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EMERGENCY RESPONSE EQUIPMENT AND RELATED TRAINING

AIRBORNE RADIOLOGICAL COMPUTER SYSTEM (MODEL-II) USER'S MANUAL

Revision 3.0

Approved for Public Release; Further Dissemination Unlimited

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About This Manual

Purpose

This User's Manual is intended to enable the ARCS-II Operator to:

- Assemble and disassemble the Airborne Radiological Computer System, Model II (ARCS-II)
- Calibrate and inspect the system
- Collect the gamma count rate data
- Set-up and telemeter the data to a ground-station computer
- Transfer the data to a notebook computer and superimpose (plot) the results onto a geographically referenced base map
- Playback/display the results from a previous flight

Scope

This manual covers the following topics:

- Overviews and specifications
- Safety precautions
- Assembling and starting up the system
- Calibrating the system
- Performing initial system checks
- Collecting the data
- Transmitting the data to a ground-station computer
- Analyzing and plotting the data
- Routine troubleshooting procedures

These topics focus on the procedures necessary for the proper operation of the ARCS-II.

Components of the ARCS-II

Overview

The materials included in the Airborne Radiological Computer System, Model-II (ARCS-II) were assembled with several considerations in mind. First, the system was designed to measure and record the airborne gamma radiation levels and the corresponding latitude and longitude coordinates, and to provide a first overview look of the extent and severity of an accident's impact. Second, the portable system had to be light enough and durable enough that it could be mounted in an aircraft, ground vehicle, or watercraft. Third, the system must control the collection and storage of the data, as well as provide a real-time display of the data collection results to the operator. The notebook computer and color graphics printer components of the system would only be used for analyzing and plotting the data.

In essence, the provided equipment is composed of an acquisition system and an analysis system. The data can be transferred from the acquisition system to the analysis system at the end of the data collection or at some other agreeable time.

Diagram

The figure below shows the components of the ARCS-II data acquisition system. The figure shows the ARCS-II unit with keyboard, track-pointer mouse, display screen, and the thallium-activated sodium-iodide, NaI(T*l*) detector pod, Global Positioning System (GPS) Antenna, USB ZIP drive,. Not shown is the analysis system, which includes a notebook computer and a color graphics printer.

Functional Description

ARCS-II unit

The ARCS-II is a stand-alone, dedicated computer system based on PC/104 standard bus architecture. The PC/104 standard was chosen over traditional portable computer architectures to eliminate the larger computer bus form factor, card cages, and backplanes. It maintains full hardware and software compatibility with standard portable computers, while savings in space and power make it ideal for use in deployed situations.

The ARCS-II unit consists of the following subsystems:

1. PC/104 Card Cage
   - Tri-M Systems Power Distribution II Card
   - Diamond Systems Quartz-MN V2 Counter Card
   - Zeli SATPAK Global Positioning System (GPS) Carrier Board with Trimble ACE-II GPS Receiver
   - RDT Technologies 1GHz CPU
   - Parvus Fan Card
2. Power Supply
3. Gamma Amplifier/Discriminator Modules (4)
4. Two Hard Drives: 2.0- and 4.0-Gigabyte (GB)Capacity
5. USB 1.4 Megabyte (MB) Floppy Drive
6. USB Zip Drive
7. USB CD Drive
8. CyberResearch LCD Display
9. Keyboard
10. Track-pointer mouse

Detector Pod

The gamma detector pod contains three, NaI(T*l*), detectors and three high-voltage power supplies. The detectors are categorized by size as:

- 2x4x16-inch NaI(T*l*) log
- 2x4x4-inch NaI(T*l*) crystal
- 1-inch diameter by 1-inch length NaI(T*l*) crystal

GPS Antenna	The (GPS) antenna is a small, circular, magnetic-mount, FOG antenna, that is used in vehicles that do not normally have a GPS antenna.
Notebook Computer	The notebook computer contains the ARCVIEW GIS software which will be used to process, analyze, and prepare the survey results for display.
Color Graphics Printer	The color graphics printer is used to display the analysis results. Results are typically shown either as an exposure-rate or gross count rate path plot (color-coded dots) superimposed on a geographically referenced base map or image of the survey area.

Equipment Precautions

High Voltage

Make sure the high voltage from the ARCS-II unit is turned off before connecting or disconnecting the cables between the ARCS-II unit and the NaI(T*l*) detector pod. MAKE SURE THE UNIT HAS BEEN TURNED OFF FOR AT LEAST 30 SECONDS BEFORE CONNECTING OR DISCONNECTING THE DETECTOR POD.

Temperature

The NaI(T*l*) detectors can be damaged by rapid changes in temperature. If you anticipate a rate of change greater than 10^{o}C per hour, apply power to the detectors for at least 30 minutes prior to exposure to the lower or higher temperatures do not open the detector box whenever it is being used in extreme temperature-changing environments. KEEP IT CLOSED.

Mechanical Shocks

The ARCS-II unit is a sensitive electronic instrument. Do not drop or hit it.

The NaI(T*l*) crystals and log detectors can be cracked or broken if subjected to severe shocks. Handle the detector pod with care. Do not drop or hit the detectors.

The notebook computer and the color graphics printer are sensitive electronic instruments and should not be dropped.

Specifications

ARCS-II Unit	Power:	10 to 32vdc [Volts Direct Current] 12V internal battery (for backup use only) 3V Lithium battery (for CMOS backup; 18 to 24 month battery life)
	Battery Life:	1 hour (limited data collection capability)
	Breaker/Fuse:	Circuit breaker (ARCS-II top panel) 10-ampere internal battery fuse (inside ARCS-II) power supply fuse (inside ARCS-II)
	Size:	16-inch length x 10-inch width x 13-inch height (40.6 cm x 25.4 cm x 33 cm)
	Weight:	25 pounds (11.4 kilograms)
	Temperature:	0^{o}C to 40^{o}C (operating)
	Humidity:	20% to 80% non-condensing
NaI(T*l*) Detector Pod	Power:	High voltage and preamplifier power are supplied through the ARCS-II electronic unit.
	Size:	33-inch length x 17-inch width x 10-inch height
	Weight:	59 pounds (26.8 kilograms)
	Detectors:	2 x 4 x 16 inch log (large) 2 x 4 x 4 inch crystal (medium) 1-inch diameter x 1-inch long crystal (small)
	Resolution:	10% or less full-width-at-half-maximum at 661 keV [Kiloelectron Volt]
	Temperature:	0^{o}C to 40^{o}C (operation) -40^{o}C to 70^{o}C (storage) NOTE: Do not expose to temperature changes greater than 10^{o}C per hour.
	Humidity:	Up to 95% non-condensing

Notebook Computer	Power:	12 V internal battery or 100-120/220-240 VAC using the AC adapter
	Battery Life:	1hour (typical time, dependent on condition of use)
	Temperature:	10^{o}C to 40^{o}C (operation) -20^{o}C to 50^{o}C (storage)
	Humidity:	10% to 95% non-condensing (operating) 5% to 95% non-condensing (storage)

Overview of the Data Collection and Analysis Process

Purpose

An overview of the procedure used to collect, analyze, and display the data is presented in the following table.

Location	Task	Description
In Laboratory	Test System	Perform periodic maintenance on the system
	Perform Calibration	• Before first use • Every 3 months • Prior to each deployment
	Initialize the Field Survey Parameters	• Load the base imagery map • Clear all previous data sets • Set survey origin location • Set all data plot scale levels • Select the data display type • Set the map plotting levels
At Base-of-Operations	Assemble Equipment	After transportation to the field • Remove equipment from transport cases • Assemble the system • Check system operation
	Daily Checks	• Perform system checks • Check calibration
At Work Site	Collect, Record, and Save the Data	• Collect the data and record it on the hard drive • Use the On-Top Marker function to delineate areas of interest • Copy the collected data files (7) to a storage device
At Base-of-Operations or at the Work Site	Transfer the Data to the Computer	Copy the data files (7) from the storage device onto the computer
	Analyze the Data	• Input data into ArcView GIS mapping program • Examine areas of interest collectively or individually • Plot the results to the printer
	Plan future Activity	Based on the data results, revise survey plan, if necessary
At Base-of-Operations	Disassemble Equipment	At the end of the survey, disassemble and pack the equipment for transport

Assembling the ARCS-II

Overview

This section discusses the assembly of the ARCS-II unit, the keyboard, the track-pointer mouse, the display screen, and the gamma detector pod.

Procedure

This procedure will discuss the installation and setup of the ARCS-II data acquisition system for field survey operations.

1. Unpack and inspect all the equipment.

   Caution: Keep the gamma detector pod sealed when encountering extreme temperature-changing environments (refer to “Equipment Precautions” in the General Information section of this manual).

   1.1. Open the ARCS-II cover and visually inspect the display screen, cabling, and connectors for exterior damage.

   1.2. Visually inspect the gamma detector pod cabling and connectors for exterior damage.

   1.3. Visually inspect the keyboard and track-pointer mouse cabling and connectors for exterior damage.

2. Install the ARCS-II unit, the display screen, external battery box (if applicable), and the gamma detector pod into a vehicle.

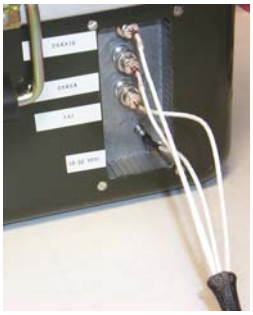
3. After the equipment has been installed, connect the display screen to the ARCS-II panel.

3.1. Using the 15-pin conductor cable, connect the DB-15HD connector to the [VGA] port located below the mouse-and keyboard port on the ARCS-II panel. Connect the other end of the cable to the VGA port located on the upper right-hand side of the display screen panel.

3.2. Connect the power for the LCD screen's power cable to the 2-pin "Display Power 12VDC @3.75 amp" port located below the VGA connector port on the ARCS-II panel.

4. Connect the keyboard and the track-pointer mouse connectors to the appropriate ports located on the upper left-hand side of the ARCS-II panel. The mouse port is located on the far left and the keyboard port is located to its right.

5. Connect the gamma detector pod to the ARCS-II panel. Ensure that the output of each detector is connected to the correct input port.



5.1. Using the supplied BNC cable, connect the cable labeled "Detector 2x4x16" to the "2x4x16" port on the gamma detector pod. Connect the other end of the cable to the "2x4x16 Input" port on the ARCS-II panel.

5.2. Connect the cable labeled "Detector 2x4x4" to the "2x4x4" port on the gamma detector pod. Connect the other end of the cable to the "2x4x4 Input" port on the ARCS-II panel.

5.3. Connect the cable labeled "Detector 1x1" to the "1x1" port on the gamma detector pod. Connect the other end of the cable to the "1x1 Input" port on the ARCS-II panel.

5.4. Connect the LEMO connector cable to the “Pod Power” on the gamma detector pod. Connect the other end of the cable to the “Pod Power” port located below the VGA port on the ARCS-II panel.

6. Using the supplied cable, connect the external power supply (from the vehicle, external battery box, or bench-top power source) to the “10-32VDC Input” port cable (pin A is positive and pin C is ground) located to the left of the floppy disk drive on the ARCS-II panel.

7. Connect the GPS antenna cable to the “GPS Antenna” port located to the left of the “1x1 Input” detector port. Mount the GPS FOG antenna on a suitable metal surface on top of the vehicle.

8. Ensure that the ARCS-II, the external battery box (if applicable) and the gamma pod are securely fastened (tied down) in the vehicle prior to use.

ARCS-II Calibration and System Checks

Overview

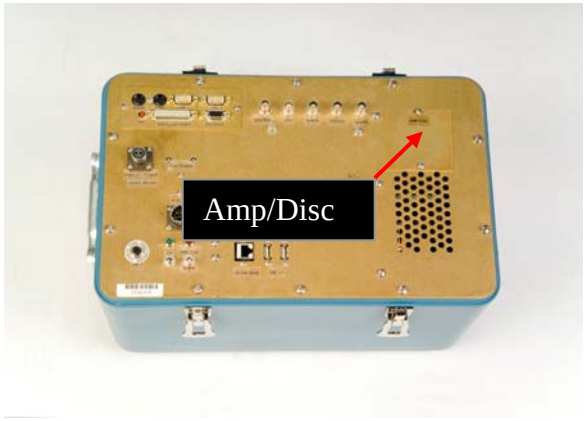
This section provides the procedures for calibrating the ARCS-II data acquisition system. The system should be calibrated prior to first use, every 3 months, and/or prior to being deployed to the field.

