EG9601839

THE NATIONAL ENVIRONMENTAL RADIATION MONITORING NETWORK IN EGYPT

SAMIRA M. MORSY

Atomic Energy Authority Cairo - Egypt

ABSTRACT

Post accident environmental pollution with radionuclides occurs at accident site, and can also cross borders to affect distant localities. The situation in Egypt presents special importance regarding its position near Asian and Europian nuclear sites. Also, the present and future nuclear installations in Egypt. Environmental base line monitoring data is essential knowledge in nuclear practices.

For these reasons, the Egyptian government took steps to set up a national response plan for dealing with inside and outside accidents. The key elements of the plan is the establishment of a National Environmental Monitoring Network (NERMN) and a Nuclear Emergency Response System (NERS).

The NERMN will detect radioactivity resulting from any accident affecting the Egyptian territory even if it is not formally reported under international agreements or if there are delays in notification.

Therefore, the system provides the means of assembling and analyzing the radiological monitoring data related to the accident, and allowing information for the authorities. This trealiste presents the instrumental structure of the network, and the various aspects dealing with its overall function .

INTRODUCTION

The establishment and implementation of NERMN in Egypt are essentially for two purposes, to detect radioactivity resulting from any accident affecting the Egyptian territory even if it is not reported under International Agreements, or if there are delays in notification; and to provide information which makes it possible to evaluate and assess the accident situation. This will enhance introducing the necessary countermeasures to keep the radiation doses to the public as low as reasonably achievable.

The above objectives are met with through the use of a fully automatic system for gamma radiation monitoring, and a semiautomatic system for air activity monitoring (aerosol), and a network of liquid monitors.

The fully automatic system makes use of gamma detection units equipped with connections and interfaces for remote indication and alarm within 1000 Km as an automatic processor-controlled system which sends the data to a central control room, at the National Center for Nuclear Safety and Radiation Control, Nasr City, Cairo.

The central control room contains data telecommunication facilities with the monitoring stations via public telephone network. The semiautomatic system for activity monitoring (aerosol) makes use of detection units for air activity monitoring by measuring independently the gross beta activity and the alpha activity both compensated for gamma emission. The system can be operated from the central control room but the data are locally stored on a microprocessor and can be collected periodically. The central control facility contains the hardware and software to process the data stored on the microprocessor in the monitoring stations.

The proposed Environmental Monitoring System consists of a network of forty two (42) Model ERM-2 (Eberline Instrument Corporation) environmental monitoring stations, fourteen (14) beta aerosol monitors, and eleven (11) aquatic

stations modem-linked to a Central Computer. The Central Computer contains hadware and sofware support for collection of environmental data from all monitors in the system. The various stations where the monitoring system detectors are installed at various locations covers all the Egyptian territories from East, North Coast, West, South, the Delta, and Upper Egypt. This distribution is shown in the table.

ERM-2 ENVIRONMENTAL RADIATION MONITOR.

The model ERM-2 Environmental Radiation Monitor is a self-contained radiation measurement system designed to provide continuous, on-line quantitative assessments of environmental gamma radiation level. Each ERM-2 monitor is comprised of a Mode HP-270 energy compensated GM type detector coupled to a single board data acquisition microcomputer with built-in computer - controlled high voltage supply. These components are protected by a sealed and insulated weather proof enclosure. Battery back-up of the ERM-2 computer and detector is provided for approximately 40 hours should AC power interruptions be encountered. The ERM-2 is a data logging microcomputer based instrument which has the capability to store up to several weeks of data for down-loading to a central computer via a standard RS-232 serial communication port.

The ERM-2 continuously stores approximately 1500 data points in its internal battery-backed memory. When operating in a 10% fixed percision mode at normal background levels, this corresponds to approximately 3 weeks worth of storage. In the event, the Central Computer is inactive for an extended period, data is not lost. When this storage area is full, the ERM-2 discards the oldest point and installs the new point at any time new log data is available while still maintaining the latest 1500 data points.

