EG&G
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EG&G/EM SURVEY REPORT
EGG-10617-1080
SEPTEMBER 1991

THE
**REMOTE
SENSING
LABORATORY**
OPERATED FOR THE U.S.
DEPARTMENT OF ENERGY BY EG&G/EM

AN AERIAL RADIOLOGICAL SURVEY OF THE

WEST VALLEY DEMONSTRATION PROJECT

AND SURROUNDING AREA

WEST VALLEY, NEW YORK

DATE OF SURVEY: AUGUST-SEPTEMBER 1984

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DE92 003606

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This work was performed by EG&G/EM for the United States Department of Energy under Contract Number DE-AC08-88NV10617.

ABSTRACT

An aerial radiological survey of the West Valley Demonstration Project and the surrounding area was conducted from mid-August through early September 1984 by EG&G Energy Measurements, Inc. for the United States Department of Energy. The radiological survey was part of the United States Department of Energy Comprehensive Integrated Remote Sensing (CIRS) program, which provides state-of-the-art remote sensing to support the needs of the various DOE facilities.

The survey consisted of airborne measurements of both natural and man-made gamma radiation emanating from the terrestrial surface. These measurements allowed an estimate of the distribution of isotopic concentrations in the area surrounding the project site. Results are reported as isopleths superimposed on aerial photographs of the area. Gamma ray energy spectra are also presented for the net man-made radionuclides.

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1.0 INTRODUCTION

The United States Department of Energy (DOE) has established the Comprehensive Integrated Remote Sensing (CIRS) survey program providing state-of-the-art airborne remote sensing to support the needs of the DOE community. The major airborne remote sensing capabilities of the CIRS program consist of aerial photography, multispectral scanning imagery, and airborne nuclear radiometric surveys. The basic technical capability is currently maintained and operated for the DOE by EG&G Energy Measurements, Inc. (EG&G/EM), an independent contractor. The airborne nuclear radiometric survey capabilities are carried out using an aerial surveillance system called the Aerial Measuring System (AMS). All the AMS survey operations are conducted at the request of federal or state agencies and are under the direction of the DOE.

An aerial radiological survey of the West Valley Demonstration Project site, the surrounding area, and Cattaraugus Creek was conducted by EG&G/EM from mid-August through early September 1984. The survey consisted of airborne measurements of both natural and man-made gamma radiation from the terrestrial surface and was conducted to determine the level of man-made activity due to operations at the West Valley site prior to the inception of the West Valley Demonstration Project (WVDP).

2.0 SITE DESCRIPTION

The West Valley Demonstration Project site is located approximately 48 km (30 miles) south of Buffalo, New York, in a rural area on New York's western plateau at an average elevation of 400m (1,300 feet). The site facilities occupy approximately 100 hectares (250 acres) enclosed by a chain link fence within a 1,340-hectare (3,300-acre) reservation which constitutes the Western New York Nuclear Service Center (WNYNSC) under the control of New York State ERDA. The communities of West Valley, Riceville, Ashford Hollow, and the village of Springville are located within 8 km (5 miles) of the plant. No human habitation, hunting, fishing, or public access is permitted on the WNYNSC although several roads and one railway pass through the Center.

The project site was formerly known as the Nuclear Fuel Service (NFS) Center, a commercial nuclear fuel reprocessing plant, and was operated under Nuclear Regulatory Commission (NRC) license. NFS operations were terminated in early 1972. In February 1982, the operations and maintenance of the former NFS reactor fuel reprocessing facility were transferred to the Department of Energy. Public Law No. 96-368, enacted in 1980, mandated the demonstration of high-level radioactive waste management technology for solidification of commercial fuel reprocessing liquid wastes held in underground storage tanks at the facility.

3.0 SURVEY PLAN

The survey was designed to cover approximately 62 square kilometers (24 square miles) surrounding the West Valley Demonstration Project site with a single flight line path following Cattaraugus Creek from its junction with Highway 240 east of the site to the shoreline of Lake Erie (Figure 1). The gamma ray spectral data were processed to provide both a qualitative and quantitative analysis, where applicable, of the radionuclides in the survey area. The steering computer was programmed to set up a series of parallel flight lines to cover the general area survey surrounding the project site. The flight path of the creek survey was determined by the course of the Cattaraugus Creek. The creek survey started approximately three kilometers above the WVDP site to determine the gamma ray background in the area and the cesium-137 from worldwide fallout. For this survey, all lines were nominally flown at an altitude of 46 meters (150 feet) above ground level (AGL) with a line spacing of 76 meters (250 feet).

4.0 SURVEY EQUIPMENT

A Messerschmitt-Bolkow-Blohm (MBB) BO-105 helicopter (Figure 2) was used for the low altitude survey. The aircraft carried a crew of two and a Radiation and Environmental Data Acquisition and Recorder (REDAR) system. Two pods—each containing ten 12.7-cm diameter by 5.1-cm thick, thallium-activated sodium iodide, NaI(Tl), detectors—were mounted on the sides of the helicopter.