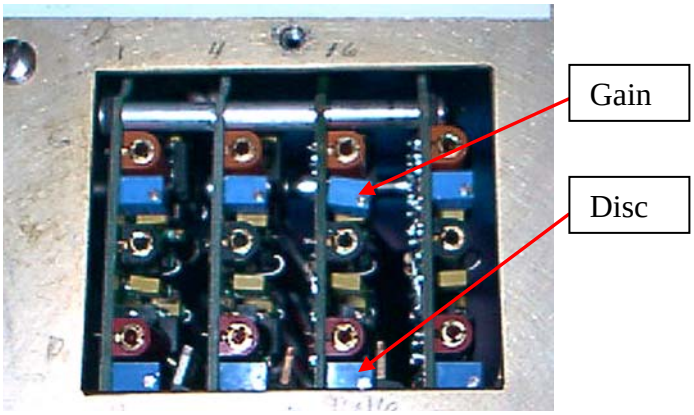
Procedure

This procedure will discuss the necessary steps in performing an ARCS-II system calibration and system checks.

Calibration

1. To gain access to the four amplifier/discriminator modules, remove the access panel's two securing bolts. The access panel is located on the upper right hand side on the front panel of the ARCS-II unit (see figures below). The four modules are located directly below the access panel cover. The modules are aligned from left to right for the 1x1-, 2x4x4-, 2x4x16-, and the Spare.





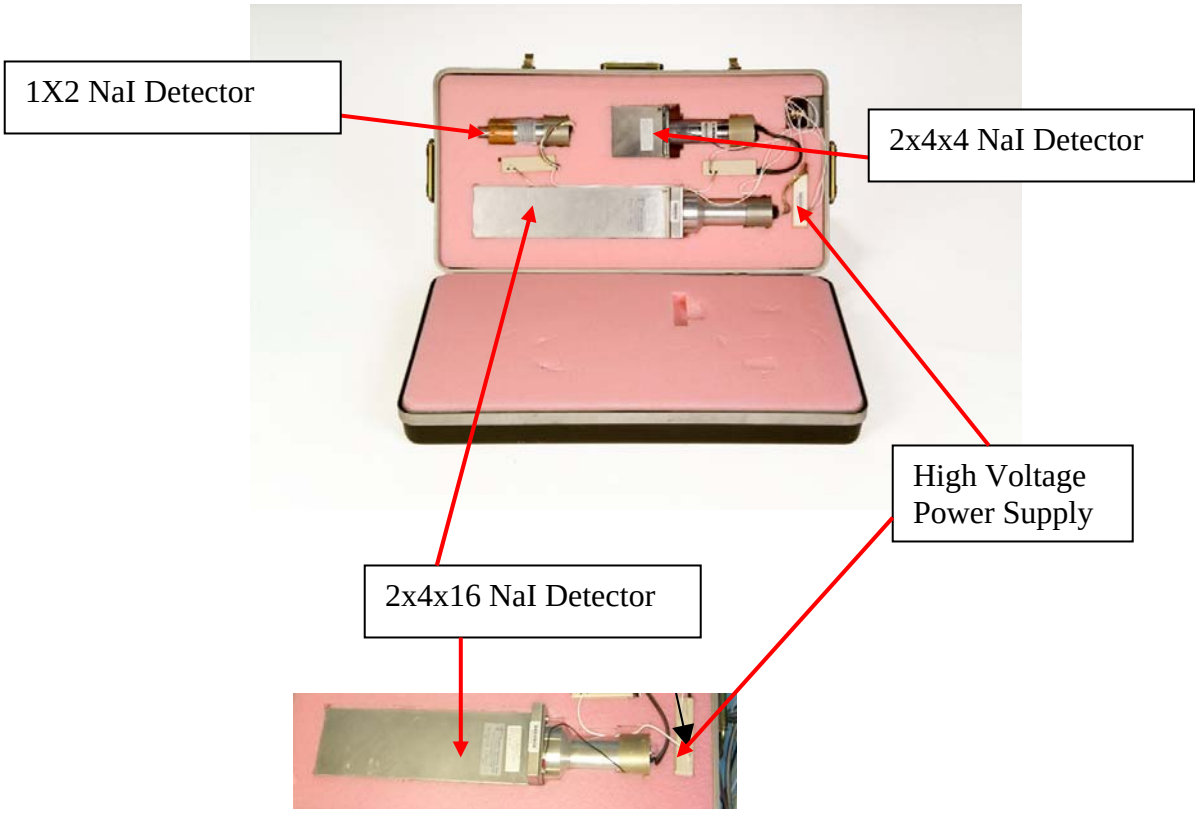
2. Apply power to the ARCS-II by turning on the power switch, located on the lower left-hand side of the ARCS-II panel, and wait until WindowsXP has been loaded and is running.

   NOTE: If the "Power Fail Light" located to the right of the power switch is "ON", the input voltage is either below 10 Volts or not present. Check your external power source because the system is only operating on the internal backup battery.

3. Obtain a cesium-137 (Cs-137) gamma check source.

4. NaI(T*l*) Detector Calibration (frequency: every 3 months)

   WARNING: A high voltage power supply is located inside the gamma detector pod near each of the detectors. Each power supply contains voltages that could cause death or serious injury. Use extreme care when making the following set of adjustments. (Figure shown is for illustration purposes only.)



   4.1. Place the Cs-137 source near the detector pod and use the oscilloscope (set to 50 ohm input impedance) to determine if the output signal from each detector produces a "band" that peaks at approximately –10 mV (millivolts). If not,

use a screw driver to adjust the "R1" potentiometer on the detector's high voltage power supply until the output signal is set to –10 mV. Perform check/adjustment on all detectors.

4.2. Set the oscilloscope voltage/division scale to 2V/cm [volts/centimeter] (V/cm) and the sweep time scale to 1 microsecond (μsec) with the oscilloscope input terminating into 1-megohm (MΩ).

4.3. Connect the oscilloscope input to the Gain test point (*i.e.*, the orange terminal) and the "Ground" to the black terminal on the amplifier/discriminator module. (See the second figure shown in Step 1.) Minimize (turn counter-clockwise) the R9 potentiometer, labeled gain to zero. Then adjust the R9 potentiometer ten (10) full turns clockwise.

4.3.1. Place a Cs-137 source near the detector and adjust the R1 potentiometer on the high voltage power supply for a –4V peak signal at the Cs-137 peak.

4.3.2. If the peak is at saturation, reset the Gain potentiometer five (5) full turns from zero, and repeat step 4.3.1.

4.4. Connect a digital volt meter (DVM) to the discriminator test point (Disc: red terminal) on the amplifier/ discriminator module (see second figure in Step 1). Adjust the discriminator potentiometer, labeled "R11", for a -270 mV peak signal.

4.5. Repeat Steps 4.3 through 4.4 for the remaining two detectors' high voltage power supplies and amplifier/ discriminator modules.

4.6. The following adjustments are made for each detector each time the ARCS-II is calibrated.

4.6.1. Remove the screws to the amp/disc access cover and remove the cover to expose the test points and the adjustment potentiometers.

4.6.2. Set-up an oscilloscope as discussed in Step 4.2.

4.6.3. Using the BNC to pin jack cable, check the amplitude on each detector's amplifier (Gain test

point, orange terminal) for –4 Volts at the Cs-137 “band”.

4.6.4. If needed, adjust the Gain potentiometer, labeled “R9” for –4V.

4.6.5. Check each detector’s signal cutoff (Discriminator test point, red terminal) as discussed in Step 4.4

4.6.6. Replace and secure the amp/disc access cover.

5. When finished, reassemble and turn-off the ARCS-II unit.

System Checks

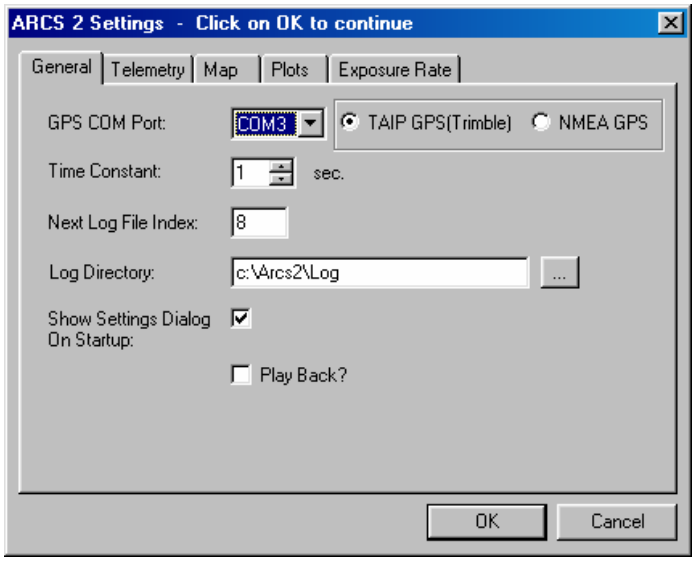
1. Apply power to the ARCS-II by turning on the power switch located on the lower left-hand side of the ARCS-II panel.

   NOTE: If the “Power Fail Light” located to the right of the power switch is “ON”, either the input voltage is below 10 Volts or not present. Check your external power source, because the system is only operating on the internal backup battery. It should be noted that the unit can be operated from the internal battery, but the Power Fail switch setting must be reset from “Norm” to “Power Fail”. This setting will re-enable the display screen. When the external power is restored, the Power Fail switch must be reset to its “Norm” setting.

2. After Windows98 has loaded and is running and using the cursor, double click on the “ARCS2 Vs3.xx”-icon located on the display screen. This will activate the “ARCS.EXE” program (Version 3.6 or greater) located in the “C:\ARCS2” directory. The folder from which the ARCS2 application is run (usually the C:\ARCS2 folder) has to have a “layers” folder containing the “Geogrid” shape files (Geogrid.dbx, Geogrid.shx, Geogrid.shp).

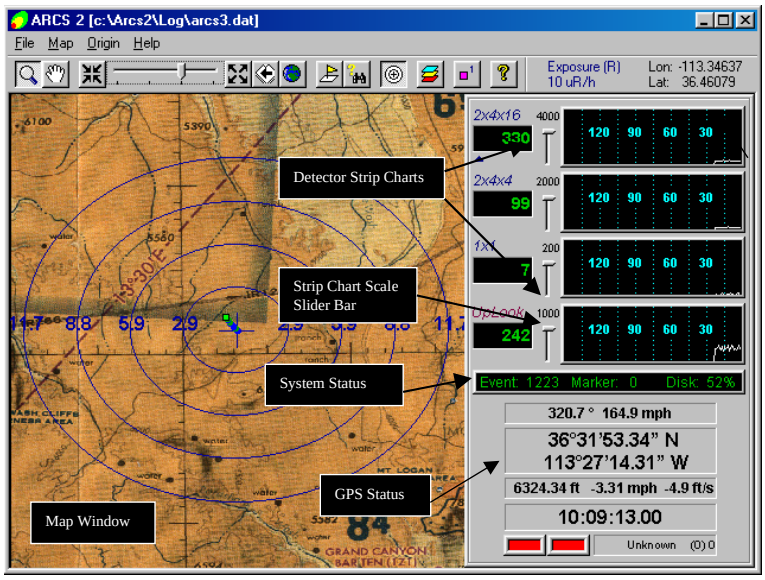
3. Upon start-up, the ARCS-II display screen will show either:

   3.1. The “ARCS2 Settings - General” PopUp menu. This is the default screen if the “Show Settings Dialog On Startup” box has been previously checked. If this menu is displayed, **click “OK”**.



3.2. After clicking “OK”, the data acquisition screen, as shown below, will now be displayed. The data acquisition screen shows:

- The last sampling interval’s gross count rates for each detector
- The gross count rate strip-charts (150-sampling interval history) for each detector
- GPS (Global Positioning System) status information
- Map imagery that had been previously loaded from the map layer directory (the map shown is for illustration purposes only).



4. If everything is connected properly and the system is not shielded from the GPS satellites (*i.e.*, indoors), check the following status items:

4.1. The Detector Status is provided in the upper right-hand side of the screen.

- If a detector’s input is not connected, no value will be shown in the value box located to the left of the gross count-rate strip-chart plot for that detector. NOTE: A marker will be displayed beneath the gross count-rate value box of the detector data being plotted in the map window.

- If the gross count rates for any of the input detectors should exceed 30,000 counts per second, the number being displayed in the value box will change colors from green (okay) to yellow (warning). If the count rates should exceed 60,000 counts per second, the color will change from yellow (warning) to red (high).

  NOTE: The program displays the gross count rates in counts per second (cps). If the data sampling interval "Time Constant" (*i.e.*, the sample's measured live time interval) is set at 2 seconds, the acquired gross count data will be divided by its live time (*e.g.*, "2") prior to being displayed.

- Use the strip chart plot scale slide bar, located to the left of each strip chart, to adjust the plot's vertical position. To change the maximum allowable plot scale level for each strip chart, refer to the "ARCS-II Field Operation Setup" section in this manual.

