ENVIRONMENTAL SURVEILLANCE OF EG&G IDAHO WASTE MANAGEMENT FACILITIES AT THE IDAHO NATIONAL ENGINEERING LABORATORY[a]

T. G. Hedahl
B. D. Reyes
Idaho National Engineering Laboratory
EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

ABSTRACT

The EG&G Idaho, Inc. Environmental Surveillance Program performs routine and special environmental monitoring of waste management facilities at the Idaho National Engineering Laboratory (INEL). This comprehensive program includes air, water, soil, biotic, and ambient radiation monitoring at six waste management facilities.

Routine monitoring activities primarily involve environmental sampling and analyses for gross alpha/beta, gamma-emitting radionuclides, and specific alpha- and beta-emitting constituents. The purpose of the monitoring activities is to provide for continuous evaluation and awareness of environmental conditions resulting from current operations, to detect trends, to ensure compliance with Department of Energy Orders and regulations, and to provide data for predictive models. Various special monitoring studies are also planned and conducted each year to enhance the routine monitoring program or obtain information for predictive modeling and performance assessment activities.

The environmental monitoring activities performed at EG&G Idaho waste management facilities are described. Past data results are also evaluated and discussed. One special monitoring study performed during 1986 is also described.

INTRODUCTION

The Idaho National Engineering Laboratory (INEL), located in southeastern Idaho and managed by the Department of Energy (DOE), is involved in nuclear research and development. Several facilities at the INEL are used for waste management activities.

The EG&G Idaho, Inc. Environmental Surveillance Program performs routine and special environmental monitoring of waste management facilities at the INEL. This comprehensive program includes air, water, soil, biotic, and ambient radiation monitoring at the following six waste management facilities (see Fig. 1):

1. Radioactive Waste Management Complex (RWMC)
2. Waste Experimental Reduction Facility (WERF)
3. Process Experimental Pilot Plant (PREPP)
4. Stored Waste Examination Pilot Plant (SWEPP)
5. Stationary Low-Power No. 1 (SL-1) Surplus Area
6. Organic Moderated Reactor Experiment (OMRE) Surplus Area.

The RWMC is used to dispose of low-level radioactive waste and store transuranic waste received primarily from other DOE sites. Activities conducted at WERF, SWEPP, and PREPP are waste reduction, incineration, and transuranic waste certification and processing; and technological development. SL-1 and OMRE are decontaminated and decommissioned (D&D) surplus facilities.

Routine monitoring activities primarily involve environmental sampling and analyses for gross alpha/beta, gamma-emitting radionuclides, and specific alpha- and beta-emitting constituents. The purpose of the monitoring activities is to provide for continuous evaluation and awareness of environmental conditions resulting from current operations, to detect trends, to ensure compliance with DOE orders, and to provide data for predictive models.

a. Work supported by the U.S. Department of Energy under DOE Contract No. DE-AC07-76ID01570.