The preamplifier signal from each detector was calibrated with a Na-22 source. Normalized outputs of each detector were combined in a

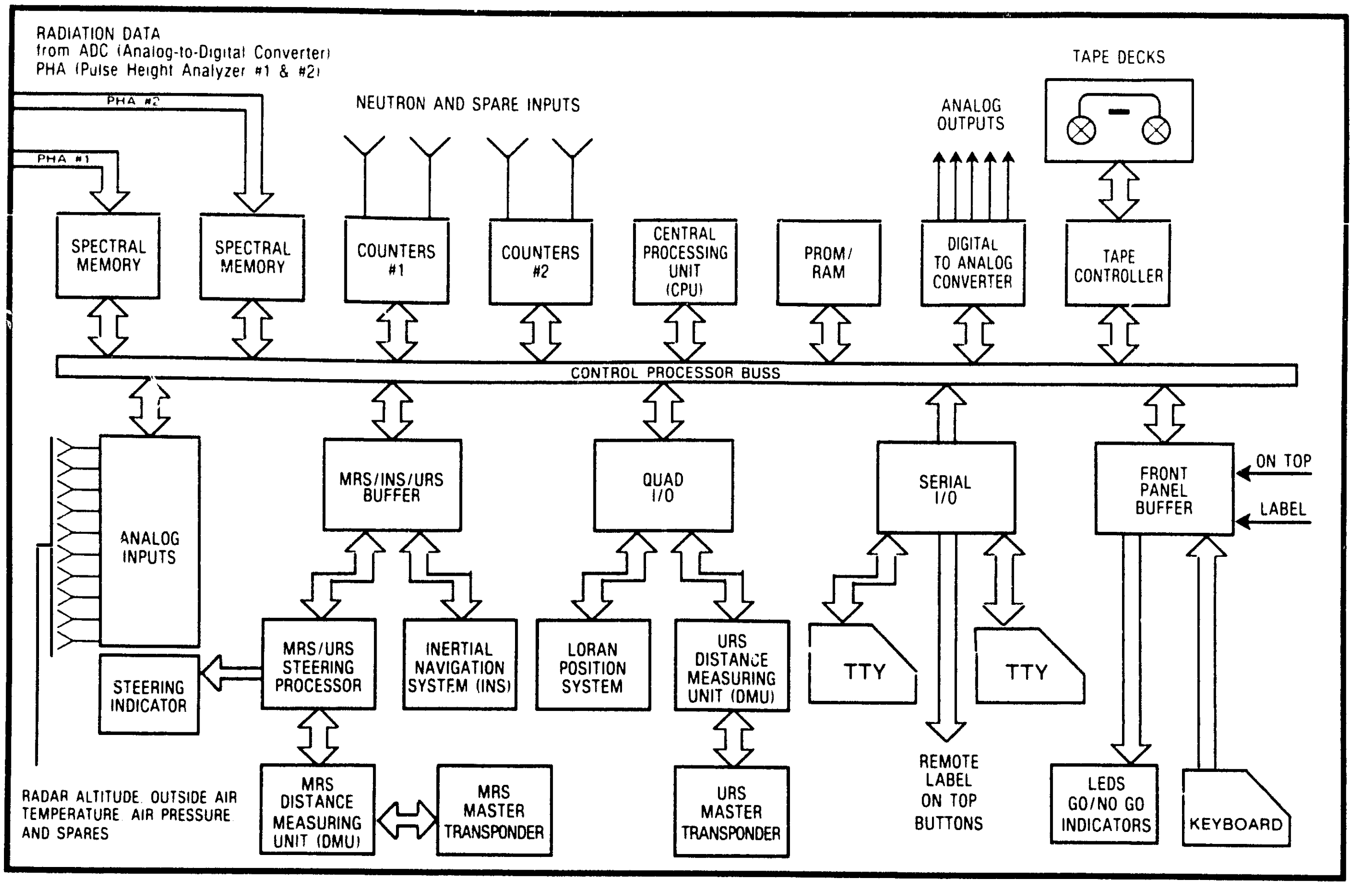

FIGURE 3. ***REDAR IV PROCESSOR SYSTEM BLOCK DIAGRAM***

Table 1. REDAR IV Spectral Data Compression

E_γ (keV) At Input Channel Center	Input Channel (linear @ 4 keV/channel)	Output Channel (compressed)	Output Channel Energy Coefficient ΔE (keV/channel)
0 - 300	0 - 75	0 - 75	4
304 - 1,620	76 - 405	76 - 185	12
1,624 - 4,068	406 - 1,017	186 - 253	36
4,072 - Cutoff	1,018 - 1,023	254	N/A
		255 (always zero)	

second. In subsequent computer processing, these distances were converted to position coordinates for the steering indicator to direct the aircraft along the predetermined flight lines.

