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TITLE USING TLDS TO MONITOR LOS ALAMOS DRILLBACKS AT THE NEVADA TEST SITE

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USING TLDS TO MONITOR LOS ALAMOS DRILLBACKS AT THE NEVADA TEST SITE

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ABSTRACT

Los Alamos National Laboratory uses LiF TLDs to measure the quantity of radiation in the environment during drilling, sampling and hole cementing operations following underground nuclear testing.

The procedures for preparing the TLDs, placing the TLDs in the field and their subsequent analysis and dose evaluation will be presented.

INTRODUCTION

After an underground nuclear test is conducted at the Nevada Test Site (NTS) a conventional drill rig (Fig. 1) is used to drill into the rubble and to retrieve samples of test debris. Just prior to drilling, TLDs are positioned around the perimeter of the drilling site to provide the "fence post" dose rate in event of a leak of radioactivity. TLDs are also used during the cementing of the hole (cement-back) and for the interim period which usually lasts several weeks before the hole is sealed and cemented. The use of TLDs for environmental measurements at the NTS is exacerbated by high variations in background levels depending on site location. In addition, the variation in duration of the interim and cement-back periods may result in TLDs being stored for a few weeks or as long as a year.

The procedures outlined in this report, were also followed in our participation in the Sixth International Environmental Dosimeter Intercomparison Project (SIEDIP) in 1983 (GeR3). The project enabled participants to ascertain the accuracy of their TLD measurement results in comparison to the other participants. This comparison allowed us to identify needed improvements in our TLD handling procedures at NTS which are also discussed in this report.

MATERIALS AND METHODS

Basic Concept

It is generally accepted that accuracy is enhanced when all of the TLDs are annealed as

