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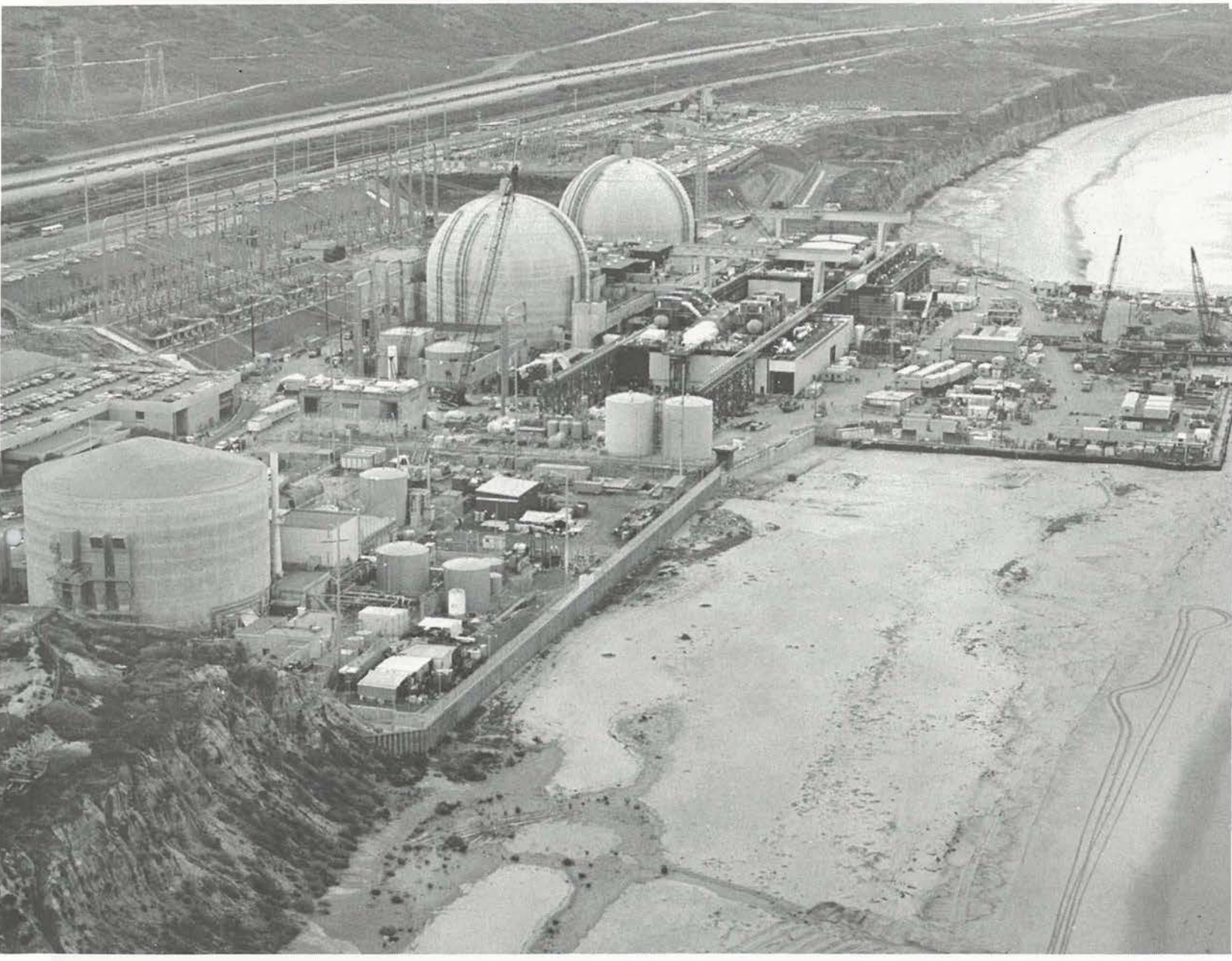

AN AERIAL RADIOLOGICAL SURVEY OF THE

SAN ONOFRE NUCLEAR GENERATING STATION

AND SURROUNDING AREA

SAN CLEMENTE, CALIFORNIA

DATE OF SURVEY: 9-17 JANUARY 1980

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L. K. Hilton
Project Scientist

APPROVED FOR PUBLICATION

T. P. Stuart, Manager
Remote Sensing Sciences Department

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G. P. Stobie
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ABSTRACT

An airborne radiological survey of an 11 km^2 area surrounding the San Onofre Nuclear Generating Station was made 9-17 January 1980.

