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ECT FOLLOW-UP REPORT
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AN AERIAL RADIOLOGICAL SURVEY OF THE

SHPACK PROPERTY

Norton, Massachusetts

DATE OF SURVEY: AUGUST 1979

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ABSTRACT

An aerial radiological survey to measure terrestrial gamma radiation was carried out over the Shpack property in Norton, Massachusetts. In past years this property was used as a dump site for certain types of radioactive waste materials.

Gamma ray data were collected over a 2.2 km^2 area centered on the site by flying northwest-southeast lines spaced 60 m apart. Processed data indicated that detected radioisotopes and their associated gamma ray exposure rates were consistent with those expected from natural background emitters. Within the limitations of detectability the aerial survey data did not show any evidence that man-made radioactive waste materials were present at the site.

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 data were taken at the time of the aerial survey.

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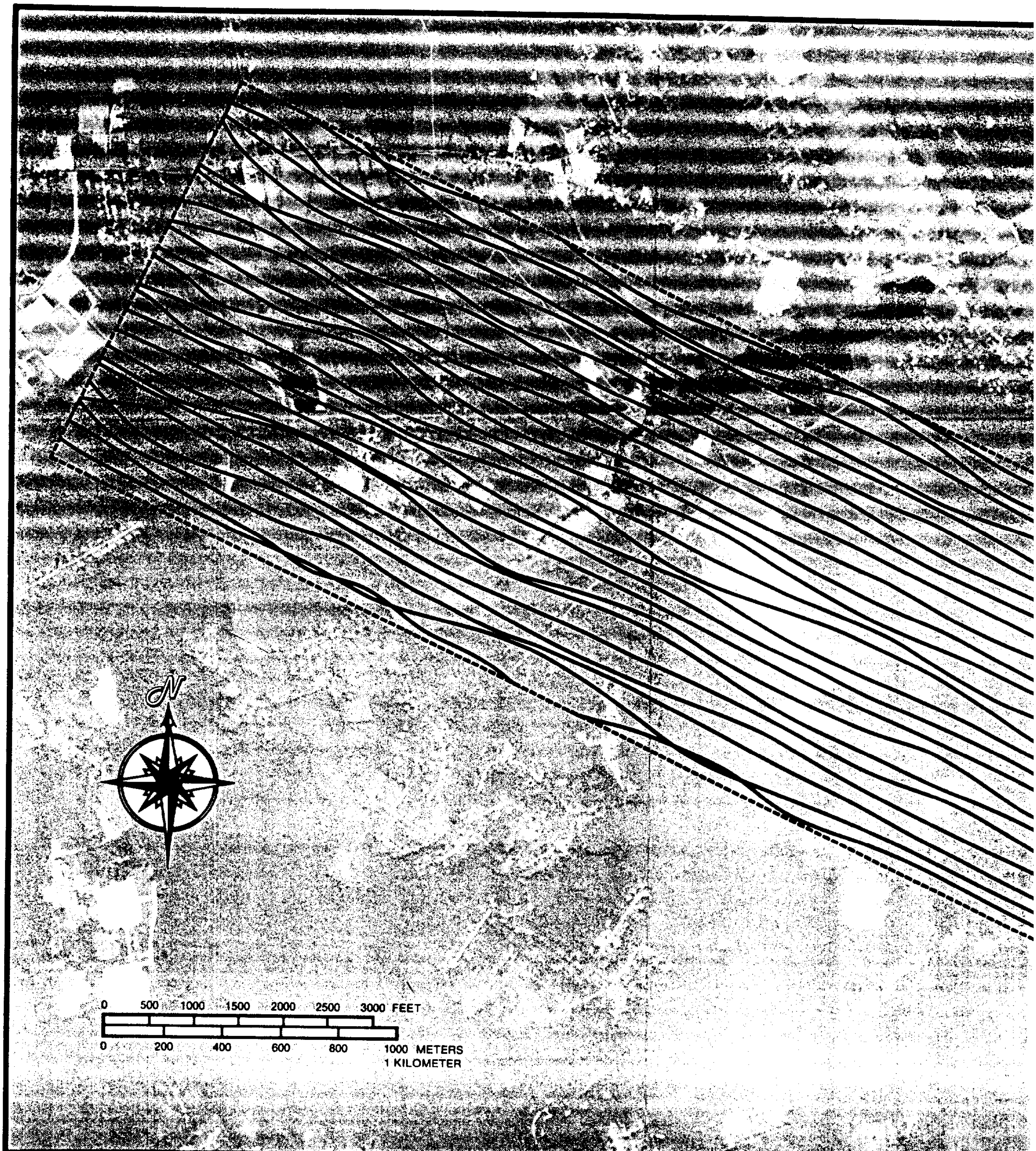


