LA-6856-PR

Progress Report

UC-70

Issued: June 1977

**Development Activities on Shallow Land Disposal of
Solid Radioactive Waste
January—December 1976**

Environmental Group, H-8

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

An Affirmative Action/Equal Opportunity Employer

MASTER

**UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
CONTRACT W-7405-ENG. 36**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

This is the first report in this series.

Work supported by the US Energy Research and Development Administration, Division of Waste Management, Production, and Reprocessing.

**Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy \$3.50 Microfiche \$3.00**

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

CONTENTS

ABSTRACT	1
I. Special Activities	2
II. Evaluation of Transuranic-Contaminated Waste Burial Sites	3
III. LASL Radioactive Waste Disposal Site Studies	4
IV. Radioactive Waste Burial Technology	7
Publications/Presentations	8

25

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DEVELOPMENT ACTIVITIES ON SHALLOW LAND DISPOSAL
OF SOLID RADIOACTIVE WASTE

Summary Progress Report
January-December 1976

ABSTRACT

This report summarizes progress on projects focused on problems of shallow land burial of radioactively contaminated solid waste. Developments on a system to evaluate the containment adequacy of existing burial sites are described. Efforts to describe the environmental factors in monitoring the LASL disposal sites are discussed. The aim of a new program on radioactive waste burial technology is outlined.

INTRODUCTION

This report presents a summary of the research and development activities at the Los Alamos Scientific Laboratory (LASL) during 1976, related to shallow land disposal of solid radioactive waste. A program to develop an overall method to evaluate the adequacy of burial sites containing transuranic (TRU)-contaminated waste has been in progress since FY 73. Technical accomplishments during CY 76 included the completion of a procedure for evaluating biological uptake and transport of radionuclides from buried waste, and a preliminary evaluation of the major LASL solid waste burial ground. A program to develop monitoring systems for LASL radioactive solid waste burial sites was initiated in FY 74. A compilation of existing information on the use, waste inventory, and geology of selected LASL burial sites was completed this year. A program was

initiated during FY 77, entitled "Radioactive Waste Burial Technology," as part of an ERDA plan to develop a technology for the shallow land burial of solid low-level radioactive waste. Investigations were performed at a site previously used for disposal of liquid radioactive waste to determine the mechanisms responsible for migration of radionuclides in low-moisture regimes. Several significant special assignments on waste burial, received during the year, are discussed in the section entitled Special Activities. Various topical reports, technical publications, and ERDA or Nuclear Regulatory Commission documents have been produced which contain the specific details of the work performed.

The importance of shallow land burial to the back-end of the light water reactor fuel cycle is illustrated by noting that it has been projected in ERDA-76-43 (May 1976,

"Alternatives For Managing Wastes From Reactors and Post-Fission Operations in the LWR Fuel Cycle," Volume 1, Section 3.0) that about 80% (volume) of the solid waste generated will be low-level, beta-gamma contaminated, solid waste materials requiring shallow land burial or its equivalent. It is, therefore, important that work proceed in the general areas of: developing burial site selection criteria using geologic and hydrologic principles; developing and selecting engineering techniques to further optimize the containment capability of natural systems; and developing and specifying waste forms to assure optimum waste material immobility at the point of waste emplacement in shallow land disposal facilities. The programs summarized below are oriented toward contributing to these areas; principally site selection, site operation, and natural system engineering. While a portion of the activities are specific to LASL, the remainder are potentially applicable at any location.

I. SPECIAL ACTIVITIES

Several projects not specific to scheduled programmatic activities were addressed in CY 76. In response to an ERDA request, an extensive review of the current technology for radioactive waste disposal by shallow land burial was prepared for the document "Alternatives for Managing Wastes from Reactors and Post-Fission Operations in the LWR Fuel Cycle" (ERDA-76-43, May 1976). This document detailed the available technology for the management of commercial nuclear energy generated wastes. The LASL-prepared portion on shallow land disposal described currently used techniques, typical wastes and volumes, and the containment history of existing burial sites in the United States. In addition, some attention was given to the problems of environmental monitoring of burial grounds, and their ultimate disposition or decommissioning. A paper entitled "Burial

Grounds" was presented at the ERDA sponsored "International Symposium on the Management of Wastes from the LWR Fuel Cycle." (CONF-76-0701, Denver, July 1976).

