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LS-2018A RADIOACTIVE WASTE BURIAL TECHNOLOGY

J. W. Nyhan, Principal Investigator

The objective of this continuing program is to improve the technology related to the shallow land burial of radioactive waste. The need for modifying present burial techniques to provide a more effective means for the disposal of waste generated by the nuclear power industry has been recognized for some time. Several problem areas are pursued in this endeavor, including modifications to burial sites, modified operational procedures, altered site selection procedures, and improved monitoring. This program pays particular attention to an examination of radionuclide mobilization and migration mechanisms, developing and improving monitoring techniques around burial sites, the development of engineering methods to improve waste containment, and the construction of a waste burial demonstration facility.

Progress to Date

Progress has been made in several research areas through June 1978. Drilling operations are in progress at Area T to sample tuff beneath a previously used liquid radioactive waste disposal bed. Concurrently, a hyperpure germanium (HpGe) detector system is being developed to analyze tuff samples, such as those collected at Area T, for plutonium, americium, and thorium. Tuff leaching studies have been initiated to determine the effects of various nonradioactive components of waste solutions on the migration of radionuclides through Bandelier Tuff. Feasibility studies have been initiated to characterize erosion, vertical migration, and plant uptake of radionuclides near waste disposal pits, using stable-elements as chemical analogs of radioactive con-

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taminants and neutron activation techniques. We have also initiated evapotranspiration studies, using the heat balance equation, the profile method, and the combination method, to provide information on one of the driving variables influencing tritium release from disposal pits and near-surface distribution of other radionuclides. The engineering studies of waste containment practices (University of Texas subcontract; annual report) has generally involved a survey of shallow land burial techniques for radioactive and nonradioactive waste through literature surveys and actual disposal site visits.

Work During August 1978

Several specific accomplishments were made during August 1978, as related to the research areas discussed above. The drilling operations at Area T were temporarily halted due to repairs needed on the drill rig, and a second hole was drilled in Pit 2 to a depth of 7 m, with continuous split spoon sample collection. The experimental apparatus for the tuff leaching experiment is currently being constructed and arrangements for lab space were made. The computer system and additional radionuclide counting equipment obtained for the hyperpure germanium GE(Li) system is being developed to assay tuff samples for transuranics and high-energy gamma-ray emittors and a procedure is being developed for rapid stripping of plutonium from tuff samples by leaching followed by anion exchange collection of the mobilized plutonium. In addition, a consulting trip was made to University of Texas at Austin to plan and evaluate the research to be carried out during the next fiscal year.

Publications/Presentations

1. Abeele, W. V., The Influence of Access Hole Parameters on Neutron Moisture Probe Readings, LA-7241-MS, April 1978.

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The objective of this continuing program is to improve the technology related to the shallow land burial of radioactive waste. The need for modifying present burial techniques to provide a more effective means for the disposal of waste generated by the nuclear power industry has been recognized for some time. Several parallel general approaches are pursued in this endeavor, including modifications to burial sites, modified operational procedures, altered site selection procedures, and improved monitoring. This program pays particular attention to an examination of radionuclide mobilization and migration mechanisms, developing and improving monitoring techniques around burial sites, the development of engineering methods to improve waste containment, and the construction of a waste burial demonstration facility.

Progress has been made in several research areas through March 1978. Drilling operations are in progress at Area T (Fig. 1) to sample tuff beneath a previously used liquid radioactive waste disposal bed. Concurrently, a hyperpure germanium (HpGe) detector system is being developed to analyze tuff samples, such as those collected at Area T, for plutonium, americium, and thorium. Tuff leaching studies have been initiated to determine the effects of various nonradioactive components of waste solutions on the migration of radionuclides through Bandelier Tuff. Feasibility studies have been initiated to characterize erosion, vertical migration, and plant uptake of radionuclides near waste disposal pits, using stable-elements as chemical analogs of radioactive contaminants and neutron activation techniques. We have also initiated evapotranspiration

studies, using the heat balance equation, the profile method, and the combination method, to provide information on one of the driving variables influencing tritium release from disposal pits and near-surface distribution of other radionuclides. The engineering studies of waste containment practices (University of Texas subcontract; annual report) has generally involved a survey of shallow land burial techniques for radioactive and nonradioactive wastes through literature surveys and actual disposal site visits.