Figure 1. *Survey Flight Lines*

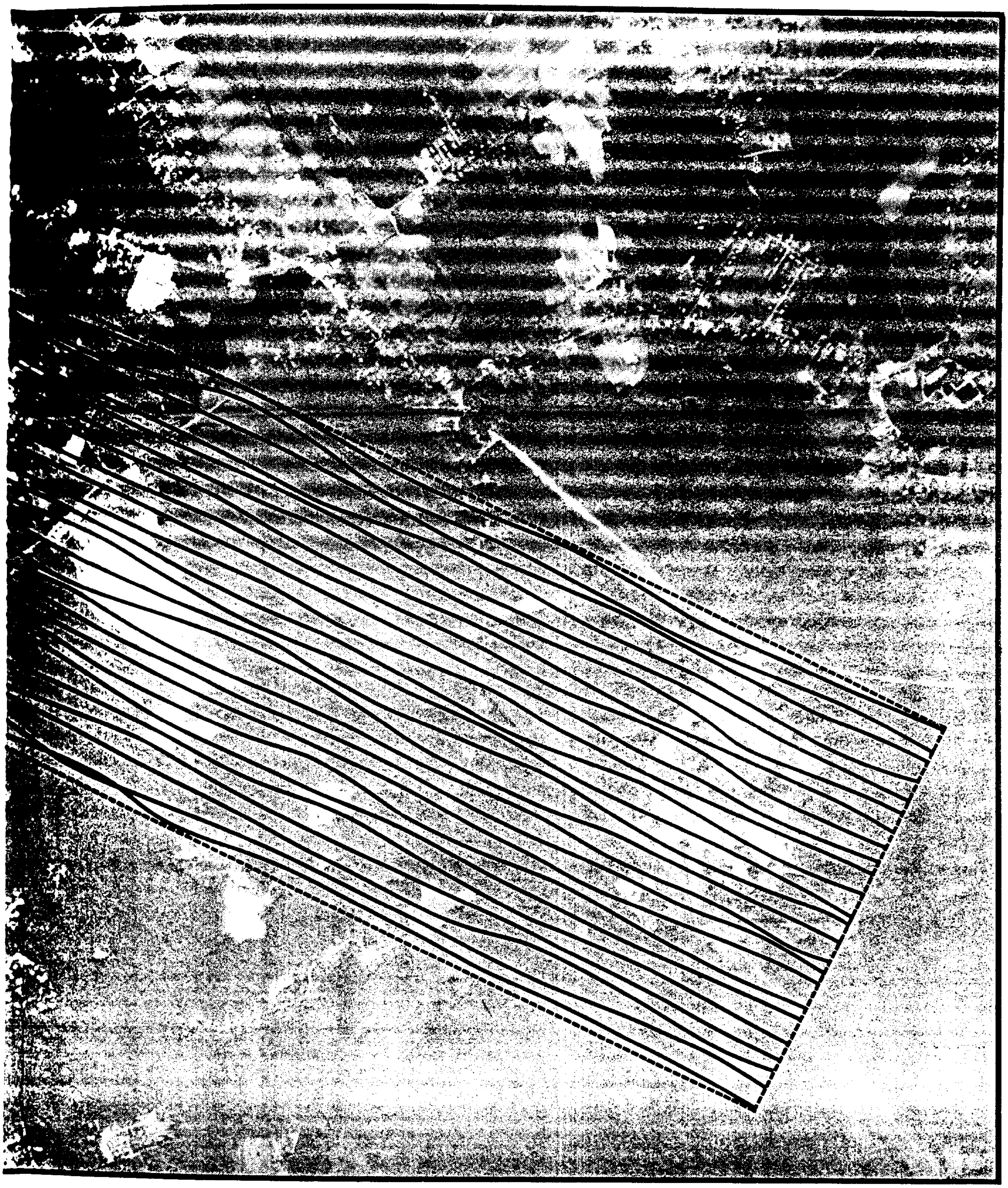


Figure 1. *Survey Flight Lines*

1.0 INTRODUCTION

The purpose of this aerial survey was 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. This survey was conducted by Aerial Measuring Systems (AMS).*

AMS is maintained by the United States Department of Energy (DOE) and operated by EG&G. Begun in 1958, AMS is a continuing nationwide program involving surveys to monitor radiation levels in and around facilities producing, utilizing, or storing radioactive materials. AMS is deployed for various aerial survey operations at the request of DOE, other federal agencies (such as the United States Nuclear Regulatory Commission), and state agencies.

On 9 August 1979 this survey was carried out from a base of operations at Hanscom Airport, Boston, Massachusetts.

At one time the site received certain types of radioactive waste materials which were buried underground.

2.0 SURVEY AREA LOCATION

The area surveyed was 2.2 km^2 and it was centered on the dump site. The dump site is located on Union Road in Norton, Massachusetts, approximately 2 km east of Attleboro and 0.5 km southwest of Chartley (both in Massachusetts).

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 programmed flight lines on the photograph. The survey pattern consisted of 23 parallel lines spaced at 60 m intervals, 4.5 km in length. The flight lines were oriented in a northwest-southeast direction (Figure 1). Flight altitude was 45 meters.

Formerly the Aerial Radiological Measuring System (ARMS).

A BO-105 helicopter was utilized for the survey (Figure 2). The BO-105 carried a crew of two: pilot and navigator. It employed a lightweight version

Figure 2. *BO-105 Helicopter*

