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EG&G ENERGY MEASUREMENTS

EGG-10617-1219
APRIL 1993

AN AERIAL RADIOLOGICAL SURVEY OF THE QUAD CITIES NUCLEAR POWER STATION AND SURROUNDING AREA

CORDOVA, ILLINOIS

DATE OF SURVEY: MAY 1989

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This work was performed by EG&G/EM for the United States Nuclear Regulatory Commission through an EAO transfer of funds to Contract Number DE-AC08-93NV11265 with the United States Department of Energy.

ABSTRACT

An aerial radiological survey was conducted over the Quad Cities Nuclear Power Station in Cordova, Illinois, during the period May 9 through May 18, 1989. The survey was conducted at an altitude of 61 meters (200 feet) over a 65-square-kilometer (25-square-mile) area centered on the power station. The purpose of the survey was to document the terrestrial gamma environment of the Quad Cities Power Station and surrounding area and to determine any radiological impact on the area over the past twenty years.

The results of the aerial survey are reported as inferred gamma radiation exposure rates at 1 meter above ground level in the form of a contour map. Outside the plant boundary, exposure rates were found to vary between 5 and 15 microroentgens per hour (μR/h) and were attributed to naturally-occurring uranium, thorium, and radioactive potassium gamma emitters.

The aerial data were compared to ground-based "benchmark" exposure rate measurements and radionuclide assay of soil samples obtained within the survey boundary. The ground-based measurements were found to be in good agreement with those inferred from the aerial measuring system.

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1.0 INTRODUCTION

An aerial radiological survey of the Quad Cities Nuclear Power Station and surrounding area in Cordova, Illinois, was conducted during the period May 9 through May 18, 1989, at the request of the United States Nuclear Regulatory Commission (NRC). The survey was performed using the Aerial Measuring System[1] (AMS) operated by EG&G Energy Measurements, Inc. (EG&G/EM) for the United States Department of Energy (DOE). EG&G/EM routinely conducts aerial surveys for the Department of Energy, the Nuclear Regulatory Commission, and other U.S. government agencies as part of an ongoing nationwide program to map and document the radiological conditions at various nuclear sites. Aerial radiological surveys have been effective in detecting regions of enhanced radiation, determining average ground-level exposure rates, and identifying specific radionuclides associated with regions of anomalous radiation levels.

The Quad Cities Nuclear Power Station is jointly owned by Commonwealth Edison Company (75%) and Iowa-Illinois Gas and Electric Company (25%). The power station contains two General Electric boiling water reactors (BWR), each capable of producing 769 million watts of electrical power. The two units were ready for operation in 1972 and began serving the local communities in February 1973. The power station is situated on 784 acres on the east bank of the Mississippi River, approximately 6.4 kilometers (4 miles) north of the city of Cordova, Illinois.

In 1968, prior to the initial start-up phase, a large-area aerial radiological survey (625 square miles) was conducted over the proposed site for the Quad Cities Nuclear Power Station. The aerial survey was flown at an altitude of 91 meters (300 feet) above ground level (AGL) with a 1.6-kilometer (1-mile) line spacing using a Beechcraft Twin Bonanza aircraft. Data collected during the survey were used to document the radiological baseline at the future plant site and surrounding area.

The present aerial survey was flown at an altitude of 61 meters (200 feet) using a grid pattern composed of parallel flight lines spaced 107 meters (350 feet) apart to cover the 65-square-kilometer (25-square-mile) area. The aerial data were used to derive exposure rates at 1 meter AGL. In support of the aerial measurements, ground-based exposure rates and soil samples were obtained from four benchmark sites identified by the aerial survey to contain only natural gamma activity. Radionuclide assay of the soil samples was performed to determine radioisotopic concentrations. Oblique aerial photographs of the Quad Cities Nuclear Power Station were also obtained in conjunction with the survey.

2.0 SURVEY SITE DESCRIPTION

The Quad Cities Nuclear Power Station is located in Rock Island County, approximately 6.4 kilometers (4 miles) north of the city of Cordova, Illinois. Presented in Figure 1 is a large-scale aerial photograph (June 1989) of the power station and surrounding area. The survey boundary, outlined in Figure 1, encompasses a 65-square-kilometer (25-square-mile) area centered on the power station. The Mississippi River, which defines the Illinois-Iowa state line, splits the survey area nearly in half. The Illinois side of the river consists of sparsely populated rolling hills used primarily for farming. The Iowa side of the river is comprised mostly of the wetlands and marshlands which make up the Upper Mississippi Wildlife and Fisheries Reserve.