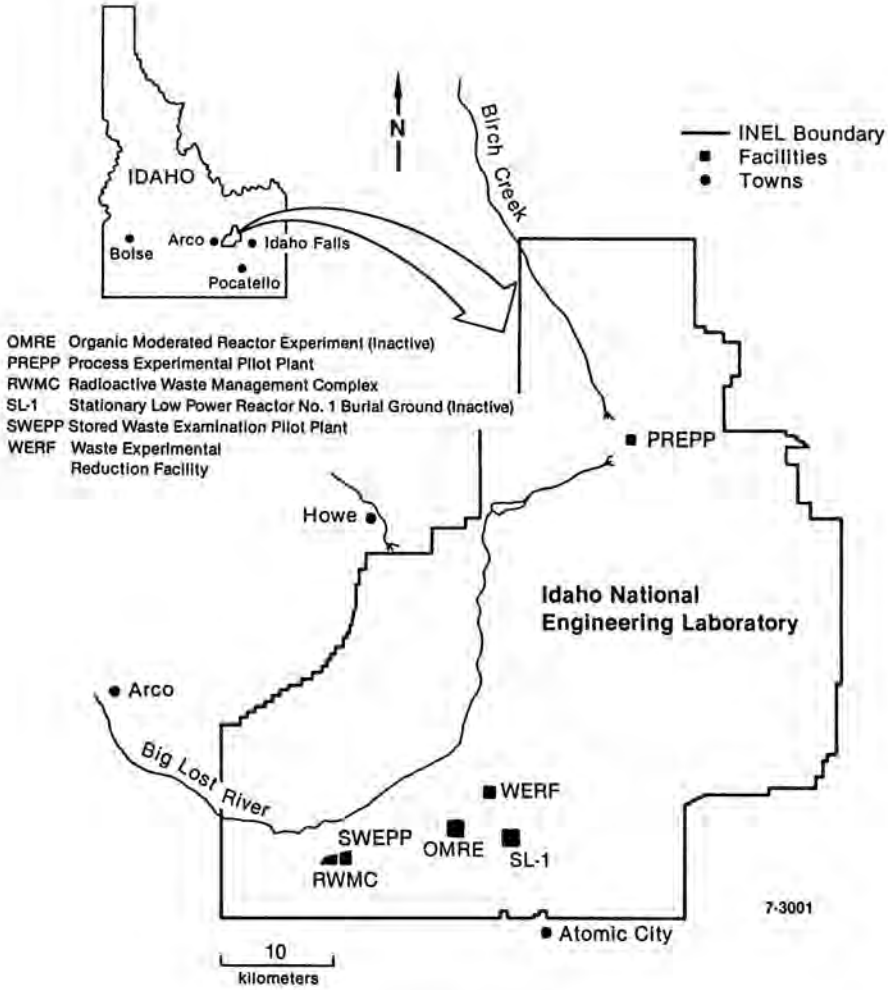


Fig. 1. Idaho National Engineering Laboratory location map.

ENVIRONMENTAL MONITORING ACTIVITIES

Routine Monitoring

The Environmental Surveillance Program performs routine environmental monitoring of these waste management operational facilities and activities and recommends any necessary corrective actions. The DOE Radiological and Environmental Sciences Laboratory (RESL) performs routine monitoring outside the RWMC, around other operational facilities, and on and off the INEL site. The National Oceanic and Atmospheric Administration (NOAA) cooperates with RESL on a weather-monitoring network. The U.S. Geological Survey (USGS) monitors subsurface water beneath the INEL and is participating in a special investigation to study radionuclide transport beneath the RWMC.

Because airborne transport may be the most likely pathway for radionuclides to migrate away from the RWMC, PREPP, and WERF, EG&G Idaho conducts extensive air monitoring at these facilities.

EG&G Idaho conducts surface water sampling and analysis only at the RWMC to determine radionuclide concentrations in standing water and to indicate if radionuclides are being transported from the facility during runoff. Generally, no surface water flows from the RWMC because the RWMC is located in a low depression. Streams that enter the INEL depend on seasonal flow and are dry the majority of the year.

Groundwater in the Snake River Plain aquifer, approximately 177 m beneath the INEL, is monitored to determine if radionuclides from waste buried at the RWMC have migrated there. Water samples are collected quarterly by the INEL Project Office of the USGS from four aquifer wells drilled north, south, east, and west of the RWMC Subsurface Disposal Area (SDA) and are analyzed for radioactivity and nonradiological parameters.

The purpose of soil sampling and analysis is (a) to determine if RWMC, PREPP, and WERF operations contribute to soil contamination and (b) to monitor long-term trends. Surface soils at the RWMC have become slightly contaminated with radionuclides during transportation and handling of radioactive wastes, from past flooding, or by migration from buried waste via physical and biological transport. Surface soils at PREPP and WERF could become contaminated by deposition of radionuclides in airborne effluents or by handling of radioactive waste. EG&G Idaho is responsible for soil monitoring activities at all three facilities.

Plants and animals can affect the integrity of buried waste containment by channeling through the soil and allowing water to reach the waste or by transporting radionuclides to the surface. Therefore, routine sampling of small mammals and vegetation is also conducted by EG&G Idaho to detect biological transport of radionuclides. Vegetation sampling is conducted at PREPP, WERF, and the RWMC; but small mammal sampling is conducted only at the RWMC.

Thermoluminescent dosimeters (TLDS) are used to measure ionizing radiation exposures at the RWMC and WERF to detect any increase in exposures attributable to handling or disposing of radioactive waste. In addition, EG&G Idaho performs a surface radiation survey at the RWMC every six months to locate areas with radiation levels above background within the facility boundary.