Count rates observed at 60 m altitude were converted to exposure rates at 1 m above the ground and are presented in the form of an isopleth map.

Detected radioisotopes and their associated gamma ray exposure rates were consistent with that expected from normal background emitters, except directly over the plant.

CONTENTS

1.0 INTRODUCTION

The United States Department of Energy (DOE) maintains an aerial surveillance operation called the Aerial Measuring System (AMS). AMS is operated for DOE by EG&G. This continuing nationwide program, started in 1958, involves surveys to monitor radiation levels in and around facilities producing, utilizing, or storing radioactive materials. The purpose of the survey is to document, at a given point in time, the location of all areas containing gamma emitting radioactivity (visible at the surface) and to aid local personnel in evaluating the magnitude and spatial extent of any radioactive contaminants released into the environment. At the request of DOE, other federal agencies (such as the United States Nuclear Regulatory Commission), and state agencies AMS is deployed for various aerial survey operations.

The measurements reported here were made from a base of operations at the Camp Pendelton Air Base southeast of San Clemente, California, on 17 January 1980. At the time of this survey the reactor was shut down.

This is the second radiological survey made by AMS of the San Onofre Nuclear Generating Station: the first was made from a fixed wing aircraft in April 1976 and reported in EG&G report number EGG-1183-1731.

2.0 SITE LOCATION

An 11 km^2 area was surveyed: this was centered over the San Onofre Nuclear Generating station. The plant is located on the Pacific Coast 7 km southeast of San Clemente, California.

The facility is owned by the Southern California Edison and San Diego Gas and Electric Companies. It is operated by Southern California Edison.

3.0 SURVEY METHOD AND AIRBORNE EQUIPMENT

Contiguous USGS maps were used to define the survey area (scale 1:24,000). A total of 23 flight lines paralleling the coastline, each 5.5 km long with 90 m spacing, were flown at 60 m altitude.

The survey vehicle, a Hughes H-500 helicopter (Figure 1) carried a pilot, navigator, and a lightweight version of the Radiation and Environmental Data Acquisition and Recorder system (REDAR). Two pods were mounted on the sides of the helicopter; each pod contained ten NaI (Tl) detectors. The crystal in each detector is 12.7 cm in diameter and 5.1 cm in height. Gamma ray signals from the twenty detectors were summed and routed through an analog-to-digital converter and pulse-height analyzer. Gamma ray counting rates and energy spectral data were accumulated in 1 second intervals and recorded on magnetic tape.

Figure 1. *HUGHES H-500 SURVEY HELICOPTER*

The helicopter position was established with two systems: a Trisponder/202A Microwave Ranging System (MRS) and an AI-101 radio altimeter. The Trisponder master station mounted in the helicopter interrogated two remote transceivers mounted at stationary positions overlooking the survey area. By measuring the round trip propagation time between the master and remote stations the master computed the distance to each. These distances were also recorded on magnetic tape each second. In subsequent computer processing they were converted to position coordinates.

In like manner the radio altimeter measured the time lag for the return of a pulsed signal and converted this to aircraft altitude. For altitudes up

to 150 m, the accuracy was ± 0.6 m or ± 2%, whichever is greater. These data were also recorded on magnetic tape so that any variations in gamma signal strength caused by altitude fluctuation could be compensated accurately.

The detectors and electronic systems which accumulate and record the data are described briefly here. They are described in detail in a previous report.*

4.0 DATA PROCESSING

Data processing was done with the Radiation and Environmental Data Analysis Computer system (REDAC). This is a computer based analysis laboratory mounted in a mobile van (Figure 2). The van and aircraft were based at the Camp Pendelton Air Base southeast of San Clemente, California.