The ERM-2 can be operated either as an integrating scaler with an operator selected integration time or in a unique fixed precision mode whereby the ERM-2 automatically varies the integration period with exposure rate to maintain a fixed data precision of 2, 5, 8 or 10 percent. In either mode, the ERM-2 automatically

stores an exposure rate average at the completion of the integration period which is transferred to the Central Computer for storage the next time communication between the two is established. When operated in the fixed integration time mode, the operator and/or Central Computer is presented with a new reading on fixed time intervals. The precision of the data varies with the exposure rate.

When operated in the fixed precision mode (the recommended mode of operation for this system), the operator and/or Central Computer is presented with new readings very frequently when the background is high and less frequently when the background is low. With the HP-270 detector, which has a sensitivity of approximately 2 cps/uSv/h and when operating in the 10% fixed precision mode, the ERM-2 presents new data approximately every 17 minutes at 0.2 uSv/h and every second at 1 mSv/h all with the same operator selected precision.

1. Gamma Radiation Monitor Detector.

The ERM-2 and Eberline model HP-270 consists of energy compensated Geiger-Muller detector. The detector is mounted safely inside the low atomic number ERM-2 case. The reduction in detector photon response as a result of being housed within the enclosure is less than 10% at 60 KeV and less than 4% at 1 Mev. The protection from vandalism, weather changes, and direct sunshine afforded by placing the detector internal to the enclosure more than offsets the minor loss in sensitivity.

A simple coax cable connects the detector to the ERM-2 electronics. The detector can be removed in a few seconds for calibration or replacement. The detector is very expensive to replace and should have a service life of several years.

The fact that the counting pulses from the detector are not affected by the installed cabling allows the detector to be removed from the ERM-2 for calibration on an Eberline scaler or spare counting computer. The calibration constant (count / Sv) is entered into the system parameter file of the ERM-2 computer either locally or remotely at the central Computer. The calibration constant, detector

dead time, and high voltage can all be viewed / adjusted remotely at the Central Computer under password control.

Dead time compensation algorithms in the ERM-2 automatically correct for dead time counting losses. The linearity of the system is within ± 2% up to 10,000 uSv/h with a maximum deviation from linearity of less than 25% at the maximum range of the detector (30,000uSv/h). The energy response of the model HP-270 detector is ± 17% from 60 KeV to 1.25 MeV. The linearity and energy response are illustrated in figures 1,2 and 3.

The shield assembly, detectors and counting computers are housed within a weather-proof electronics housing and mounted to a frame assembly with integral shaded enclosure. The sample pump is a high temperature, totally enclosed, pump is fitted with an Eberline air pump regulator to provide automatic flow control of the sample stream. A computer actuated relay control internal to the electronics housing provides remote control of the sample pump allowing its actuation from the remote central computer.

BETA AEROSOL MONITOR.

The beta aerosol monitor station block diagram is given in Fig. 4

1. Beta Aerosol Monitor Communications.

At each beta aerosol monitor the three ERM-2 counting servicing the three detector channels are connected to a modem splitter which is then connected to the station telephone modem. The modem is housed within the electronics enclosure on the beta aerosol monitor. This configuration gives the central computer a single telephone line interface to all three counting computers at the station. Each counting computer at the station has a unique hardware address enabling the central computer to communicate with each computer independently. A failure of any counting computer does not affect the ability of the Central Computer to communicate with the remaining computers.

2. Beta Aerosol Monitor Detectors.

Three active monitoring channels are used for data collection at each of the monitoring stations equipped with a beta aerosol monitor. The data from the station gamma, beta particulate and alpha particulate channels are all collected and used by central computer in reporting the beta particulate activity. Data files are created on the central computer hard disk for each monitoring channel.