Several specific accomplishments were made during April 1978, as related to the research areas discussed above. We completed drilling our first hole in Pit 1 at Area T to a depth of 31 m and analyzed the 200 samples collected for their water content; elevated water levels were found in and around tuff fracture zones, which contained large amounts of fine-textured particles with high water-holding capacities. More tuff samples were collected adjacent to Area T and cut into 12-cm core segments with a rock saw for the tuff leaching experiments. A special plastic sample container is currently being designed for the hyperpure germanium detector system transuranic analyses, and a preliminary 24-hour plutonium assay procedure was developed which will lower the plutonium detection limits on this counting system to less than 0.5 pCi Pu/g. A collector was constructed to collect soil adhering to plant surfaces as part of our project to determine the role of plant uptake in disposal areas using stable element tracers. Dewpoint hygrometers for the meterological tower at Area G (Fig. 1) were ordered to get the evapotranspiration studies started, and the theoretical preparatory work involved in the application of evapotranspiration formulae to the Los Alamos environment was completed.

AREA B

General Information

Area B is located on the south side of DP Road approximately 488 m (1600 ft) east of the intersection of DP Road and Trinity. It is east of the old trailer court area and west of TA-21. (See Fig. B-1) By LASL coordinates it is E.145+00, E.120+00, N.90+00, N.95+00. Surveyed corners, clockwise from the northeast corner are N.91+92, E.143+35; N.90+72, E.142+96, N.93+90, E.134+08; N.92+45, E.123+06; N.91+00, E.123+14; N.91+08, E.122+35; N.93+64, E.122+38; and N.95+09, E.133+28. It can also be located by township and range--SE 1/4 sec. 15, T. 19 N., R. 6 E., and SW 1/4 sec. 14, T. 19 N., R. 6 E. Approximate acreage is 6.03. The western two-thirds of Area B is presently covered by a layer of asphalt and is leased by Los Alamos County for storage of privately-owned boats and trailers.

Area B probably was the first common solid waste burial ground for LASL. It appears on Engineering Drawing ENG-R 4458 as one large pit; no individual pits are shown within the area. However, from old memos dated July 5, 1945 through January 31, 1952, it would appear that Area B is actually a series of pits. The July 5, 1945, memo[17] is a request for the provision of a new pit for disposal of contaminated trash from CM-Division laboratories.

> ...suggest that a trench 15 ft wide and 30 ft long be bulldozed out as deep as practical before hard rock is encountered, starting just east of the now covered CM[R] disposal pits located SE of the coal storage yard, and running parallel to and about 40 or 50 ft north of the DP power lines. This trench should have a parking bumper along its north edge with a gravelled 20-ft clearing for truck access, and of course a fence surrounding the whole area.
>
> Such a trench in the suggested location would, ... be a realistic solution to the contaminated trash disposal problem and would have the further advantage that it could be progressively filled and covered from the west end toward the east, and if necessary be extended for several hundred yards should the need arise.[17]

By July 12, 1945,[20] the pit had been located, staked out, and a work order issued for completion by August 1, 1945. On

July 30, 1945,[21] there was a request to extend the completion date for the new pit. The request asked, "...that work on the new pit be continued until a 12' depth is reached, or until September first whichever is sooner."[21] A penciled note on this memo notes completion August 8th.

A January 10, 1947,[24] memo states:

> The present contaminated materials disposal ditch is judged by the CMR Division maintenance engineer to be adequate for approximately three months from date. Past experience also indicates the necessity of starting the preparation of a new ditch of that size not less than a month before actual usage. It is therefore felt necessary to start digging about March 1.
>
> The present site is probably too small for expansion unless the south fence is moved closer to the canyon edge, or the east fence moved farther in that direction. Either of these moves would be a somewhat temporary expedient, and we suggest the assignment of a larger area permitting reasonable expansion. Perhaps east of the DP-East site.[24]

There are several notes on this memo. A typed note from H. R. Hoyt, Assistant Associate Director, sent this memo to the Maintenance Group on January 13, 1947, with the statement "for necessary action." A penciled note dated February 5, 1947, says "...will issue job order to enlarge ditch until some decision has been reached by the Director." At the top of the January 10, 1947, memo is another penciled notation indicating that someone could not decide whether the memo was discussing what is now called Area A or Area B. (Area B is the pertinent area because the south ~~and east~~ fences of Area A would not have been near the canyon edge.) This memo is the first record of discussion to find a new location for the common burial ground; however, it was the May 3, 1948, fire in Area B which initiated construction of Area C.

