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Environmental Monitoring Report Sandia Laboratories 1976

Theodore N. Simmons

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ENVIRONMENTAL MONITORING REPORT
SANDIA LABORATORIES 1976

Theodore N. Simmons
Health Physics Division, 3312
Sandia Laboratories, NM 87115

ABSTRACT

Water and vegetation are monitored to determine Sandia Laboratories impact on the surrounding environment. Non-radioactive pollutants released are reported. Radioactive effluents are also reported and their person-rem contribution to the Albuquerque population is calculated.

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Environmental Monitoring Report
Sandia Laboratories 1976

Introduction

Sandia Laboratories is a nuclear ordnance laboratory with prime responsibility for interfacing nuclear weapons developed by Los Alamos Scientific Laboratory (LASL) and Lawrence Livermore Laboratory (LLL) to delivery systems required by the military services. This activity includes performing weapons testing, quality control and assurance, arming and fuzing, safety, delivery system modification, and safeguards.

Sandia components are tested for proper functioning in such environments as shock, vibration, temperature, moisture, and radiation.

The exclusion area (Technical Area V) was created for some of Sandia's environmental testing facilities. Technical Area V was placed ten kilometers south of Albuquerque to provide a remote location for nuclear reactor operations. Currently, the research reactors SPR and ACPR operate there. They share Technical Area V with flash X-ray facilities and large electron beam accelerators. The Sandia Pulsed Reactor (SPR) facility began operations in May 1961. SPR is an unreflected, cylindrical, enriched-uranium assembly. The Annular Core Pulse Reactor (ACPR), a modified TRIGA type reactor, became operational in June 1967.

Technical Area V is located on a mesa bounded topographically on the west by the Rio Grande, on the north by Tijeras Arroyo-Canyon, on the south by Hell's Canyon wash, and the east by the Manzano Mountains. Technical Areas V and I can be found on the map in Figure 1.

Figure 1.

Area I is on a similar mesa north of Tijeras arroyo. Area I houses research and design facilities along with administrative and support functions (laboratories and shops). The three elevation points given in Figure 1 indicate the large topographical relief of the Albuquerque vicinity. Albuquerque's climate is termed "arid continental." Roughly half of the average 0.20 m average annual rainfall comes during the months of July through September. Winter months are quite dry (Ref. 1). Temperature ranges are wide, but extreme temperatures such as -18° and 38°C occur infrequently (Ref. 1). Strong winds are confined primarily to the late winter and early spring months. The wind speed reaches 13.3 m/s (Ref. 1) less than 13% of the days of the year. In Area V the prevailing wind blows in a quadrant bounded by the southwest and northwest. The water table lies 137 m beneath this area. There are indications that the ground water flows westward to the Rio Grande at that location (Ref. 1).

The mountains east of Sandia Laboratories are used primarily for forestry and recreation. The sparse and rugged land of the Isleta Indian reservation to the south is little used.

Radioactive releases to the atmosphere from Sandia include ^{41}Ar from the Area V reactors and tritium from Area I research activities. Depleted uranium is infrequently spread over limited areas during explosive tests. These releases have no potential for reaching areas used by the public. Neither the SPR nor the ACPR reactor releases cooling water. Both reactor air exhaust systems are equipped with particulate effluent samplers. ACPR is further equipped with a continuous gaseous effluent monitor. These systems measured no radioactivity released during 1976. The reported amount of ^{41}Ar

released was computed from reactor operating parameters. Cesium-137 is a fission product produced abundantly in reactor fuel and is completely contained therein. Sandia analyzes environmental samples for ^{137}Cs in order to provide a final check on all reactor radiological safety systems. These systems include containment, alarm and monitoring systems, and exhaust air filtration. Gross beta measurements in water samples provide an additional check. There were no offsite liquid discharges containing measurable amounts of radionuclides from Sandia Laboratories in CY 1976.

Summary

The environmental monitoring for calendar year 1976 shows that concentrations of radioactive materials in the Albuquerque area are typical of natural background for the area. An exception is a single onsite location where slightly abnormal uranium concentrations are expected. An estimated 0.044 person-rem Albuquerque area (80 km radius) population dose commitment results from calculated Sandia Laboratories releases. Over the same area 57,000 person-rem is accumulated from natural background. There were no measurable offsite radioactive effluent releases in CY 1976.

Monitoring Program

The environmental monitoring effort at Sandia Laboratories began in February of 1959 and continues today. This monitoring program is designed to detect the release and/or migration of radioactive material. The monitoring is achieved through soil, vegetation, and well-water sampling and subsequent analysis.