The primary detector for the beta aerosol monitor is an Eberline model RDA-3A beta scintillation detector which consists of a 2 inch diameter photo multiplier tube. The crystal is covered by a very thin (1.6 mg/cm) mylar window. The RDA-3A detector provides extremely good beta efficiency with very low efficiency to interfering gamma radiation.

The secondary detector for beta aerosol monitor is an Eberline model RDS-1 solid state alpha detector which is used to compensate the beta measurement for naturally occurring daughters of radon. The RDS-1 uses a 490 mm diffused junction detector which has essentially no effeciency to radiation other than alpha. The alpha activity measurement performed by the RDS-1 detector is a direct indication of the beta emissions of radon daughters since the equilibrium ratio of beta to alpha is very nearly a factor of 2.

3. Beta Aerosol Monitor Activity Determination.

The beta particulate airborn concentration in units of activity per unit volume of air (e.g.u Ci/cm^3) cannot simply be measured directly from the filter. Instead, the airborne concentration must be derived by the central computer by determining the activity deposition rate on the fixed sample filter and taking into account the total volume of air which has passed through the filter during the deposition interval. The activity deposition rate is determined by comparing the average activity on the filter for two consecutive and equal time periods.

The sensitivity of the beta aerosol monitor is determined by taking into account the sensitivity of the beta scintillation detector, the detector background,

the monitoring period used to determine the concentration and the sample flow through the filter for the monitoring period.

LIQUID MONITOR

The Liquid Monitor Station block diagram is shown is figure 5.

1. Liquid Monitor Communications.

At each liquid monitor the ERM-2 counting computer servicing the detector channel is connected to the station teleophone modem. The modem is housed within the electronics enclosure.

2. Liquid Monitor Detector.

The detector for the liquid monitor is an Eberline model RDA-5A Nai gamma scintillation detector which consists of a 2 inch diameter by 2 inch thick Nai crystal coupled to a 2 inch diameter photo multiplier tube. The detector is installed inside a 2.8 liter sample vessel through which the liquid sample flows. The detector and sample vessel are shielded by 3 inches of lead shielding to improve sensitivity and reject ambient background.

3. Liquid Monitor Activity Determination.

The liquid monitor is calibrated by removing the sampler assembly and temporarily replacing it with a sealed calibration vessel containing a NBS traceable solution of Cs-137 suspended in a liquid epoxy matrix. The solidified liquid epoxy bonding reduces the possibility of leaking from the calibration source vessel.

Once this calibration is performed, the detector net count rate is a direct indication of the activity concentration of the liquid allowing the monitor to directly measure the liquid concentration in unit of Bq/L.

The sensitivtiy of the liquid monitor is determined by taking into account the sensitivity of the scintillation detector, the detector background and the monitoring used to determine the concentration.

The top range of the monitor 10^6 cmp corresponds to a maximum measurable concentration of 6.63 cpm/Bq/L or approximately $1x10^5$ Bq/L.

CENTRAL COMPUTER.

The proposed Central Computer consists of a U.S. manufactured IMB Model 80 386 computer with 2 Mbytes of random access memory, a high speed 80 Mbyte hard disk drive, a 20 Mbyte removable cartridge disk drive, a high density (1.44 Mbyte) micro-floppy disk drive, a 1.2 Mbyte floppy disk drive, a serial RS-232 interface, 80387 math co-processor, a parallel interface, a 250 cps NEC 5200 dot matrix printer, a mouse and a Virtual Graphics Array (VGA), color monitor and video card. An entire years worth of data for the proposed system can be stored on a single removable cartridge.

5. Central Computer Communications.

All communications between the ERM-2 monitor and the Central Computer is error-checked via high reliability cyclic redundancy check (CRC-16) algorithms thus assuring that all data transferred from the remote monitor has retained its integrity. Erroneous data transfers are re-requested by the Central computer as needed.

The communication protocol is a high speed binary protocol utilizing IEEE 4 byte single precision floating point format for the transmitted data.