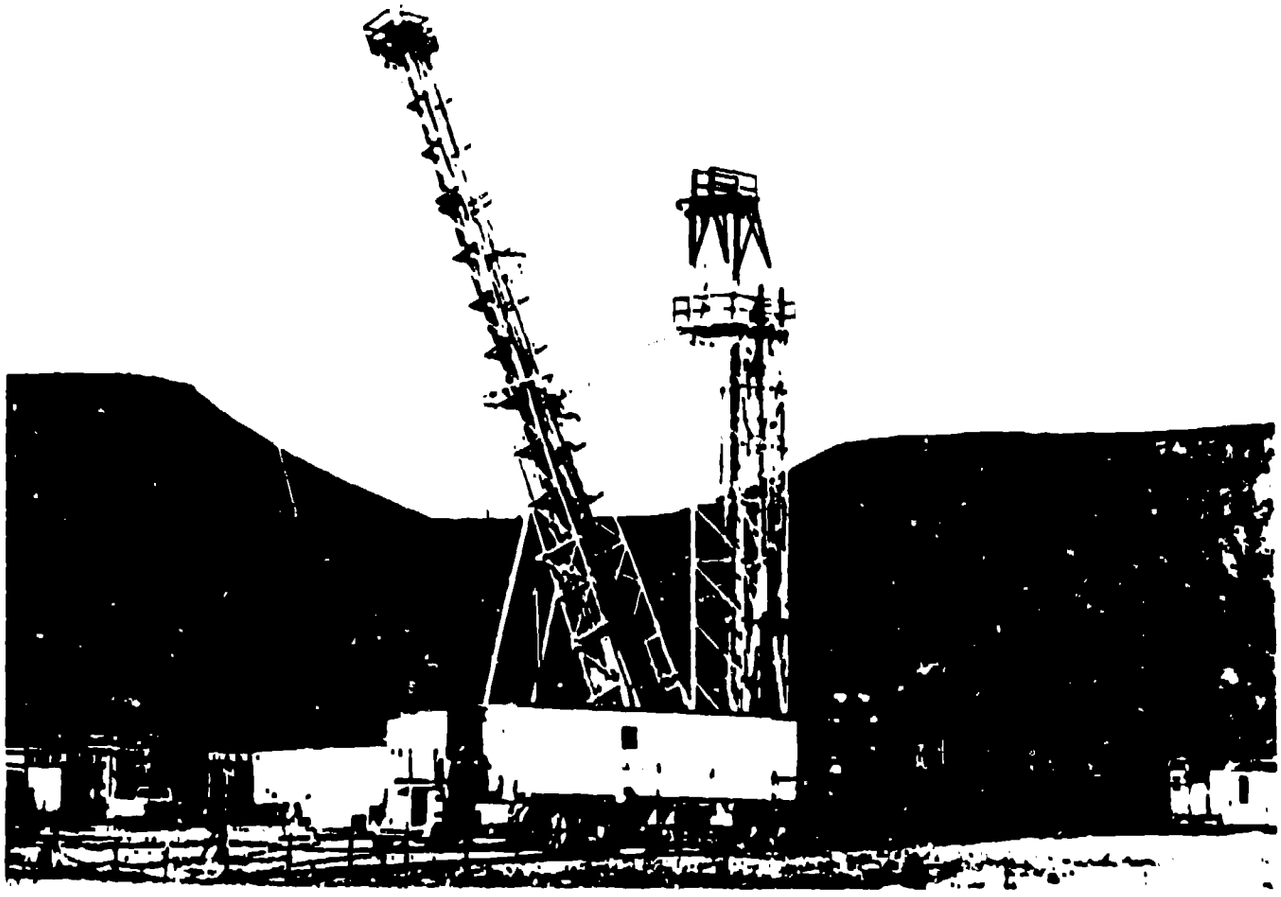

Figure 1 Conventional Drill Rig

one group (Mc81). Error due to variations in oven temperature is minimized. Mathematical corrections for fading and for different backgrounds due to varying lengths of times is also minimized. In order to report drillback results in a timely manner and to still retain group accuracy, duplicate sets of TLDs are used: one set for the drillback and one set for the interim period and cementback combined. If the interim/cementback period lasts less than one month then both sets are treated as one group. All of the TLDs will be post annealed at the same time and read on the same day. If it is anticipated that it will be longer than a month before the drillhole is cemented then the TLDs will be treated as two separate groups. In that case, all of the drillback TLDs will be post annealed, read and reported, while the interim cementback TLDs are left in the field until the hole is cemented.

Type of TLD

TLD-700s which are ±15% of the mean TLD average were used for these procedures. Each TLD is 0.32 x 0.32 cm in area and 0.089 cm thick. The TLD-700 is depleted in ^{6}Li and thus insensitive to neutrons.