Also at ERDA request, LASL has participated in the development of a follow-up document (generic environmental impact statement) on the environmental impact of commercial waste management. This document will evaluate the environmental impact of the current technology for managing the wastes from postfission phases of the commercial LWR fuel cycle. LASL input provides the information for assessing the impact of shallow land disposal of radioactive wastes. It addresses the impacts of a range of burial environments, from arid to humid climates, encompassing the conditions at existing burial sites.

In summer 1976, the Nuclear Regulatory Commission (NRC) issued a special request to ERDA to provide technical assistance in revising AEC document WASH 1248, which assesses the specific environmental impact of the uranium fuel cycle and provides the basis for reactor licensing procedures. This revision was generated in response to a court ruling that the document was inadequate in the areas of waste management and fuel reprocessing. LASL contributed the low-level waste disposal documentation. The revised NRC supplement was issued as NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle" (October 1976). A follow-up task to the NRC effort is the review and reply to formal comments submitted in response to NUREG-0116, ongoing at year's end.

The final unscheduled project was involvement, at the request of ERDA, in an IAEA Advisory Group on "Site Selection, Operation, Control and Decommissioning of Low- and Intermediate-Level Radioactive Waste Burial Grounds." This project included LASL personnel on the official U.S. delegation to the IAEA Advisory Group. The

purpose of the effort was to provide guidance to nations embarking on nuclear waste disposal projects and provide a basis for international similarity in the objectives of low-level radioactive waste disposal. Draft material was prepared at an IAEA meeting in Madrid, Spain, in November 1976.

II. EVALUATION OF TRANSURANIC-CONTAMINATED WASTE BURIAL SITES

[W. J. Smith, II, M. L. Wheeler, and L. J. Johnson]

This program was initiated to develop a technique for evaluating the long-term adequacy of existing burial ground containing transuranic (TRU)-contaminated waste. The evaluation system will initially determine which, if any, transuranic waste disposal sites at LASL pose a potential problem. It will then be used to evaluate similar disposals at other specified sites.

The development of an evaluation procedure is being achieved in several phases: (1) definition of techniques and procedures for performing the analysis, (2) preliminary analyses of the impact of selected release mechanisms at the main LASL disposal site, (3) extension of the analyses to other reasonable release mechanisms and other LASL disposal sites, and (4) generalization of the analytical technique to aid in developing a standardized procedure for determining the acceptability of other radioactive waste burial sites.

The first task in evaluating the potential impact of buried wastes is to identify the mechanisms specific to a given burial site that would result in radionuclide releases to the environment. Second, the rates or frequency of these processes must be determined. Finally, the movement of the released radionuclides through the biosphere must be described in order to arrive at some estimate of the resultant consequences of the release.

The evaluation procedure is based on a number of geologic, hydrologic, and climatic considerations and is supported by

simulation models of radionuclide transport by biomass transfer in the environment. The models have been developed to simulate many parts of the Los Alamos area environment such as native forests, grass lands, wildlife, cattle grazing, and agriculture. The LASL environmental simulation models are unusual in that the design is to model dynamic flow in the biotic and abiotic system, as opposed to most models that rely on static average values for the biomass components. They are primarily biomass models, using the parameters of the ecosystem that follow the generation and transfer of biomass. The incorporation of radionuclide information, which is the purpose of the effort, is incidental to the functioning of the simulation itself.

The radionuclide release and transport mechanisms specific to the LASL waste burial facility at Area G, TA-54, were identified and a preliminary evaluation was performed this year. A review of potential natural release processes indicates that the frequencies of probabilistic events--earthquake, meteorite impact, and tornado--are very low (10^{-6} to 10^{-7} per year) for this site. The low occurrence frequencies, combined with the small effects these mechanisms exert on buried wastes, indicate that they can be discounted as significant for radionuclide release from LASL burial sites.