A 1200 band modem is connected to the Central Computer which enables it automatically to call up and communicate with every monitor in the system.

2. Central Computer Software.

The programming in the Central Computer is written in comiled Pascal. The graphics supported by the software is the fastest available on any system running on a comparable computer. the current size of the program is less than 250K allowing ample room for future software expansion if needed. The following tasks are supported by the Central Computer programming:

LOGGING.

The Central Computer automatically polls all active environs monitors in the system for stored log data. This data is stored to hard disk and used for report generation. While logging is being performred, a system specific high resolution color map display is constantly updated with the status and current reading of all monitors. Status changes are constantly logged to the attached printer with data and time stamps.

On one hour intercals, the time clock in each counting computer is synchronized with the central computer. At the same time, the disk stored channel parameter file is compared with that stored in the counting computer for automatic verification of system calibration, detector high voltage, and other operational parameters.

REPORTING.

Daily System Summary and Daily Monitor Specific reports are generated both automatically and upon manual command. Monthly System Summary reports are generated when requested by the operator. A manually initited report can be selected for any current or past archive period (day or month).

CHANNEL FILES.

A disk based library of channel parameter files is maintained on the Central Computer disk drive. Files may be viewed, edited and/or printed at any time. All changes to the operating parameters are protected by password control. The operator has the option of manually requesting a monitor specific channel parameter file download to intially start up the system or verify that the parameters in the monitors are identical to those maintained by the Central Computer.

GRAPHING.

The operator is able to request a screen graph generation of all the data points logged for a specific monitor on any day down to a five minute detail. The

operator can move a screen pointer to any point during the day and display the digital reading associated with the selected time period. The minimum, maximum, and average reading for the day is calculated and displayed along with a dashed line plotted two standard deviations above and below the daily average.