3.0 NATURAL BACKGROUND RADIATION

Natural background radiation originates from radioactive nuclides which are present in various low-level concentrations in the earth and atmosphere, as well as cosmic rays entering the earth's atmosphere from outer space. Terrestrial radiation, which originates primarily from the uranium decay chain, the thorium decay chain, and radioactive potassium, is detected at the surface of the earth at exposure rates between 1 and 15 μR/h (9 and 130 mrem/y). The exposure rates from terrestrial radionuclides are dependent on the composition of the soil and bedrock near the point of interest. In addition to the above-mentioned sources of natural radiation, cesium-137 (^{137}Cs), a product of nuclear fission, is present worldwide in trace quantities from fallout due to above-ground nuclear tests conducted until the early 1960s. Exposure rates due to ^{137}Cs in the environment are typically less than 1 μR/h.[2]

Radon gas, a by-product in the decay chain of both uranium and thorium, diffuses through the soil into the

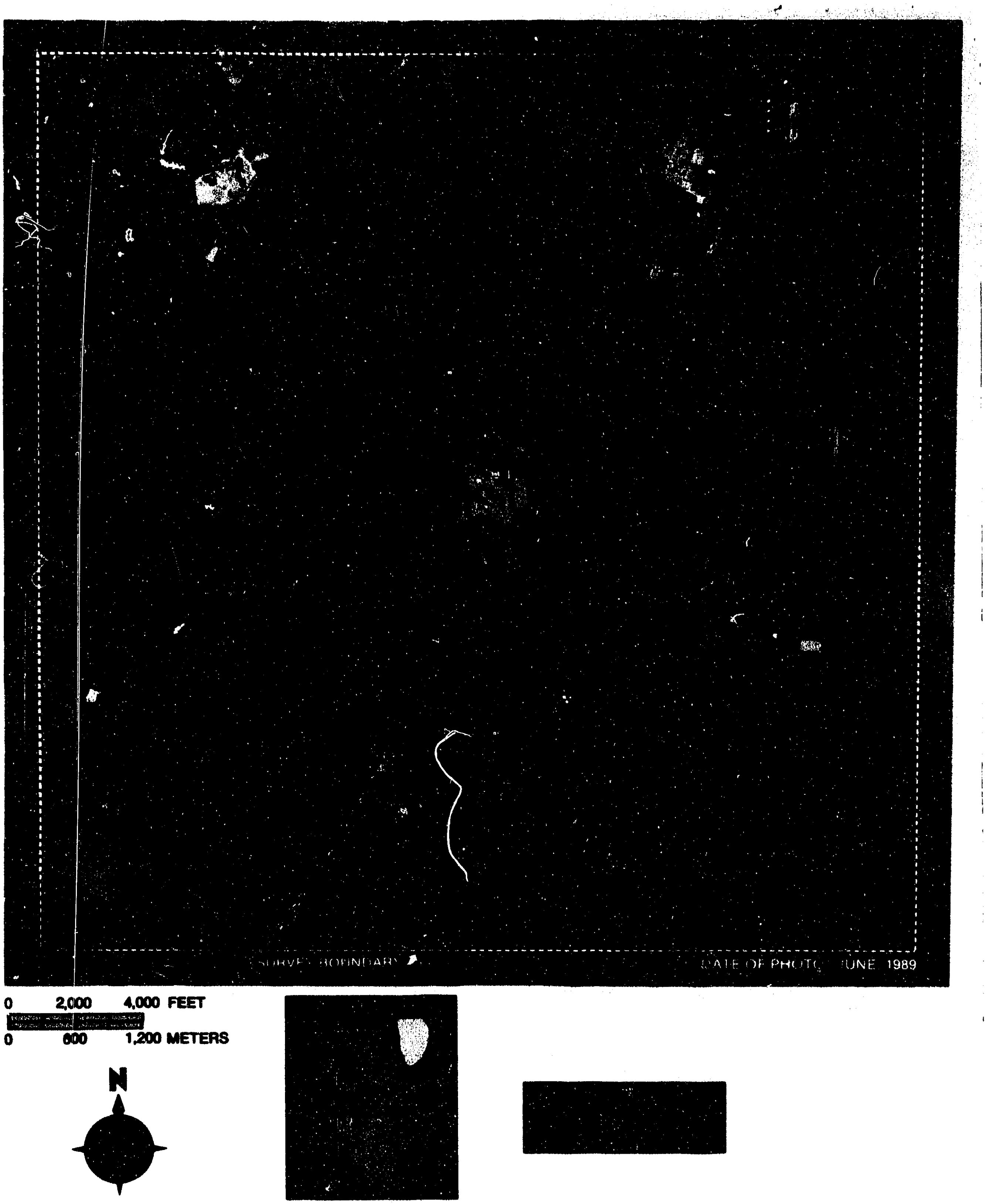

FIGURE 1. *AERIAL PHOTOGRAPH OF THE QUAD CITIES NUCLEAR POWER STATION AND SURROUNDING AREA*

atmosphere and contributes to the radiation levels near the surface of the earth. The radon concentration in a particular area, however, depends on several factors including meteorological conditions, mineral compositions, and permeability of the soil. Airborne radiation from radon and its decay products typically contributes from 1% to 10% to the natural background radiation.

Cosmic rays, high-energy radiation originating from outer space, also contribute to the levels of natural background radiation. The cosmic rays from outer space shower the earth with a nearly constant flux of radiation which interacts with elements in the earth's atmosphere and soil, producing an additional source of background activity. Radiation levels due to cosmic rays vary with altitude and geomagnetic latitude. Typical values range from 3.3 μR/h at sea level to 12 μR/h (up to 100 mrem/y) at elevations of 3 kilometers (10,000 feet).[3] For the Illinois-Iowa (midwest U.S.) area, the cosmic ray contribution is about 3.7 μR/h.

4.0 SURVEY EQUIPMENT AND PROCEDURES