Because of the arid climate and accompanying deep water table, no transport of radioactive material by water is expected, nor has any been detected by the monitoring program (Refs. 1-5). In 1969 soil core samples were taken (Ref. 3) in the vicinity of Sandia's low-level radioactive dump. (This dump is located in Area III (Figure 2); Area III is immediately west and south of Area V on the same mesa.) Samples were taken at depths of 7.62 and 15.24 m. These samples showed no evidence of radionuclide migration from the burial ground. The mesa topography near the burial trenches makes flooding quite unlikely. The next core sampling is planned for 1979.

In 1959 (Ref. 4) uranium analysis was performed on collected soil, water, and vegetation samples which gave no indication of environmental contamination. During a series of aerosol generation experiments (PAGE), a small amount of uranium was purposely released at the Coyote Canyon cable site (Site 16, Fig. 2) during 1975. The site was sampled in 1975 and again this year to determine the extent of uranium spread.

Vegetation samples are collected at eleven sites (Figures 1 and 2). Deep (approximately 305 m) well-water samples are collected from potable water wells on Kirtland Air Force Base which are functioning at sampling time. Fewer wells

Figure 2.

were available in 1976 than 1975. Well samples were taken in February of 1977.

All other samples were taken in November of 1976.

The following is a list of sampling sites. These sites can be located on Figures 1 and 2.

1. Pennsylvania Avenue and Tijeras Arroyo between southwest side of bridge and truck bypass.
2. Manzano Base main gate.
3. Coyote Canyon control area - vicinity of Building 9925.
4. Isleta Reservation gate.
5. McCormick Ranch (now McCormick gate). Sample was picked up in vicinity of the southwest corner of Area III perimeter fence.
6. Old Area III gate - east of Area III perimeter fence at Building 6501.
7. Arroyo (aqueduct) north of Area III.
8. Corrales Bridge - east side of bridge, north of street (Fig. 1).
9. Sedillo Hill - Comer's Cafe and Service Station (Fig. 1).
10. Oak Flats picnic area on south State Highway 14 (Fig. 1).
11. Isleta Pueblo at irrigation control gates on east side of river (Fig. 1).
12. Base Well No. 1 (West).
13. Base Well No. 2 (East).
14. Sandia Technical Area III well.
15. Base Well No. 11 (East).
16. Coyote Canyon (cable site).
17. Seismic Center Gate.
18. Isleta reservation boundary (East).

Preparation and Radiochemical Analysis Procedure

Preparation and Radiochemical Analysis Procedures for Vegetation Samples

Vegetation and water samples were analyzed for cesium-137. Water samples were further analyzed for total long-lived beta-emitting radionuclides.

Approximately 0.5 kg of the aerial portion (stems and leaves) of vegetation characteristic of the sample site is collected at each location. The sample is stored in plastic bags with air holes to prevent decomposition before analysis (though little decomposition is possible due to its dry state). The sample is mixed, cut fine with a commercial-type blender, and reduced to a fine gray ash in a muffle furnace at 450°C. Radiochemical analyses are then performed on the ash residue.

Cesium-137 Determination -- A 10 gram sample of vegetation is ashed, and the cesium is removed with nitric acid. The resulting solution is filtered. The filtrate is passed through an ion-exchange of KCFC (organic ion-exchange resin, potassium hexacyanocobalt II ferrate) which absorbs the ^{137}Cs . The ion-exchange column containing the cesium is then counted in a gamma well counter.

Preparation and Radiochemical Analysis Procedures for Water Samples

Two litres of water are collected at each site in an acid-cleaned plastic jug that has been rinsed in distilled water.

Gross Beta Determination -- The hardness of the water is determined so that no more than 7 mg/cm² of solids will be in the final deposit. (Heavier solid deposits require greater correction for self-absorption of beta activity.) Water is filtered through a hydrosol-type membrane filter (0.45 μm). The filter is saved for a gross beta count of suspended solids.

Filtered water is acidified with nitric acid and evaporated to a small volume which is transferred to a 5 cm, tared, stainless steel planchet. The water is then completely evaporated, and the residue is reweighed and beta-counted. The count is due to dissolved solids.

The membrane filter is transferred to a 5 cm, tared, stainless steel planchet (with solids down against the planchet), the filter is dissolved in acetone, and the excess acetone is burned off. The planchet is reweighed and beta-counted. This count is due to suspended solids from the water sample. The total of dissolved and suspended solids activity is reported.

Cesium-137 Determination - Water containing the cesium is passed through a KCFC ion-exchange column. The resin containing the cesium is gamma-counted.

