Docket file, KI

EGG-1183-1748

UC-41

EG&G

Energy Measurements Group

Aerial Measuring Systems

AN AERIAL RADIOLOGICAL SURVEY OF THE AREA SURROUNDING THE

NUCLEAR FUEL SERVICES FACILITY

ERWIN, TENNESSEE

DATE OF SURVEY: NOVEMBER 1977

MAY 1979

70-143

Docket file, RI

EGG-1183-1748

UC-41

EG&G

Energy Measurements Group

Aerial Measuring Systems

AN AERIAL RADIOLOGICAL SURVEY OF THE AREA SURROUNDING THE

NUCLEAR FUEL SERVICES FACILITY

ERWIN, TENNESSEE

DATE OF SURVEY: NOVEMBER 1977

MAY 1979

70-1393/Mod-5

NOTICE

Printed in the United States of America

Available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

Price:

Printed Copy - $4.00
Microfiche - $3.00

EG&G

EGG-1183-1748
May 1979

AN AERIAL RADIOLOGICAL SURVEY OF THE AREA SURROUNDING THE

NUCLEAR FUEL SERVICES FACILITY

ERWIN, TENNESSEE

DATE OF SURVEY: NOVEMBER 1977

L. K. Hilton
Project Scientist

APPROVED FOR PUBLICATION

T. P. Stuart, Manager
Remote Sensing Sciences Department

This Document is UNCLASSIFIED

G. P. Stobie
Classification Officer

This work was performed by EG&G for the United States Nuclear Regulatory Commission through an EAO transfer of funds to Contract No. DE-AC08-76NV01183 with the United States Department of Energy.

ABSTRACT

An aerial radiological survey to measure terrestrial gamma radiation was carried out over the Nuclear Fuel Services Facility at Erwin, Tennessee.

Gamma ray data were collected over a 2.5 km^2 area centered on the Facility with flight lines 60 m apart. Processed data indicated that detected radioisotopes and their associated gamma ray exposure rates were consistent with those expected from normal background emitters, except at certain locations described in this report.

Average exposure rates 1 m above the ground, as calculated from the aerial data, are presented in the form of an isopleth map. No ground sample data were taken at the time of the aerial survey.

Contents

Sections

Figures

1.0 INTRODUCTION

The United States Department of Energy (DOE) maintains an aerial surveillance operations 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, or other federal and/or state agencies (such as the United States Nuclear Regulatory Commission), AMS is deployed for various aerial survey operations.

On 1-2 November 1977 this survey was carried out from a base of operations at Tri-City Airport, which is north of Johnson City, Tennessee.

2.0 SITE DESCRIPTION

A 2.5 km^2 area was surveyed. This area centered on the Nuclear Fuel Services, Inc. (NFS) Facility in Unicoi County, approximately 2 km southwest of Erwin, Tennessee. This Facility is near the east bank of the Nolichucky River and U.S. Route 23.

The Facility receives UF_6 gas enriched with ^{235}U and converts that product to usable solids. The Facility also reprocesses low enriched uranium scraps for use in the manufacture of reactor fuel. For a time during and prior to 1971, materials containing ^{232}Th were processed at the Facility. Quantities of this material are still stored in the large building at the southwest corner of the Facility compound and in the ponds on the north end of the compound.

3.0 SURVEY METHOD AND AIRBORNE EQUIPMENT

An enlarged aerial photo of the site was used to lay out the survey flight lines. The navigator visually directed the aircraft along the flight lines programmed on the photograph.

Aerial data were accumulated at an altitude of 45 m above the terrain along flight lines 2.2 km in length and spaced at 60 m intervals (Figure 1). Eighteen lines were flown using the AMS Hughes H-500 helicopter (Figure 2) equipped with twenty NaI(Tl) cylindrical detectors, 12.7 cm in diameter and 5.1 cm in height.

The helicopter also carried a lightweight version of the Radiation and Environmental Data Acquisition and Recorder system (REDAR). Gamma ray signals from the 20 detectors were summed and routed through an analog-to-digital converter and a pulse-height analyzer. Gamma spectra were accumulated at 3 second intervals and recorded on magnetic tape.