The radar altimeter similarly measured the time lag for the return of a pulsed signal and converted this delay to aircraft altitude. For altitudes up to 610 meters, the accuracy was ±0.6 m or ±2%, whichever was greater. These data were also recorded on magnetic tape so that any variation in gamma signal strength caused by altitude fluctuations could be compensated. The detectors and electronics systems which accumulated and recorded the data are described in considerable detail in a separate publication.[1]

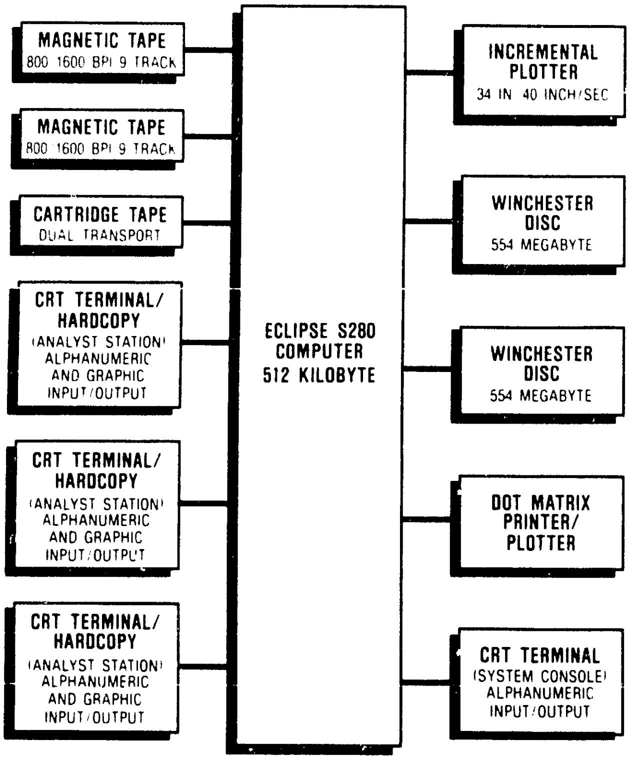

FIGURE 6. ***REDAC SYSTEM BLOCK DIAGRAM***

different ways: gross count, man-made gross counts, and cesium-137 (Cs-137) photopeak count rate extractions.

6.1 Gross Count

The gross count method was based on the integral counting rate in that portion of the spectrum between 38 and 3,026 keV. This count rate (measured at survey altitude) was converted to exposure rate (microroentgens/hour) at 1 meter above ground level by application of a predetermined conversion factor. This factor assumes a uniformly distributed source covering an area which is large compared with the field of view of the detector (approximately 100-200 meters at the survey altitude of 46 meters). The gross count conversion factor was derived for soils having natural mixes of radionuclides. This value will underestimate the exposure rate where both man-made and natural gamma emitters occur. For a finite source distribution which is small compared to the field of view of the detector system, it is necessary to modify the exposure rate values by utilizing the data in Table 2. The exposure rate values could be one or two orders of magnitude higher for a source localized in a small area.

Table 2. Correction Factors Versus Diameter of Source Activity

Diameter of Contaminated Circular Area (meters)	Correction Factor
5	300
10	100
25	10
50	6.5
100	2.5
200	1.2
300	1.0
>300	1.0

6.2 Man-Made Gross Count

The man-made gross count rate (MMGC) algorithm is designed to sense the presence of changes in spectral shape. Large changes in gross counting rates from natural radiation usually produce only small changes in spectral shape because the natural emitters change in more or less constant ratio as the detector moves from one location to another. The algorithm senses counts in the lower portion of the spectrum in excess of those predicted, on the premise that these counts bear a constant ratio to counts in the upper portion. Since the algorithm is designed to be most sensitive to man-made nuclides, the spectrum dividing line is chosen at an energy (1,394 keV) above which most long-lived, man-made nuclides do not emit gamma rays. It is analytically expressed as:

$$\text{MMGC} = \sum_{E\,=\,38\text{ keV}}^{1{,}394\text{ keV}} \text{counts}_E - K_m \sum_{E\,=\,1{,}394\text{ keV}}^{3{,}026\text{ keV}} \text{counts}_E$$

The counts in the upper energy window (1,394-3,026 keV) are multiplied by a constant, K_m, to equal the counts in the lower energy window (38-1,394 keV), and the resultant MMGC is equal to zero for areas containing naturally occurring gamma emitters. The man-made gross count algorithm is general and will respond to a wide range of nuclides. The result of using this generality is the lack of sensitivity to specific nuclides. If the search nuclide is known, more sensitive algorithms can be devised.

6.3 Cesium-137 Photopeak

The photopeak count rate from Cs-137 was determined by using two windows as shown in Figure 7. The background window, B, (746-1,250 keV) was used to remove counts due to natural and other man-made isotopes that appear in the Cs-137 photopeak window (494-746 keV). The photopeak count rate due to Cs-137 is equal to:

$$\text{Cs-137} = \sum_{E = 494\text{ keV}}^{746\text{ keV}} \text{counts}_E - K_c \sum_{E = 746\text{ keV}}^{1{,}250\text{ keV}} \text{counts}_E$$

Where K_c is analogous to K_m, in the previous equation.

This technique of photopeak count rate extraction calculates a deviation in the Cs-137 activity from the average worldwide fallout background for the survey area. The Cs-137 contours indicate activity above the average worldwide fallout for the WVDP area.