Samples are counted for beta activity by using a gas proportional chamber with a thin window. During each counting cycle, samples, background, and a standard source are counted in a prescribed sequence which provides all required information for interpretation of results in terms of disintegrations per minute.

Background level and counter efficiency are determined during each counting run; thus, any abnormal variation will be noticed, and corrective action can be taken. Counter efficiencies are obtained by reference to standard sources.

Data

The data obtained from the samples collected for this report are summarized in Tables I, II, III, and IV.

Table I

Vegetation

<u>Site</u>	<u>Cesium-137</u> <u>pCi/g dry*</u>
1	< MDL
2	"
3	"
4	"
5	"
6	"
7	"
8	"
9	"
10	"
11	"
16 d, e, f, g, and i	"
17	"
18	"
Minimum Detectable Limit (MDL)	2 pCi/g

*There are no federal standards for cesium-137 in vegetation.

Table II

Water Data

<u>Site</u>	<u>Gross Beta</u> <u>$\mu\text{Ci/mL}$</u>	<u>Percent of</u> <u>Standard*</u>	<u>Cesium-137</u> <u>$\mu\text{Ci/mL}$</u>	<u>Percent of</u> <u>Standard*</u>
8	$(4.7 \pm 2.0) \times 10^{-9}$	47	< MDL	< 0.4
11	$(7.0 \pm 2.1) \times 10^{-9}$	70	"	"
13	$(5.2 \pm 2.0) \times 10^{-9}$	52	"	"
14	$(3.8 \pm 1.9) \times 10^{-9}$	38	"	"
15	$(2.9 \pm 1.9) \times 10^{-9}$	29	"	"
Minimum Detection Limit (MDL)	1.8×10^{-9}	18	2.74×10^{-8}	0.4
RCG	1×10^{-8}		7×10^{-6}	

* Standards for Radiation Protection, USERDA Manual, Appendix 0524.

Table III

Uranium Data*

<u>Site No. and description (16 only)</u>	<u>Soil ($\mu\text{g/g dry}$)</u>	<u>Vegetation ($\mu\text{g/g dry ash}$)</u>
1		0.028
2		0.013
3		0.023
4		0.021
5		0.015
6		< MDL
7		0.018
8		0.015
9		0.016
10		< MDL
11		0.026
16 a Ground Zero (GZ)	0.044	
16 b 30.5 m W of GZ under cable	0.038	
16 c 15.2 m E of GZ under cable	0.028	
16 d 61 m SW of GZ	0.033	0.046
16 e 152 m SW of GZ	0.044	0.019
16 f 305 m SW of GZ	0.030	0.018
16 g 152 m NE of GZ	0.032	0.030
16 h 61 m E of GZ	0.035	
16 i 61 m W of GZ	0.42	0.25
17		0.035
18		0.030
Minimum detection limit (MDL)	0.010	0.010

*There are no federal standards for uranium in soil or vegetation.

Table IV

Nonradioactive Pollutants from Area I

<u>Pollutant</u>	<u>Most Restrictive Quality Standard and Authority</u>	<u>Percent of Standard</u>	<u>1975 Release</u>
SO ₂	Lowest sulfur fuel available (40CFR76.5a)	N/A	3076 kg ⁽¹⁾
Cr	0.01 mg/L (NM Water Quality Control Commission)	< 50	35 kg ⁽²⁾

(1) Based on fuel oil burned at steam plant assuming 0.38% sulfur content.

(2) Based on material balance calculations for discharging processes. Chromium is released to the sewers exclusively in Area I. These particular sewers drain into a base lagoon used to irrigate the base golf course. Infrequently the lagoon fills and the excess is diverted to the Albuquerque sewer system.

Dose Assessment for Public

The concentrations of argon-41 and tritium are too low to be measured in public locations. The concentrations at locations where the public resides can be estimated using Pasquill's atmospheric diffusion equations (Ref. 6), the amount of radionuclides known to be released, and assumed meteorological conditions. These estimated airborne radionuclide concentrations allow a dose estimate for the public to be made.

The following is Pasquill's Gaussian diffusion equation:

$$X = \frac{f Q}{\pi \sigma_y \sigma_z u} \exp \left[- \left(\frac{y^2}{2 \sigma_y^2} + \frac{h^2}{2 \sigma_z^2} \right) \right] \quad \text{Eq. 1}$$

where

Q = source strength in curies per second.

u = mean wind speed in metres per second.

y = receptor location in metres from the plume axis.

h = source height in metres.

