

3.4 REMOTE GAMMA-RAY SPECTROMETRY STATIONS

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3.4.1 SCOPE

EML's global studies are comprised of a Global Fallout Program, a Surface Air Sampling Program, and a Remote Atmospheric Measurements Program (Sanderson et al., 1994). These programs currently represent EML's effort to sample, measure, and study radionuclides in the lower troposphere and their deposition on the earth's surface (Larsen et al., 1994).

Using remote atmospheric measurement systems (RAMS) in RAMP, EML is able to measure gamma-ray emitting radionuclides having short half-lives, such as ^7Be , that have been collected by drawing air through highly efficient filters, see Procedure 2.2.2.2. The gamma-ray spectrum is transmitted to ARGOS communications systems flown aboard polar-orbiting National Oceanic and Atmospheric Administration (NOAA) satellites, retransmitted to ground stations, and recovered via a telephone link by EML's computer. The recovered sodium iodide (NaI) gamma-ray spectrum is automatically resolved using a linear least squares program with a library of 18 possible gamma-ray emitting radionuclides. The last background spectrum received is also included in the library. When the analysis is complete, the results are written to a report file and a computer mail message is issued to report the completion of the analysis.

Once a RAMS station has been set up, its weekly operation requires <1 h of an operator's time. Each week one sample, one calibration, and one background is counted. Each month the weekly air filter samples are sent to the University of Miami and the computer floppy disk is sent to EML.

3.4.2 COMPONENTS

A. Gamma-ray detector.

A 12.7 cm x 10.2 cm diameter integral inline NaI(Tl) gamma-ray detector with ^{241}Am doping for gain stabilization is used in the RAMS. The photopeak produced by the ^{241}Am alpha particles should approximate a 3.5 MeV gamma ray.

B. Lead shield.

The copper-lined shield is composed of 12 interlocking steel and lead rings with a sample holder drawer at its base. The rings are 27 cm in diameter at the lower half and 22 cm for the top half of the shield and weigh either 20 kg or 9 kg, depending on the size.

C. Heated environmental chamber.

A heated environmental chamber is used to house the lead shield, NaI detector, multiplying phototube, and preamplifier. The temperature inside the chamber is set $\sim 5^\circ\text{C}$ above the highest expected ambient temperature.

D. Lead-acid gel-cell batteries and DC charger (power supply system).

The power supply system provides primary and backup battery power to the RAMS. This system uses: a transformer to convert 240-V power to 120 V (if required); sealed, lead-acid gel-cell batteries; and battery chargers. The EML-designed power supply can sustain 8 h of continuous operation when a line power failure occurs.

E. Multichannel analyzer (MCA).

The portable MCA used in the RAMS has the following features: 4096 channel, battery operated, CRT display, preamplifier power, detector high voltage, RS232 input/output. Davidson Model #2056-C MCA or equivalent is used.

F. Laptop computer.

A computer with backlite LCD display, either dual floppy, one fixed and one floppy disk, at least one RS232 and one parallel port, 512K memory, and simple 12-V DC operation are required.

G. Satellite transmitter and antenna.

A 2 W, 401.650 MHz transmitter, 30.5 m of low-loss cable and an omnidirectional quadrafilar helix antenna are used to transmit the gamma-ray data to the ARGOS satellites. Polar Research SITRA-1 or SITRA-2 or equivalent is used.

Figure 3.8 shows a block diagram of EML's second generation NaI RAMS.

3.4.3 INSTRUMENTATION ASSEMBLY

A. Lead shield and NaI detector.

Place the removable bottom of the environmental chamber on a table or floor that will support about 200 kg. The shield parts are numbered for assembly. Place the lead base (1) on the indicated circle. Place lead ring (2) on top of (1) and lead ring (3) on top of (2). Align these rings so that the sample drawer fits properly. Continue to install lead rings (4), (5), and (6). Next, install the small copper insert, the NaI gamma-ray detector with preamplifier attached, and then the large copper housing. Add lead rings (7), (8), (9), (10), and (11). Finally, place the lead plug (P) on top of the shield and place the environmental chamber over the completed shield.