EG&G Idaho also conducts monitoring activities at the Stationary Low-Power No. 1 (SL-1) Surplus Area and the Organic Moderated Reactor Experiment (OMRE) area. The SL-1 contains buried contaminated building remnants in one pit and two trenches. The OMRE area is a decontaminated and decommissioned reactor facility and leach pond. Both SL-1 and OMRE are nonoperational surplus facilities and require less surveillance than the RWMC, PREPP, and WERF. Table I summarizes the monitoring activities conducted at the RWMC, SWEPP, PREPP, WERF, SL-1, and OMRE.

Environmental Monitoring Results

Particulate airborne radioactivity is monitored continuously at the RWMC, WERF, and PREPP. Air filters are routinely analyzed for gross alpha, gross beta, and specific alpha-, beta-, and gamma-emitting radionuclides (see Table I). All gross beta activities at the RWMC in 1985 were several orders of magnitude below DOE Derived Concentration Guides (DCGs) for airborne release of strontium-90 to a public area. Gross beta concentrations measured in airborne particulates at the RWMC did not differ statistically from those measured at the control location. Fig. 2 illustrates the 1985 trend of gross beta concentrations in air for the RWMC. Air samples were also analyzed for specific gamma-emitting radionuclides. Some radionuclides, primarily cesium-137, were detected above background concentrations; but the concentrations were variable and well below DCGs. The presence of cesium-137 was attributed to resuspension of slightly contaminated soil at the RWMC. No unusual gross beta activity was detected at WERF during 1985, and gamma-emitting radionuclides detected in WERF air samples were well below the DCGs. Some gross beta activity was detected above ambient levels at PREPP and was probably due to resuspension of contaminated soil. Cesium-137 was also detected at levels well below the DCGs in PREPP samples.

Positive gross alpha and specific alpha and beta analytical results are typically reported infrequently at waste management facilities. Detectable concentrations normally occur during the summer months at the RWMC, probably due to resuspension of slightly contaminated soils. Specific alpha- and beta-emitting radionuclide analyses were started on a quarterly basis in 1986. Plutonium, americium, and strontium have been sporadically detected at low levels at various sampler locations, but more data will have to be detected to determine any trends. All specific radiochemistry results have been below DCGs.

Man-made radionuclides were detected in seven RWMC surface water samples collected in 1985. Results indicate that minute quantities of radionuclides have been transported from contaminated surfaces in the RWMC Subsurface Disposal Area (SDA) via surface runoff.

Tritium was detected in three of six RWMC wells monitored by the USGS. The source of the tritium is from past disposal of wastewater at the Idaho Chemical Processing Plant and the Test Reactor Area at the INEL.

USGS wells at the RWMC are routinely monitored for specific conductance, chloride, and sodium. Variances have been noted in recent years in specific conductance. Several possible explanations are offered, but conclusions regarding the cause of the fluctuations cannot be drawn based on available data. A special hazardous material study was conducted on the production well sample in the fall. All results were well below the Environmental Protection Agency (EPA) drinking water standards.

Special preoperational soil samples were collected at PREPP and analyzed by gamma spectroscopy and radiochemistry. Cesium-137 and strontium-90 were detected in the majority of the PREPP soils. This may be the result of contamination of Test Area North (TAN) soils by previous activities at that facility.

Preoperational monitoring was also conducted at SWEPP, which is located at the RWMC. Cesium-137 was detected in most of the SWEPP soils, including the controls. The concentrations were at background levels. The concentrations of specific alpha and beta emitters detected were well below the INEL concentration guides for soil.

Preoperational and routine vegetation samples were collected at SWEPP, PREPP, and the SDA. No detectable gamma-emitting radionuclides were reported for these locations. Analysis for specific alpha- and beta-emitting radionuclides indicated no detectable concentrations in sagebrush around SWEPP or PREPP, but near-background strontium-90 concentrations were detected in crested wheatgrass growing in the previously flooded area of the SDA.