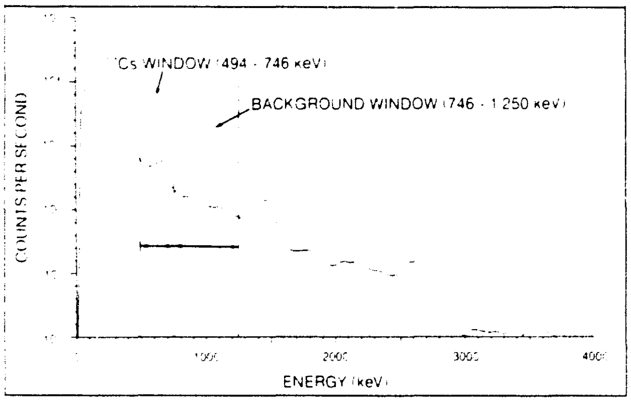

FIGURE 7. *TWO-WINDOW Cs-137 EXTRACTION*

7.0 MINIMUM DETECTABLE ACTIVITY

Table 3 indicates the minimum detectable activity for Cs-137 as a function of source geometry for the aerial system as employed in the WVDP survey. The radioactivity was assumed to be distributed exponentially with depth in soil, *i.e.*,

$$S_v = S_v^0 \, e^{-\alpha z}$$

where

S_v^0 = the soil activity per gram at the surface
S_v = the soil activity per gram at a depth, z
α = the reciprocal of the relaxation depth

The total activity per unit area can then be written as:

$$S_A = \rho \int_0^\infty S_v dz = \left(\frac{S_v^0}{\alpha}\right) \rho$$

where ρ is the soil density. It was assumed in Table 3 that no additional shielding existed between the source and the detector array. It was further assumed that distributed sources were spread over an area comparable to several times the survey altitude.

Table 3. Minimum Detectable Activity for Cesium-137 as a Function of Source Geometries

	Minimum Detectable Activity[a]		
Isotope	**Point Source (mCi)**	**Surface Source (μCi/m^2)**	**Uniform Volume Source (pCi/g)**
^{137}Cs	0.9	.07	0.9

[a] Assuming a survey altitude of 46 meters

8.0 CONVERSION FACTORS

The photopeak count rates for Cs-137 can be converted to the appropriate term depending on the geometry of the source by using the data in Table 4.

The conversion factors for Cs-137 are broken into finer increments of relaxation depths for units of γ/cm^2-sec, μCi/m^2, and pCi/g in Table 5.

The conversion factors for Cs-137 activity assume a uniformly distributed source laterally covering an area which is large compared to the

Table 4. Conversion Factors Relating Aerial Photopeak Count Rate Data to Radionuclide Concentrations on the Ground for a Variety of Source Distributions and Geometries

	Conversion Factor[a]								
	Point Source on Surface $\frac{\mu\text{Ci}}{\text{cps}}$		Uniform Surface Distribution		Exponential Distribution			Uniform Volume Distribution	
Radionuclide	Directly under aircraft	At lateral distance of 20 m	$\frac{\mu\text{Ci/m}^2}{\text{cps}}$	$\frac{\mu\text{R/h}^{b}}{\text{cps}}$	Relaxation depth (cm)	$\frac{\mu\text{Ci/m}^2}{\text{cps}}$	$\frac{\mu\text{R/h}^{b}}{\text{cps}}$	$\frac{\text{pCi/g}}{\text{cps}}$	$\frac{\mu\text{R/h}^{b}}{\text{cps}}$
^{137}Cs	13.6	16.9	1.0 (10^{-3})	1.1 (10^{-2})	0.1	1.0 (10^{-3})	1.1 (10^{-2})	1.4 (10^{-2})	8.8 (10^{-3})
					1.0	1.3 (10^{-3})	7.7 (10^{-3})		
					10.0	3.1 (10^{-3})	7.3 (10^{-3})		

[a] Conversion factors are given for the twenty 12.7-cm × 5-cm NaI(Tl) detector array at an altitude of 46 meters, assuming an air density of 1.153 g/l and a soil density of 1.6 g/cm^3 (10% soil moisture content). All results given are an average between those computed for an isotropic and for a cosine detector angular response.

[b] At the meter level, assuming a smooth air-ground interface (*i.e.*, no surface roughness).

Table 5. Cesium-137 Photopeak Count Rate Conversion Factors[a]

Relaxation Depth α(cm^{-1})	γ/cm^2-sec	μCi/m^2	pCi/g
Infinite[b]	.0032	.0010	—
10.00	.0033	.0010	.6931
3.03	.0035	.0011	.2216
2.00	.0036	.0011	.1518
1.00	.0039	.0013	.0837
0.33	.0053	.0017	.0376
0.20	.0066	.0021	.0282
0.14	.0079	.0025	.0241
0.10	.0099	.0031	.0209
0[c]	—	—	.0136

[a] Per count per second in the detector system at an altitude of 46 meters (150 ft)

[b] Represents a surface source

[c] Represents a uniform volume source

detector field of view (approximately 100-200 meters at a survey altitude of 46 meters). For finite source distributions which are small compared to the detector field of view, it is necessary to modify the values by utilizing Table 6. For a given count rate at altitude, the activity is significantly higher for a source localized in a small area.

Table 7 gives the point source conversion factor for a Cs-137 source on the surface of the ground for various lateral displacements up to 60 meters (200 feet). Actual point source activity could vary by a factor of 3.7, depending on source location relative to the actual flight path of the helicopter with 76-meter (250-foot) line spacings.

Conversion factors for various soil sample depths and relaxation depths of the Cs-137 source in the soil are given in Figure 8. The units are in picocuries per gram of soil per counts per second.