4.1 Aerial Measuring System

The low-altitude aerial survey was flown using a Messerschmitt-Bolkow-Blohm (MBB BO-105) helicopter (Figure 2). The twin-engine helicopter was outfitted with two gamma detection pods and a Radiation and Environmental Data Acquisition and Recorder System (REDAR IV). The two large detector pods were mounted on the sides of each skid rack on the helicopter. Each pod housed four 4-in × 4-in × 16-in log-type, thallium-activated sodium iodide NaI(Tℓ) gamma ray detectors. The energy response of the detector array was calibrated using the 60-keV and 1,274-keV gamma rays from americium-241 (^{241}Am) and sodium-22 (^{22}Na), respectively. At an altitude of 61 meters (200 feet), the AMS gives accurate terrestrial gamma exposure levels up to 50 μR/h. The dynamic range of the AMS is extended to 400 μR/h through the use of a single 4-in × 4-in × 16-in detector.

FIGURE 2. MBB BO-105 HELICOPTER WITH DETECTOR PODS

Data acquisition was performed using REDAR IV, a rack-mounted, portable, multimicroprocessor real-time analysis system. The system was designed to operate in adverse conditions, such as those encountered in helicopter or fixed-wing platforms. The REDAR IV system recorded on magnetic tape data from the detector array, ambient temperature and barometric pressure sensors, radar altimeter, and the helicopter positioning system. Visual inspection of the data by on-board personnel was provided by a video display. The REDAR IV system was also equipped with the capability for real-time inspection of gamma energy spectra.

Aircraft positioning was established using an ultra-high-frequency ranging system (URS) and the radar altimeter. Two ground-based transponders, one positioned on the light beacon at the Clinton municipal airport and one positioned on a grain elevator in the town of McCausland, Iowa, were periodically interrogated by a master unit housed in the helicopter. By triangulation, the position of the helicopter was obtained to within a precision of ±3 meters (10 feet). The position information was recorded on magnetic tape and was also fed into a steering indicator which the pilot used to guide the aircraft along a predetermined set of flight lines.