B. Equipment rack.

Place the RAMP system power supply on the top shelf of the equipment rack, passing the cables through the hole in the back of the shelf. Place the MCA on the center shelf and connect the cables from the NaI gamma-ray detector preamplifier to the "0 TO 1250 V POSITIVE H.V.," "PULSE INPUT," and "PREAMP POWER." Place the serial/parallel two-way converter to the left and to the back of the bottom shelf.

Hang the transmitter on the two screws on the back of the equipment rack. Connect the printer cable to the computer printer port. The other end of this cable is connected to the PARALLEL side of the serial/parallel two-way converter.

Connect a 25-pin RS232C cable to the SERIAL side of the serial/parallel two-way converter and to the 25-pin connector on the transmitter. Use tape to secure this cable to the back of the equipment rack.

Connect the 9-pin end of an RS232C cable to the computer, connect the other end of this cable to the 25-pin I/O Port RS232C on the MCA. Connect the antenna cable to the transmitter and the ARGOS antenna.

***** WARNING *****

The power switch on the back of the RAMP system power supply must be in the down (OFF) position and the ARGOS antenna connected to the transmitter before proceeding. The transmitter will be damaged if power is applied without a load on the antenna connector. Connect one end of the AC power cord to the inside of the environmental chamber, connect the other end to the multioutput AC extension box.

Connect the RED power plug from the RAMP system power supply to the computer.

Connect the BLACK power plug with the hole in the center from the RAMP system power supply to the MCA.

***** WARNING *****

Very carefully connect the BLACK miniature phone power plug from the RAMP system power supply to the serial/parallel two-way converter. It is possible to cause a short circuit and blow an internal fuse if this plug is not inserted properly.

Connect the AMP lock power connectors to the transmitter.

Connect the AC power cord of the RAMP system power supply to the multioutput AC extension box.

Power the RAMP system power supply with the switch on the back of the unit.

Power the MCA and perform setup as follows:

Press SETUP on the MCA.

Press the UP ARROW.

Press YES eight times or until BAUD RATE=9600 appears again.

Press the UP ARROW.

Press YES six times or until PARITY=8+NONE appears again.

Insert the SYSTEM DRIVE A disk into drive A on the right side of the computer.
Insert a formatted data disk into drive B on the left side of the computer.

Power the computer. The switch is toward the back on the right side. The computer will self-test, load, and execute "1RAMP," the RAMS control program.

The system is now ready for operation. Set the clock as described in Appendix A and perform the steps described in Appendix B. In the event of problems, go to Appendix C for system troubleshooting. Appendix D gives the schedule of routine operation.

3.4.4 EML QUALITY CONTROL

All data records being received from Service ARGOS are monitored by EML personnel daily to ensure that all sites are transmitting valid data. This includes almost continuous monitoring of EML VAX mail messages by EML personnel during the normal work day. All completed spectra received from Service ARGOS are also examined daily. Calibration spectra are computed and plotted as received. Background spectra are plotted and visually compared with previous background spectra. The results of the analyses of the sample spectra are examined for quality of fit and for the likelihood of fission products. The cause of excessively high quality of fit or fission product likelihood is determined, corrected, and a reanalysis is then performed.

All hard copy and computer files, both original data and results of analyses, are maintained at EML.

REFERENCES

Larsen, R. J., H.-N. Lee, M. Monetti and C. G. Sanderson
"EML's Global Sampling Programs"
Proc. of the Conference on Atmospheric Chemistry, American Meteorological Society,
Boston, MA (1994)

Sanderson, C. G., N. Latner and R. J. Larsen
"Environmental Gamma-Ray Spectrometry at Remote Sites with Satellite Data
Transmission"
Nuclear Instruments and Methods, A239, 271-277 (1994)

Latner, N., C.G. Sanderson, V.C. Negro, S. Wurms and N. Chiu
"AUTORAMP - An Automatic Unit for Unattended Aerosol Collection, Gamma-Ray
Analysis and Data Transmission from Remote Locations"