Geology and Hydrology

Area B is located on the same narrow eastward trending mesa as Areas A and T. The south side of Area B is approximately m (100 ft) from a canyon tributary to Los Alamos Canyon. The Area B pits are probably cut in Unit 3a of the Tshirege member of the Bandelier tuff.

Space-out - this is not a quote.

The thickness of the Bandelier tuff beneath the disposal pits is estimated to exceed 243.8 m (800 ft). The tuff is in the zone of aeration with the zone of saturation (water table) at a depth of approximately 365.8 m (1200 ft) below the surface of the mesa.[26]

Pit Descriptions

Background

The question of how many pits and where they are located in Area B cannot be answered by available information. Area B ~~may be~~ probably is the first Materials Waste Disposal Area at LASL.

> Letters in the CMR-12 files indicate that sometime in 1944 a pit located in the fenced area [Area B] between the Trailer Court and the CMR Laundry [Area V] was in use. When this pit was filled two more were dug in the area now known as the General's Tank Area [Area A]. When these were filled (1945) three more pits were dug in the area between the Trailer Court and the CMR Laundry. Space in this area was exhausted in 1948 and new pits were started at the present location [Area C] on Pajarito Road.[22]

The 1944 "pit located in the fenced area"[22] could well be "the now covered [as of July 5, 1945] CM disposal pits located southeast of the coal storage yard."[17] Three pits, constructed and filled after July 5, 1945, are referred to in memos dated June 14, 1949,[12] and January 31, 1952.[22] In a June 12, 1964, memo[27] on review of preliminary drawings: "Materials Disposal Areas" comment 6 states that

> There is a covered shallow trench in Area B (ENG-R 3641) which was used for disposal of hazardous materials. The trench was three feet in depth, two feet wide and about 40 feet long. It lies parallel to the south fence line E.140+00 and below line N.92+50. It extends about half the distance to E.142+50. (Ref 27)

This "shallow trench"[27] lies in the extreme eastern end of Area B and therefore cannot be "the now covered CM disposal pits located southeast of the coal storage yard"[17] which would have had to have been located in the extreme western end of Area B in order to have had 91.4 m (300 ft) long pits located to the east of them. It would thus seem that there are a minimum of five pits located in area B.

> I am sure that the area contains six pits: two in the west end running north and south making the 'L' shape to the fence and four running east and west in the area parallel to DP Road. There was at least one small, shallow trench which was used by CMR-DO safety personnel to dispose of hazardous chemicals.*

*Written communication, D. D. Meyer, Fall 1974.

Type of Waste

Solid waste placed in Area B was logged in LA Notebooks No. 1743 (January 6, 1947 through November 23, 1948) and No. 2587 (November 24, 1948 through April 28, 1950).[23] Opinions on the waste vary. January 30, 1952,[13] the waste was said to be predominantly long-life alpha accompanied by slight amounts of beta and gamma. January 31, 1952,[22] the following was stated:

> The contamination on materials in these pits consists of all types of radioactive materials used at Los Alamos. Some of the known types of activity are: plutonium, polonium, uranium, americium, curium, RaLa [radium/lathanum], actinium and waste products from the Water Boiler. No attempt has been made to keep the various materials separated.[22]

January 4, 1971,[19] information was given that

> The total volume of the pits, after deducting the three foot of cover material, is 28 000 cubic yards. These pits actually contain very little Plutonium. At the time they were in use, Pu was scarce and only that which was present as contamination was buried. I [D. D. Meyer] would estimate that the entire pit area contains no more than 100 grams of ^{239}Pu.[19]