The helicopter position was established with two systems: a Trisponder/202A Microwave Ranging System (MRS) and an AL-101 radio altimeter. The Trisponder master station mounted in the helicopter interrogated two remote transceivers mounted on tripods outside 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 recorded on magnetic tape each second. In subsequent computer processing they were converted to position coordinates.

A 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 is $\pm$ 0.6 m or $\pm$ 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 accurately compensated.

The detectors and electronic systems which accumulate and record the data are described in detail in a previous report.[1]

4.0 DATA PROCESSING

Data processing was done with the Radiation and Environmental Data Analyzer and Computer system (REDAC). This is a computer analysis laboratory mounted in a mobile van (Figure 3). The van and aircraft were based at Tri-City Airport.

Formerly the Aerial Radiological Measuring System (ARMS)

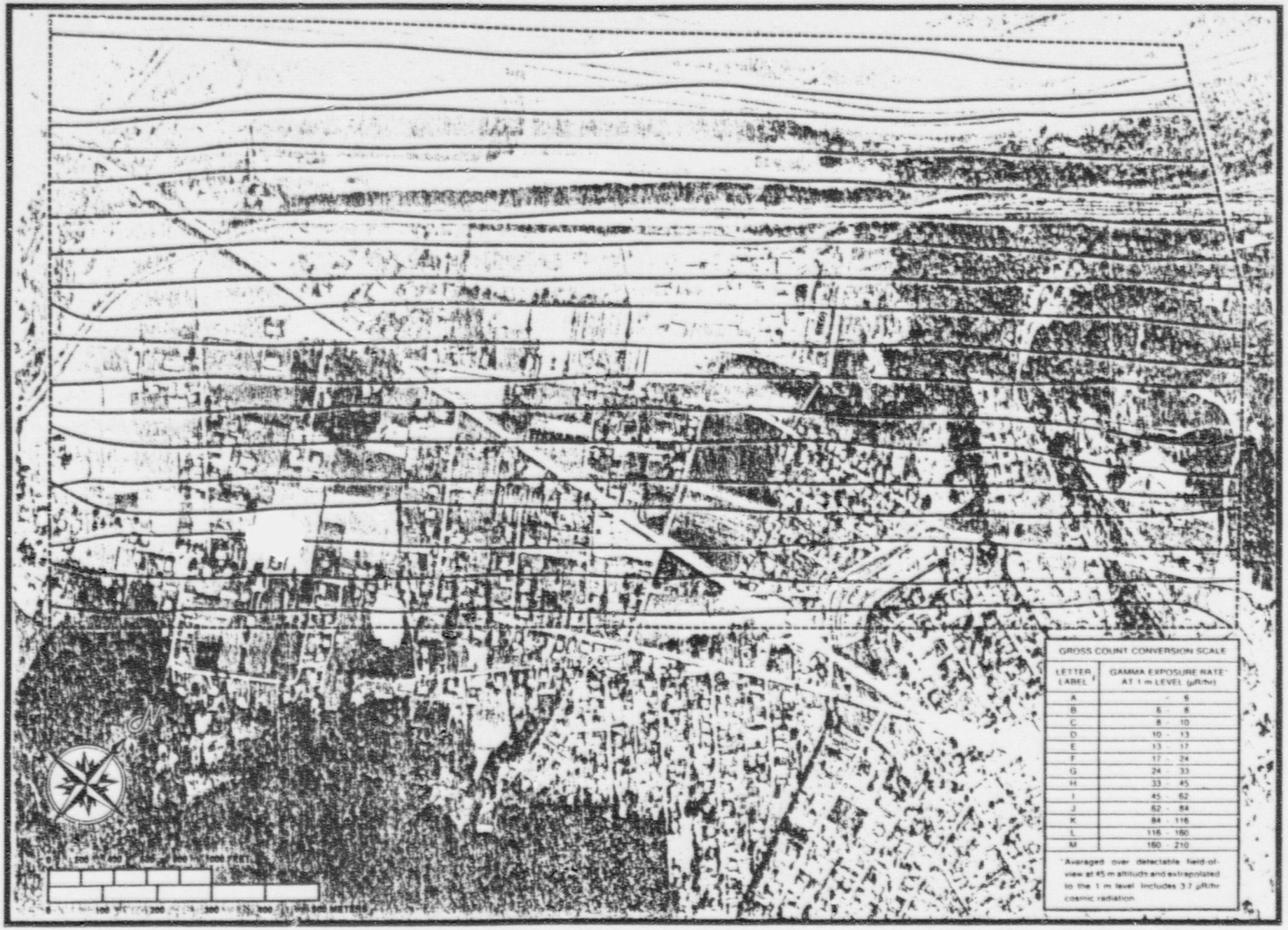

Figure 1. *FLIGHT LINES*
These navigation lines are superimposed on an aerial photo of the NFS Facility.

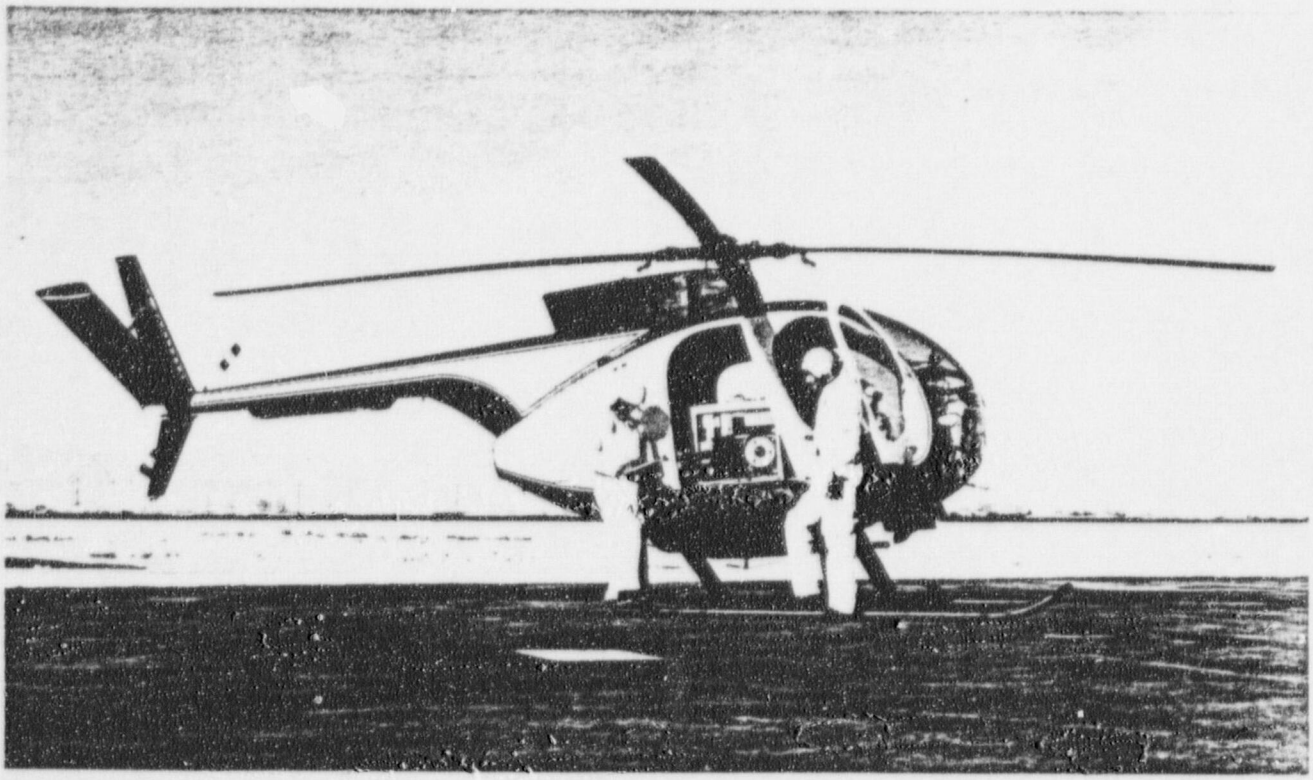

Figure 2. *HUGHES H-500 HELICOPTER*
This aircraft contains the REDAR system.