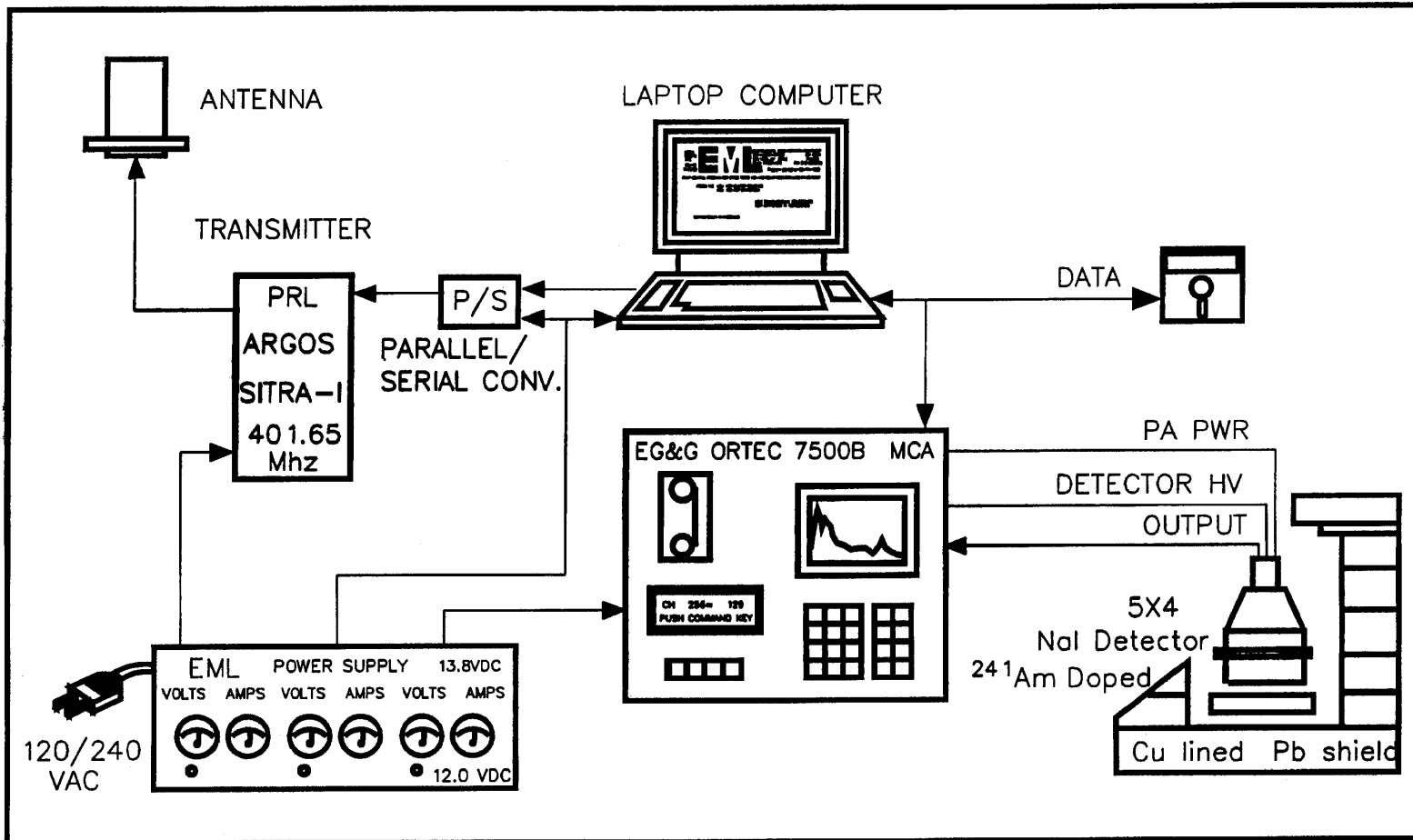


Figure 3.8. Block diagram of EML's second generation NaI RAMS.

APPENDIX A

OPERATION PROTOCOL

CONTROL PROGRAM MENUS

When the RAMP control program starts, there are four possible operations.

- I* - for initial setup,
- C* - for system clock reset,
- G* - for MCA gain check, or
- A* - for data acquisition.

INITIAL SETUP

Press the 'I' key on the computer. Enter the local date and time in the format as shown on the screen. Press ENTER. If the entry is correct, press the 'Y' key on the computer. If the entry is incorrect, press the 'N' key on the computer and reenter the correct local date and time.

If the 'Initial Setup' is entered in error, press the 'Q' key to quit this routine.

The default values displayed can be accepted by pressing ENTER. Press the 'Y' key to accept this value, or 'N' to enter a new value.