Table 6. Finite Cesium-137 Source Correction Factors Versus Area of Contamination for Various Relaxation Depths

Source Diameter (meters)	Correction Factor					
	$\alpha = 0\ \text{cm}^{-1}$	$\alpha = 1\ \text{cm}^{-1}$	$\alpha = 5\ \text{cm}^{-1}$	$\alpha = 10\ \text{cm}^{-1}$	$\alpha = 50\ \text{cm}^{-1}$	$\alpha = 1{,}000\ \text{cm}^{-1}$
10	126.6	114.9	96.2	88.5	78.7	75.2
20	35.0	31.5	26.5	24.5	21.7	20.8
40	9.2	8.3	7.1	6.6	5.9	5.7
60	5.0	4.5	3.9	3.6	3.3	3.2
80	3.3	3.0	2.6	2.5	2.3	2.2
100	2.6	2.3	2.0	1.9	1.8	1.7
140	1.8	1.6	1.5	1.4	1.4	1.4
180	1.5	1.4	1.3	1.3	1.2	1.2
300	1.2	1.1	1.1	1.1	1.1	1.0
>300	1.0	1.0	1.0	1.0	1.0	1.0

Table 7. Cesium-137 Surface Point Source Conversion Factors

Lateral Displacement (meters)	mCi per counts per second[a]
0	.0136
10	.0143
20	.0169
30	.0212
40	.0279
50	.0374
60	.0502

[a] Assuming an aircraft velocity of 36 m/sec and an altitude of 46 m (150 ft).

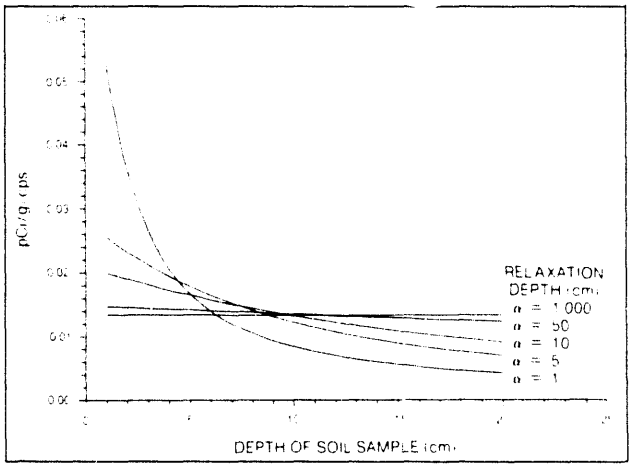

FIGURE 8. *SOIL SAMPLE ACTIVITY CONVERSION FACTORS FOR Cs-137*

9.0 GROUND-BASED MEASUREMENTS

Exposure rates were measured and soil samples collected at four locations during the WVDP survey to support the integrity of the aerial results. The locations for the ground-based measurements were chosen to be in areas which were assumed to exhibit only a normal background radiation level and were away from any obvious anomalies. A Reuter-Stokes pressurized ionization chamber was used for each exposure measurement at a 1-meter height at the center of a 120-meter (396-foot) diameter measurement area. Soil samples, to a depth of 15 cm, were also obtained at the center and at four points of the compass in the circumference of the circular area. The soil samples were dried, and their gamma activities were measured using a germanium-based detector system located at EG&G/EM's Santa Barbara laboratory. Detailed descriptions of the systems and procedures used for soil sample data collection and analyses are outlined in separate publications[2,3,4].

10.0 NATURAL BACKGROUND

Natural background radiation originates from radioactive elements present in the earth, airborne radon, and cosmic rays entering the earth's atmosphere from space.

The natural terrestrial radiation levels depend upon the type of soil and bedrock found immediately below and surrounding the point of measurement. Within cities, the levels are also dependent on the nature of street and building materials. The gamma radiation originates primarily from the uranium decay chain, the thorium decay chain, and radioactive potassium. Local concentrations of these nuclides produce radiation levels at the surface of the earth typically ranging from 1 to 15 μR/h (9 to 130 mrem/y).[5] Some areas with high uranium and/or thorium concentrations in the surface minerals exhibit even higher radiation levels, especially in the western states.

One member of both the uranium and thorium radioactive decay chains is an isotope of radon, a noble gas, which can both diffuse through the soil and travel through the air to other locations. Therefore, the level of airborne radiation due to these radon isotopes and their daughter products at any specific location depends on a variety of factors, including meteorological conditions, mineral content of the soil, and soil permeability. Typically, airborne radon contributes from 1 to 10% of the natural background radiation levels.

Cosmic rays, the space component, interact with elements of the earth's atmosphere and soil. These interactions produce an additional natural source of gamma radiation. Radiation levels due to cosmic rays vary with altitude and geomagnetic latitude. Typically values range from 3.3 μR/h at sea level in Florida to 12 μR/h at an altitude of 3 km (1.9 miles) in Colorado.[6]

11.0 DISCUSSION OF RESULTS

The results of the WVDP Site aerial radiological survey are detailed in later sections of this report and include a comparison of results from the 1979 survey.[7] The results of the Cattaraugus Creek Survey were presented to the DOE Project Office in June of 1985 in the form of an informal summary report[8] and will not be discussed in this report except in relation to the site survey which includes the portion of the Cattaraugus Creek that indicated levels approaching two times the worldwide fallout levels of Cs-137.