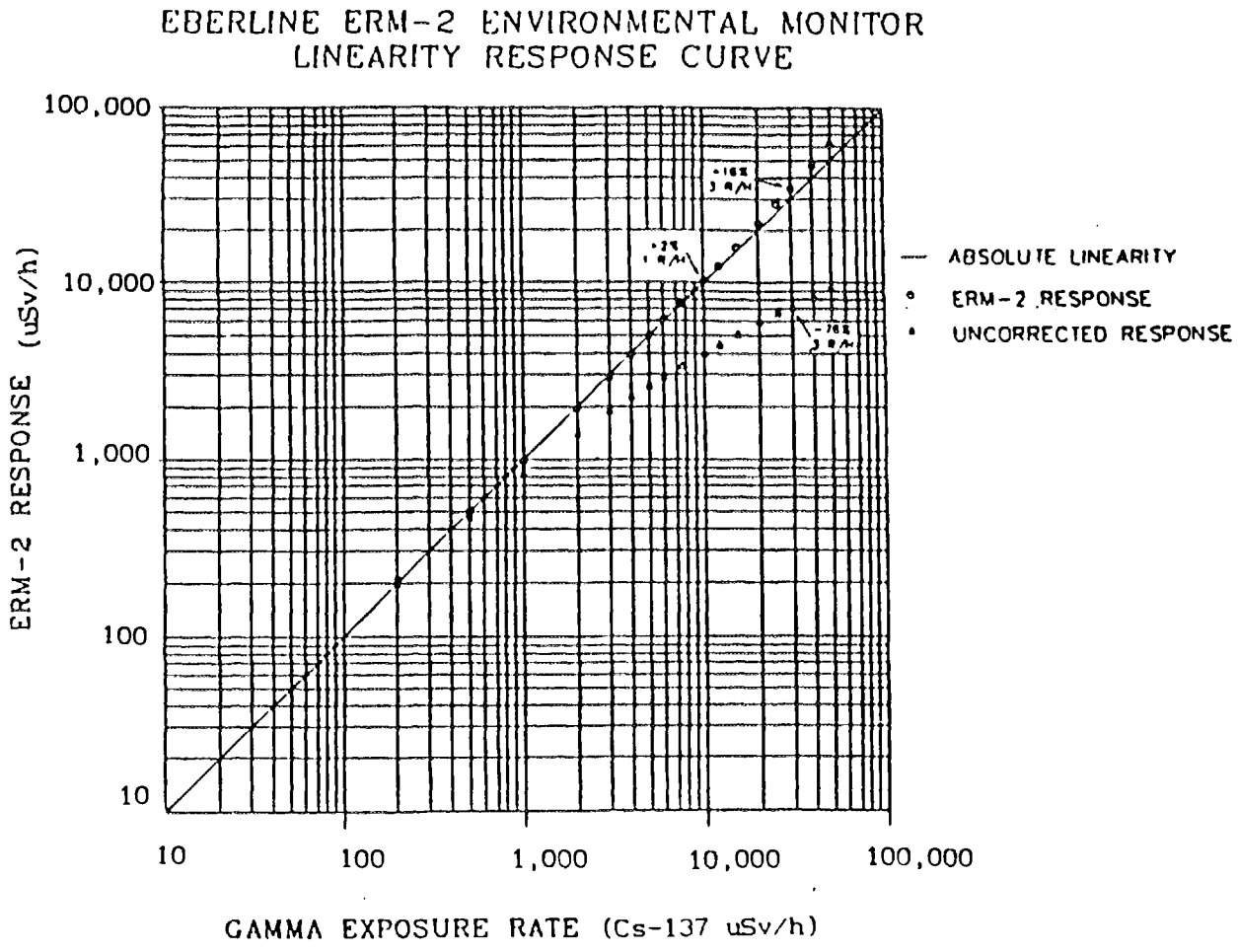

Figure 1 *ERM-2/HP-270 Linearity Response*

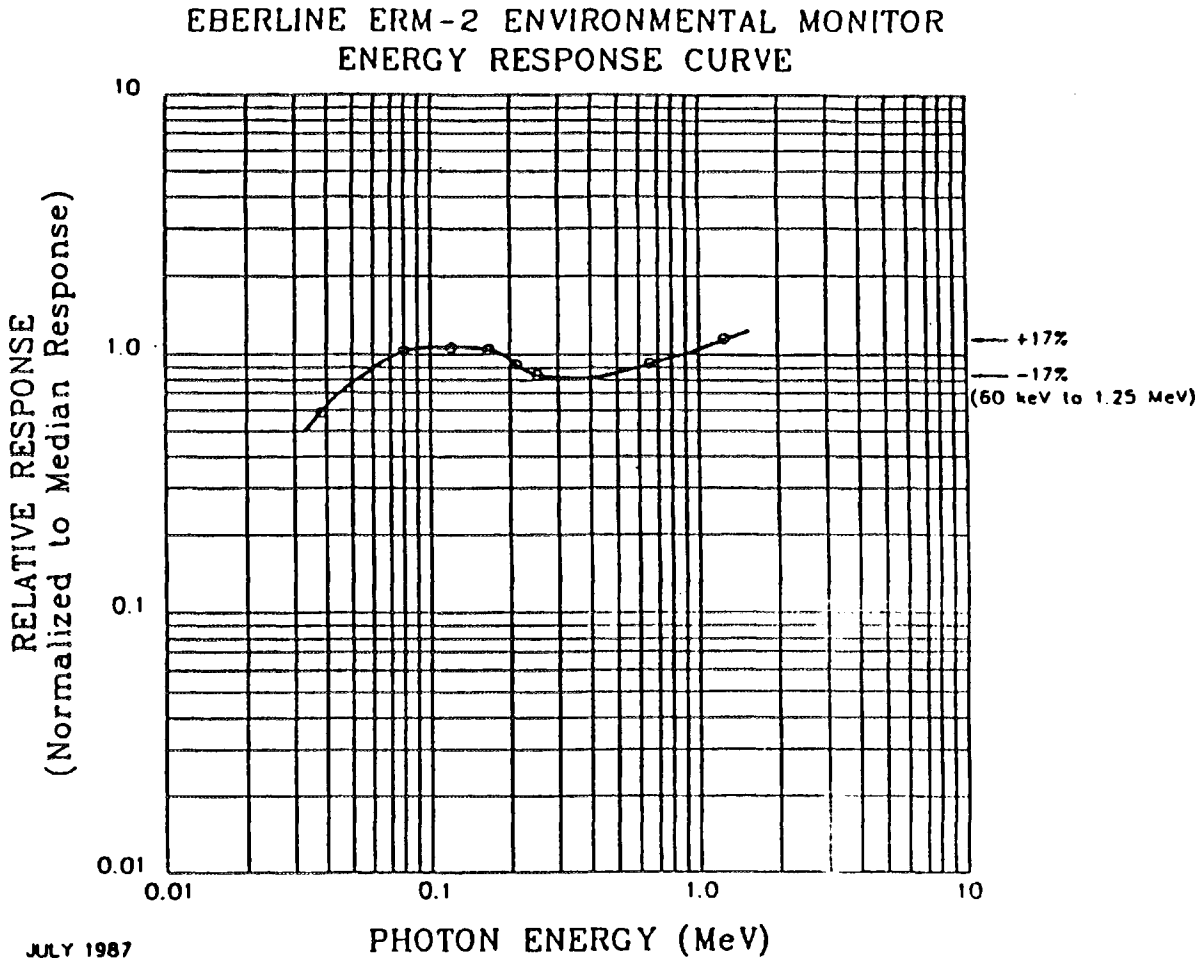