CLOCK RESET

It is very important that the date and time displayed in the upper-left corner of the screen is correct to within 1 h. If the date and time should change by more than 1 h, it must be reset. Press the 'C' key on the computer and enter the current local date and time

in the format as shown on the screen. Press ENTER. If the entry is correct, press the 'Y' key on the computer. If the entry is incorrect, press the 'N' key on the computer and reenter the correct local date and time.

DATA ACQUISITION - CALIBRATION

Press the 'A' key on the computer for data acquisition. When the 'A' key is pressed, there will be five possible operations.

- S - for sample count,*
- B - for background count,*
- C - for calibration count,*
- G - for MCA gain check, or*
- P - to return to previous menu.*

The first set of data obtained by the system must be a calibration count. Place a Coleman lantern mantle into the drawer of the RAMS counter and start data collection by pressing the 'C' key on the computer. The computer will automatically set up the analyzer and begin data collection. The calibration data should be collected for at least 4 h. Stop the calibration count by pressing the 'S' key, then the 'Y' key, and then the 'T' key. The calibration data will then be recorded on the floppy disk and transmitted to the ARGOS satellite. Remove the Coleman lantern mantle from the drawer of the RAMS counter.

DATA ACQUISITION - BACKGROUND

Press the 'A' key on the computer for data acquisition. When the 'A' key is pressed there will be five possible operations.

- S - for sample count,*
- B - for background count,*
- C - for calibration count,*
- G - for MCA gain check, or*
- P - to return to previous menu.*

Background data must be collected after the calibration and before any samples. Remove the Coleman lantern mantle from the drawer of the RAMS counter and replace with a BACKGROUND filter. Start data collection by pressing the 'B' key on the computer. The computer will automatically set up the analyzer and begin data collection. The background data should be collected at least overnight. Stop the background count by pressing the 'S' key, then the 'Y' key and then the 'T' key on the computer. The background data will then be recorded on the floppy disk and transmitted to the ARGOS satellite.

DATA ACQUISITION - SAMPLE

Press the 'A' key on the computer for data acquisition. When the 'A' key is pressed, there will be five possible operations.

- S - for sample count,*
- B - for background count,*
- C - for calibration count,*
- G - for MCA gain check, or*
- P - to return to previous menu.*

After one calibration and one background data set have been collected, exposed air filter samples can be counted.

Prepare for sample data collection by pressing the 'S' key. Enter the following information when requested on the computer screen.

- Date & time that sample collection started.
- Date & time that sample collection ended.
- Reading of running time meter when sample collection started.
- Reading of running time meter when sample collection ended.
- Reading of pressure meter when sample collection started.
- Reading of pressure meter when sample collection ended.
- Temperature when sample collection started.
- Temperature when sample collection ended.

Please refer to Appendix D for a schedule of when SAMPLES, CALIBRATIONS, and BACKGROUNDS should be counted.

When instructed, place the folded sample air filter into the drawer of the RAMS counter and start data collection by pressing any key on the computer. The computer will automatically set up the analyzer and begin data collection.

APPENDIX B

FIELD QUALITY CONTROL

POWER SUPPLY METERS

Each voltmeter should read about 14 V.

The MCA ammeter should read about 0.7 A with the display OFF and about 1.0 A with the display ON.

The laptop ammeter should read about 0.3 A with the display OFF and about 0.5 A when the display is ON.

The transmitter/converter ammeter should read about 0.3 A. Every 3 min when the transmitter is active this ammeter will read about 0.8 A for a second. This meter deflection is a good indication that the transmitter is operating.

LIGHT EMITTING DIODE (LED) INDICATORS

A red LED on the parallel/serial converter should be on, as it indicates the unit is powered.

A green LED on the MCA indicates that the battery is charging properly. If this LED should become red, a fault condition exists and EML must be notified by TELEX or FAX, but no operator action is required.

The three LEDs on the power supply should be on, as they indicate that the battery chargers are operating.

APPENDIX C

SYSTEM TROUBLESHOOTING

Once the system has been set up and is running, it should continue to do so indefinitely. There are a number of error traps built into the computer software program. If an error occurs and is trapped by the program, a message will be displayed indicating what action the operator should take.