- Below the strip chart display, the unit displays the number of events being logged, the last on-top marker number assigned, and the percentage of the disk that is full.

4.2. The GPS Status is provided in the lower right-hand side of the screen.

- The status shows the vehicle's heading in degrees, its speed in miles per hour (mph), its current latitude and longitude coordinates, its vertical altitude in feet (ft) above the "GPS sphere" model of the earth, and its vertical velocity in both mph and feet per sec (ft/s). The vertical velocity will be negative for a descending vehicle and positive for an ascending one.

- The GPS clock shows the Universal Time Coordinated (*i.e.*, Greenwich or Zulu time) after the satellite acquisition is achieved.

- The last status line displays the quality of the GPS data (*i.e.*, the two color boxes) and the number of satellites being tracked (number in parenthesis).

- The left-most GPS quality color box shows the GPS mode: Red indicates no GPS coverage or poor

reception, Yellow designates 2D mode, and Green designates 3D mode.

- The right-most color box indicates the age of the GPS data, ranging from Green (new data), Yellow (old data), or Red (unknown status).

- If the GPS system is working properly, both GPS quality boxes will be "green".

- If the GPS system is not running at all, refer to the Trimble and Zeli Systems GPS User Manuals for the procedures in setting up the system for first time use.

- If the GPS quality is poor, check your GPS antenna placement. If the GPS is not working or updating, the unit may need to be placed outside far away from any buildings or other obstacles, so that the GPS can update its working almanac with the most current information.

4.3. At the top of the screen, the program cites the location and filename where the data is recorded. For this example, it is being logged to "C:\ARCS2\LOG\ARCS2.DAT". Each time the program is run, a new data file is automatically created where the attached file number (*i.e.*, "2") is incremented sequentially. It should be noted that the log file index number for the next file can be reset or initialized in the "Settings- General" PopUp menu — Next Log File Index (see the figure in Step 3.1).

5. Detector System Verification Check (frequency: prior to use)

5.1. Place a cesium-137 (Cs-137) gamma check source approximately 62.5 cm directly below the middle of the gamma detector pod. Depending on the activity of the Cs-137 being used (*e.g.*, 7.0 µCi), the gamma detector pod count rates should be approximately within the following set of ranges:

NaI (T*l*) Detector Type	**Gross Counts**
1- x 1-inch round crystal	30 to 90
2-x 4- x 4-inch crystal	1,000 to 1,300
2- x 4- x 16-inch log	3,200 to 3,800

[NOTE: Values are detector pod and source activity dependent]

5.2. Regardless of the Cs-137 source being used, the detectors' gross count ratio values (where GC1 represents the 2x4x16-inch detector, GC2 represents the 2x4x4-inch detector, GC3 is the 1x1-inch detector, and GC_{Up} is the 2x4x4-inch up-looking detector) should be in the range of:

Gamma Detector Pod Averaged Ratio Results		
Ratio	**Cs-137 (7.0 µCi)**	**Background**
GC2/GC1	0.328 – 0.330	0.405 – 0.411
GC3/GC1	0.015 – 0.017	0.023 – 0.025

NOTE: If the values are within the suggested guidelines, the system is ready for use. If not, the system may require calibration or repair.

ARCS-II Field Operation Setup

Overview

This section discusses the steps in setting up the data acquisition and map display features of the ARCS-II.

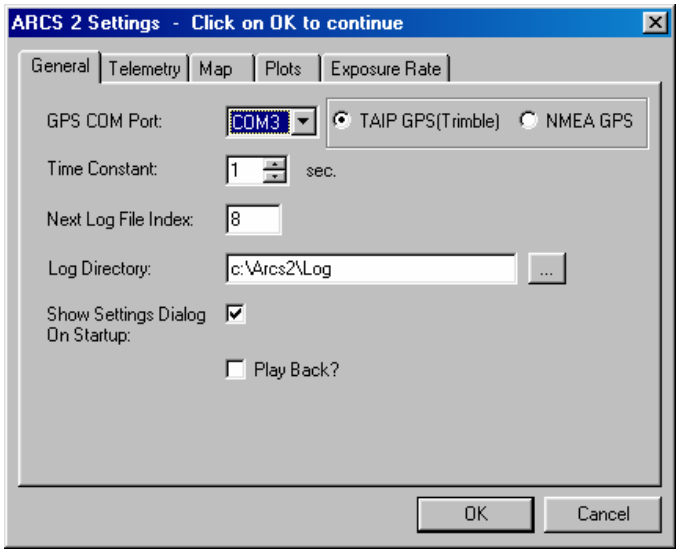
"Setup" Menu

1. Apply power to the ARCS-II by turning on the power switch located on the lower left-hand side of the ARCS-II panel (see the **Getting Started** section of this manual).

2. After WindowsXP has loaded and is running and using the cursor, double click on the "ARCS2" icon located on the display screen. This will activate the "ARCS.EXE" program (Version 3.71), which is located in the "C:\ARCS2" directory. Upon start-up, this program will load and use the default program parameter settings stored in the "arcs2.ini" file.

"General" Sub-Menu

3. Upon start-up, the display screen will show the "ARCS2 Settings - General" pop-up menu. This is the default screen if the "Show Settings Dialog On Startup" box had been checked (see below). If this box was not checked, the data acquisition screen will be displayed. From the top toolbar menu on the data acquisition screen, click **"File"** then **"Setup**" to return to this menu.



NOTE: If at anytime during the Setup process the "OK" or "Cancel" buttons are pressed, the program will automatically leave the Setup Menu and begin the data acquisition process.

3.1. GPS COM Port: **COM3** (Default). The ARCS.EXE program acquires the GPS information from the internal GPS receiver board via the COM3 port. DO NOT CHANGE THIS SETTING.

3.1.1. Select the appropriate GPS format type to be inputted -- click on either the TAIP GPS (Trimble) or NMEA GPS setting.

NOTE: The internal GPS card (COM3) in the ARCS-II unit uses the TAIP GPS (Trimble) format.

3.2. Time Constant: **1** second (Optimum Setting). This is the sampling time interval (or live time) for acquiring the data and to refresh (update) the map display screen. If a value of "2" is entered, the gross count data will be acquired over the selected sampling interval, but the displayed count rate values will be the summed count rate data divided by the acquired live time value.

3.3. Next Log File Index: **XXXXX** (a number from 1 to 99999). This number is sequentially incremented upon start-up of the program but the Operator has the option of resetting this index value prior to collecting the data. This index number will be used in forming the filename of the seven logged data files that are generated (*e.g.*, ARCS1.DAT or ARCS99999.DAT).

Caution: If the filename already exists, the program will append the current data to the previously named history data file (*i.e.*, the file with the extension of "*.dat"). However upon exiting the program, the three ARCSxxx shapefiles (*.shp, *.shx, and *.dbf) will not be generated.

3.4. Log Directory: **c:\arcs2\log**. Specifies where the seven logged data files (*i.e.*, arcsxxx.dat, arcsxxx.dbf, arcsxxx.shp, arcsxxx.shx, arcs_ontopxxx.dbf, arcs_ontopxxx.shp, and arcs_ontopxxx.shx) are to be written.

3.4.1. To change the directory, click the **"…"** button and select the desired directory (**Warning**: the directory must already exist).

3.4.2. The following seven data files will be generated (see the appendix for more detailed information):

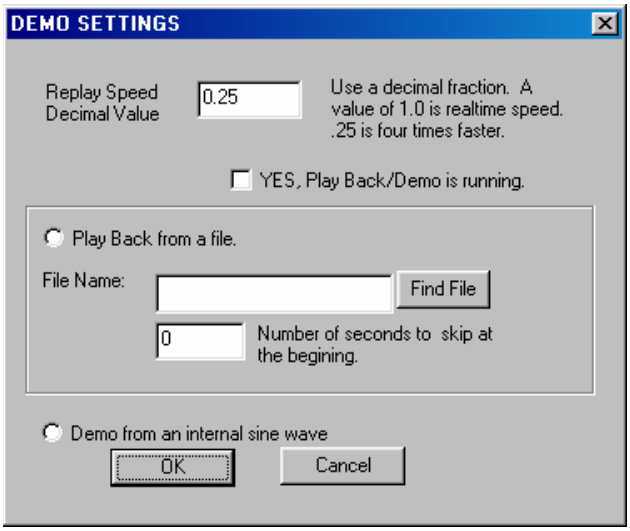
arcsxxx.dat	History of the actual data (19 variables) collected during each data sampling interval for sequence "xxx". The data is stored in an ASCII comma-delimited file format.
arcsxxx.dbf	These files contain an abbreviated sample of the data collected in the "arcsxxx.dat" file. Only 11 of the variables collected during the sampling period are stored. The data is stored in an ASCII database file format.
arcsxxx.shp	Shapefile containing the gross count or exposure rate data (11 variables per collection time interval) for sequence "xxx". This file is used as input into the ArcView GIS program.
arcsxxx.shx	This cross reference index file must accompany the "*.shp" file before the ArcView GIS program can be run.
arcs_ontopxxx.dbf	ASCII database formatted file containing the unique "on-top marker" data (4 variables per event) for sequence "xxx".
arcs_ontopxxx.shp	Shape file containing the unique "on-top marker" data (4 variables per event) for sequence "xxx".
arcs_ontopxxx.shx	Cross-reference index shapefile used by the ArcView GIS program.

NOTE: The arcsxxx.("dbf", "shp", and "shx") files will only be created after the program has successfully terminated.

3.5. Show Settings Dialog On Startup: (default: box is checked). If this box is enabled, the "ARCS2 Setting" pop-up menu will be displayed every time that the program is started and before the data acquisition sequence commences.

3.6. Playback: If this box is enabled, the Operator has the capability of either "playing back" a previously collected set of ARCS-II data or setting the unit into demonstration mode (internal sine wave generator).

3.6.1. Click on the Play Back box to display the "Demo Setting" PopUp menu.



3.6.2. Replay Speed Decimal Value (default: 0.25). Enter a number from 1.0 (real time) to 0.1 (10 times faster) to set the play back viewing speed.

3.6.3. Yes, Play Back/Demo is running: Clicking on this option and nothing else will enable/run the internal sine wave demonstrator. Not clicking on this box will not affect the operation of the other options.

3.6.4. Play Back from a file: Click on this box to enable the replaying of a previously collected set of ARCS-II data. Click on the "Find File" button (browser) to search /open the "arcsxxx.dat" file to be replayed.

3.6.4.1. Enter the number of events/seconds to be skipped at the beginning of the inputted "arcsxxx.dat" file prior to plotting.

3.6.5. Demo from an internal sine wave: Click on this box to enable the internal sine wave demonstrator mode generator.

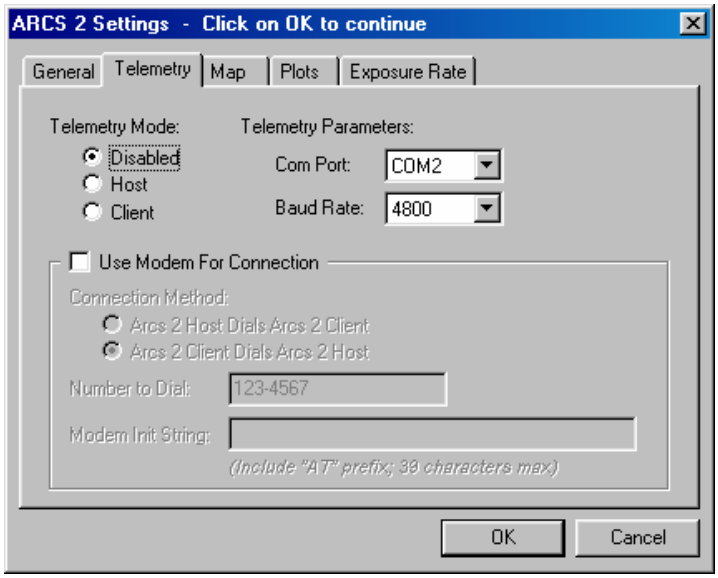
3.6.6. Clicking either the "OK" (feature enabled) or "Cancel" button will return the Operator to the "Setup – General" sub-menu.

3.6.7. To activate the demonstrate/playback feature, click "OK" on the "Setup – General" PopUp sub-menu which will activate the main data screen window. NOTE: The GPS Status lights will both be "red".

3.6.8. To disengage/turn-off the demonstration/playback feature, close the ARCS-II program by clicking "File" then "Exit". NOTE: The program will automatically terminate once the end of the "arcsxxx.dat" is read.