4.2 Ground-Based Measurements

Total exposure rates and soil samples were obtained from four ground-based benchmark sites for verification of the aerial measurements. The four sites, designated in Figure 1, were identified by the aerial survey as having only natural background radiation. At each site, total exposure rates were measured with a gamma ionization chamber and five soil samples were taken for laboratory analysis. Soil sample analysis was performed at the EG&G/EM Santa Barbara Laboratory in accordance with previously outlined procedures.[4]

4.3 Mobile Data Processing Laboratory

The operations base for the survey was the Clinton Municipal Airport in Clinton, Iowa, located approximately 11.2 kilometers (7 miles) northwest of the Quad Cities Nuclear Power Station. The Radiation and Environmental Data Analyzer and Computer (REDAC) system, a mobile computer laboratory for analysis of the aerial survey data (Figure 3), was located at the operations base. The REDAC system consists of a Data General MV-7800XP computer with 4 megabytes of memory, 1.1 gigabytes of disk space for mass storage, two 9-track magnetic tape drives for data transfer and archiving, a 36-inch-wide plotter for data contouring, a laser printer, and three video graphics display terminals.

The REDAC system utilizes an extensive software library for analysis of the pre- and post-flight detector system checks and provides on-site preliminary analysis of the aerial measurements on a flight-by-flight basis.

4.4 Survey Procedures

The aerial survey over the Quad Cities Nuclear Power Station and surrounding area was conducted according to EG&G/EM standard procedures,[1,5] which will be discussed only briefly in this section. First, the perimeter of the survey area was flown utilizing roads easily identifiable on the large-scale aerial photograph. Roadway intersections and landmarks were noted by flight crew personnel for future use in scaling the radiation contour data to aerial photographs.

FIGURE 3. MOBILE COMPUTER PROCESSING LABORATORY

Altitude profiles were then flown over designated water and land test lines. An altitude profile consists of several passes over a test line at nominal altitudes ranging from 61 meters (200 feet) to 244 meters (800 feet). The water test line was flown approximately one-half mile from shore over a man-made lake near Savanna, Illinois, which is located about 16 kilometers (10 miles) north of the survey site. Data accumulated during the water test line profile were used to determine the nonterrestrial background radiation which originates from airborne radon, the helicopter and detector system, and cosmic rays. Typically, the water test line is flown at the survey altitude at least once during each survey flight to monitor fluctuations in the radon concentration. For the land test line, a section of open field situated along a fence line was chosen. The terrestrial data from the altitude profile over the land test line, corrected for the nonterrestrial background, were used to derive the air attenuation coefficient.

The aerial survey covered an area of 65 square kilometers (25 square miles) as outlined in Figure 1. A grid pattern, consisting of 75 parallel flight lines separated by 107-meter (350-foot) intervals, was flown at an altitude of 61 meters (200 feet) AGL. All flights were flown at an average ground speed of 36 meters/sec (70 knots). The aerial survey over the Quad Cities Nuclear Power Station and surrounding area was completed in six flights over a period of four days.

5.0 DATA REDUCTION PROCEDURES

5.1 Total Exposure Rate

A contour map of the total gamma radiation exposure rates in μR/h at 1 meter AGL was prepared from the aerial data. The total exposure rate contour map was derived from the gross count rates and aircraft position coordinates recorded during the survey flights. The gross count rate data were determined from the integrated yield of all gamma activity within the energy range 38 through 3,026 keV. Gross count rates in counts per second (cps) obtained from the aerial survey were converted to exposure rates in μR/h at 1 meter AGL according to:

$$\text{Exposure Rate } (\mu R/h) = \frac{GC - B}{991} e^{(A-200)\times C} \quad (1)$$

where

GC = gross count rate at survey altitude (cps)

B = background count rate at survey altitude (cps)

A = survey radar altitude (ft)

C = air attenuation coefficient (ft^{-1})

An air attenuation coefficient having a value of 0.0019 ft^{-1} was determined empirically from the background-subtracted gross count data obtained from the altitude profile over the land test line. The gross count rates were converted to exposure rates using a conversion factor of 991 cps/(μR/h) at 61 meters (200 feet) derived from data obtained at the Calvert County calibration[6] range near Washington, D.C. The reported exposure rates include a contribution from cosmic rays which, for the Cordova, Illinois area, is estimated to be 3.7 μR/h.