Power for the transmitter/converter is protected with a 5 A internal fuse. If the LED on the serial/parallel two-way converter is not illuminated, and the transmitter/ converter meters indicate no voltage, this fuse may need to be replaced. In order to replace this fuse, the cover for the RAMP system power supply must be removed. The fuse holder is at the back of the left side of the unit. Spare fuses have been supplied with the backup equipment.

If none of the power supply LEDs are lit, the ammeters read 0 and the voltmeters read between 12 and 13 V, then the AC fuse at the back of the unit must be replaced to restore the AC (main) power. The batteries inside the power supply will continue to provide power for the RAMS for about 8 h.

If the computer does not respond, press 'CTRL,' 'ALT,' and 'DEL' at the same time. This will reset the computer and restart the program. Press the 'A' key, then either the 'C,' 'B' or 'S' key, as appropriate.

If the computer has entered the DOS operating mode as indicated by the DOS prompt A>, type 1RAMP and press ENTER to restart the program. Press the 'A' key, then either the 'C,' 'B' or 'S' key, as appropriate.

If the MCA has been turned off or has lost power for a long time, it will be necessary to reset the high voltage and to recycle the baud rate and parity so that communications with the computer can be established. Proceed as follows:

Press SETUP on the MCA.

Press the UP ARROW.

Press 'YES' eight times or until 'BAUD RATE=9600' appears again.

Press the UP ARROW.

Press 'YES' six times or until 'PARITY=8+NONE' appears again.

Press END.

Use 'CTRL,' 'ALT,' and 'DEL.' (This will reset the computer and restart the program.)

When the RAMP control program starts, there will be four possible operations.

- I - for initial setup,*
- C - for system clock reset,*
- G - for MCA gain check, or*
- A - for data acquisition.*

Press the 'I' key on the computer. Accept the default values displayed by pressing ENTER. Press the 'Y' key to accept these values. The high voltage will automatically be set to the correct value by the initial setup routine.

Computer software problems can develop if: 1) the MCA amplifier gain is beyond the range that the computer can correct; 2) the MCA gain setting when the unit was packaged for shipment was preset to an invalid value; and 3) the internal temperature of the environmental chamber was not set at 88°F. The MCA gain can be checked and adjusted as follows.

Press the 'G' key on the computer keyboard. "THE CURRENT GAIN VALUE IS" message will be displayed. After a few seconds, the current gain value will also be displayed. If the gain is very different from the preset value, enter the preset value and press the ENTER key on the computer. Press ENTER on the computer to leave the current gain value unchanged.

The MCA gain can also be reset automatically by the software. The procedure is as follows:

From the initial menu, press 'I' for initialization.

Enter the correct local date and time.

When prompted for a GAIN value, enter the word RESET.

Follow the instructions on the computer screen.

If the data that is being transmitted is not received by EML in New York City, EML will inform site operators by TELEX or FAX and ask operators to TELEX or FAX the status of the RAMS. After EML has determined the correct resolution of the problem, instructions will be communicated to site operators.

APPENDIX D

SCHEDULE FOR ROUTINE OPERATION

MONDAY - Transmit the SAMPLE count started on Friday by sequentially pressing the S, Y, and T keys on the computer.

Remove the exposed sample filter from the RAMP counter, write the date of transmission on the filter label under Notes, and mail the filter to the University of Miami.

Place the Coleman lantern mantle into the RAMP counter and start data collection by sequentially pressing the A and C keys on the computer.

WEDNESDAY - Transmit the CALIBRATION count started on Monday by sequentially pressing the S, Y, and T keys on the computer.

Remove the Coleman lantern mantle from the RAMP counter; store mantle.

Place the unexposed background filter into the RAMP counter and start data collection by sequentially pressing the A and B keys on the computer.

Change RAMP air filter and record pump data as outlined in Appendix A; store filter.

FRIDAY - Transmit the BACKGROUND count started on Wednesday by sequentially pressing the 'S', 'Y,' and 'T' keys on the computer.

Remove the unexposed background filter from the RAMP counter; store filter.

Fold and place the exposed filter sample collected on Wednesday into the RAMP counter and start data collection by pressing the 'A' and 'S' keys on the computer. Enter the data requested by the computer.

MONTHLY - At the end of each month, replace the data disk in Drive B of the computer and mail the old disk to EML.