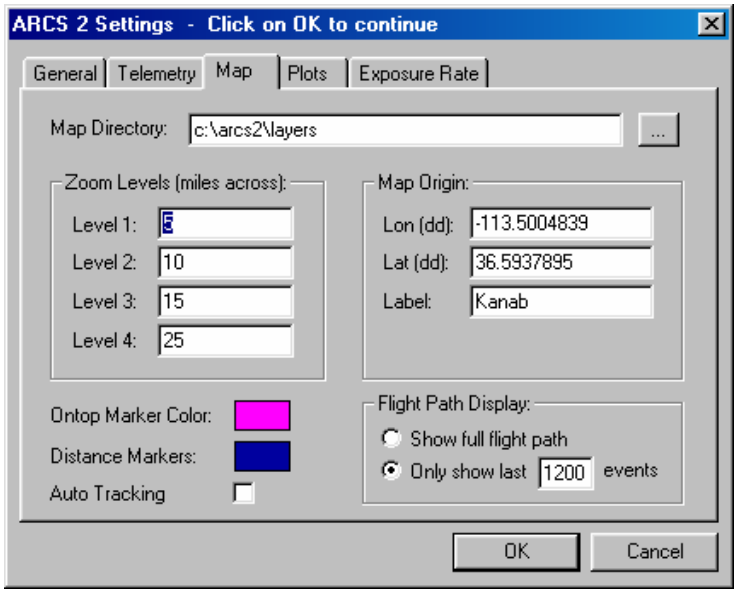
"Telemetry" Sub-Menu

4. The "Telemetry" sub-menu tab on the "ARCS2 Settings" Main Menu will be discussed in the appendix. However for non-telemetry flights, the Operator needs only to verify that the Telemetry Mode: "Disabled" option has been enabled.



"Map" Sub-Menu

5. Click on the "Map" sub-menu tab on the "ARCS2 Settings" Main Menu.



5.1. Map Directory: **c:\arcs2\layers**. Assigns the default directory where the program will first search in its attempt to load the geo-referenced map imagery files that it requires.

NOTE: Due to the large size of a map imagery file, a second hard disk drive was added to each ARCS-II unit. The default map directory for the ARCS-II units is **d:\arcs2\layers** and not "c:" as shown.

5.1.1. To change the directory, click on the **"…"** button and select the desired directory.

5.1.2. It should be noted that on first time use and if the default directory has been changed, the Operator may have to exit and re-enter the program in order to activate/display any of the map imagery files located in the new directory.

5.2. Scaling Levels (miles across): Four levels can be set. One of the features of the map window display is the incorporation of a toggle magnification slide bar, which would allow the Operator to toggle through four different preset map scale settings. The initialization for those four slide bar settings is entered in this tab. Furthermore, the

initial setup of the main window display will be set to the first toggle magnification setting.

5.3. Map Origin: Enter the longitude "Lon(dd)" and latitude "Lat(dd)" coordinates in decimal degrees of a site or location that is to be marked on the displayed map. A text label ("Label"), also will be added and plotted near the marked origin location.

5.4. Ontop Marker Color: Assigns the color to be used for plotting the "Ontop" marker number on the displayed map.

5.4.1. To change the color, click on the color box and choose one of the colors presented in the table.

5.5. Distance Markers: Assigns the color to be used to plot the concentric (or ring) distance ovals onto the displayed map.

5.5.1. To change the color, click on the color box and choose from the colors presented in the table.

5.6. Auto Tracking: If the Operator wishes to force the map window to "follow" the vehicle's current location, click on the check box to enable this feature. This will cause the map to re-center itself on the vehicle's current position whenever the current position marker is near the edge of the map border. If this is not enabled, the current map display can only be adjusted manually.

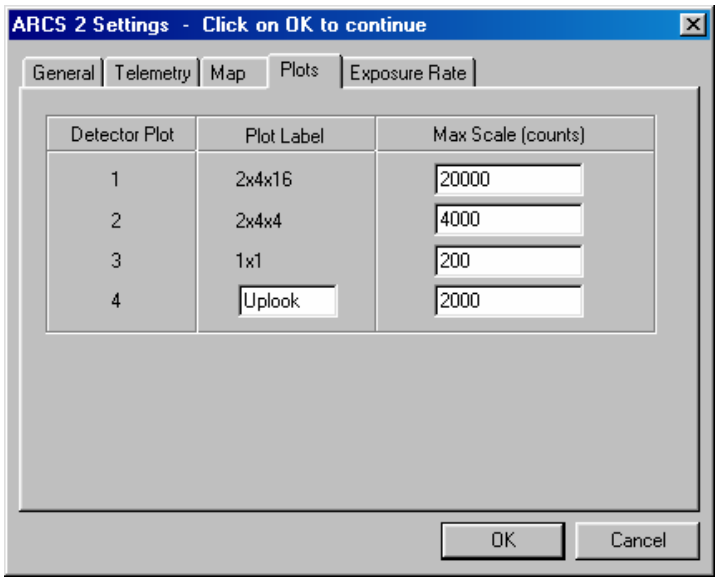
5.7. Flight Path Display: This feature was added to allow the Operator the ability to display only the last portion of a set of overlapping data.

5.7.1. If the option **"Only show last XXX events"** is selected, the Operator must enter the number (*i.e.*, XXX) of previous events (from the current position) to be displayed on the map screen whenever the map screen is next updated. For example, if a "12" is entered, then each time that the screen updates only the last twelve data points (*i.e.*, events) of the flight path will be displayed on the screen.

5.7.2. If the option **"Show full flight path"** is selected, then the entire set of flight data will be displayed every time that the map screen is updated.

"Plots" Sub-Menu

6. Click on the "Plots" sub-menu tab of the "ARCS2 Settings" Main Menu. The Operator has the ability to adjust/change the maximum scale height of the strip chart plot for each detector.



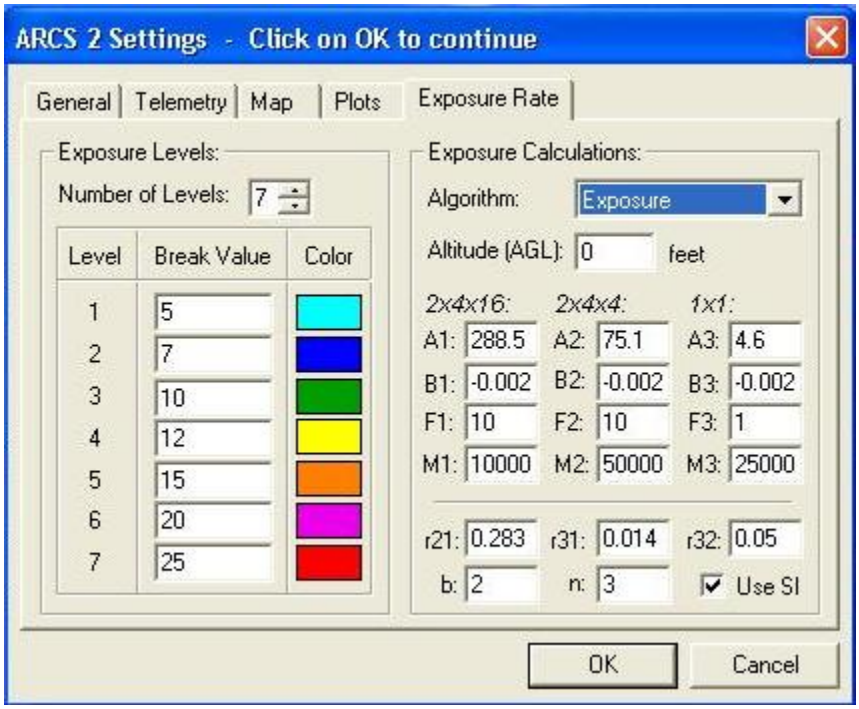
6.1. Max Scale (counts): The strip charts in the Main screen window display the gross count rates for each detector in the range from "0" to the Max Scale (maximum) value selected by the Operator. Any Max Scale setting changes made are only implemented at the startup of the program. By adjusting the strip chart's slider bar, the Operator can re-adjust the vertical (y-axis) height of the strip chart to this Max Scale setting.

NOTE: The fourth detector Max Scale setting cannot be set to a value greater than "2000". This value was chosen as a maximum display level for the selection of the Ratio Algorithm option (see the Exposure Rate Sub-Menu section for more details).

6.2. Plot Label: The Operator only has the ability to assign a name to the fourth detector (*i.e.*, UpLook or Ratio), which will be displayed on the main screen window.
Maximum Size: 6 characters.

"Exposure Rate" Sub-Menu

7. Click on the "Exposure Rate" sub-menu tab of the "ARCS2 Settings" Main Menu.



7.1. Number of Levels: Indicates the number of display levels that are to be used in plotting the exposure or gross count rate data points on the map screen window. The Operator can select 2 to 7 plot levels.

7.2. Break Values: Displays the break values for each display level. A new value can be entered for each level. Verify that the break value is consistent with the Algorithm type.

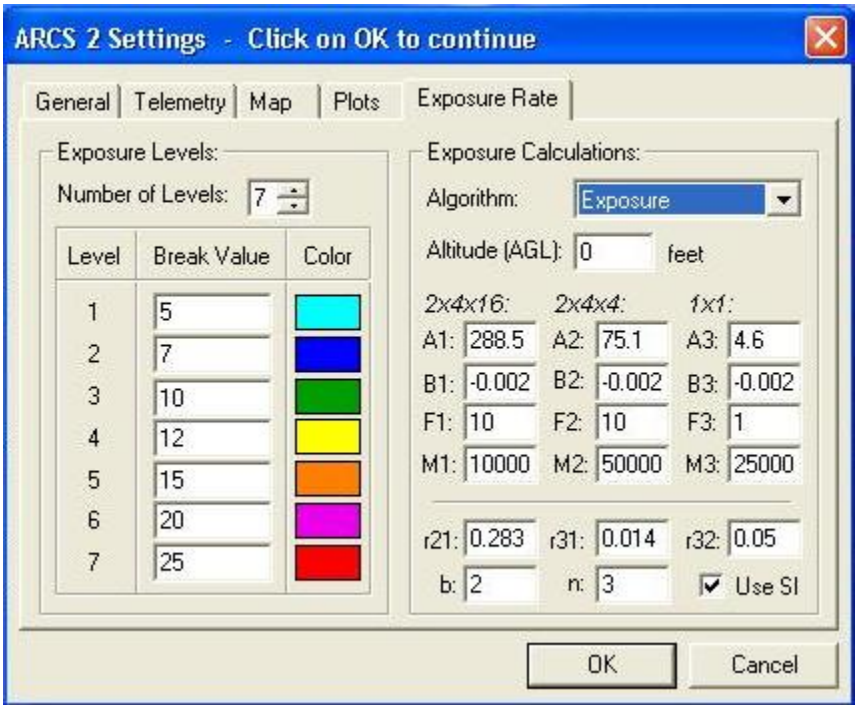
7.2.1. As shown in the figure, the first break level will plot the assigned color for data with values less than "5", but not equal to "5".

7.2.2. Data with values greater than or equal to the last break value selected will be plotted with the same color as the highest selected "Break Value".

7.3. Break Colors: Displays the break colors for each plot level. Click on the color box next to the level to choose a new color for that level. From the color table, select the color to be plotted on the map screen window.

7.4. Altitude (AGL): Enter the presumed survey flight altitude in feet above ground level (AGL). This value is only used in the exposure rate calculation.

7.5. Algorithm: Click on the pull-down menu box to change the type of data to be processed and displayed (*i.e.*, gross counts or exposure rates).



7.5.1. None (counts): The gross count rate (GC) data for all three detectors will be reported in the detector's data window and strip chart displays. No exposure rate calculations and no data verification tests are performed. Only the GC data for the 2x4x16-inch log detector will be displayed on the map screen window.

7.5.2. Exposure: Enables the basic exposure rate (Exp) derivation calculation routines (see the appendix for more details).

- The basic exposure rate conversion equation is:

  $Exp_{det} = GC_{det}/(A_{det} * \exp(B_{det} * Altitude))$

  The values for A_{det} and B_{det} are entered as shown in the figure above for the three primary

detectors, as well as the presumed flight altitude (feet AGL) to be flown.

- A test is performed on the gross count rates of the three primary detectors verifying that their values are within the Operator-specified minimum (F_{det}) and maximum (M_{det}) limits.

- The exposure rate data for the best available (*i.e.*, 2x4x16-, 2x4x4-, or 1x1-inch) detector will be displayed on the map screen window. To denote which detector data is currently being displayed, a marker will be placed beneath the GC-rate value box of that detector.

- A numeric read-out of the data (and its units) being plotted on the map screen window will be displayed on the main toolbar menu.

- If the Up-Looking (2x4x-4-inch) detector is connected (to the fourth detector input port), the gross count rates for that detector are recorded and displayed. No exposure rate calculations or verification tests are performed on the fourth detector port data.