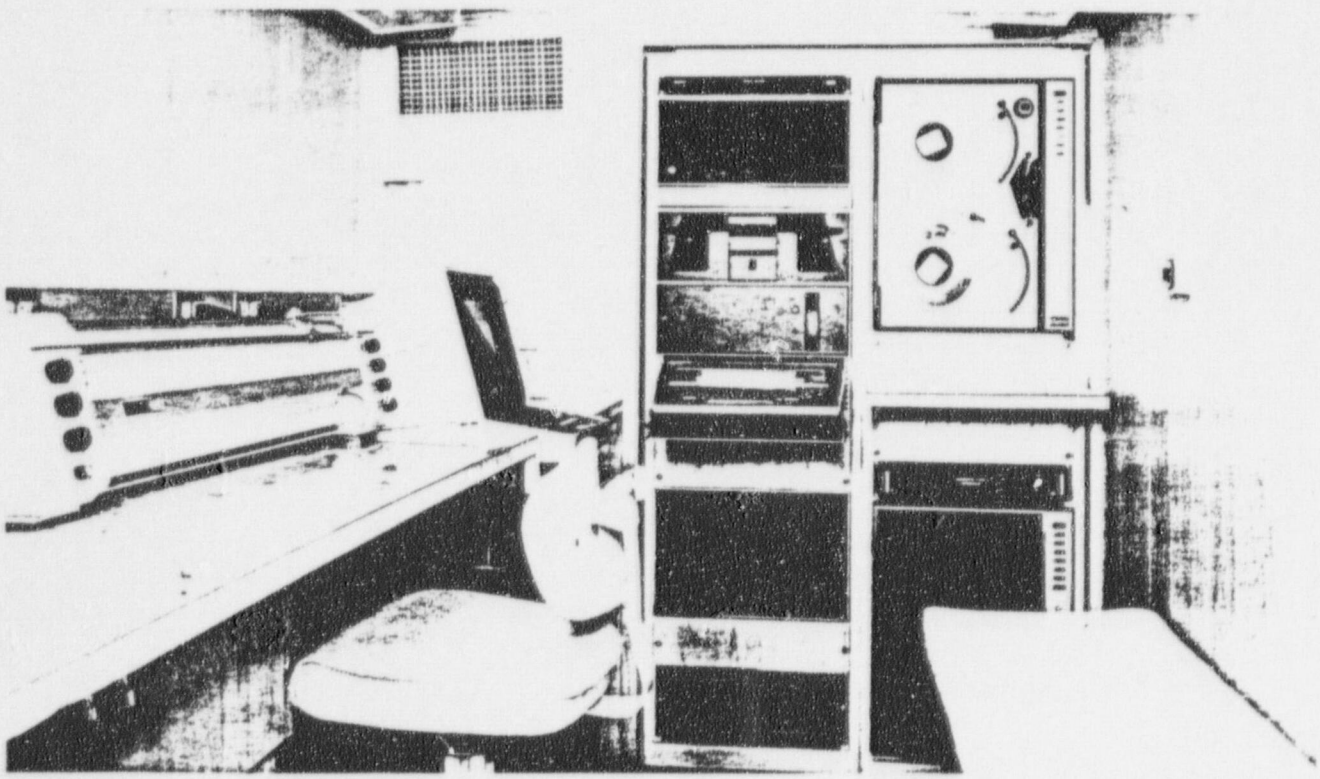

Figure 3. *MOBILE COMPUTER*
This processing laboratory contains the REDAC system.