The total gamma exposure rates measured using the AMS represent average exposure rates for gammas emitted from nuclides distributed over a large area on the ground. The averaging process is a function of the angular resolution of the detector system and the motion of the aircraft during data accumulation. In general, two-thirds of the detected gamma rays emanate from a circular area having a radius which is nearly the same as the detector altitude above ground level.

5.2 Man-Made Gross Count Rate

The aerial survey data were also used to determine the location of man-made radionuclides. The man-made gross count (MMGC) is defined as the fraction of the gross counts which are directly attributed to gammas from man-made radionuclides. In general, evidence for the detection of man-made radioisotopes can be found from increases in the gross count rates. However, slight changes in the gross count rates are not considered adequate reason to suspect a man-made isotope. Slight variations in the gross count rates can be attributed to fluctuations in the geologic structure as well as changes in the ground coverage.

A more conclusive approach for detecting man-made isotopes involves a comparison of gross counts from various regions of the gamma energy spectrum. In particular, the ratio of spectral intensities from different regions of the gamma spectrum will remain nearly constant when only background radiation is present. Although this procedure can be applied to any region of the gamma spectrum, the most common practice is to place into the source window, all counts below 1,394 keV, *i.e.*, where most man-made radiation occurs, and into the background window, all counts above 1,394 keV. The MMGC algorithm has been found to be sensitive to low levels of man-made radiation (*i.e.*, < 1 μR/h) even in the presence of slight variations in the natural background.

The MMGC rate can be expressed analytically in terms of the integrated count rates in specific spectral energy windows (in keV) from the gamma energy spectrum

$$MMGC = \sum_{E=38\,keV}^{1394\,keV} Counts_E - K \cdot \sum_{E=1394\,keV}^{3026\,keV} Counts_E \quad (2)$$

where

$\sum_{E=38\,keV}^{1394\,keV} Counts_E$ = integral count rate in the energy window from 38 to 1,394 keV

$\sum_{E=1394\,keV}^{3026\,keV} Counts_E$ = integral count rate in the energy window from 1,394 to 3,026 keV

and

$$K = \sum_{E=38\,keV}^{1394\,keV} Counts_E \Big/ \sum_{E=1394\,keV}^{3026\,keV} Counts_E \quad (3)$$

The constant, K, was obtained from the summation spectrum composed of the gamma spectra acquired over a region of the survey area which was identified to contain only gamma activity from naturally-occurring radionuclides. The resultant MMGC will yield an average value equal to zero for areas containing only natural radionuclides and a value greater than zero for areas containing man-made radionuclides. Identification of the radionuclides responsible for anomalous behavior in the man-made gross count data can be obtained from the corresponding gamma energy spectra.

6.0 SURVEY RESULTS AND DISCUSSION

6.1 Aerial Survey Results

Presented in Figure 4 is a contour map showing the total gamma exposure rates (μR/h) at 1 meter AGL inferred from the aerial data at the Quad Cities Nuclear Power Station and surrounding area. The contour map is superimposed on a large-scale aerial photograph. Exposure rates were found to vary from 5 to 15 μR/h outside the plant boundary. Directly over the power plant, the exposure rates exceeded 400 μR/h. Included in the exposure rate data is a cosmic ray contribution of 3.7 μR/h. The location of the nuclear power plant is readily discernable from the series of concentric rings near the center of the map.

The exposure rates measured outside the plant boundary are attributed to naturally-occurring radionuclides in the environment and are fairly uniform, varying from 5 to 15 μR/h. A typical gamma energy spectrum obtained outside the plant boundary is presented in Figure 5. The most prominent gamma peaks are identified as those from naturally-occurring radionuclides from the uranium and thorium decay chains as well as radioactive potassium-40 (^{40}K).

A net gamma energy spectrum obtained over the plant is presented in Figure 6. Peaks observed were 1,173 and 1,332 keV associated with cobalt-60 (^{60}Co), an activation product, and a 511 keV annihilation peak associated with nitrogen-16 (^{16}N). Nitrogen-16 is produced by an (n,p) reaction with oxygen-16 (^{16}O) during reactor operations. The ^{16}N decays via the emission of 6.1 and 7.1 MeV gamma rays resulting in a high count rate in the high energy portion of the spectrum and an annihilation gamma ray peak at 511 keV.