11.1 1984 Site Survey Results

The results of the 1984 aerial radiological survey conducted over the WVDP survey area are presented as contours of terrestrial gamma exposure rates and net Cs-137 counts superimposed on an aerial photograph of the site.

The gamma exposure rate contours (Figure 9) report the total external exposure rate (assuming uniformly distributed terrestrial sources) in μR/h extrapolated to 1 meter above ground level and include an estimated cosmic ray exposure rate of 3.9 μR/h. The exposure rates reported over highly localized sources of radiation may be underestimated due to the large-area averaging by the aerial detection system. A typical natural background gamma energy spectrum for the survey area is shown in Figure 10.

The total terrestrial gamma background ranged from approximately 5 to 11 μR/h. It should be noted the terrestrial exposure rate was normalized to 1 meter above ground, but only as a large area average. Aerial systems integrate radiation levels over an area whose diameter may be 10 times the height of the platform above ground. This is a function of gamma ray energy, their birth within the soil matrix, and the response characteristics of the detector package. For activity fairly uniformly distributed over large areas, which is typical of natural background radiation, the agreement between ground-based readings and those inferred from aerial data is generally quite good. Because of the large area integration of the airborne system, however, localized anomalies will appear to be spread over a larger area with lower activity than actually exists on the ground. Therefore, for localized anomalies, ground-based measurements will not agree very well with the aerial results. The aerial data, therefore, simply serve to identify the existence of such anomalies. Ground-based surveys are required for more accurate definition of the spatial extent of the anomaly. As indicated in Figure 9, there are areas where the total terrestrial exposure rate is considerably higher than the normal background range. The areas of higher than background exposure rate are attributed to man-made sources of radiation on the

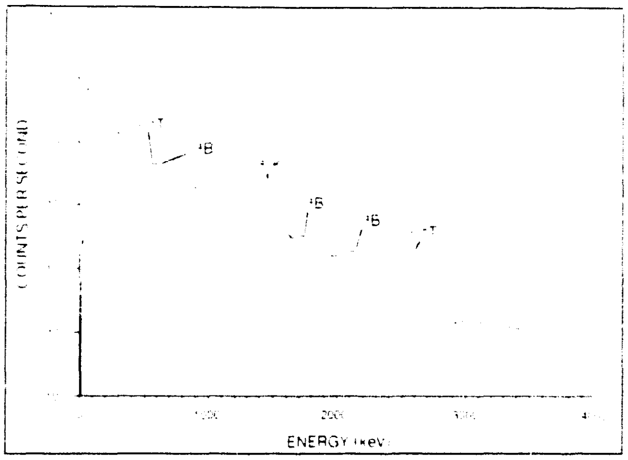

FIGURE 10. ***GAMMA RAY ENERGY SPECTRUM TYPICAL OF THE NATURAL BACKGROUND IN THE SURVEY AREA***

ground, such as the burial and storage areas located within the facility, and can primarily be attributed to Cs-137.

The MMGC algorithm was used to search the WVDP aerial survey data for man-made gamma emitters. The contours produced via this method did not reveal as much detail as the excess Cs-137 net rate contours and are not presented in this report.

The Cs-137 net count rate contour map of the WVDP Site is shown in Figure 11. As expected, the Project Site indicates higher than background levels of Cs-137. As stated before, due to the large area averaging inherent in the aerial measuring system, the spatial extent of the Cs-137 on the ground in the general area of the plant site is overemphasized for very localized sources. Section 8 of this report has several conversion tables for different source diameters and depth distributions to correct for those areas on the plant site of known contamination. Two separate extensions to the northwest of the project site indicate small concentrations of Cs-137. They are: Buttermilk Creek, to the confluence of the Cattaraugus Creek, and an area adjacent to Buttermilk Creek in a general northwest direction along Rock Springs Road. Figures 12 through 16 are net Cs-137 spectra for the areas labeled Area 1 through 5 on Figure 11.

11.2 Ground-Based Measurements

Ion chamber measurements and soil samples were collected at four sites within the survey boundaries during the aerial survey. The site locations (Numbers 1 through 4) are labeled in Figure 9. The soil samples were dried and counted on a calibrated gamma spectrometer in the laboratory. The soil analysis exposure rates were computed from the primary isotopic concentrations in the soil samples and include the effect of soil moisture. The calculated soil exposure rate values are compared with ion chamber measurements and the aerial measurements in Table 8. These exposure values represent the terrestrial plus cosmic components only.

The isotopic and ion chambers measurements generally agree with the aerial measurement interval at each site. There are several contributors to differences among the measurement methods:

1. The aerial data were not taken at exactly the same places and times as the ground data.
2. Each one-second data point obtained with the airborne system covers an area several thousand times as large as a measurement made at 1 meter, such as with a survey meter, and several million times as large as a typical soil sample.
3. Since only a limited number of soil samples were taken, statistical deviations are significant.
4. Ground cover reduces the computed isotopic exposure by as much as 5 percent.

Table 9 presents the results of the soil sample analysis.