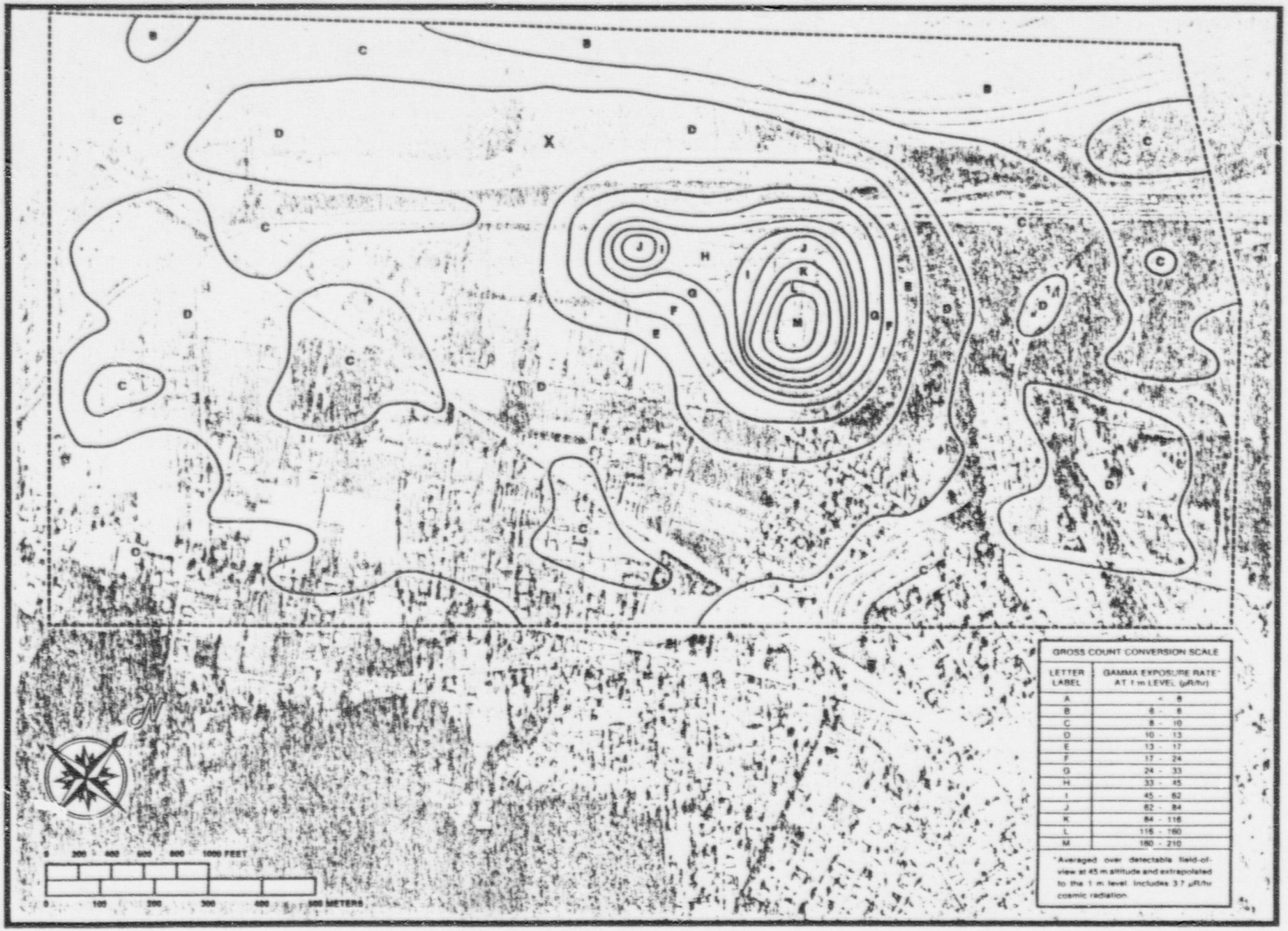

Figure 4. *EXPOSURE RATE ISOPLETHS*
These isopleths are superimposed on an aerial photograph of the NFS Facility.