Routine small mammal samples were collected at the RWMC in 1985. Cesium-137 was detected in one deer mice composite that was collected next to the

TABLE I

Environmental Surveillance Activities Performed Waste Management Facilities

Facility	Sample	Description	Frequency of Analysis	Type of Analysis
RWMC SDA and TSA	Air	11 low-volume air samplers operated at 0.14 m^3/min (includes 1 control and 1 replicate)	Biweekly Biweekly Monthly Quarterly	Gross alpha Gross beta Gamma spectroscopy Radiochemistry
	Water			
	Surface	4-L samples from SDA, TSA-1, TSA-2, TSA-3, and control locations	Quarterly, but depends on precipitation	Gross alpha Gross beta Gamma spectroscopy Radiochemistry
	Subsurface (sampled by the USGS)	2-L samples from each of six wells	65-m well annually 183-m wells quarterly Production well quarterly	Gamma spectroscopy H-3, Sr-90, Pu-238, -239, and -240, Am-241 Specific conductance Chloride, sodium, nitrate
	Direct Radiation			
	Surface gamma	Truck-mounted VRM-1 detector system	Semiannually	External radiation levels
	Ionizing (conducted by RESL and EG&G Idaho)	25 TLD packets (RESL), 2 TLD packets (EG&G Idaho) and 6 background communities (RESL)	Semiannually	External radiation levels
	Small mammal	3 composites in each of 5 major areas (plus 1 control area)	Annually, but species sampled varies each year	Gamma spectroscopy, Radiochemistry[a]
	Soil	5 locations each of 5 major areas (plus 1 control area)	Biennially	
	Vegetation	5 locations in each of 5 major areas (plus 1 control area)	Biennially Annually, but species sampled varies each year	Gamma spectroscopy, Radiochemistry[a]
	Visual inspection	Tour SDA and TSA	Monthly	Results recorded for any required corrective action
SWEPP (Integrated with RWMC Monitoring)				
	Soil	9 locations sampled at surface (+ 2 control areas)	Biennially	Gamma spectroscopy Radiochemistry[a]
WERF	Air	4 low-volume air samplers operated at 0.14 m^3/min (includes 1 control and 1 replicate)	Biweekly Biweekly Monthly	Gross alpha Gross beta Gamma spectroscopy
	Direct radiation	11 TLD packets (EG&G Idaho) and 6 background communities (RESL)	Semiannual	External radiation levels
	Soil[b]	15 surface samples	Triennially	Chemical Gamma spectroscopy
	Vegetation	15 locations (includes 3 controls)	Triennially	Gamma spectroscopy
SL-1	Surface gamma radiation	Truck-mounted VRM-1 detector system	Semiannually	External radiation levels
	Visual inspection	Tour SL-1	Semiannually	Results recorded for any required corrective action
OMRE	Surface gamma radiation	Truck-mounted VRM-1 detector system	Annually	External radiation levels
	Visual inspection	Tour OMRE	Quarterly	Results recorded for any required corrective action
PREPP	Air	5 low-volume air samples operated at 0.14 m^3/min (includes one control and one replicate)	Biweekly Biweekly Monthly Quarterly	Gross alpha Gross beta Gamma spectroscopy Radiochemistry[a]
	Soil	24 locations	Annually, but locations vary over a 3-year period	Gamma spectroscopy Radiochemistry[a]
	Vegetation	4 locations (includes 1 control)	Triennially	Gamma spectroscopy Radiochemistry[a]

a. Analysis includes Am-241, Pu-238, Pu-239, -240, U-235, U-238, and Sr-90.
b. Sampling frequency may vary if air radioactivity levels increase.