of the Radiation and Environmental Data Acquisition and Recorder system (REDAR). Twenty NaI(Tl) detectors were contained in an aluminum box extended from the rear of the helicopter. Each detector is 12.7 cm in diameter and 5.1 cm in height. 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 in 1 second intervals and recorded on magnetic tape.

The helicopter position was established with two sytems: 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 towers outside the survey area. By measuring the round trip propagation time between the master and remote stations the master computed the distance to each (see Appendix). These distances were 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.†

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

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 the Hanscom Airport.

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 1.2×10^6-word disc memory. An extensive collection of software routines is available for data processing.

The gross count data (integral counts between 50 keV and 3000 keV) were corrected for system dead time and altitude deviation. Corrections to the gross count rates were also made for contributions from airborne radon daughter, aircraft background, and cosmic rays.

The corrected gross count rates were converted to exposure rates at 1 m altitude with the factor 1100 counts per second (cps) per μR/h 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 Shpack property dump site indicated 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 3-5 μR/h. A cosmic ray exposure rate contribution of 3.7 μR/h is not included in Figure 4.

Contours with E level activity (6-7 μR/h) are located over some portions of the site. Figure 5 is a background-subtracted spectrum from the survey area. Slightly elevated amounts of the naturally occurring radioisotopes are observed, including an increase in ^{40}K (1.46 MeV). No man-made radioactivity was evident in the survey data taken at 45 m altitude.