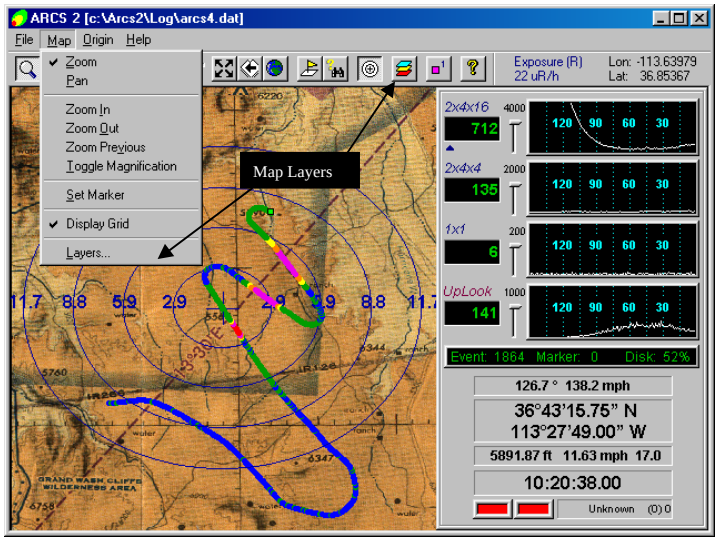
7.5.3. Ratio: The "Exposure" routines and data verification tests are enabled, as well as a computation of the ratio of the gross count rates of the up-looking (2x4x4-inch) detector to the 2x4x16-inch log detector. The ratio values (times "1000") will be displayed in the fourth detector data window and strip chart.

7.6. r21, r31, r32, b, n (not enabled): Future development was to include a ratio test between the various detectors as an additional verification on the quality of the data. An explanation of the algorithms employed and the appropriate parameter values to be entered is given in the appendix.

7.7. SI: Entering a check mark (click) in the box will display the exposure rate in SI units. nGy/h.

When the Operator finishes entering and/or changing the program initialization settings, the ARCS-II will be ready to commence taking the data. Click the "OK" button to update the system settings and save the new settings to the "arcs2.ini" file. To cancel all changes, click on the "Cancel" button.

8. Map Window Configuration: After clicking "OK" (or "Cancel") in any of the "ARCS2 Settings" sub-menu boxes, the Main Data Acquisition Screen will display a map screen window, strip charts, GPS status window, pull-down menus, and a tool bar (see figure). The last step in configuring the ARCS-II unit is to determine what assortment of geo-referenced maps or photographs (if any) should be displayed in the map screen window.



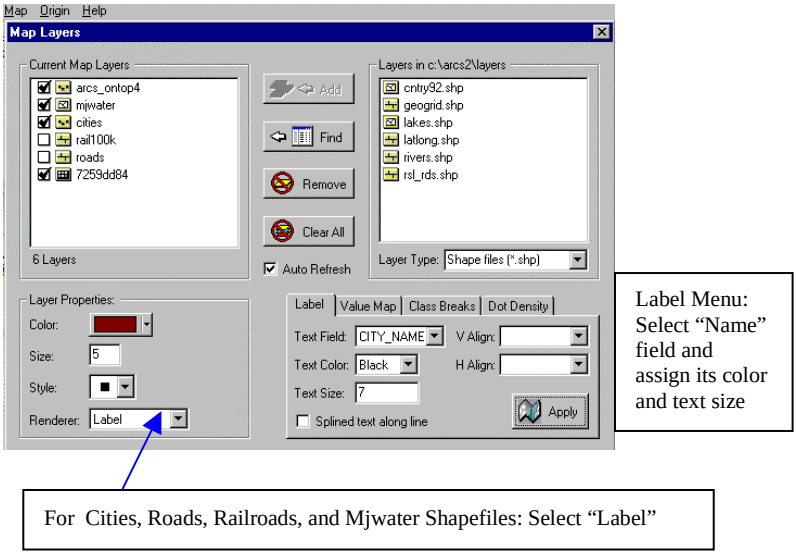
8.1. To view the map layers dialog box, click on the Map Layers tool (three stacked sheets) or choose "Layers" from the "Map" menu located on the main menu toolbar.

8.2. A dialog box (see figure in step 8.4) will appear showing a list in the "Current Map Layers" side of the dialog. To turn a layer on or off, click on the check box to the left of the layer name. To change the default layer name, single click the name of the layer to select it, and then click again to allow the label to be changed. To view the filename associated with the layer, double-click on the layer name.

8.3. To add a new layer to the map, select the desired map file (shapefile or image file [12345678.shp(.tif) – an

8-character filename is the maximum allowed]) from the list on the right side of the dialog by clicking on the layer. Then, click on the “Add” button. To remove a map layer, select the existing map layer and click on the “Remove” button. To add a layer which does not appear in the Map Directory list, click on the "Find" button. You may then locate any file in the pop-up explorer dialog. (NOTE: To change the default map layers directory refer to step 5.1.)

8.4. To change the color or symbology used to draw a shapefile layer, use the various tools located on the lower left portion of the map layers dialog (*e.g.*, color, size, and style).



8.5. To activate or add an annotation label (*e.g.*, street names, city or airport name) to a shapefile, click and select “Label” from the “Renderer” property (see figure above). The “Label” dialog menu will be displayed. For the Text Field, select either “Name” or “City Name” (for cities.shp) option and then select the appropriate Text Color and Text Size to be plotted on the map screen window.

8.6. By default, layer settings are updated each time any change is made. To change this behavior, uncheck the "Auto-Refresh" button. After all changes have been made, click on the "Auto-Refresh" button to update the map.

8.7. To return to the main screen, click on the “x” in the upper right hand corner of the “Layers” menu window.

The System is Now Ready for Use!

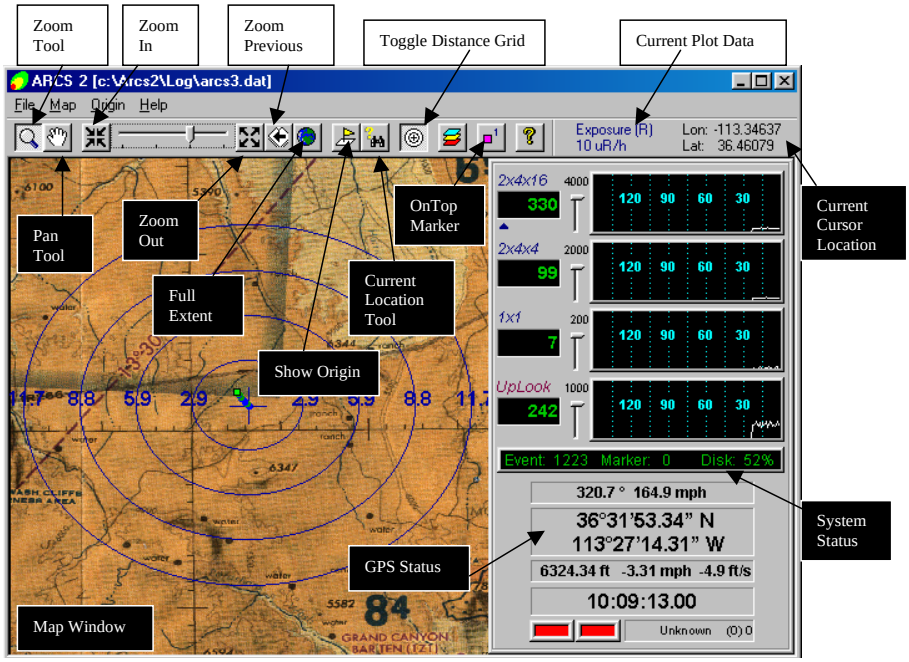
Collecting the Gamma Gross Count Data

Overview

This section discusses the monitoring of the ARCS-II, during data acquisition phase, and the general features of the main data acquisition display screen.

"Main Screen"

1. After clicking "OK" in the setup window, the main data acquisition screen appears. The gross count rate should be seen in the value boxes for detectors that are connected. If no gross count rates are seen, review the "Getting Started" section of this manual.



The ARCS-II main display screen consists of several sections. The upper part of the screen contains the menu and toolbar and allows various settings and operations to be performed. The left part of the screen contains a map window which displays the previously loaded map layers, along with the vehicle's current location, on-top markers, and exposure or gross count rate values. The upper right part of the screen contains plots, which display the detector gross count rate information in a strip chart, along with the current gross count rate readings. The lower right part of the screen displays the GPS information including heading, speed, longitude/latitude, vertical altitude above a GPS spheroid model of the earth, the GPS time, and the GPS status information.

1.1 Toolbar: The toolbar allows the most frequently used operations to be performed quickly and provides an alternative to selecting the corresponding menu item from the pull-down menus. To view a description of the tool, simply position the mouse pointer over the desired tool item. A tool-tip will appear which describes the selected tool.

1.1.1 The tools are described below in order

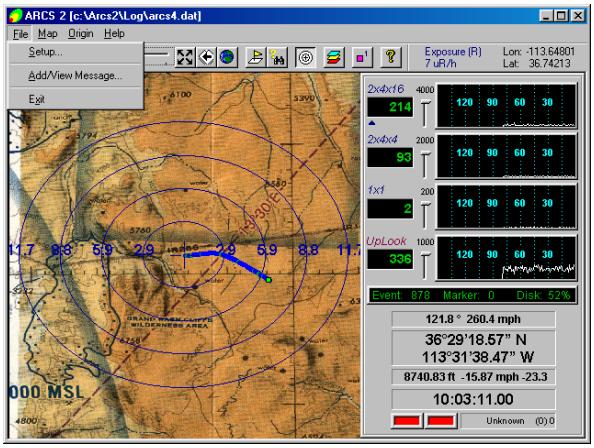
- Zoom Tool - Drag a rectangle on the map to "zoom in" the map display.
- Pan Tool - Click and hold the mouse down and then drag the map to change the map extent.
  NOTE: The Zoom or Pan Tool cannot both be active at the same time.
- Zoom In Tool - Zoom in the map a fixed distance.
- Zoom Level Slider - To toggle through the four different map scales, click on the selector and either slide it or click to the left or right to position the slider on the desired zoom level.
- Zoom Out Tool - Zoom out on the map a fixed distance.
- Zoom Previous Tool - Zoom to the previous map extent.
- Full Extent Tool - Zoom to show area from the current displayed point to the initial displayed point. Previously, this button showed the whole world.
- Show Origin Tool - Center the map at the origin location.
- Current Location Tool - Center the map at the current vehicle's location.
- Toggle Distance Grid - Toggles the display of the distance grid of concentric circles or rings. The grid has been changed since the last version to display distance in miles correctly. Because maps are displayed in longitude and latitude, the distance grid will in most cases be oval instead of a circle since a degree of latitude will represent a different distance in miles depending on the value of the longitude.
- Map Layers Tool - Displays the map layers dialog for setting map layer properties.
- On-top Marker Tool - Sets an on-top marker at the current vehicle's location.

- About Tool – Displays the ARCS2 program version number and general information.

1.2 Map Window: The map window displays current location information, on-top markers, exposure or gross count rates, and map layers. The various map tools can be used to pan and zoom the map to the desired location. The auto-tracking feature can be used to always keep the most current position in view. To keep the same land point or origin location in view, the auto-tracking feature must be disabled. The distance grid can be toggled "on-off". As the mouse is moved over the map, its map coordinates will be displayed (in decimal degrees) on the upper right part of the screen. The data type (Counts or Exposure) and the most current value (in counts (cts) or µR/h) being plotted are shown to the left of the current cursor location display. A marker to denote which detector data is being plotted will be displayed beneath the specific detector's gross count rate value box.

1.3 Pull-Down Menus:

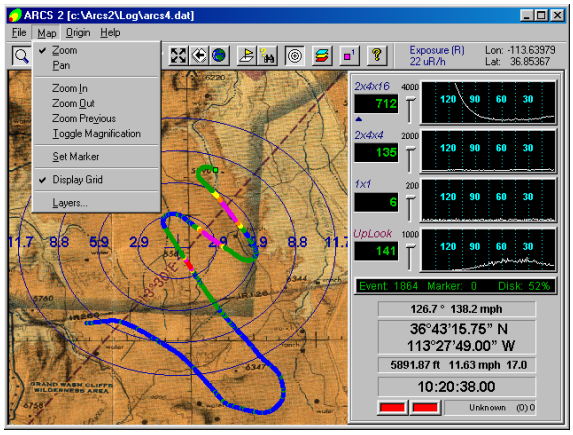
1.3.1 File: This pull-down menu contains three options:



- "Setup": Allows the system settings to be reviewed and modified.
- Add/View Message: On telemetry flights, the Operator has the ability to download a one-way, 50-character message string to the ground monitoring team. This capability should be used sparingly because its takes up too much system operation time, plus no data will be displayed on the map window until after the message has been sent.