11.3 Comparison of 1979 and 1984 Results

The most recent aerial survey of the WVDP site (formerly the Nuclear Fuels Service Center) prior to this 1984 survey was conducted in September of 1979. The results of that survey were reported in Reference 7. For purposes of direct comparison, the 1979 aerial survey results for excess Cs-137 had been reprocessed for equivalent

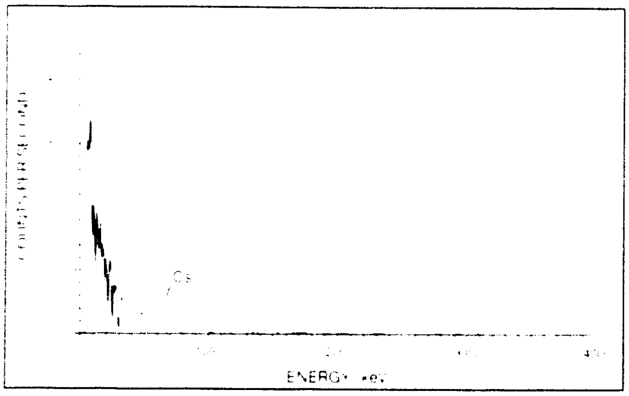

FIGURE 12. ***NET GAMMA RAY SPECTRUM OF AREA 1***

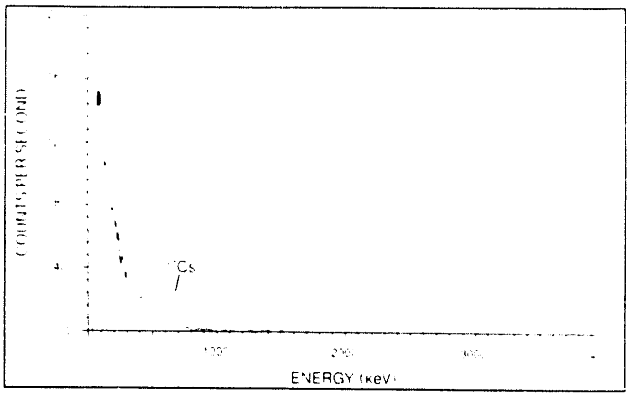

FIGURE 14. ***NET GAMMA RAY SPECTRUM OF AREA 3***

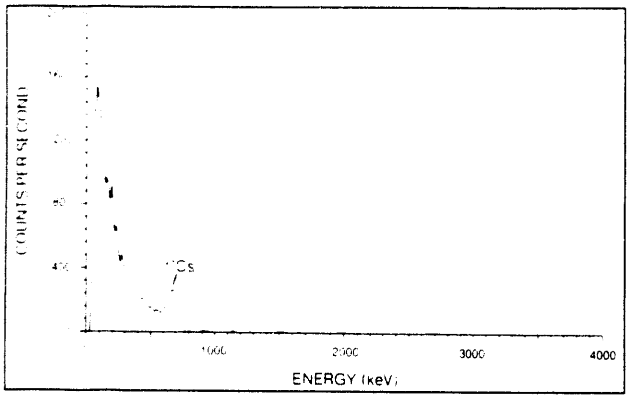

FIGURE 13. ***NET GAMMA RAY SPECTRUM OF AREA 2***

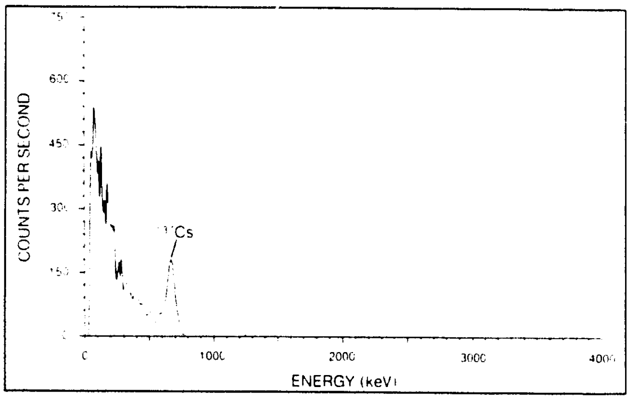

FIGURE 15. ***NET GAMMA RAY SPECTRUM OF AREA 4***

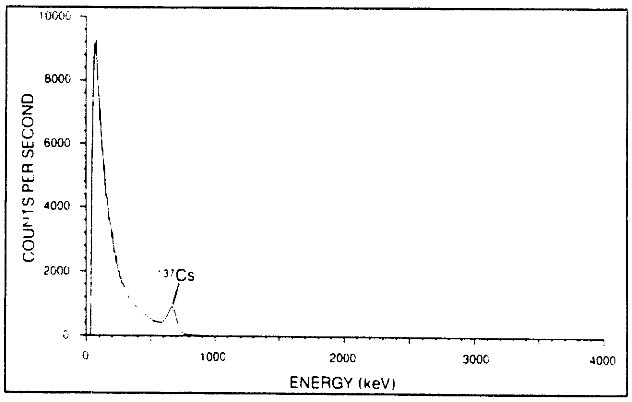

FIGURE 16. ***NET GAMMA RAY SPECTRUM OF AREA 5***

Table 8. Comparison of Aerial and Ground-Based Measurements			
	Exposure Rate (μR/h at 1 meter Above Ground Level)		
Sample Location[a]	Soil Analysis[b,c]	Ion Chamber[d]	Inferred Aerial Data
1	9.3 ± 0.5	8.9 ± 0.5	9 - 11
2	9.7 ± 0.6	9.3 ± 0.5	9 - 11
3	8.9 ± 0.6	9.3 ± 0.5	9 - 11
4	8.4 ± 0.9	8.9 ± 0.5	9 - 11

[a] See site locations in Figure 9.