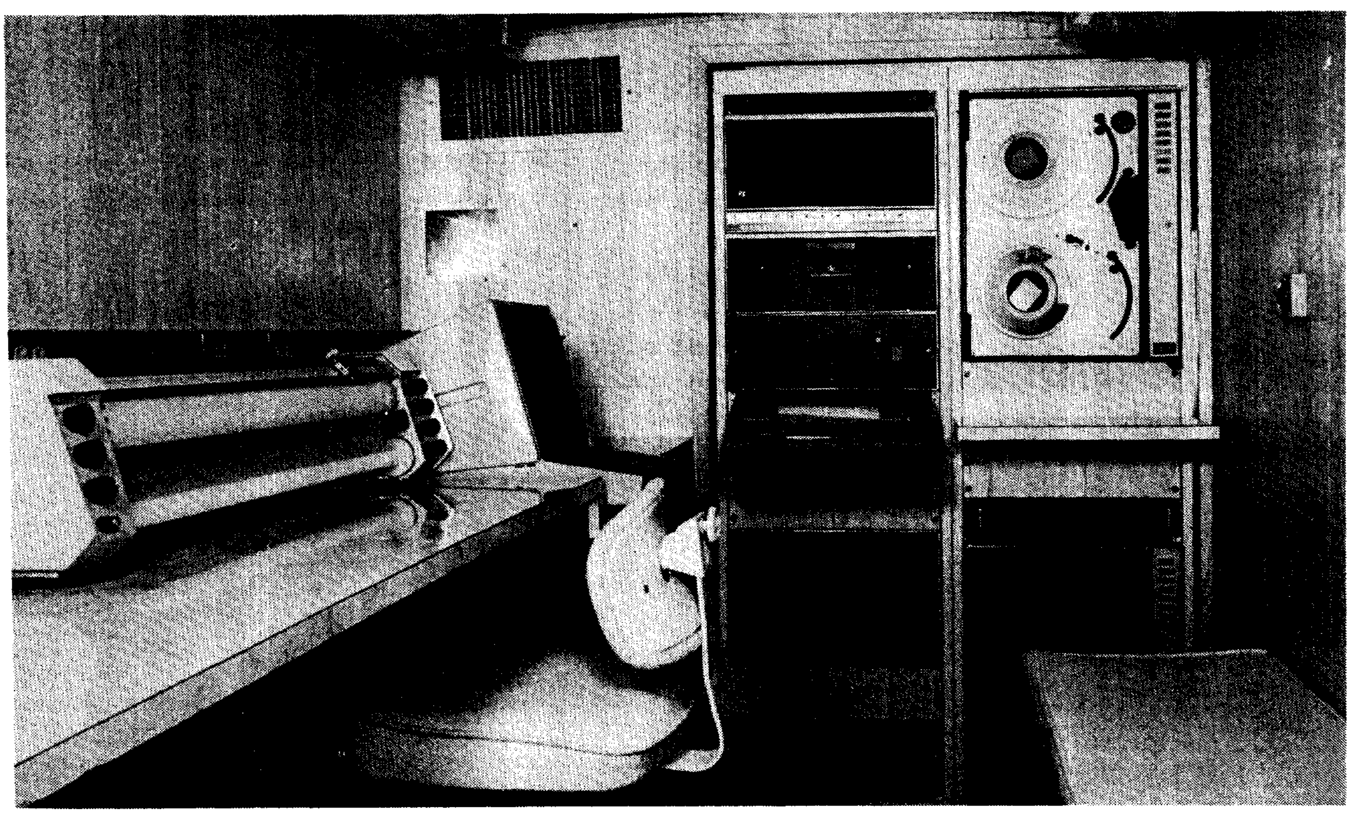


Figure 3. *Mobile