The soil types and climatic conditions at Area G are such that movement of radionuclides into the environs by soil moisture involves transport times greatly in excess of the half-life of even ^{239}Pu . Chronic release, resulting from soil erosion to the depth of the buried wastes, could be expected to occur on a time scale of 50 000-150 000 years.

The most evident chronic release mechanism appears to be plutonium uptake by deep plant roots, with subsequent dispersal to the above-ground environs. An analysis was made of a plant uptake release scenario,

assuming revegetation of waste burial grounds with the natural species of the Los Alamos area. The analysis was performed by a preliminary version of the evaluation scheme mentioned above, and employed both estimated and adapted input parameters obtained from current literature. Within the uncertainties inherent in the use of a model of this nature, and the uncertainties present in the estimated input data, it appears that plant uptake from LASL burial grounds could, over a period of about 5000 yr, increase plutonium concentrations in the soil directly over the waste emplacement by levels that are about the same as those presently observed as a result of worldwide fallout plutonium.

The details of this preliminary evaluation are being issued as a topical report entitled, "A Preliminary Evaluation of the Potential for Plutonium Release from Burial Grounds at the Los Alamos Scientific Laboratory," (LA-6694-MS). Documentation of the biological transport model is also in preparation. The user's manual contains complete descriptions of the model's available options, a list of the required data types and formats, and detailed operating instructions. The documentation report includes a glossary of all variables with units and descriptions; analyses of all explicit and implicit assumptions; review of all equations, with references and development; and a discussion of all numerical parameters, providing justifications and explanations as may be needed by anyone wishing to use this evaluation scheme.

III. LASL RADIOACTIVE WASTE DISPOSAL SITE STUDIES

[M. A. Rogers, L. K. Trocki, and C. J. Umbarger]

The Los Alamos Scientific Laboratory has been routinely disposing of solid radioactive wastes since 1944, principally by means of pit disposal, but vertical shafts have also been used. The LASL Materials Disposal Areas under study are solid

radioactive waste disposal areas A, B, C, D, E, F, and G, and liquid waste disposal Area T, all shown in Fig. 1. Areas A, T, and G were active as of January 1977; Area G is the major radioactive solid waste burial site.

Radioactive contamination monitoring has been carried on since the inception of disposal activities at LASL. The United States Geological Survey (USGS) performed the majority of the specific migration studies, and a significant amount of the monitoring, particularly in the 1950s and 1960s.

An evaluation of site monitoring practices, both past and present, is in progress or planned for all major ERDA sites by the USGS under contract to ERDA and in cooperation with ERDA contractors. The USGS/LASL evaluation at LASL began in September 1973. The USGS report, "Evaluation of Monitoring of Radioactive Solid-Waste Burial Sites at Los Alamos, New Mexico" (Open-file report 75-406), was issued August 1975.

As the data were being collected for the evaluation, it became apparent that LASL had a need for a report which would parallel the USGS Report to ERDA, but which would include much more detail. A report has been compiled to provide a readily available source of accurate, in-depth information for reference on radioactive waste burial at LASL. This report, "History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T): A Source Document" (LA-6848-MS), includes information through July 1976.

As a result of the USGS/LASL evaluation, two monitoring programs have recently been initiated at the LASL radioactive solid waste disposal site at Area G, TA-54 (see Fig. 1). A soil moisture monitoring program is obtaining data describing the changes in water content, with depth and time, in fill material overlying buried waste and in the

Fig. 1. Map of Materials Disposal Areas.

tuff surrounding waste disposal shafts to a radius of 6 m. The data are used to infer the quantities of moisture penetrating to the depth of the waste material and moving outward from the waste. Information on such moisture movement is required to determine if a hydrologic mechanism for transporting radionuclides out of the disposal emplacement exists.

The data for one hole are presented in Fig. 2. The major variations in water content occur within a meter of the surface, presumably due to spring snowmelt and summer storms. No significant changes are indicated below 3 m. The downward decrease in water content may indicate a small downward moisture flux; work is in progress to resolve this question.

Moisture readings are made once a month for each of 10 augered holes; 4 into crushed tuff backfill, 6 into adjoining tuff. Additional boreholes will be drilled and monitored as more pits and shafts are completed. The measurements are made using

a neutron soil moisture probe. Fast neutrons emitted by the probe are thermalized by hydrogen atoms in the water molecules, and the return incidence of slow neutrons is electronically converted to a measure of the volumetric water content surrounding the probe. A computer program compiles, coordinates, analyzes, and graphically displays this information.