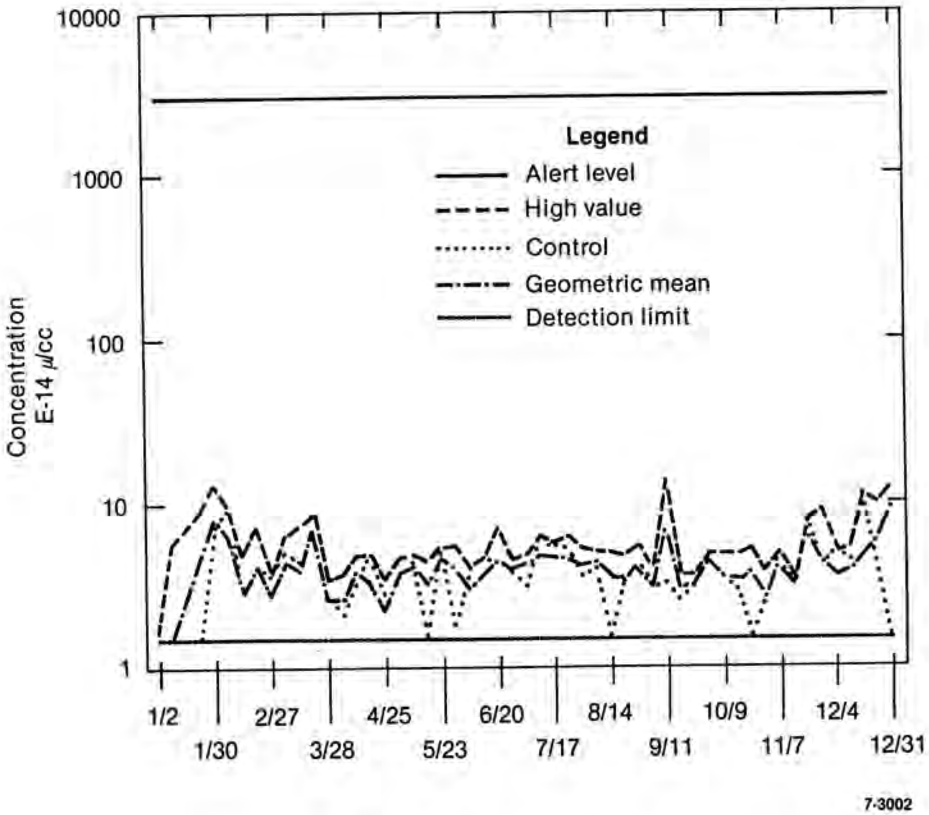


Fig. 2. RWMC gross beta air filter results.

open active pit in the SDA. Strontium-90, plutonium-239, -240, americium-241, uranium-234, and uranium-238 were also detected in that sample, as well as in the control samples. Only strontium-90 and uranium-234 concentrations were greater in the SDA sample than in the control samples. However, the strontium-90 result was well within the range of values obtained from previous RESL studies of radionuclide concentrations in deer mice at the RWMC. No previous uranium-234 concentrations were available for comparison.

TLD data and surface radiation surveys show levels of radiation above background around the current waste disposal pit and at localized areas within the SDA. The maximum 6-month ionizing radiation exposure measured by TLDs at the RWMC has, in general, decreased over time since 1974 (see Fig. 3). The lowest maximum exposure at the RWMC was recorded in 1985. Analysis of the WERF TLD data from November 1982 to November 1985 showed that the 6-month exposures measured immediately around the WERF waste storage area are statistically higher than all other exposures measured around WERF. This difference is associated with the proximity to radioactive waste stored outside at the WERF facility.

Surface radiation was routinely monitored at two inactive areas, SL-1 and OMRE. Several localized areas exceeding background radiation levels were identified at SL-1. The source of the increased levels was either removed or covered with soil. No areas exceeding background were identified at OMRE.