Preannealing and Cleaning

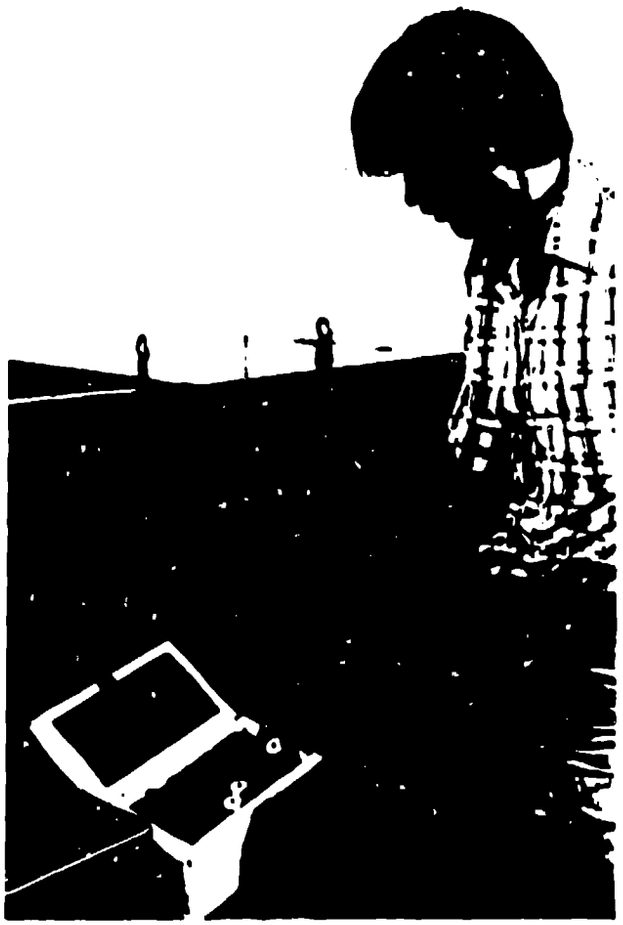

Figure 2 Portable and Large Pig

The TLDs are preannealed for one hour at 400°C in a petri dish. The dish is transferred immediately to the refrigerator for 15 minutes of cooling at four degrees centigrade.

The TLDs are then preannealed for two hours at 100°C, immediately transferred to the refrigerator for 15 minutes of cooling and placed inside of a large lead pig.

After preannealing, the TLDs are bathed and agitated in trichloroethylene and then rinsed in methanol. The TLDs are then separated into five categories: calibration, controls, field background, drillback and interim/-cementback.

Calibration and Control TLDs

Twelve TLDs are placed inside of a polyethylene holder which provides five millimeters of polyethylene for electronic equilibrium. Six of the TLDs are exposed to 50 mR and six are exposed to 500 mR from Co-60. These twelve TLDs serve as the calibration TLDs for the drillback and cementback. After exposure, the TLDs are transferred to the large lead pig, where six control TLDs have already been placed. Three of the controls provide the lead pig backgrounds for the drillback while the other set is for the interim/cementback.

Field Background TLDs

TLDs are placed inside of plastic discs, which are called field holders, to protect the TLDs from the environment. Two field holders, each containing three TLDs, are placed inside of a smaller portable lead pig (Fig. 2) and taken to the drillback site at least five days prior to the drillback. These field TLDs serve as the field background for the drillback and for the interim/cementback. On the day the drillback begins both holders are put into the portable pig and transferred to the large lead pig.

Drillback and Cementback TLDs

On the day the drillback begins twelve holders, each containing three TLDs, are placed one meter high on the perimeter fence surrounding the drill rig at 30° intervals as shown in Figures 3 and 4. When the drillback is completed the twelve drillback holders are transferred by the portable pig to the large lead pig and are replaced with twelve new holders. The new holders which contain three TLDs each, remain on the perimeter

Figure 3 Perimeter Fence

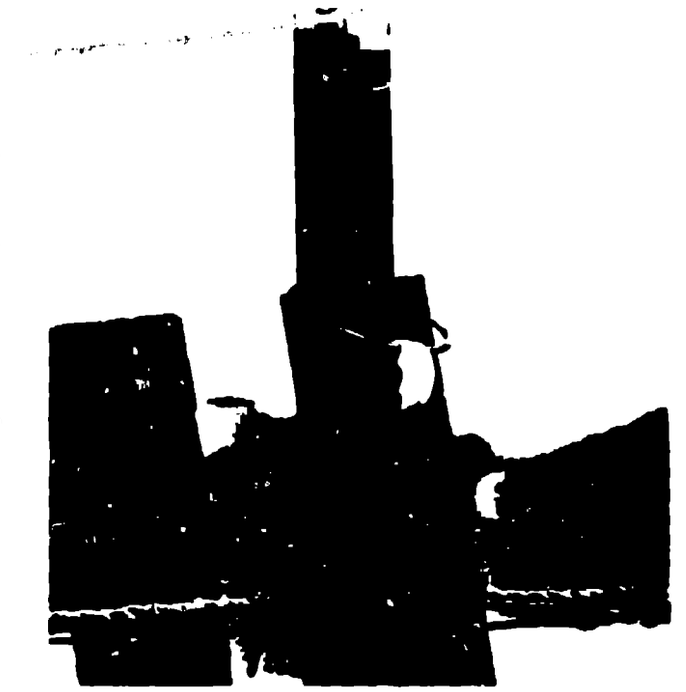

Figure 4 TLD Holder on Fence

fence until the drill hole is sealed and cemented.