The second program, for collection of meteorological data, is still in the construction phase. A 40-ft steel tower and an adjoining instrumentation shelter are currently being erected at Area G. Initial climatological measuring and recording equipment will include three Gill U.V.-component anemometers and three temperature thermistors, a dew cell, a weighing bucket snow and rain gauge, an IR thermometer, and several soil heat-flow disks. These instruments will measure and record wind speed, air temperature, humidity, precipitation, surface temperature, and heat transfer in the soil, respectively. The system will be operated in two modes. Routine surveillance of wind direction and velocity will provide data for evaluating possible accidental atmospheric releases during site operations, as well as providing information on local climatological phenomena. Secondly, intensive studies will be conducted on atmospheric dispersion processes, soil moisture flux, and evaporation and precipitation.

One aspect of designing a monitoring system is the selection or development of instruments and techniques for measuring small quantities of radionuclides in the field--in the Los Alamos area specifically, a semiarid environment. The elements/isotopes of particular interest in the Los Alamos waste disposal sites are principally plutonium, uranium, tritium, and strontium. Methods and instrumentation are being developed or adapted for detection and measurement of these elements *in situ* (on the surface and in augered holes), or *in vitro*

Fig. 2. Soil moisture monitoring data for Bore Hole SI50-1, data for year 1976.

(lab analyses) in the tens of picocuries per gram range.

The first step taken in addressing this problem was to determine presently available techniques for measuring these isotopes in soils. Responses were solicited from an interdisciplinary group of scientists at LASL and other ERDA-contractor laboratories concerned with atomic, nuclear, and chemical measurement techniques, as to the most sensitive systems which could be employed. The following promising methods were identified: a portable gamma-radiation measurement instrument, the phoswich, developed and in use at LASL; an *in vitro*, gross-alpha scintillation instrument with detection limits in the 20- to 30-pCi/g range; a gross-beta scintillation instrument with detection limits in the 5- to 10-pCi/g range; *in vitro* track-etch methods coupled to chemistry which can detect 6×10^{-5} pCi/g plutonium in biological samples;

atomic methods using lasers to detect a single atom of contaminant in a gas sample; a gas-filled field detector for ^{90}Sr ; and a NaI-based rock-core screening station currently being used on the horizontal drill-hole samples described below. Upon completion of these development studies, selected methods will be deployed to monitoring migration pathways around the LASL solid waste disposal sites.

In line with the development of a monitoring system for LASL solid radioactive waste disposal sites, various geologic investigations have been undertaken including a horizontal core-drilling project at Area G; surface monitoring studies at Area C, TA-50, and Area F, TA-6 (see Fig. 1); and a routine geologic inspection and approval program for new disposal pits or shafts. A related, but not site-specific, program performed during 1975 and 1976 is a detailed gravity survey of the Pajarito

Plateau to determine the subsurface structure and stratigraphy near Los Alamos.

The aforementioned gravity survey has identified a small NNE-trending basin or subbasin within the Rio Grande rift zone beneath the Pajarito Plateau. This feature is only partially expressed in the surface geology of the area; the western boundary of the basin coincides with the Pajarito Fault Zone. A report from this study is in review.

Five horizontal core holes were drilled underneath Pit 3, a waste disposal pit at Area G, filled about 15 yr ago. The purpose of the core holes is to determine the extent, if any, of moisture and/or radionuclide migration under the pit. The combined lengths of the five horizontal holes is 418 m, from which a total of 263 m of core was recovered. The rock cored was the Tshirege Member of the Bandelier tuff. Samples are being selected for radiochemical analyses by extraction using dissolution and ion exchange techniques and then plutonium or uranium measurement by electroplating or fluorometric methods. A vertical hole was also drilled near this pit to define stratigraphy under the waste disposal site.

The studies at Areas C and F are intended to determine if there is any radioactive contamination on or near the surface of these closed waste disposal areas. Preliminary analyses of soils and vegetation collected at Area F indicate no contamination above background. Analyses of Area C samples are in progress.