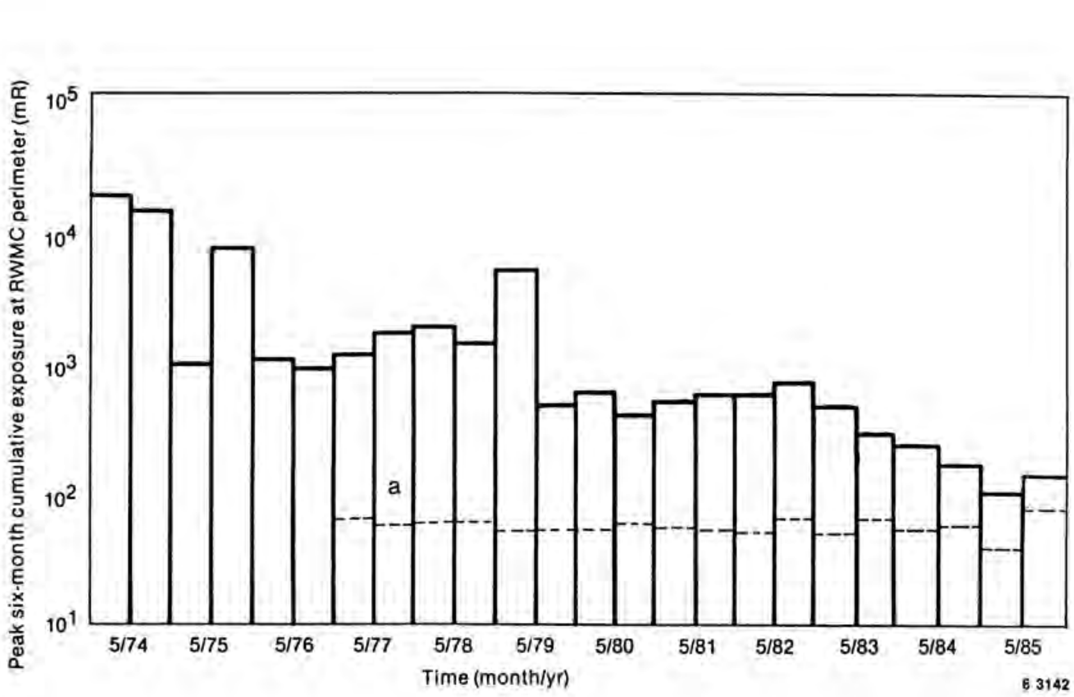
Soils at WERF were analyzed for 15 specific trace elements and inorganic chemical compounds, based on the metals and combustible waste processed at WERF. There is no evidence of soil contamination by those materials because of WERF operations.

Special Monitoring Studies

Various special monitoring studies are planned and conducted each year to enhance the routine monitoring program or obtain information for predictive modeling and performance assessment activities. One special study recently conducted at the RWMC is discussed below.

A short-term radon study was conducted at the RWMC to obtain preliminary measurements of radon concentrations above radioactive waste disposal areas. The Terradex Corporation Type M track etch systems were used to determine air concentrations of radon-222. This type of system discriminates against thoron (Rn-220), which is a product of natural-occurring thorium. Thus, only radon-222, a daughter of U-238, was measured by the detectors. Each track etch system consists of a plastic detector mounted in a cup.

The open end of the cup is covered with a filter permeable to radon. Upon exposure to the atmosphere, alpha particles from radon or radon daughters plate out inside the cup, penetrating the plastic nuclear track detector and producing radiation damage tracks. The tracks become visible following a chemical etching process in the



[a] Dotted line indicates background measured at distant community stations.

Fig. 3. Six-month maximum RWMC perimeter TLD results from 1974 to 1985.

laboratory and are counted microscopically. The number of alpha tracks is proportional to the average radon exposure.

Each track etch system was either placed on the soil surface or mounted approximately 1 m above the ground on a stake made from a reinforcing bar. The track etch system was placed in a protective canister, constructed of polyvinyl chloride (PVC) pipe and a PVC pipe cap.

A total of 39 detector systems were emplaced in the field from May 13 through July 31, 1986. This length of exposure was sufficient to result in a detection limit of 6 E-02 pCi/L. An additional system was kept as a blank in a protective aluminum foil package for the duration of the study. Detector systems were placed either directly on the ground or 1 m above the soil surface. The detector systems placed on the ground were used to indicate the relative rates of emanation from buried waste. The systems placed above the ground were used to measure the concentrations of radon in air for comparisons with regulatory guidelines.

The majority of results obtained for samples collected in air 1 m above the ground are close to or less than the control results. In addition, the control and blank sample results are similar. An Analysis-of-Variance (ANOVA) test ($p = 0.05$), followed by Duncan's Multiple Range Test, was performed on the data. The results indicate that there are no significant differences between radon concentrations in air over most disposal area pits and trenches sampled and control areas. However, two previously closed disposal pits containing transuranic and low-level waste showed statistically higher concentrations than the reported control result. The measured air concentrations were also variable between replicates, with only one replicate, in each case, exceeding the control and blank. The inconsistency between replicates may indicate spurious results because it was expected that radon would be relatively homogeneously mixed in air at that distance from the soil surface.