Post Annealing and Reading

All of the TLDs are transferred to a porcelain annealing tray and annealed for ten minutes at 115°C. The tray is immediately transferred to the refrigerator for 15 minutes of cooling to enhance glow peaks four and five (Ma76). The TLDs are then read using a Harshaw Model 2000D automated TL analyzer system with output to a Texas Instrument Model 720 teletype-writer.

Dose Evaluation

The TLD readings are entered into a computer program where the doses for the period of the drillback and interim/cementback are individually calculated.

The average field background reading per day is multiplied by the number of days the drillback TLDs were in the field to result in the total field background. The total field background is subtracted from the drillback readings to result in the net drillback value. The lead pig background reading per day is multiplied by the number of days the drillback TLDs were in the lead pig and subtracted from the net drillback value. The 50 mrem calibration TLDs are used to convert light units to mrem for TLD readings that are less than 250 mrem. The 500 mrem TLDs are used for readings that are larger than 250 mrem.

SIFDIP PARTICIPATION

TLDs which were annealed and cleaned according to our normal procedure were placed in modified drillback and cementback holders and were mailed to Idaho Falls for participation in the Sixth International Environmental Dosimeter Intercomparison Project. Upon receipt at Idaho Falls the eight TLD holders were divided into four categories consisting of two holders per category: 1)

controls, 2) environmental field exposure for three months, 3) environmental field exposure following exposure to Cs-137, and 4) exposure to Cs-137 only. After the TLDs were exposed they were returned to the NTS where they were handled according to our normal procedure. The actual TLD exposures were determined by the project coordinators through the use of a high pressure argon ion chamber.

A tabular summary of the results is given in Table I (Ge83).

DISCUSSION AND CONCLUSIONS

The Laboratory results for the field exposure were 2.2% higher than the average exposure reported by all participants in the Project and 5.4% higher than the actual exposure delivered.

The Laboratory results for the Cs-137 irradiated TLDs were 20% higher than the actual delivered doses and 25% higher than the average exposure reported by all participants. The higher reading is attributed to the orientation and type of TLD holder as well as the inaccuracy of the TLDs. Charged particle equilibrium will not be attained near boundaries between materials of differing compositions (At68). Transition zone effects are known to occur whenever a beam of radiation passes from air to tissue (At69). It is consequently postulated that electronic equilibrium was not achieved during the exposure to the Cs-137 source due to the thickness, composition and air space of the holder. The Cs-137 plus field exposure was 5% higher than the actual delivered doses and 11% higher than the average of the reported exposures. This is probably due to the same reasons mentioned earlier.

The discrepancies which were realized have resulted in the changing of our materials. New TLDs which are $\pm$5% of the mean TLD average were purchased and are now being used to monitor drillbacks and cementbacks at NTS. In addition, a new TLD holder is being used which is multidirectional and should result in improving electronic equilibrium for both Cs-137 and Co-60. The new TLDs and holders were used to participate in the Seventh International Environmental Dosimeter Intercomparison Project, the results of which are not available yet.

In conclusion, the procedures for preparing the TLDs and the method for analyzing them, as used by the Los Alamos Laboratory at NTS, will measure an exposure within $\pm$20%. This performance is expected to improve with the use of the new TLDs and the improved holder.

TABLE I
SUMMARY OF RESULTS OF SIEDIP

TYPE OF EXPOSURE	AVERAGE OF RESULTS BY REPORTED PARTICIPANTS (mR)	LANL RESULTS (mR)	ACTUAL EXPOSURE (mR)
Field, (Environment)	45	45	43.5
Cs-137	149	199	158
Cs-137 Plus Field	191	212	202

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