Computer Processing Laboratory*

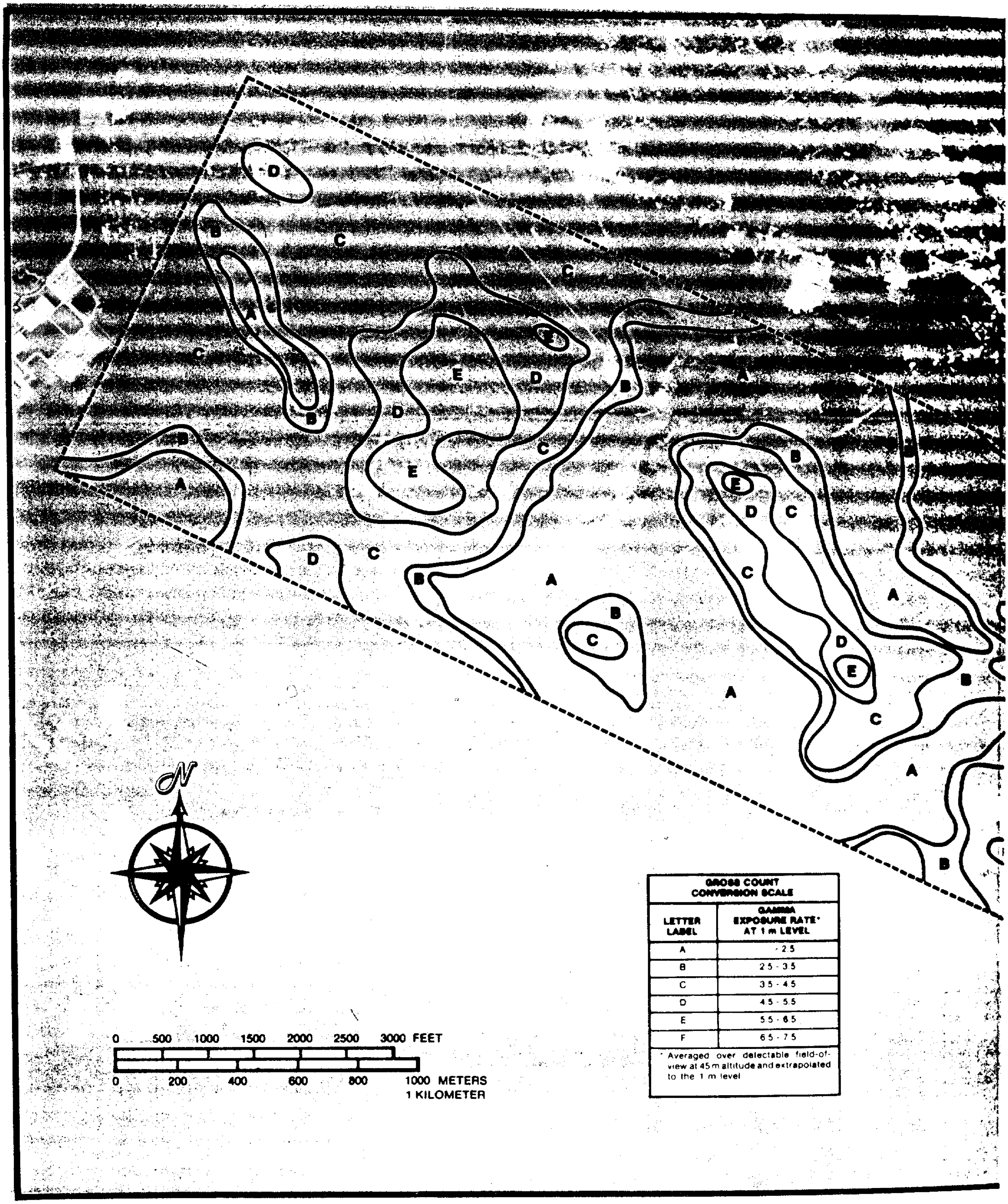
