there should be an escape of gases. The Board staff concurs with the LLNL assessment.

It was noted that future LLNL sponsored experiments at LYNER may involve larger detonations than HOLOG and require more robust primary containment. LLNL officials indicated that an effort would be made to develop the appropriate trade-off between zero room size and primary barrier thickness relative to the size of planned experimental detonations.

5. **Future Staff Actions:** The Board staff will continue to follow and observe all containment activities associated with REBOUND-1 and HOLOG through post-experiment evaluation of containment performance. In the interim, additional REBOUND-1 and HOLOG containment- related documents have been requested and will be reviewed as received. Concerns, if any, noted by the staff as a result of the document reviews will be brought to the attention of the Board.

Given the variability in containment needs seen for KISMET, REBOUND-1, HOLOG, and planned future experiments a DNFSB staff review will likely be required for each experiment.