$\sigma_y \sigma_z$ = diffusion coefficients in metres. These coefficients are a function of distance from the stack.

f = frequency the wind blows in the given direction.

X = concentration in curies per cubic metre.

A neutral Type D Pasquill meteorological condition is assumed. A wind speed of 4 m/sec is assumed and is compatible with Type D conditions. A conservative simplifying assumption that $y = 0$ and $h = 0$ is further made. The maximum mean time the wind blows in a given direction (Ref. 7) is 11.4% (based on 10 years of data). Reference 8 gives less conservative data, but will not be used. These parameters are used in Equation 1 to generate the results in Table V. The results in Table V are used in further calculations.

Table V

<u>Distance from release point (m)</u>	<u>X/Q (sec/mL)</u>
50	2.52×10^{-9}
3000	5.37×10^{-13}
80000	2.27×10^{-16}

The release rates (Q) of tritium and ^{41}Ar from the radioactive effluent data (Table VI) were multiplied by the X/Q's of Table V. These products were then used to further calculate dose rates at site boundaries (Table VII). For each radionuclide a dose rate conversion factor (DRCF), based on the radiation concentration guides (RCG) of Table VII, was used.

Table VI

Radioactive Effluent Data

<u>Release Site</u>	<u>Effluent</u>	<u>Ci Released</u>	<u>Release Rate</u> <u>$\mu\text{Ci/sec}$</u>
Area I	^3H	0.03	9.52×10^{-4}
Area V	^{41}Ar	3.87	0.128

Table VII

Dose Rates at Site Boundaries

<u>Nuclide</u>	<u>Distance to Site Boundary</u>	<u>Boundary Concentration ($\mu\text{Ci/mL}$)</u>	<u>RCG* ($\mu\text{Ci/mL}$)</u>	<u>Ratio of Boundary Concentration to RCG</u>	<u>Dose Rate mrem/yr</u>	<u>Radiation Protection Guide (RPG)* (mrem/yr)</u>	<u>Ratio of Site Boundary Dose Rate to RPG</u>
^3H	50 m	2.40×10^{-12}	6.7×10^{-8}	3.6×10^{-5}	6×10^{-3}	1700	3.5×10^{-5}
^{41}Ar	3 km	6.87×10^{-14}	1.3×10^{-8}	5.2×10^{-6}	8.6×10^{-4}	1700	5×10^{-6}

* Standards for Radiation Protection, USEFDA Manual Chapter 0524

In Table VIII the annual person-rem is given for the Albuquerque area. The 80 km radius area is assumed to have 3.8×10^5 population all living within the inner 20 km radius. The person-rem is found by evaluating the following integral where all quantities have been previously defined or are obvious.

$$\frac{3.8 \times 10^5}{\pi (20 \text{ km})^2} \int_{0.05 \text{ km}}^{20 \text{ km}} (\text{DRCF}) 2 \pi x \, dx$$

This integral overestimates ^{41}Ar dose as it does not include the decay of the nuclide as it traverses the 20 km with its 1.83 hour half-life.

Table VIII

Annual Person-rem for Albuquerque Area

^3H	6.5×10^{-5} person-rem
^{41}Ar	0.044 person-rem

Evaluation

Cesium-137 was not present in detectable quantities in any of the samples collected. If present, the nuclide was in concentrations of less than 0.4% of the RCG for water.

During the span of Sandia's Environmental Monitoring Program (started 1959), the range of gross beta measured in water has been 0-2527 $\mu\text{Ci/mL}$. Samples taken this year fall in the low end of this range and should be considered background.

The uranium data in Table III for uranium soil content is below the average earth crustal concentration of 0.76 $\mu\text{g/g}$ (Ref. 9). Sampling location 161 (see Table III), though well below 0.76 $\mu\text{g/g}$, is well above other Coyote Canyon uranium soil concentrations. Hoffman (Ref. 10) reports that the uranium content of a few foods ranges from 0.007-6.71 $\mu\text{g/g}$ of ash. The dry ash uranium content of vegetation (Table III) is at the lower end of this range. Again site 161 in Coyote Canyon is well above the vegetation uranium content found at other sites.

The calculated site-boundary concentrations for gaseous radionuclides are five orders of magnitude below the applicable radiation concentration guides. These concentrations are unmeasurable using conventional radiation monitoring techniques. The gaseous radionuclides result in 0.044 person-rem over the 80 km radius Albuquerque area (Figure 1). The natural background rate of Albuquerque (about 150 mrem/yr) results in 57,000 person-rem over the 80 km radius area. The gaseous radionuclide impact is minute in comparison.

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