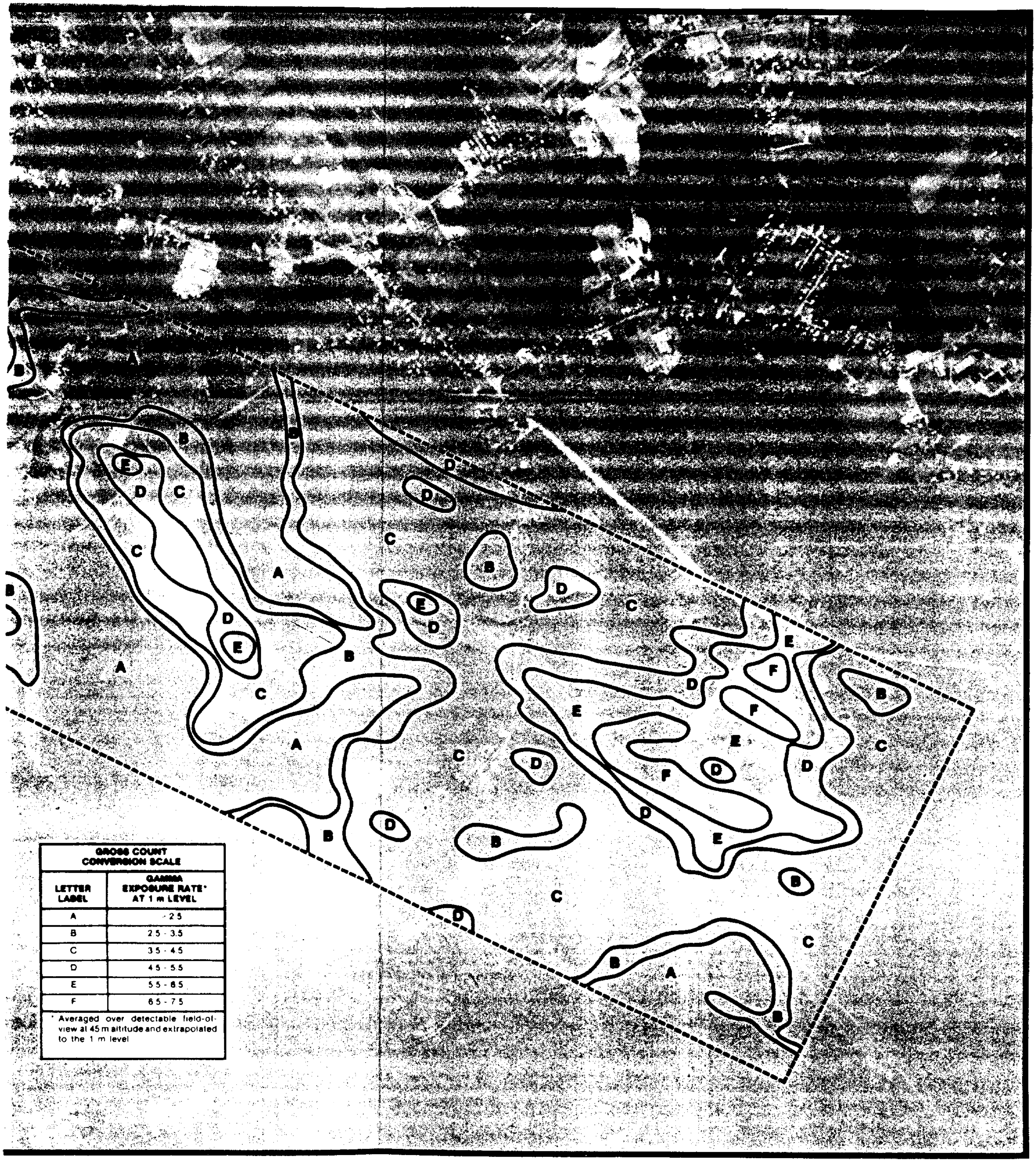