In addition to the exposure rate contours (Figure 4), a man-made gross count (MMGC) contour was also produced. The only significant gamma activity shown by the MMGC extraction was directly over the plant. Because plant activity is adequately described by the exposure rate contour, the MMGC contour is not presented in this report.

6.2 Ground-Based Measurement Results

Identified in Figure 1 are the locations of the four ground-based measurements. Total exposure rates and soil samples were obtained at four benchmark sites for comparison and verification of the aerial measurements.[7] A comparison of the exposure rates from the aerial and ground-based measurements is given in Table 1. Both soil analysis estimates and the inferred aerial results include a 3.7 μR/h cosmic contribution and may be directly compared with the gamma ionization chamber data. The results from the aerial and ground-based measurements are shown to be in excellent agreement.

Table 1. Exposure Rates from Aerial and Ground-Based Measurements

	Exposure Rate (μR/h at 1 meter AGL)		
Site	Soil Analysis[a]	Ion Chamber[b]	Aerial Survey
1	7.0 ± 0.5	7.5 ± 0.5	7.4 ± 1.2
2	6.8 ± 0.5	7.2 ± 0.5	7.6 ± 1.2
3	9.1 ± 1.5	9.1 ± 0.5	8.9 ± 1.4
4	9.3 ± 0.5	9.3 ± 0.5	9.7 ± 1.5

[a] Calculation includes a cosmic ray contribution of 3.7 μR/h and a moisture correction of the form 1/(1+m).

[b] Reuter-Stokes Model Number RSS-111, Serial Number G003.

Presented in Table 2 are the results of the radionuclide assay of the soil samples from the four