[b] Includes a cosmic ray contribution of 3.9 μR/h

[c] Includes a moisture correction of the form 1/1 + m

[d] Reuter-Stokes Model RSS-111, Serial No. R574

Table 9. Results of Soil Sample Analysis					
	Soil Sample Analysis (Average Values)				
Site[a]	Soil Moisture (%)	U-238 (ppm)	Th-232 (ppm)	Cs-137 (pCi/g)	K-40 (pCi/g)
1	24 ± 2	2.3 ± 0.3	8.6 ± 0.8	0.43 ± 0.05	13.6 ± 0.5
2	21 ± 2	2.3 ± 0.4	9.4 ± 1.0	0.63 ± 0.09	14.4 ± 1.2
3	23 ± 3	2.2 ± 0.6	8.0 ± 0.7	0.45 ± 0.26	13.5 ± 0.9
4	27 ± 5	1.8 ± 0.6	7.2 ± 1.8	0.47 ± 0.14	13.4 ± 2.3

[a] See site locations in Figure 9

levels of excess Cs-137 as presented in Figure 11. Figure 17 indicates the reprocessed 1979 net count rate contours for Cs-137. Although the net count rates between the 1979 and 1984 survey are different, the letter labels represent equivalent Cs-137 concentrations on the ground.

The 1979 survey encompassed a slightly smaller survey area. In addition, the survey altitude was 61 meters (200 feet) AGL versus 46 meters (150 feet) AGL in 1984. This higher survey altitude in 1979 accounts for the slightly lower net count rates for Cs-137. In directly comparing both the 1979 and the 1984 excess Cs-137 contours (Figures 17 and 11, respectively), there does not appear to be any appreciable difference between the two, aside from the fact that the 1984 survey covers a slightly larger area.

APPENDIX A

WVDP SITE SURVEY PARAMETERS

Survey Site:	West Valley Demonstration Project Site West Valley, New York
Survey Coverage:	63 square kilometers (24 square miles)
Survey Date:	August 23 through September 6, 1984
Survey Altitude:	46 meters (150 feet)
Aircraft Speed:	36 meters/sec (118 ft/sec) (70 knots) (81 mph)
Line Spacing	76 meters (250 feet)
Line Length:	8.8 kilometers (5.5 miles)
Line Direction:	North-South
Number of Lines:	57
Total Flight Line Miles:	314
Detector Array:	Twenty 12.7-cm × 5.1-cm (5-in × 2-in) NaI(Tl) detectors
Acquisition System:	REDAR IV
Aircraft:	MBB BO-105 Helicopter (Tail Number: N40EG)
Survey Crew:	H. Berry, W. Vincuilla, C. Bluitt, R. Young, K. Roesner, B. Green, R. Smith, W. Farley, and R. Rae

Data Processing:

1. Gross Count Window: 38 to 3,026 keV
2. Conversion Factor: 1001 cps/μR/h
3. Cosmic Contribution: 3.9 μR/h
4. Cs-137 Window: 494 to 746 keV

REFERENCES

1. Boyns, P.K. 1976. *The Aerial Radiological Measuring System (ARMS): Systems, Procedures and Sensitivity*. Report No. EGG-1183-1891. Las Vegas, NV: EG&G/EM.

2. Mohr, R., *et al.* 1976. *Ground Survey Procedures*. Report No. EGG-1183-2339. Santa Barbara, CA: EG&G/EM.

3. Quam, W. and K. Engberg, October 1978. *Low Background Ge(Li) Detector with Anticoincidence NaI Annulus*. Report No. EGG-1183-2326. Santa Barbara, CA: EG&G/EM.

4. *Low Background Ge(Li) Detector Gamma-Ray Spectroscopy System With Sample Changer*. Report No. EGG-1183-2383. Santa Barbara, CA: EG&G/EM.

5. Lindeken, C.L., *et al.* August 1972. "Geographical Variations in Environmental Radiation Background in the United States," *Proceedings of the Second International Symposium on the Natural Radiation Environment*, August 7-11, 1972, Houston, TX. pp. 317-332. Springfield, VA: National Technical information Service, U.S. Department of Commerce.

6. Klement, A.W., *et al.* August 1972. *Estimate of Ionizing Radiation Doses in the United States 1960-2000*. U.S. EPA Report ORD/CD 72-1. Washington, D.C.: Environmental Protection Agency.

7. *A Comparison of Aerial Radiological Survey Results of the Nuclear Fuels Services Center (NFS) and Surrounding Area*. June 1981. Report No. EG&G Survey Report EP-F 001. EG&G/EM.

8. Lamonds, H.A. June 21, 1985. Informal Summary Report. Las Vegas, NV: EG&G/EM.

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