Figure 2 *HP-270 Energy Response*

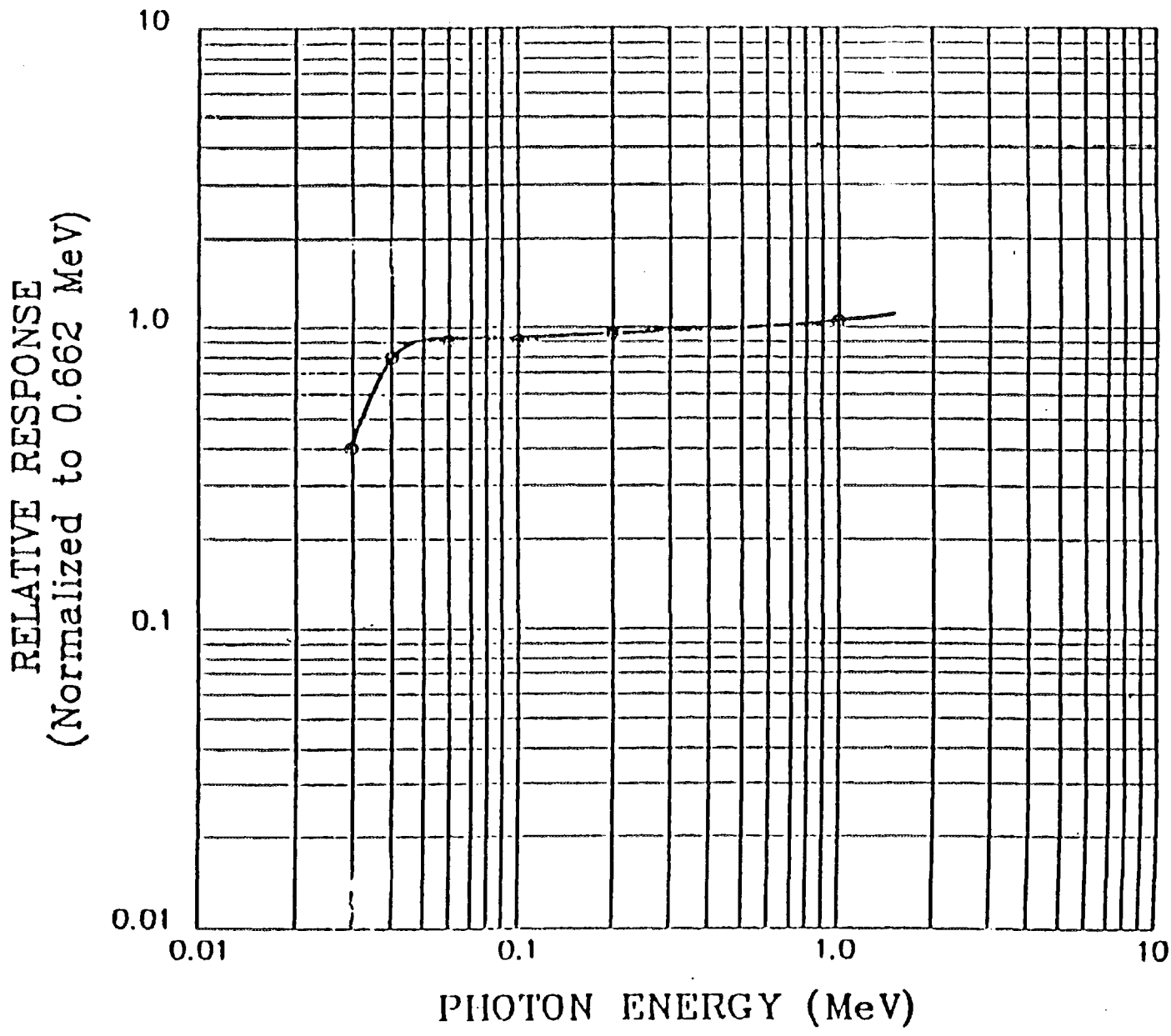
ENERGY RESPONSE CURVE
ERM-2 ENVIRONS MONITOR
RELATIVE RESPONSE
(Normalized to 0.662 MeV)
10
1.0
0.1
0.01
0.01
0.1
1.0
10
PHOTON ENERGY (MeV)