Figure 4. *Exposure Rate Isopleths*



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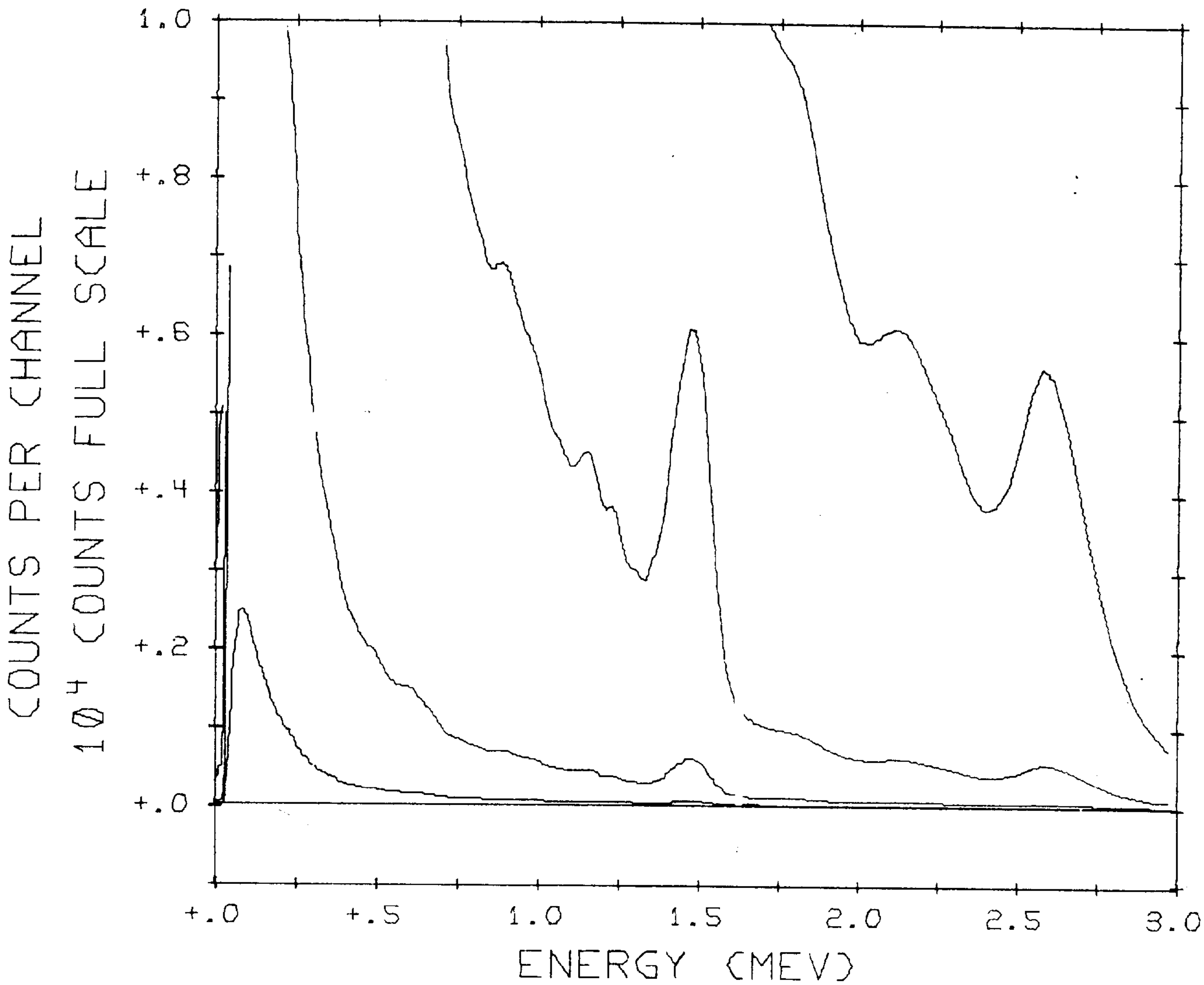

Figure 5. *Energy Spectrum Observed Over Northeast Side of Site*

APPENDIX*

Microwave Ranging System and Steering Indicator/Calculator

A line-of-sight, X-band microwave system, comprised of a master (aircraft) and two remote (ground) stations, is used to determine the distance of the aircraft from the ground stations. Each of the three transceiver units provides an output of up to one kilowatt peak power. The system is capable of measuring ranges up to 100 nautical miles under line-of-sight conditions. Resolution of the system is one foot and accuracy is better than ± 10 feet. Transmissions are coded to differentiate between the two ground-based transponders. Signals from the transponders are at a frequency different from the master's in order to guard against ranging from the master to microwave-reflecting objects.