Approximately 90% of the contaminated waste consisted of paper, rags, rubber gloves, glassware, and small metal apparatus placed in cardboard boxes by the waste originator and sealed with masking tape.[12] "The rest of the material consists of metal such as airducts and large metal apparatus. This type of material is placed in wood boxes or is wrapped with paper."[12] There is also reference to large quantities of wood from temporary storage cabinets used by the Quantity Control Department, several live storage batteries,[25] and contaminated or toxic chemicals.[22]

Mode of Disposal

In the literature[26] and in conversation Area B is frequently referred to as a single pit with an approximate depth of 6.1 m (20 ft). Area B does not appear to be a single pit. Whether some of the pits in the area have a depth of 6.1 m (20 ft) is open to speculation. It could well be the 6.1 m (20 ft) is an estimate based on the average depth of most pits excavated in Areas C and G.

For reasons already stated, the depiction on Engineering Drawing ENG-R 4458 of Area B as one continuous pit is wrong. Consistent reference has been made through the years[12,22,19] to a series of pits in Area B. One might assume their construction to be similar to the 1945 pit (4.6 m [15 ft] wide, 91.4 m [300 ft] long, and 3.7 m [12 ft] deep), with the exception of the hazardous materials pit which was described as a trench 0.6 m (2 ft) wide, 12.2 m (40 ft) long, and 0.9 m (3 ft) deep.

When area B was in use, waste was handled in the following manner.

> The waste disposal program requires three men. Two of these work on the contaminated truck and are furnished by the Zia Company. The third man is a CMR-12 monitor. This monitor supervises the handling of material. Before loading he checks the boxes for external contamination and keeps records of any accountable property that is buried.
>
> The equipment used consits of a truck and a sedan. The material in the pits is covered once a week. This requires the use of a bulldozer and operator one day a week.[12]

Unlike the current LASL practice of layering waste in pits, waste filled the depth and width of the pits in Area B before it was covered by fill dirt. As a result, ~~there was~~ subsidence occurred, ~~over the pits which was filled~~ shortly after Area B was closed, subsidence over the pits was remo by using the Area for disposal of non-contaminated concrete and dirt from construction sites. (Written communication, D. D. Meyer, Fall 1974.)

Studies and Monitoring

A fire broke out in Area B at approximately 10:20 a.m., May 3, 1948.[25] When the fire department arrived,

> ...found sixty percent of the open portion of the dump ablaze and flames shooting approximately fifty feet into the air. The firemen had little trouble in subduing the blaze, but persistent efforts to put it out were of little avail because of the loaded condition of the dump area in which the blaze was confined. Dense, low-hanging smoke prevailed in large volume.
>
> At approximately 10:35 a.m., J. Tribby was notified of the fire, in the absence of other Health Group personnel, and with representatives of the Safety Department went immediately to the scene of the blaze and took charge with H. Drager. Because of the dense smoke which scattered throughout the area, due to the condition of shifting winds, all areas east and west of the dump, from the food warehouses to the DP Laundry, were evacuated of personnel. Respiratory protection was provided for all persons at the scene, and it was necessary to close the DP road to traffic.[25]
>
> At 11:15 a.m., May 3, 1948, our monitoring section [H-2] drove to the DP contaminated dump section to assist the CMR group in surveying the extent of contamination, if any. General air count proved negative with A Pee Wee alpha survey meter...,
>
> We later helped check personnel in and around the area including firemen and security guards. The grounds and vehicles in the area were also checked. All proved negative excepting one security car windshield which had about 50 c/m and one spot on the west fence had 200 c/m. The security car is believed contaminated from former contamination trouble or from accompanying a 'hot' run. The fence is believed contaminated from dust blown from the dump because it was localized in one spot only.
>
> The smoke drifted west and close to the ground near the food storage plant corner of Trinity and DP road. The east wall was checked. No activity found.
>
> It is believed there could not have been an air count present due to the absence of any deposit on local objects.[184]
>
> By 12:15 p.m., the fire had been extinguished except for two very small, isolated points and there was no longer any hazard from smoke. Fire department personnel were dismissed at 1:15 p.m., but a stand-by crew of two men and one piece of apparatus were left until 5:30 p.m. to watch for rekindling of the fire.