- "Exit": Stops the data acquisition, closes and saves all of the data files, then exits the application.

1.3.2 Map: This menu contains the following menu items:



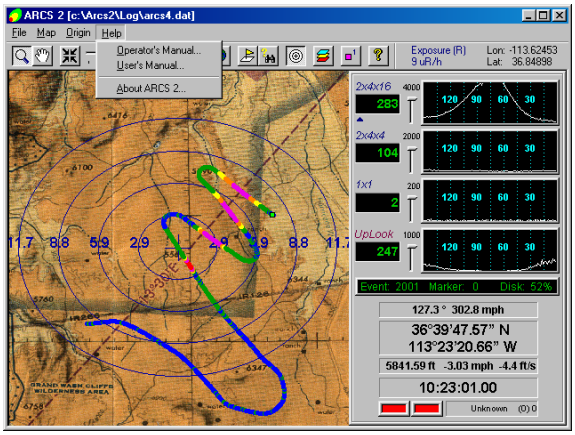
- "Zoom": After selecting this tool, drag a rectangle on the map to zoom in the map display.
- "Pan": After selecting this tool, click and hold the mouse down and then drag the map to change the map extent.
- "Zoom In": Click on this item to zoom in the map a fixed distance.
- "Zoom Out": Click on this item to zoom out on the map a fixed distance.
- "Zoom Previous": Click on this item to zoom to the previous map extent.
- "Toggle Magnification": Click on this item to toggle through four different preset map scales.
- "Set Marker": Click on this item to place an on-top marker on the map at the current location.
- Display Grid: Turns the Distance Grid "on" or "off"
- "Layers": Click on this item to view the map layers dialog box to customize the map display.

1.3.3 Origin: This menu contains the following options:

- "Set Origin Location": After clicking on this item, click on the map at the desired location to specify the map origin. After clicking on the map, a pop-up dialog will allow a label to be specified. Enter the desired label for the origin and click "OK". The map will then be updated with the origin marker and label.

- "Show Origin": Click on this item to center the map at the origin location.

1.3.4 Help: This menu contains the following menu items:



- "Operator's Manual": Displays an abbreviated ARCS-II Operator's Guide describing the application setup and configuration settings.
- "User's Manual": Displays an abbreviated ARCS-II User's Guide describing how to run and use the various features of the application.
- About ARCS2: Displays a dialog box showing version number and general information.

1.4 Detector Strip Chart Plots: The strip charts display the gross count rate information for each detector connected to the system. If a detector is not connected, no values will appear on the strip chart or in the current value box. Each chart displays the data for the past 150 sampling intervals. The most current data is always the right-most value, whereas the older data is scrolled to the left.

1.4.1 To change the maximum scale of each plot, use the slider bar located to the left of the plot and drag the slider bar up to increase the plot scale, or down to decrease the plot scale. The maximum plot scale value can be assigned in the "Setup" dialog from the "File" pull-down menu.

1.4.2 When the GC rates exceed 30,000 counts per second, the GC rate value box will change colors from green (good) to yellow (warning). If the gross

count rates exceed 60,000 counts per second, the box color will change from yellow to red (high).

NOTE: If the data sampling interval ("Time Constant" or live time interval) is set at 2 seconds, the program will divide the gross count rate by the measured live time interval (or ~"2" for this case) before the GC rate data is displayed.

1.4.3 If the basic exposure rate calculation algorithm is enabled (*i.e.*, Exposure or Ratio modes), the best detector's exposure rate results will be plotted on the map window, but the strip charts and data value boxes will still show the detectors' gross count rates. However, the current data type (and its units) being plotted will be displayed on the upper right-hand side of the top toolbar menu. Refer to the "Exposure Rate" submenu tab section for more detailed information.

1.5 System Status: The current system status is displayed underneath the detector strip chart plots. The current event number (starting from "0"), the current on-top marker, and percentage of the disk used are displayed. If the disk usage exceeds 99%, the status box will start flashing to warn the Operator. Unnecessary files should be deleted from the system to prevent system failure.

1.6 GPS display: This section includes heading and speed, longitude, latitude, vertical altitude above a GPS spheroid model of the earth, vertical rate of climb, the GPS time, the GPS quality, number of satellites being tracked, and a counter which increments each time a string is received from the GPS unit. Two color indicator boxes appear at the bottom of the screen. Each box can change color from red to yellow to green. The left most box indicates the GPS quality being received (*e.g.*, 2D, 3D, or Unknown). The right box indicates the age of the GPS data.

If the GPS stops receiving updated data due to poor reception or antenna obstruction, the GPS time will stop incrementing, and the GPS indicator boxes should start to change color from green to yellow or red after a short time.

Data Storage and Archival

Overview

This section discusses logging of the ARCS-II data and how to extract the data files for analysis.

Data Logging

1. Every time the ARCS-II application is run, a file is automatically generated to log the data. A counter is used to ensure that a unique log file is generated each time the program runs. This log file index can be changed in the "Setup – General" menu in the "File" pull-down menu. Shapefiles are automatically generated using the same log file index for storing the on-top marker and the exposure or gross count rate information. All three types of data files are written to the **"c:\arcs2\log"** directory by default. Since new files are generated automatically for each flight or application run, the Operator needs to periodically delete these log files when the files are no longer needed in order to conserve disk space.

2. After the mission has been completed, exit the program by pressing "File" then "Exit" from the toolbar menu or by clicking the "x" symbol in the upper right-hand corner of the main screen. Both of these methods will shut down the ARCS2 program. For each acquisition run, the program generates 7 files that are stored in the directory that was specified in the "Setup--General" sub-menu tab dialog box. The default directory is **c:\arcs2\log**. A description of these files is given in the appendix and the "ARCS-II Field Operation Setup" sections of this manual.

3. Copy the 7 data files to a floppy disk (floppy disk drive **A:**\) using the Windows Explorer program. "Click and Drag" or "Copy and Paste" the following files from **c:\arcs2\log** to drive **A:**\. The files to be copied are cited below, where "xxx" is the unique log file index number:

arcsxxx.dbf	arcs_ontopxxx.dbf
arcsxxx.shp	arcs_ontopxxx.shp
arcsxxx.shx	arcs_ontopxxx.shx
arcsxxx.dat	

   NOTE: If the program has not been terminated properly, the "arcsxxx.(dbf, shp, and shx)" files will not have been generated. The Operator will have to extract the data from the "arcsxxx.dat" file.

Shutting Down the ARCS-II

Overview

This section discusses the shutting-down of the ARCS-II unit and how to reboot the ARCS-II if some error had been encountered.

Shutting Down

1. Terminate the ARCS-II program “EXIT” from the “FILE’ menu or by clicking the “x” in the upper right-hand screen.
2. Archive the data files using Windows Explorer.
3. Shutdown the WindowsXP operating system by clicking on the “START” icon in the extreme lower left-hand part of the screen.
4. Select “Shut Down” from the menu and the unit should immediately close down.
5. After WindowsXP has shut down, turn off the power to the ARCS-II unit.

Analyzing and Plotting the Data

Overview This section discusses the steps in processing the ARCS-II output data files using the ArcView GIS mapping program.

Reading In the ARCS-II Data

1. Before starting, the following files should be moved from the ARCS-II hard drive and transferred to the laptop computer that will perform the analysis. Each ARCS-II flight or acquisition run should contain a total of **seven (7)** data files:

   arcsxxx.dat: This is a history of the actual data collected during each acquisition run. The data collected (*i.e.*, 19 variables collected per sampling interval) include an events counter, an on-top marker, the date and time tag for each event, the GPS positional information (latitude, longitude, and vertical altitude above a "GPS sphere" model of the earth), the gross count rates for each of the four detectors, the calculated exposure rates (or GC rates if the exposure rate option was not selected) for the three primary detectors, the exposure (or GC) rate of the best detector data available, and any Operator-sent messages (for telemetry flights only). The data is stored in an ASCII, comma-delimited, file format. A sample listing is presented in the appendix.

   arcsxxx.dbf: This file contains an abbreviated sampling of the data saved in the "arcsxxx.dat" file. This file contains only 11 of the 19 collected variables: the events counter, the GPS latitude and longitude coordinates, the calculated exposure (or GC) rates for the three primary detectors, the exposure (or GC) rate of the best detector, and the GC rates for each of the four detectors. The data is stored in an ASCII database file format and a sample listing is presented in the appendix.

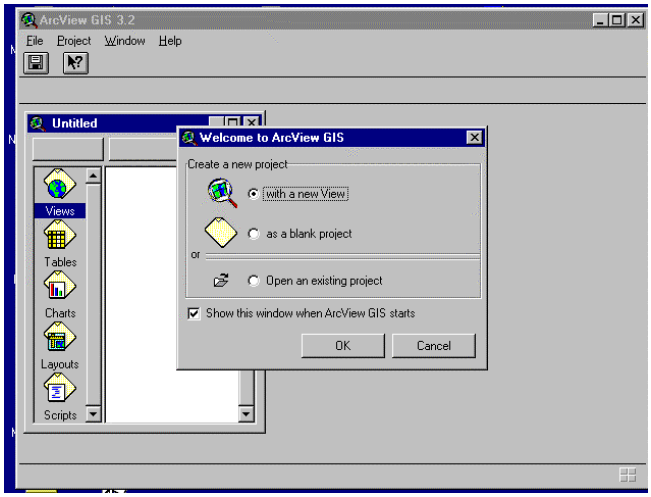
   arcsxxx.shp: This file contains the same data that is stored in the "arcsxxx.dbf" file. The only difference is that the data is stored as a binary-formatted shapefile, which can easily be imported into the ArcView GIS mapping program. A sample ArcView GIS table listing of this type of file is shown in the appendix.

arcsxxx.shx: This file is a cross reference index file that must accompany the “arcsxxx.shp” shapefile before the ArcView GIS program can be run. No sample listing for this type of file is available; hence, it is not presented in the appendix.

The **arcs_ontopxxx.dbf**, the **arcs_ontopxxx.shp**, and the **arcs_ontopxxx.shx** data files are similar to those type of files cited above for “arcsxxx”. The difference is that these files contain the on-top marker data, which include only 4 of the 19 variables collected: the events number, the on-top marker number, and their corresponding GPS latitude and longitude coordinates. If the on-top marker function is not used (executed) during the acquisition run, then these files will not contain any data. A sample listing of the arcs_ontopxxx.dbf file is shown in the appendix.

2. Start ArcView by double-clicking on the ArcView GIS icon.

3. A "Welcome to ArcView GIS" pop-up window will be opened.



3.1. If the above dialog box is not displayed

3.1.1. Click on the “View” icon shown on the left in the project (“Untitled”) window.
3.1.2. Above the “View” icon, three options will appear (New, Open, and Add). Click on “New” to create a new view frame window – “View1” will appear in the queue on the right.
3.1.3. Click on “View1” to activate the View1 frame window.

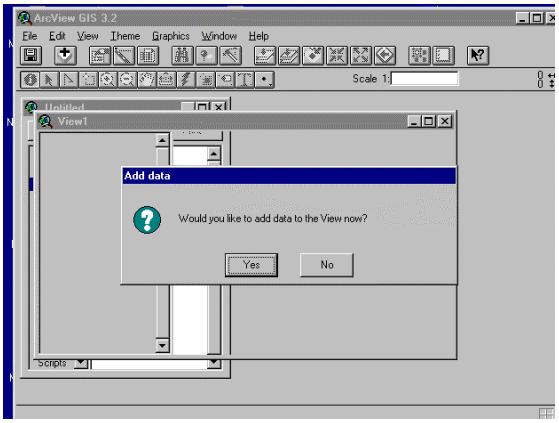
3.1.4. Follow the procedures for “Adding a Map Theme” (Steps 27 to 29) to open the ARCS-II shapefiles
3.1.5. After opening the shapefiles, continue from Step 4.3.

3.2. If the above dialog box is displayed

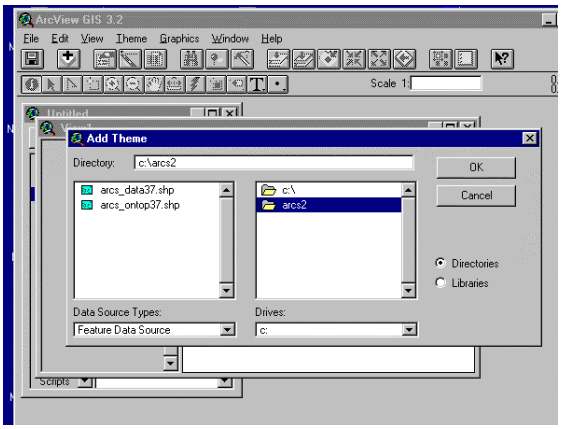
3.2.1. Click the " with a new View" selection button.
3.2.2. Then click “OK”.