A control unit in the aircraft initiates a complete interrogation cycle every 250 milliseconds. This cycle consists of a group of pulses to establish which of the two transponders is being interrogated, followed by ranging pulses (up to forty) until ten valid returns have been received. The control unit then outputs the average measured range to external equipment. If ten valid returns are not received, the control unit will output a "zero-range" to the external equipment. The procedure is repeated for the second transponder. To acquire, the two ranges may take from 45 milliseconds to 140 milliseconds. The microwave system idles for the remainder of the 250 millisecond cycle.

External Equipment Use of MRS Ranges

External equipment receiving range data from the control unit are the Radiation Data Acquisition and Recorder system (REDAR) and the Steering Indicator Calculator (SIC). A range pair is recorded on the REDAR tape along with the concurrent radiation data for each 1 second of data acquisition. The processing of REDAR tape recorded ranges is described elsewhere. The steering indicator/calculator reads in a range pair every quarter-second. These data are processed in real time to give the aircraft pilot an on-line or quantitative left- or right-of-line indication.

* Written by A.E. Villaire. May 1979. Las Vegas, NV: EG&G

Steering Indicator Calculator System

The heart of this system is a programmable desk-top calculator which weighs only 25 pounds (Hewlett-Packard 9825A). It is programmable in a high level language (similar to FORTRAN) and has about 6800 bytes of user memory for program and data storage. The unit also contains a drive mechanism for magnetic tape cartridges, a small thermal printer, and a 32-character display. The use of a high level language facilitates modification of the calculator program to fit unique field situations.

A special interface circuit effects compatibility between the MRS's 24 data output lines and 2 strobes with the calculator's 16 byte input data buss, control, and status lines. Also provided in this circuit is a digital-to-analog converter to drive the pilot's steering meter. The interface is under the direct control of the calculator program.

Calculator Program

Arithmetic calculations, using the actively measured ranges, are performed by the calculator to do the following:

- Measure the distance between the two ground stations (the "baseline" length).
- Translate and rotate the desired survey grid from the orthogonal system of the baseline to an orthogonal system centered on two observable terrain features.
- Provide the pilot with left/right steering information.
- Provide the SIC operator with information on line number, direction of flight, steering error, in or out of survey area, distance to end (or beginning) of line, and ground speed.

Operational Sequence

The relative location of the survey area with respect to the baseline (i.e., "above" or "below") must first be keyed into the calculator in order to remove the positional (bipartite) ambiguity caused by the MRS giving only two ranges and no angular information.

Prior to the start of the actual survey certain flight maneuvers are required to measure parameters.

- Baseline measurement: the distance between the ground-based transponders is measured by flying across the baseline (preferably midway) at as low an altitude as is practical. The value calculated for the baseline length is the minimum of the sum of the two ranges.
- Survey orientation and location: the aircraft crew must find two terrain features, natural or man-made, that can also be found on the map or aerial photo depicting the survey lines. Instantaneous ranges measured while passing directly over these features are entered in the calculator memory using a "hack" button. The two range pairs obtained are used by the program to calculate the angle between the baseline and the survey lines and the offset of the survey area from the baseline. If the two hack points do not lie on a line parallel to the desired survey lines, an angular correction may be manually entered in the calculator. The operator must then key in the intended survey line spacing; he may also enter values representing the longitudinal extent of the lines. The latter option is sometimes not used for extremely long lines where loss of reliable signal determines the ends of the lines. All these data are printed out and are recorded on tape so they may be recalled for use at another time.

The survey then proceeds with the operator keying in the initial line number and direction of flight (handled simply as "+" or "-"). At the end of a line, the operator increments or decrements the line number and reverses the sign of the flight direction. The pilot, after negotiating a turn, may use the steering meter to "home in" on the new line. The operator may relay to the pilot the distance to the start of the line (if the longitudinal extent values were keyed in) so that no harsh maneuvers are required in order to start the next line. (Even moderate aircraft banking causes loss of microwave signal as the fuselage or wings occlude the line of sight).