Geologic mapping of new waste burial pits is routinely conducted to collect structural geology data on the area and to make sure that there are no large unsealed fractures in the walls, as open fractures would provide potential migration pathways. (Pits #13 and #22 were inspected this year and approved for use.) Photographs and detailed fracture descriptions of each pit are maintained for possible monitoring use.

IV. RADIOACTIVE WASTE BURIAL TECHNOLOGY [M. L. Wheeler and L. J. Johnson]

This program was initiated for FY 77, in cooperation with an ERDA plan to improve the technologies applied to shallow land burial of radioactive waste at ERDA sites. LASL efforts will focus on identifying mobilization/migration processes specific to dry burial environments, and on engineering methods for preventing any undesirable migration. Techniques will also be described for defining potential radionuclide transport pathways in low-moisture regimes.

Core samples have been collected from tuff located beneath a liquid waste disposal trench used from 1945 to 1967. Core analyses indicate the presence of ^{239}Pu and ^{241}Am to depths of at least 6 m. Results for one set of sample analyses are presented in Fig. 3. Studies are in progress to define the transport processes which produced the observed distribution and to determine the present mobility of the radionuclides.

Fig. 3. Vertical radionuclide concentrations in core samples from Area T.

A contract has been established with the University of Texas College of Engineering to perform a literature search on nonradioactive hazardous waste disposal practices and experience. This information will significantly broaden our knowledge base regarding contaminant migration. In addition, the University of Texas contract calls for identification of various options for engineered containment of waste, such as surface seals over burial trenches. Selected techniques will be investigated for possible applications to radioactive waste burial site operations.

Description of potential migration pathways in the low-moisture regimes will be applied to developing burial site selection criteria; specifically the types of information required prior to locating a new burial site and the standardized format for interpreting this information. The criteria will address such matters as (1) the techniques for initial screening of possible sites, (2) the data requirements (and collection methods) requisite to final selection of a burial site, and (3) the environmental surveillance requirements for ongoing assessment of the site performance. Emphasis will be on burial sites in arid or semiarid regions.

ENVIRONMENTAL STUDIES GROUP^a (H-8)

L. J. Johnson, Ph.D., Group Leader
W. C. Hanson, Ph.D., Alternate Group Leader
M. A. Rosenthal, Group Secretary
K. K. Reupke, Secretary

Staff Members

M. L. Wheeler, Ph.D., Section Leader
W. V. Abeele, Ph.D.
D. R. Jackson, Ph.D.
M. A. Rogers, M. S.
W. J. Smith, M. S.
L. K. Trocki, B. S.

Technical

W. Herrera, B. A.
V. J. Lee
A. E. Nock, B. S.
T. C. Stevens, B. S.
D. M. Van Etten

Other LASL Staff

C. J. Umbarger, Ph.D. (H-1)
G. W. Linn, Ph.D. (G-6)
B. M. Crowe, Ph.D. (G-6)

Publications/Presentations

W. J. Smith, J. L. Warren, M. L. Wheeler, and W. J. Whitty, "Burial Grounds," Sec. 24.1, Vol. 4 in Alternatives for Managing Waste from Reactors and Post-Fission Operations in the LWR Fuel Cycle, ERDA 76-43, Vol. 4, 1976.

M. L. Wheeler, W. J. Smith, and A. F. Gallegos "A Preliminary Evaluation of the Potential for Plutonium Release from Burial Grounds at Los Alamos Scientific Laboratory," Los Alamos Scientific Laboratory report LS-6694-MS, (1977).

M. L. Wheeler and W. J. Smith, "Disposal" (of nontransuranic low-level waste), Sections 2.7.3 and 4.7.3 in Environmental Survey of the LWR Fuel Cycle, NUREG-0116 (1976).

A. F. Gallegos and L. J. Johnson, "A Simulation Study of Mineral Recycling in Ponderosa Pine Forests," Proceedings Supplement, Jour. Ariz. Acad. Sci., 11 (April 1976).

^aLASL personnel assigned part- or full-time to ERDA/DWPR-funded programs.