Investigation has failed to disclose any obvious cause for the blaze, and it is presumed that it started by spontaneous combustion. The area in which the blaze occurred had not had any trash dumped into it for about three days, and much of the trash in the fire area had been in the dump for three weeks. The trash included large quantities of wood from temporary storage cabinets used by the Quantity Control Department, several live storage batteries, large quantities of miscellaneous scrap metals, discarded contaminated clothing and boxed laboratory waste. The conditions were ideally suited for spontaneous combustion.

During the fire, there was some evidence that chemicals had been disposed of in the dump in any unauthorized manner in cardboard containers used for the regular disposal of common laboratory waste. Several cartons of waste gave off minor explosions, and upon one occasion a cloud of pink smoke arose from the debris in the dump. Whether this was due to the heat of the fire, the action of the water or chemical reaction is not known. The condition certainly did not help in keeping the fire under control.

This most recent dump fire should serve as an object lesson in many respects. It should point to the hazards of having the dump located in areas near or in line with living and working areas where toxic smokes and vapors can create an emergency condition. Even though we are presently short of dump space, it is poor policy to leave the dump uncovered for extended periods of time. If it is not practical to cover the trash with a light layer of dirt as a temporary measure before covering over any portion completely, it is suggested that the dump be wet down with large quantities of water at least twice a week until such a time as more adequate precautions can be taken.[25]

As a result of the fire, the relocation of the common ~~central~~ burial ground. ~~was relocated and~~ there were no doubt many other changes ~~as an indirect result of this incident.~~ besides. The following is from a February 1963 USGS report.[8] "The highest concentration of gross alpha in soil samples collected in June 1955 a short distance downgradient in the canyon south of the pit [Area B] was 48 disintegrations per minute per dry gram." There is no map showing the precise location of the sampling point (which may have been closer to Area V than it was to Area B).

The USGS was asked to do a study of Area B in 1966.

Expansion of laboratory facilities and increased growth of the community of Los Alamos has caused a

> re-evaluation of present land use to determine if the land is being utilized in the best possible way. It was proposed by the Los Alamos Scientific Laboratory and the U. S. Atomic Energy Commission that a portion of the filled-in contaminated waste pit, outside the radius of 1050 ft from TA-21 (an area approved for commercial property), be leveled, filled where necessary, and sealed with asphalt, and used for a storage area for trailers and boats. It is thought that a seal of aslphalt will prevent any contamination from reaching the surface of the storage area.[26]

The USGS drilled test holes, 7.6-15.2m (25-50 ft) deep, around the perimeter of Area B (see Fig. B-2). Moisture content of the soil and tuff penetrated by the test holes was determined by neutron scattering moisture probe. Samples of the drill cuttings were analyzed for gross alpha and gross beta-gamma, plutonium, and uranium. The results of the study were reported[26,29] in 1966. (See Table B-1.) The study concluded

B-

T.B-

> Distribution of moisture in five test holes indicated some lateral movement of water, probably from the contaminated waste pit.* The amount of water moving through the tuff was well below the estimated effective porosity of the tuff. Radiochemical analyses of the soil and tuff from the test holes showed no indication of radioactive contamination. A much larger amount of water than occurs from precipitation would be required to move radioactive contaminants from the waste pit into the adjacent soil and tuff. An asphalt covering on the pit with adequate drainage could prevent any movement of radioactive contaminants from the waste pit.[26]

*The USGS considered Area B to be one large pit

> A beta gamma survey of the material waste pit at TA-21 was conducted on September 16, 1966. Dose rate measurements were taken at a distance of twenty inches from the surface of the black topping with an Eberline Mod. E-112-B Geiger counter. No appreciable reading above the normal background of 0.07 mr/hr was detected.[30]

The accompanying map showed the survey was down the center of the storage area portion of Area B.

November 10, 1971, the asphalt was surveyed with an alpha counter, Ludlem Model 139, and beta-gamma counter Model E-112-B. "No alpha contamination was detected, and the beta count was background."[28]