The REDAC consists primarily of two Cipher Data tape drives, a Data General NOVA 840 computer, 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 gross count data were corrected for system dead time and altitude deviation. Corrections to the gross count rates were also made for contributions from radon, aircraft background, and cosmic rays; flights over Boone Lake were used for this purpose. The corrected gross count rates were converted to exposure rates (of terrestrial origin) at 1 m altitude. The factor 1130 counts per second (cps) per μR/h was obtained from calibration data over a Nevada test range.

5.0 DISCUSSION AND RESULTS

Analysis of the radiological data taken over the area surrounding the Nuclear Fuel Services Facility indicates that the terrestrial radioisotopes and associated gamma ray exposure rates were consistent with the natural background normally found within areas having similar geological bases.

Figure 4 presents exposure rate isopleths superimposed on an aerial photograph of the site. The background in the area is in the range of 9-12 μR/h, including 3.7μR/h from cosmic rays. The two areas of highest activity are over the ponds on the northern end of the compound and over the building at the southwest corner of the compound. Both areas contain quantities of ^{232}Th. Figure 5 is a background-subtracted energy spectrum typical of both areas. The radioactive daughters of ^{232}Th account for all the photopeaks observed.

Increased gamma activity at the 45 meter altitude extends for some distance beyond the plant boundaries (see Figure 4). This shine from the two thorium storage areas at the site would mask small variations in gamma radiation.

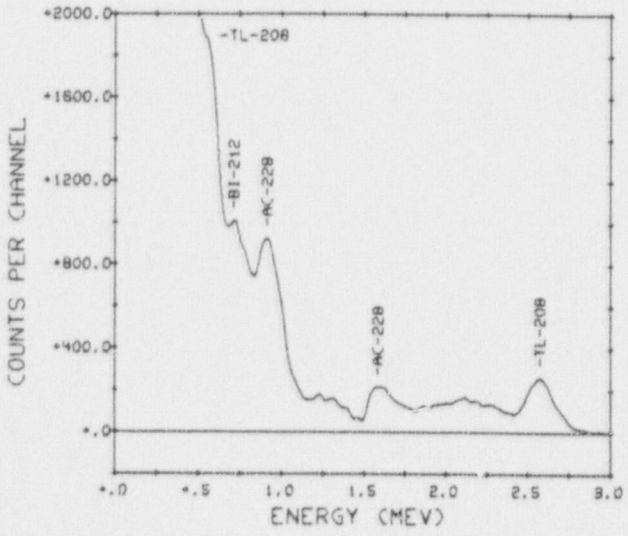

Figure 5. *ENERGY SPECTRUM OF GAMMA RADIATION*
This spectrum was observed over the NFS Facility: it characterizes both areas of enhanced activity. Normal background was subtracted before the spectrum was plotted.

To determine if any "man-made" or excess thorium exists in the survey area, the data were analyzed with a technique similar to that described in a previous report as "Anomalous Thorium Activity."[2] If the assumption is made that uranium and thorium exist in nature in the same ratio at all points in the surveyed area, then the ratio of the ^{208}Tl 2.61 MeV photopeak to the ^{214}Bi 1.76 MeV photopeak is constant.

Using an average of this ^{208}Tl to ^{214}Bi ratio from background areas as a constant, an isopleth plot was made of those areas containing an "excess" of thalium radiation. The first level of statistically significant increase or change in this ratio essentially followed the first level of shine from the storage areas (see "E" level contour on Figure 4).

One statistically significant change outside the shine was a small area located in a plowed field west of the NFS Facility: this is marked "X" on Figure 4.

Although this localized area showed an increase in the ^{208}Tl to ^{214}Bi ratio, the total gross count rate remained within the natural background level.

REFERENCES

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

2. Boyns, P. K.; Frankhauser, W. A.; Hendricks, T. J.; and Shipman, G. R. *An Aerial Radiological Survey of West Chicago, Illinois.* Report No. EGG-1183-1730. EG&G, Las Vegas, NV. August 1978