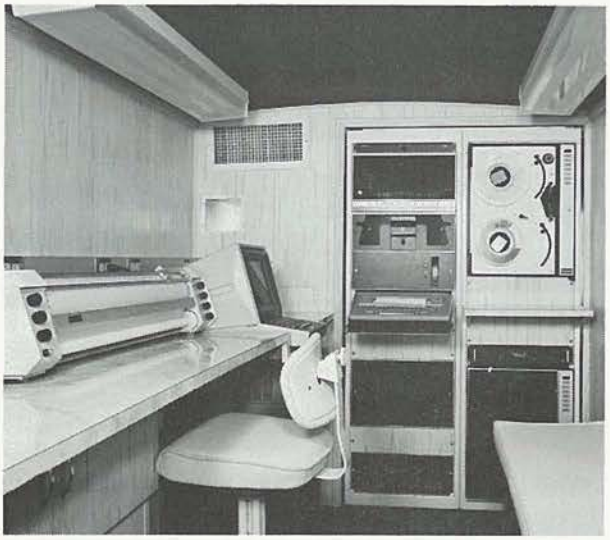


Figure 2. *MOBILE COMPUTER PROCESSING LABORATORY*

The REDAC consists primarily of a Data General NOVA 840 computer system, four tape drives, two Calcomp plotters and a Tektronics CRT display screen. The computer has a 32 k-word core memory and an additional 1.2 x 10^6-word disc memory. An extensive collection of software routines is available for data processing.

The exposure rate isopleths shown in Figure 3 were constructed from gross counting rate numbers, which refer to integral counting rates in that portion of the gamma ray energy spectrum between .05 MeV and 3.0 MeV. The terrestrial component of the gross counting rate was extracted by subtracting counting rates measured over the ocean.

The terrestrial component of the counting rate was converted to exposure rates at 1 m altitude with the factor 1024 counts per second per μR/h, a number obtained from calibration data over a Nevada test range. The cosmic ray component was added to the terrestrial component to produce the isopleths shown in Figure 3.