The current DOE concentration guide (DOE Order 5480.1A) for radon in air is 3 pCi/L in uncontrolled areas. None of the results obtained in air at the RWMC exceeded this guide. However, the most recent draft revision of this DOE order proposes that the EPA standards established for uranium and thorium mill tailings areas be adopted. The standard for air at an uncontrolled access location is 0.5 pCi/L. Two of the results obtained at the RWMC, minus the control result, exceed this standard. The highest result obtained was 2.69 pCi/L.

Concentrations measured above the soil surface at the disposal areas did not differ from those at control stations, with one exception. Surface soil results were statistically greater than the control soil results, for the transuranic waste pit closed before 1970. The results suggest that radon emanation is occurring at a more rapid rate at this location than at all other locations.

Although the two highest radon concentrations in air do not exceed current DOE concentration guides, they do exceed proposed standards. The results may appear to be spurious, however, because they deviate greatly from replicate results. A longer period of exposure, with the concomitant increase in the number of track etches, may result in more consistent data. Therefore, additional track etch systems will be placed over the suspect waste pits in FY-1987. The study will also be expanded to measure radon concentrations at different soil depths above the waste.

Subsurface Investigations

The Subsurface Investigations Program, within Environmental Surveillance, is part of a continuing effort at the RWMC to identify potential pathways and mechanisms for waste radionuclides to migrate through the subsurface environment and eventually to man. The primary objectives of the program include the following:

1. Field-calibrate a model to predict the long-term migration of radionuclides in the unsaturated zone. Achieving this objective will require measuring hydrologic transport properties, accounting for radionuclide behavior and radioactive decay, obtaining or developing a computer program for the model, and finally field-calibrating the model based on measured results.

2. Measure the actual migration of radionuclides, to date, to determine whether there is a public health and safety problem. The sedimentary interbeds between the underlying basalt layers are of greatest interest.

During fiscal year (FY) 1986, the following tasks were performed: (a) shallow drilling and sampling; (b) deep drilling and instrumentation; (c) installation of moisture monitoring equipment; (d) implementation of net downward waterflux, interface phenomena, and radionuclide concentration studies; (e) test trench construction and instrumentation; (f) weighing lysimeter installations; and (g) subsurface transport modeling. An extensive effort to prepare the drilling and sample handling procedures was conducted in FY 1984 and 1985. Results are documented in an annual subsurface investigations progress report.

STATUS AND CONCLUSIONS

The Environmental Surveillance Program monitoring activities are continually being evaluated to determine whether they fully meet program objectives. Achieving a well-designed program is complicated because waste management facilities are varied and dynamic. The monitoring activities and the research effort to support them must be multimedia. Thus, a number of complex pathways and their interactions must be addressed. Also, because the Environmental Surveillance Program has existed for several years, changes must include consideration of continuity of existing data and information. Quality assurance provisions must also be applied in all phases of the program, from sample collection, preparation, and analysis through data analysis and reporting.

In an effort to attain and ensure an optimally designed environmental surveillance program, the Monitoring Activities Review (MAR) process was developed. Initiated in 1982, the MAR consists of a detailed review by an INEL committee of waste management and environmental experts of objectives, procedures, and data for all monitoring activities conducted by the Environmental Surveillance Program. In addition to reviewing the program, the MAR committee also evaluates recommended practices from published references and other DOE sites. This includes visits to the sites to observe DOE's current monitoring methods. Based on the above review activities, the committee recommends revisions to the monitoring activities conducted by the Environmental Surveillance Program. The current activities are described in the Environmental Handbook for the RWMC and Other Waste Management Facilities at the Idaho National Engineering Laboratory, an EG&G Idaho document.

The MAR process has been completed for all major monitoring activities (air, surface water, surface soil, biotic, operational monitoring, and penetrating radiation).

REFERENCES

1. B. D. REYES, M. J. CASE, and R. N. WILHEMSEN, Annual Report 1985 Environmental Surveillance for the EG&G Idaho Radioactive Waste Management Areas at the Idaho National Engineering Laboratory, EGG-2451 (1986).

2. J. M. HUBBLE, et al., Annual Progress Report: FY-1986 Subsurface Investigations Program at the Radioactive Waste Management Complex of the Idaho National Engineering Laboratory, DOE/ID 10153 (1987).