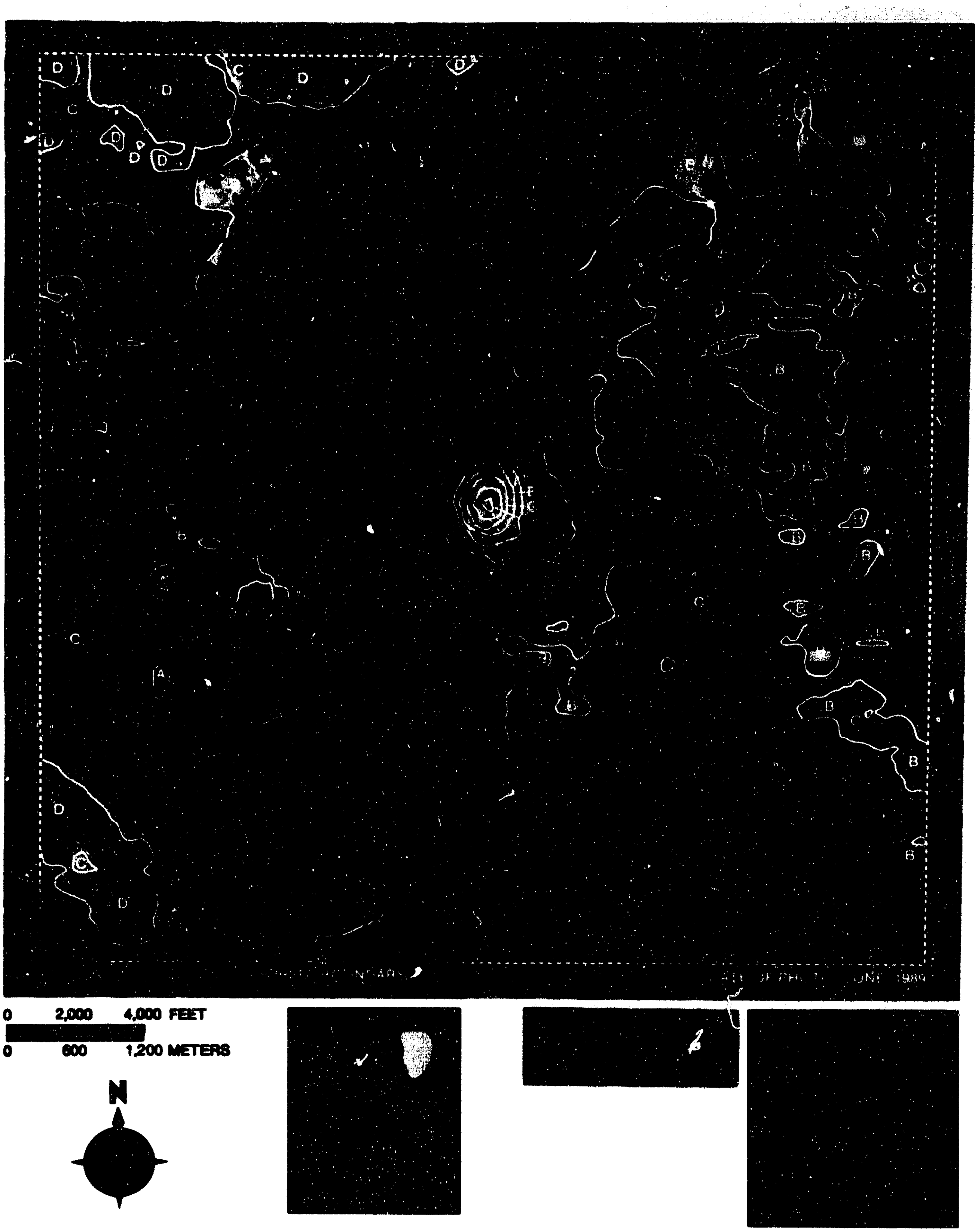

FIGURE 4. *TERRESTRIAL GAMMA EXPOSURE RATE CONTOUR MAP*

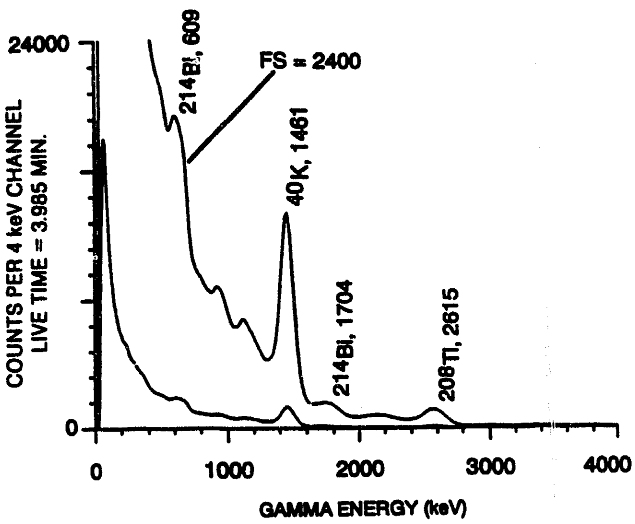

FIGURE 5. ***TYPICAL BACKGROUND GAMMA ENERGY SPECTRUM***

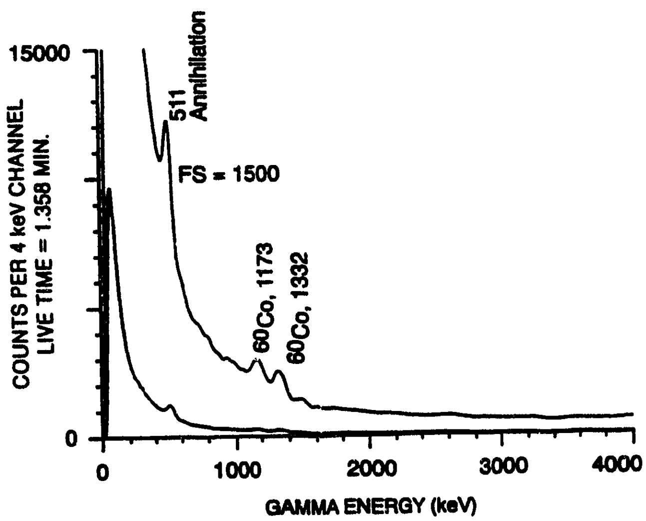

FIGURE 6. ***NET GAMMA ENERGY SPECTRUM OVER REACTOR***

benchmark sites. Soil sample results represent those from averages of five closely spaced samples obtained from each site. In addition to the naturally-occurring isotopes from the decay chains (uranium and thorium) and ^{40}K, all sampling sites exhibited a presence of ^{137}Cs. The ^{137}Cs is present in the environment as a result of worldwide fallout from above ground nuclear tests conducted until the early 1960s. The level of ^{137}Cs activity measured at the benchmark sites is typical of that measured at several locations within the continental United States.[2]