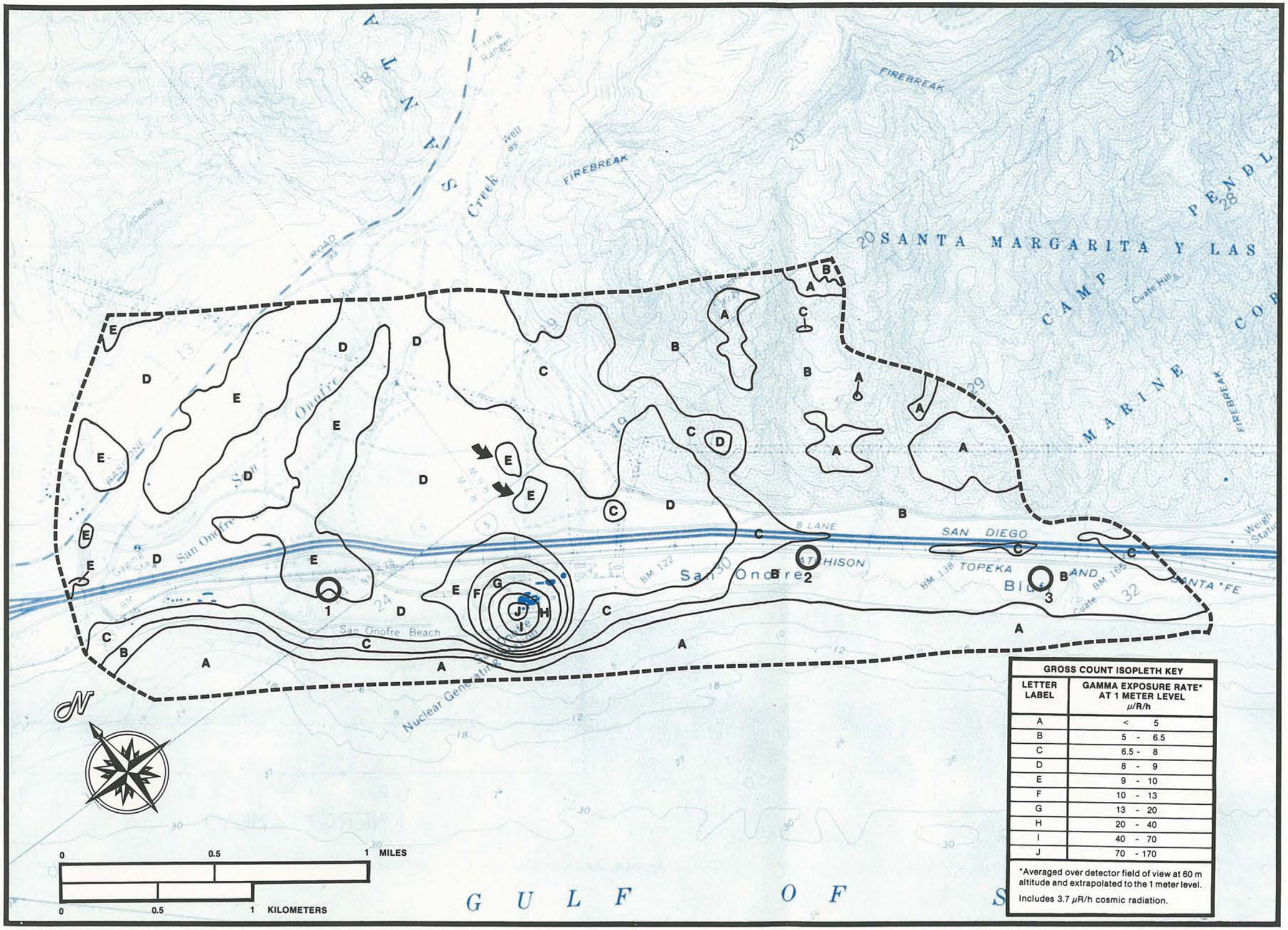
5.0 DISCUSSION AND RESULTS

Except for an area centered on the plant, the radiation levels shown in Figure 3 are consistent with the natural background normally found within areas having similar geological bases.

The areas surrounding the plant were included in both the 1976 and 1980 surveys. The resulting two sets of data show excellent agreement, even though different aircraft, flight altitudes, and detector systems were used for each survey. The 1976 fixed wing survey results indicated the natural background radiation around the plant was from 6.6 to 8.6 μR/h. The 1980 results indicated values from 6.5 to 10 μR/h. The fixed wing survey was flown at a high altitude and brought more ocean within the detectors' field of view. The ocean has very low background counting rates compared to land.

The E level areas to the northeast of the generating station are marked with arrows in Figure 3: these areas show a slight increase in activity, which appears to be due to airborne radionuclides. The background-subtracted energy spectra from these areas are consistent with the spectra from xenon 133 and 135. The data presented in Figure 3 was taken on 17 January 1980. On that date the National Weather Service reported wind from the southwest at Newport Beach (40 km north of San Onofre) at 1:00 p.m. However, on 16 January 1980 at 1:00 p.m. the wind was from the southeast: data taken on 16 January showed areas of increased activity

*Boyns, P.K. July 1976. The Aerial Radiological Measuring System (ARMS): Systems, Procedures, and Sensitivity (1976). Report No. EGG-1183-1691. EG&G, Las Vegas, NV.



GROSS COUNT ISOPLETH KEY	
LETTER LABEL	GAMMA EXPOSURE RATE* AT 1 METER LEVEL μR/h
A	< 5
B	5 - 6.5
C	6.5 - 8
D	8 - 9
E	9 - 10
F	10 - 13
G	13 - 20
H	20 - 40
I	40 - 70
J	70 - 170

*Averaged over detector field of view at 60 m altitude and extrapolated to the 1 meter level.

Includes 3.7 μR/h cosmic radiation.

Figure 3. *GROSS COUNT ISOPLETH MAP OF THE STATION AND SURROUNDING AREA*

northwest of the generating station and terrestrial background only to the northeast.

Figure 4 presents the background gamma ray energy spectrum typical of the area near the plant. Figure 5 presents the gamma ray energy spectrum from the area of increased activity directly over the plant. The background shown in Figure 4 has been subtracted from the spectrum shown in Figure 5. The photopeaks assumed to be from ^{60}Co, ^{58}Co, and ^{137}Cs are prominent in this spectrum

Table 1 presents ground level measurements at three locations marked in Figure 3.* Aerial measurements over the same locations appear in the last column of Table 1. Agreement is excellent between ground and aerial measurements.