4. Another window will open; click **YES** to the “Would you like to add data to the View now” prompt (see figure below).

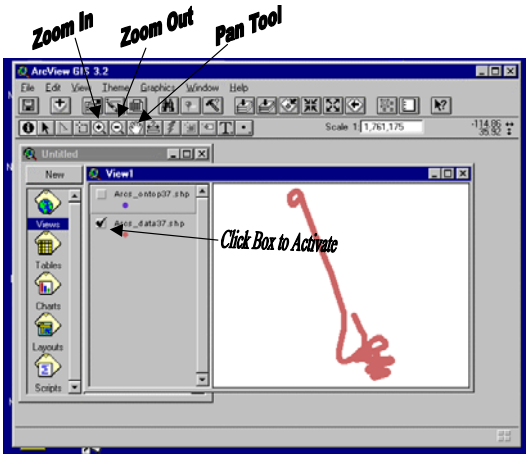
4.1. After clicking “YES”, a File Browser window will open allowing the Operator to navigate to the appropriate work directory location.



4.2. Double-click to select a single data file or simultaneously press the <shift> and <Down-Arrow>-keys to open more than one file.



4.3. The selected files or themes will be displayed or will appear in the View frame window.



4.4. To activate or display one of the images ("*.shp" files) or themes, click (check) the box in front of the image's file or theme name in the View window (see figure in Step 4.3).

4.5. Sometimes the image in the view window may appear to be too small or too large. Use the Zoom and Pan tools to adjust the image (see figure in Step 4.3).

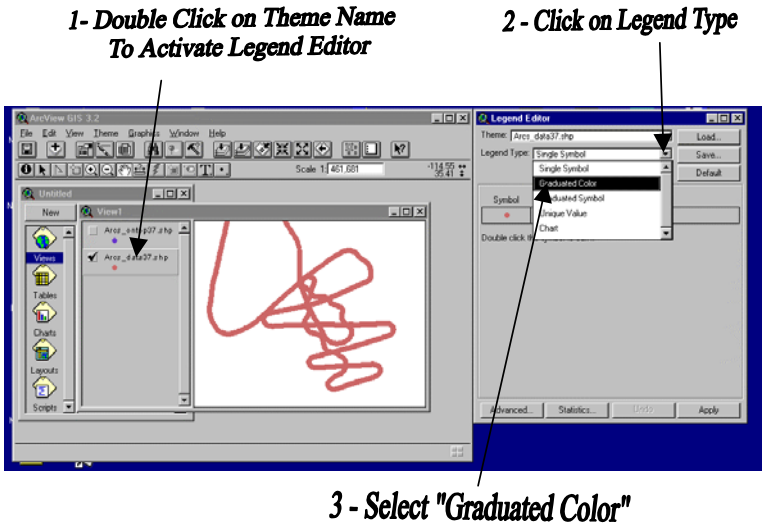
4.5.1. To enlarge the view, click "View" then "Zoom In" from the main toolbar or click the "magnifier-plus" symbol on the toolbar. After clicking the "Zoom In" toolbar symbol, position and click the mouse cursor on the View window.

4.5.2. Zoom Tool: After clicking on either the "Zoom In" (magnifier-plus), "Zoom Out" (magnifier-minus), or the Pan ("hand") toolbar symbols, the Operator can adjust the view of the image by clicking and holding the mouse down and then dragging a rectangle box over the area of interest.

Map Legend Setup

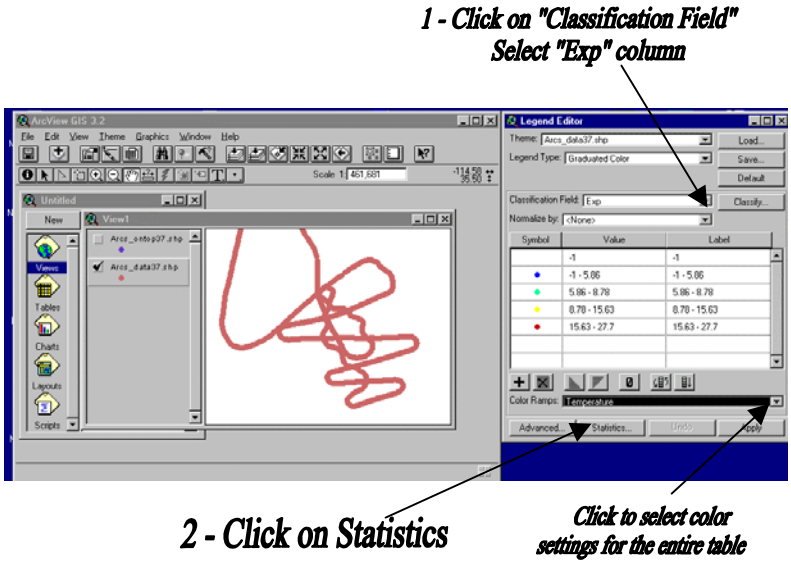
5. Double-click on one of the ARCS-II exposure or gross count rate data file theme names (*e.g.*, arcsxxx.shp) to activate the theme's "Legend Editor".

NOTE: The Legend Editor can be used to create a set of new plot ranges and/or to edit the colors and symbols for each individual plot level.



6. Click on the <Down-Arrow> to the right of the "Legend Type", and select the "Graduated Color" option.

7. A new pull-down menu will appear. Click on the <Down-Arrow> to the right of the "Classification Field" and select **"Exp"**. Available options: GC1, GC2, GC3, spare, Exp1, Exp2, Exp3 and Exp.

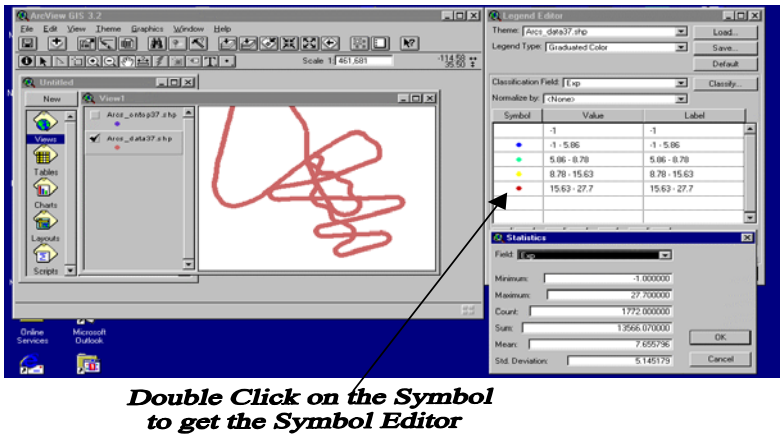


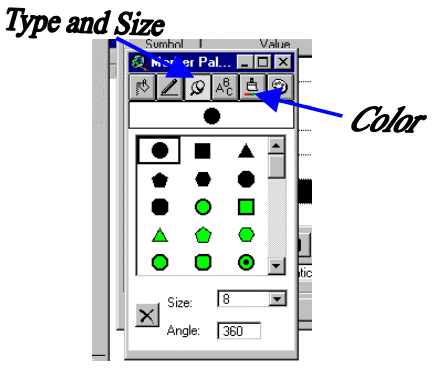
NOTE: The "arcs_dataxxx.shp" file contains the exposure or gross count rates per sampling interval for the three primary detectors, where "Exp1": 2x4x16, "Exp2": 2x4x4, and "Exp3": 1x1 detectors) and the best available detector data (*i.e.*, "Exp").

7.1. The exposure or CG rate data from the “Exp” data column will be automatically classified and broken down into 5 categories (default setting), where the “Value” and “Label” columns denote the data break-down ranges.

7.2. Click on the “Statistics” button to get a statistical summary of the data: its mean and standard deviation values, and its minimum and maximum values (see the figure on the next page). To exit the statistical summary, click “OK”.

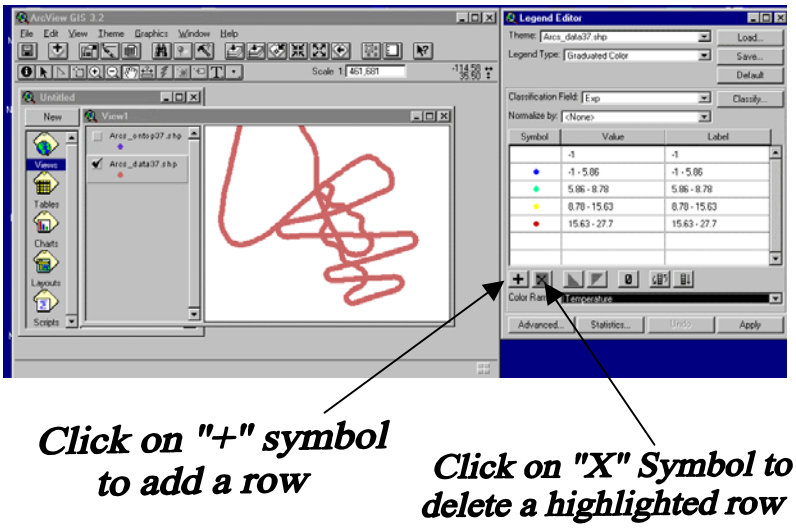
7.3. Change the symbol type (Marker Palette) or color (Color Palette) by double clicking on a row’s symbol. This will activate the “Symbol Editor” (see the figure below). To exit the “Symbol Editor”, click the “X” symbol located on the upper right-hand side of the menu.





NOTE: The “Color Ramps” option on the “Legend Editor” menu (see the figure in Step 7) can also be used to select a range of acceptable colors for the entire table.

8. The entries in the “Value” and “Label” columns can be edited to reflect a new range of data or to add units to the plot labels.



8.1. To make any changes, click on the range of values to be changed and enter a new range of values. NOTE: The hyphen-sign (-) must be included to denote a range of values.

8.2. To add a row, click on the "+" symbol located below the "Symbol" column. A new row and symbol will be added after the last row of the current data set.

8.3. To delete a row, highlight that row by clicking on the row's symbol, then click the "X" symbol located below the "Symbol" column.

8.4. To activate or see the changes, click on the "Apply" button, located on the lower right-hand side of the editor menu.

NOTE: The <Ctrl>-key can be used to highlight several non-connected rows or the <Ctrl>-<Shift>-key combination can be used to highlight several connected rows. These key combinations can also be used to change a group of symbol colors and types.

9. Three default map plot range legend files have been established to aid the Operator in setting up the map legend. These files are located in the "c:\arcs2\layers" directory and are named:

- "ER1.AVL" - exposure rate map plot legend
- "GC1.AVL" - gross count rate map plot legend
- "OTM1.AVL" – on-top marker information plot legend

9.1. To **save** a map legend

- Click “Save” on the “Legend Editor” menu
- Use the file browser to locate the directory to be used
- Enter the file name to be used. (Default extension: ***.avl**)
- Click “OK”

9.2. To **load** a previously saved map legend

- Click “Load” on the “Legend Editor” menu
- Use the file browser to locate the file (*.avl)
- Click “OK”
- Edit the map legend setup parameters, as needed

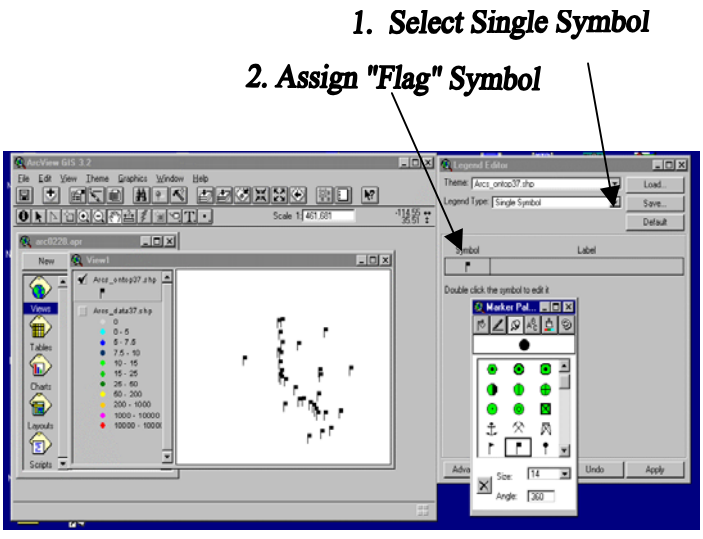
10. To close the “Legend Editor” menu, click the “X” symbol located on the upper right-hand side of the menu.

11. At this point, the Operator may wish to save the current map settings. From the ArcView GIS main menu toolbar, click “File” then “Save Project As”. Select the save directory and enter the filename to be used. (Default extension: ***.apr**).