Figure 3

The beta aerosol monitor consists of the following standard Eberline sub-assemblies:

- Model SA-2A lead shielded sampler assembly (7.6 cm lead, 4π)
- Model RDA-3A beta scintillation detector
- Model RDS-1 alpha diffused junction detector
- Model IB-3C detector electronics for RDS-1
- Regulated, 60 liter/min. sample pump
- Three ERM-2 counting computers
- Model HP-270 Energy Compensated Gamma Detector

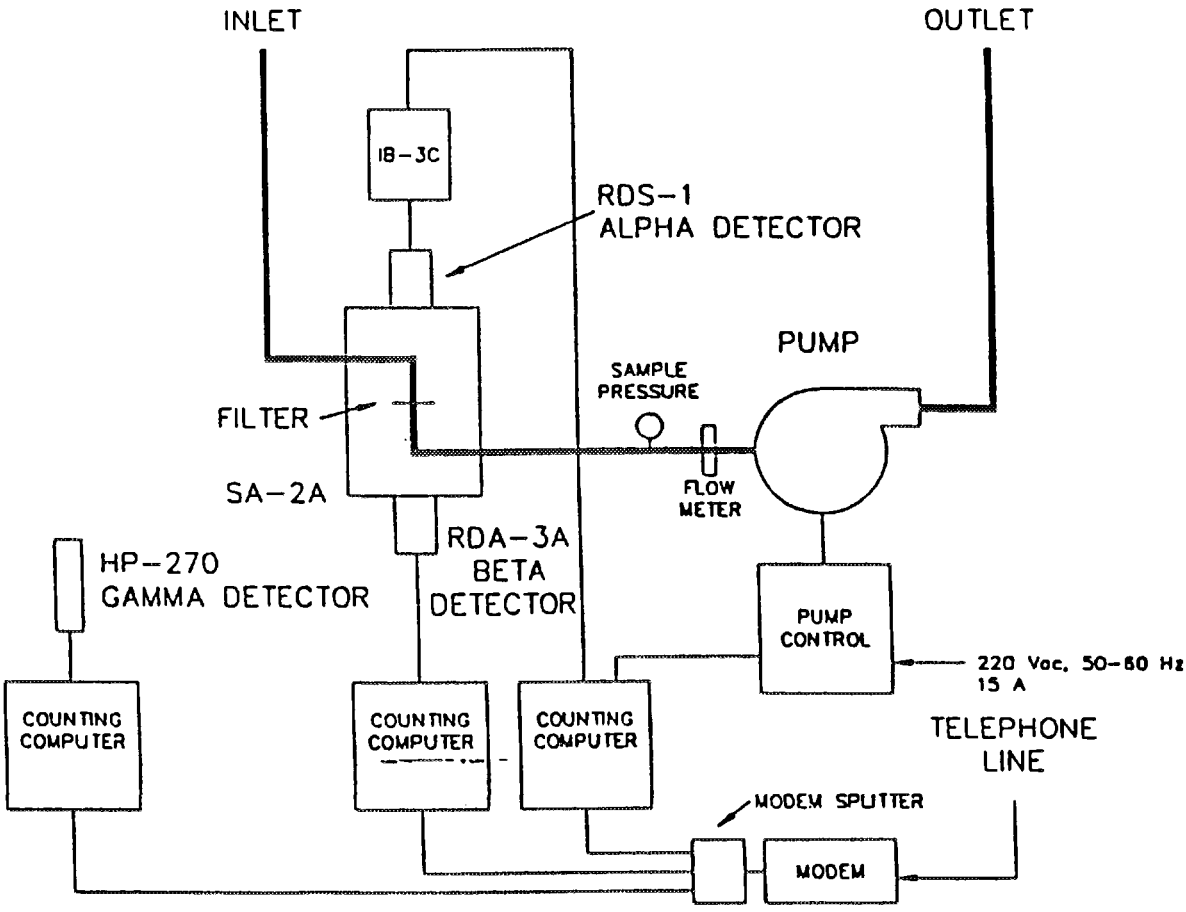

Figure 4 *Beta Aerosol Monitoring Station Block Diagram*

Distribution of Stations

No.	City	Gamma	Aerosole	Water	Total
1	Rafah	1*	1	1	3
2	El-Arish	1*	-	-	1
3	Damietta	1*	-	-	1
4	Gamasa	1	1	-	2
5	Rosetta	1*	-	-	1
6	Alexandria	2*	1	2	5
7	El-Daba	1*	-	-	1
8	Matruh	1*	-	1	2
9	Salum	1*	-	-	1
10	Kasima	1	-	-	1
11	El-Kantilla	1	-	-	1
12	Taba	1*	1	1	3
13	Nuweiba	1*	-	-	1
14	Sharm El-Sheikh	1*	-	-	1
15	El-Tor	1*	-	-	1
16	St. Catherine	1	1	-	2
17	Hurghada	1*	-	-	1
18	El-Zagazig	1*	-	-	1
19	El-Mansura	1*	-	-	1
20	Tanta	1*	1	-	2
21	Cairo	2*	2	1	5
22	Beni suef	1*	-	-	1
23	El- Minya	1*	-	-	1
24	Asyut	1*	-	-	1
25	Sohag	1*	-	-	1
26	Qena	1*	-	-	1
27	Aswan	1*	1	-	2
28	Sewa	1	-	-	1
29	El-Dakhla	1*	-	-	1
30	Port Said	1*	1	2	4
31	Ismalia	1*	1	2	4
32	Suez	1*	1	1	3
33	Inshas	7*	2	-	9
34	El-Faiyum	1*	-	-	1
	Total	42	14	11	67

* Operating Stations