**Ground based measurements were made by EG&G, Santa Barbara.*

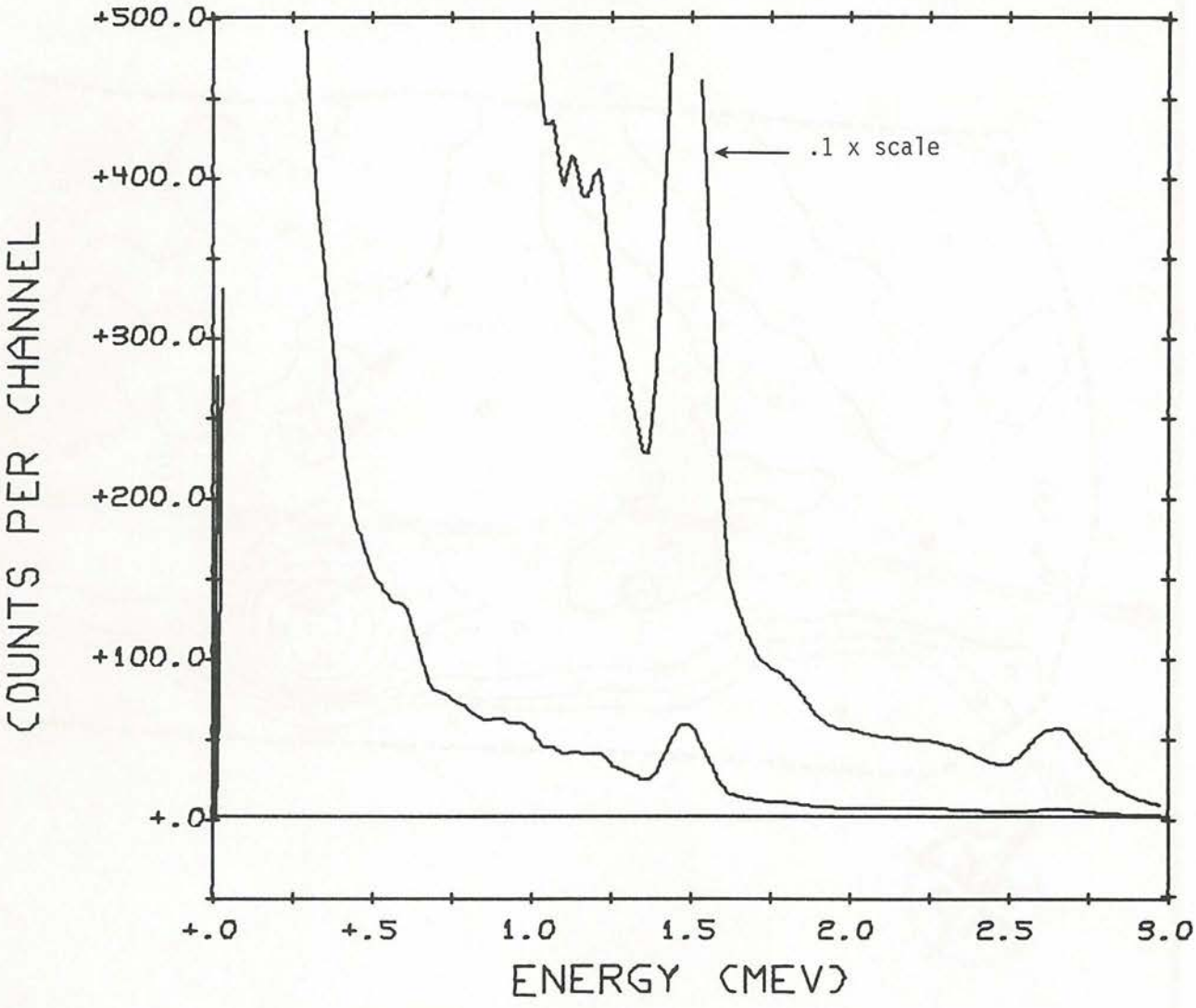


Figure 4. *BACKGROUND GAMMA RAY ENERGY SPECTRUM TYPICAL OF THE AREA NEAR THE STATION*

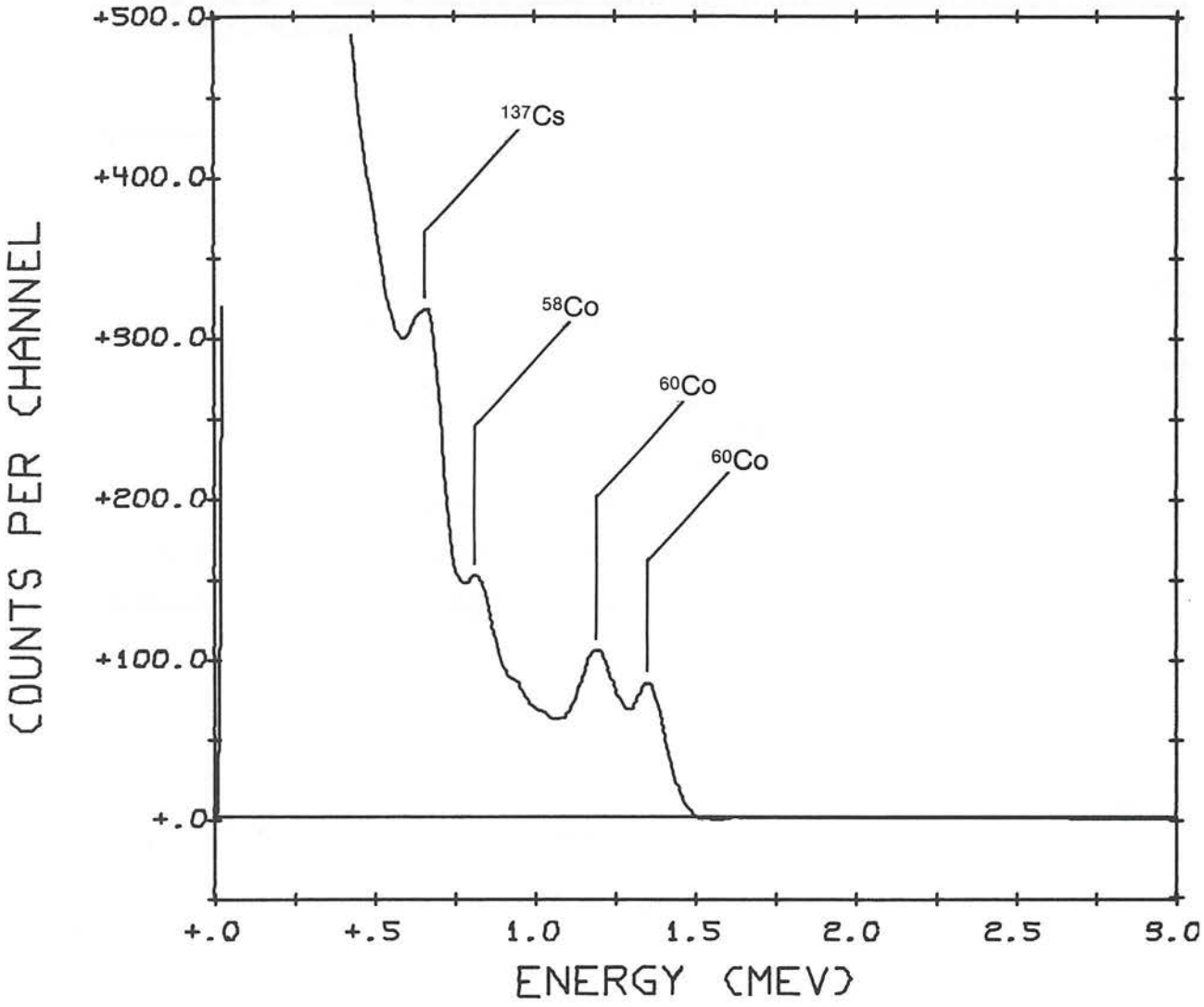


Figure 5. *GAMMA RAY ENERGY SPECTRUM WITH BACKGROUND SUBTRACTED OBSERVED OVER THE STATION*

TABLE 1. GROUND BASED RADIOLOGICAL MEASUREMENTS
San Onofre Power Station
San Clemente, CA
10 January 1980

Site Number	Soil Moisture %	Ground Survey Gamma Exposure Rate (μR/h)		Aerial Measured Gamma Exposure Rates (μR/h)
		Ion Chamber[1]	Soil Analysis Estimate[2]	
1	11.7	10.0	10.3	8 - 10
2		6.62	no data	5 - 6.5
3	15.4	6.62	5.91	5 - 6.5

[1]Reuter Stokes Model RSS-111, Serial #R574.
[2]Includes cosmic ray contribution of 3.5 μR/h.

Site Location, Description and Weather (See topographic maps for locations.)

Site 1: Gravel bluff, no significant vegetation. Mostly cloudy, wind from W, 60-65° F.

Sites 2 and 3: Sandy bluff, 3-4 foot native bushes. Overcast, still air, evidence of recent rain, 60-65° F.

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