7.0 COMPARISON OF RESULTS FROM 1968 AND 1989 AERIAL SURVEYS

In 1968, the airplane-based AMS survey encompassed an area of 1,620 square kilometers (625 square miles) centered on the proposed plant site. By comparison, the present helicopter-based AMS survey covered a much smaller area, 65 square kilometers (25 square miles) centered on the plant, but with higher spatial resolution. The results of the present survey yield exposure rates which were found to vary from 5 to 15 µR/h. These results are in agreement with those previously measured for the same area in 1968. However, the exposure rates measured with the fixed-wing-based AMS were averaged over a field of view which was about 2.5 times as large as that in the present survey. The agreement between the exposure rates measured in the two surveys indicates that operations at the Quad Cities Nuclear Power Plant over the past 20 years have had no detectable effect on the surrounding radiological environment.

8.0 SUMMARY

An aerial radiological survey of the Quad Cities Nuclear Power Station was conducted during the period May 9 through May 18, 1989. An area of 65 square kilometers (25 square miles) was surveyed at an altitude of 61 meters (200 feet) using a grid pattern consisting of parallel flight lines 107 meters (350 feet) apart. The typical terrestrial gamma radiation exposure rate was found to vary from 5 to 15 µR/h. No significant radioactivity, which could be attributed to plant operations over the past twenty years, was detected outside the plant boundary by the aerial measuring system.

Table 2. Radionuclide Assay of Soil Samples					
Site	Moisture (%)	^{238}U (ppm)	^{232}Th (ppm)	^{137}Cs (pCi/g)	^{40}K (pCi/g)
1	6.6 ± 0.4	0.8 ± 0.3	3.5 ± 0.3	0.30 ± 0.03	10.4 ± 0.8
2	6.1 ± 1.3	0.8 ± 0.1	3.1 ± 0.4	0.09 ± 0.05	9.8 ± 0.2
3	25.3 ± 1.4	2.8 ± 0.5	8.3 ± 1.1	0.52 ± 0.12	13 ± 2
4	18.6 ± 1.1	2.9 ± 0.4	8.3 ± 1.0	0.26 ± 0.01	12 ± 1

APPENDIX A
SURVEY PARAMETERS

Site:	Quad Cities Nuclear Power Station
Location:	Cordova, Illinois
Survey Dates:	May 9-18, 1989
Survey Coverage:	65 km^2 (25 mi^2)
Project Scientist:	R.J. Maurer
Survey Aircraft:	MBB BO-105 Helicopter
Acquisition System:	REDAR IV
Detector Array 1:	Eight 4-in × 4-in × 16-in NaI(Tℓ) crystals
Detector Array 2:	One 4-in × 4-in × 16-in NaI(Tℓ) crystals
Lines Surveyed:	75
Survey Altitude:	61 m (200 ft)
Line Spacing:	107 m (350 ft)
Navigation System:	URS
Average Ground Speed:	36 m/s (70 knots)

REFERENCES

1. Jobst, J.E. "The Aerial Measuring System Program." *Nuclear Safety,* March/April 1979, 20:136-147.

2. Mohr, R.A. and L.A. Franks. *Compilation of Cs-137 Concentrations at Selected Sites in the Continental United States*, Report No. EGG-1183-2437, S-724-R. EG&G/EM, Santa Barbara, California, 1982.

3. Klement, A.W., *et al. Estimate of Ionizing Radiation Doses in the United States 1960-2000*, U.S. EPA Report ORP/CD72-1. Environmental Protection Agency, Washington, D.C., 1972.

4. Mohr, R.A., A.E, Fritzsche, and L.A. Franks. *Ground Survey Procedures*, Report No. EGG-1183-2339, S-635-R. EG&G/EM, Santa Barbara, California, 1976.

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

6. Mohr, R.A. *Ground Truth Measurements at the Calvert County, Maryland Test Line*, Report No. EGG-10282-2066. EG&G/EM, Santa Barbara, California, 1985.

7. Mohr, R.A. Private Communication. EG&G/EM, Santa Barbara, California, December, 1989.

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DATE OF SURVEY: MAY 1989
DATE OF REPORT: APRIL 1993

DATE FILMED

10/12/93