12. Repeat Steps 5 to 11 for any other ARCS-II exposure or gross count rate data files that are to be processed.

On-Top Marker Legend Setup

13. Double click on the “arcs_ontopsxxx.shp” theme name to activate the “Legend Editor” pop-up menu.



14. Click on the <Down-Arrow> to the right of the “Legend Type”, and select the “Single Symbol” option.

15. Assign a “flag” symbol to represent the on-top marker locations.

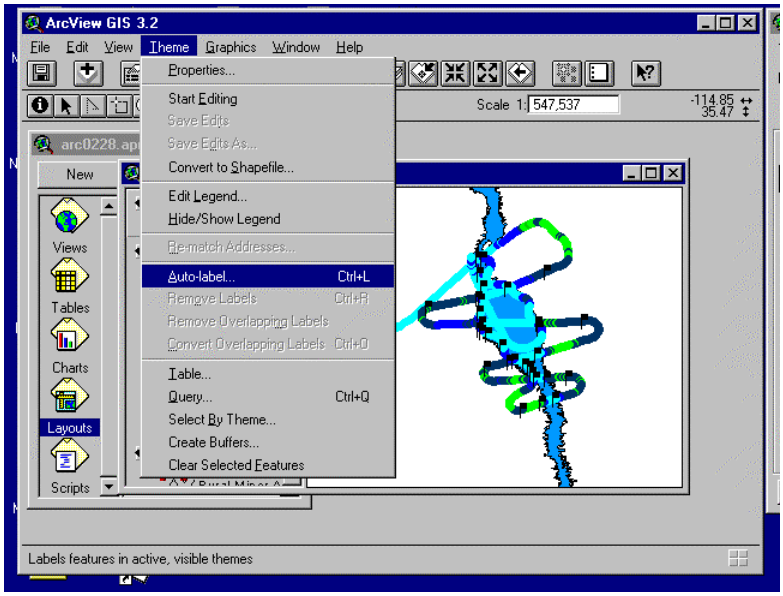
    15.1. Double click on the symbol to activate the “Symbol Editor” –“Marker Palette”. Find and click on the “flag” symbol. Set the symbol size to “14” then press enter to save the change.

    15.2. Click on the “Color Palette” submenu and assign “black” as the marker color.

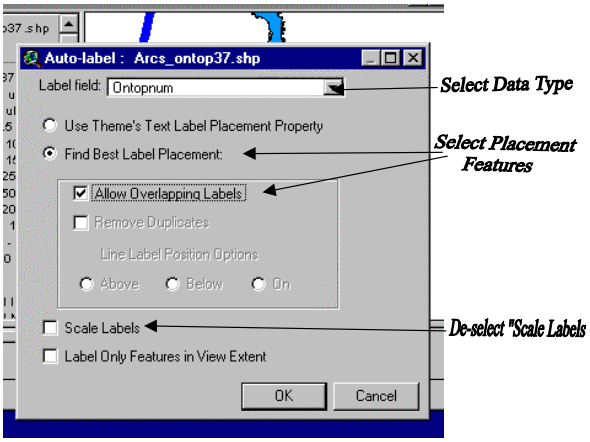
    15.3. Close the “Symbol Editor” by clicking the “X” symbol located on the upper right-hand side of the menu.

    15.4. Click the “Apply” button located on the lower right-hand side of the “Legend Editor” menu to activate and display the changes in the View window.

16. On the ArcView GIS main menu toolbar, click “Theme” then “Auto Label” to enable the on-top marker label numbers to be plotted beside each flag symbol.



17. After clicking on “Auto Label”, an “Auto Label” pop-up menu will be displayed.



17.1. Click on the <Down-Arrow> located to the right of the "Label Field" option and select "Ontopnum".

17.2. Enable the "Find Best Label Placement:" option.

17.3. Enable the "Allow Overlapping Labels" option.

17.4. Deselect "Scale Labels" option, if it is checked.

17.5. Click "OK" to exit the "Auto Label" pop-up menu.

NOTE: Two new command lines have now been activated under the "Theme" toolbar menu: "Remove Labels" and "Remove Overlapping Labels".

18. Click the "Apply" button located on the lower right-hand side of the "arcs_ontopsxxx.shp" legend editor menu to activate and see the changes.

19. As stated in Step 9, a default map legend file has been set up to aid the Operator in configuring the on-top marker map legend.

- This file is located in the "c:\arcs2\layers" directory and is named "OTM1.AVL.
- Follow the instructions in Step 9.2 on how to load the default map legend file.
- Follow the instructions in Step 9.1 on how to save the on-top marker map legend settings.

20. Close the on-top marker "Legend Editor" by clicking the "X" symbol located on the upper right-hand side of the menu.

21. At this point, the Operator may wish to save the current project settings. From the ArcView GIS main screen toolbar, click "File" then "Save Project" or "Save Project As". (Default extension: ***.apr**).

22. Repeat Steps 13 to 21 for any other ARCS-II on-top marker information files that are to be processed.

Renaming the Theme

23. To rename an active theme, click on "Theme" from the ArcView GIS main menu toolbar.

24. Click on "Properties"

25. Edit the "Theme Name:" entry

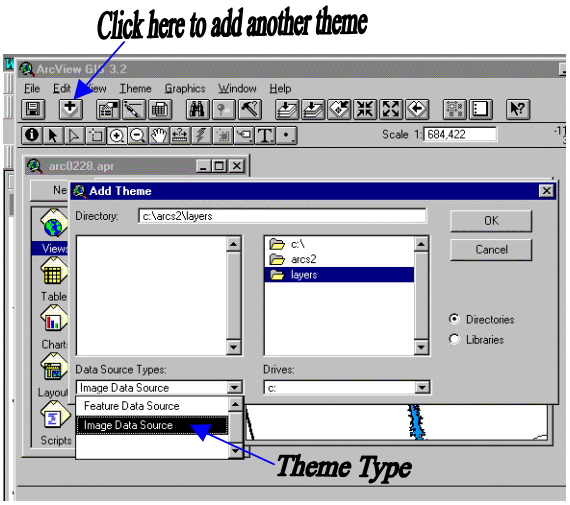
26. Repeat Steps 23 to 25 to rename any other active themes.

Adding a Map Theme (Base Map)

27. The available image formats currently supported by the ArcView GIS program can be examined by clicking "File" from the main menu toolbar then "Extensions".

    NOTE: The preferred geographically-referenced base map file format for photographs or topographic maps is the "*.tif" and its associated "*.tfw" file.

28. To add a new image or theme to the active View window, click "Theme" then "Add Theme" or use the toolbar symbol which is located below the "Edit" command (the "plus" symbol laid on top of a layer symbol).

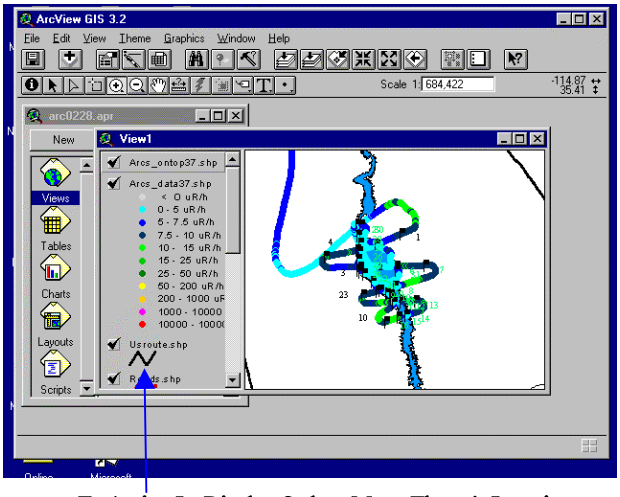


28.1. Use the File Browser to locate the base map image to be imported, then click “OK”. Be sure to change the Data Source Type to “Image Data Source”, if required.

28.2. It should be noted that the format of the CD-ROM map files supplied by the manufacturer of the ArcView GIS program use the “*.dbf” and “*.shp” file formats.

29. Repeat Step 28 for all other base map files to be imported (*e.g.*, roads.shp, mjwater.shp, landmrk.shp, airports.shp, or rail.shp).

30. To change the viewing (displaying) order of the view maps, click, drag, and drop the “Theme” names into the correct sequence. That is, the exposure (or GC) rate data themes should be displayed at the top of the View window.



To Assign Its Display Order - Move Theme's Location

NOTE: Remember to activate each theme by clicking (checking) the box in front of the theme’s name.

31. At this point, the Operator may wish to save the current project settings. From the ArcView main menu toolbar, click “File” then “Save Project” or “Save Project As”. (Default extension: ***.apr**).

32. If a base map of the region is not available, it is possible to use the ArcView Streetmap program files to add various geographic features (major water, streets, city names etc.).

32.1. In the View menu, click the “Add Theme” button

32.1.1. Data Source Type: “Streetmap Data Source”
32.1.2. Drive: “c:\esri\esridata\streetmap”
32.1.3. Click on “usa.bms”
32.1.4. Click “OK” button and wait for the data to be loaded.

32.2. To activate the Streetmap, click on the checkbox next to the “Streetmap USA” theme name. Use the “Zoom In” tools to select and enlarge the area-of-interest.

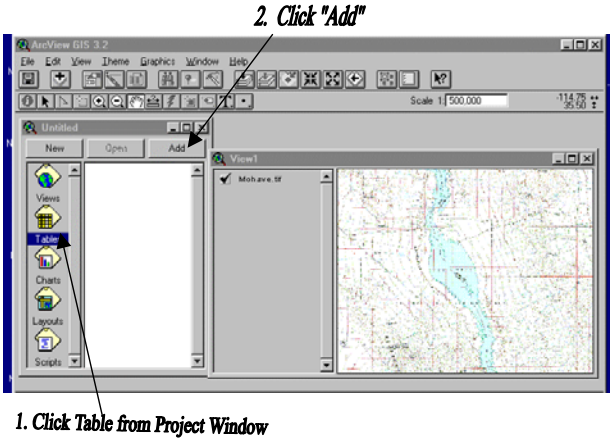
32.3. The area chosen and displayed in the View frame window may be converted and saved as a shapefile for use by the ARCS-II.

32.3.1. Select and highlight the area-of-interest

32.3.2. From the Theme menu click “Convert to Shapefile” and specify the name and location of the new shapefile name, then Click “OK”.

Adding a Table (XY-data)

Steps 33 to 42 explain how to import and plot data that is not already in a shapefile format, such as an INFO, dBase (*.dbf), or delimited text (*.txt) file. The following example is the procedure for importing and plotting the data from an “arcsxxx.dat” file.

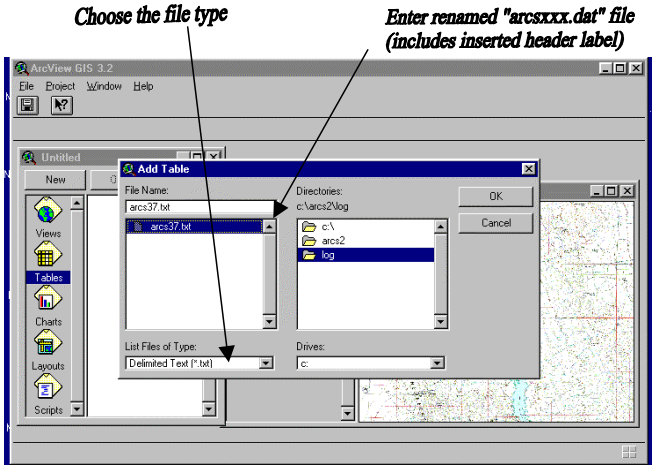


33. Verify that the first row of the text file contains a header label.

- If not, use a word processor program to insert a header label row at the beginning of the file (see the appendix section of this manual for the “arcsxxx.dat” file format.)
- Save the file as a “Text Only” file (“*.txt”).

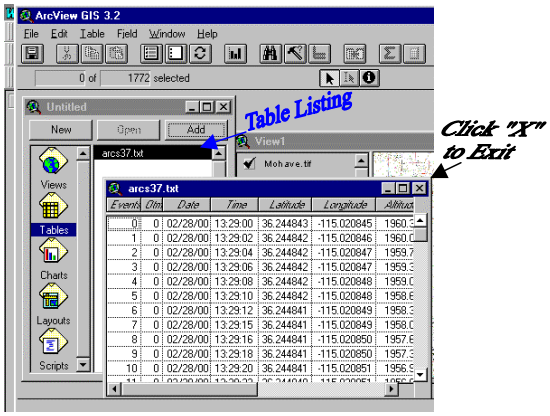
34. In ArcView GIS, click on the “Table” icon in the project window (see the figure on the previous page).

35. Click “Add”, a pop-up window will appear. From the “File Type”, choose “Delimited Text (*.txt)” or “All Files (*.*)”.

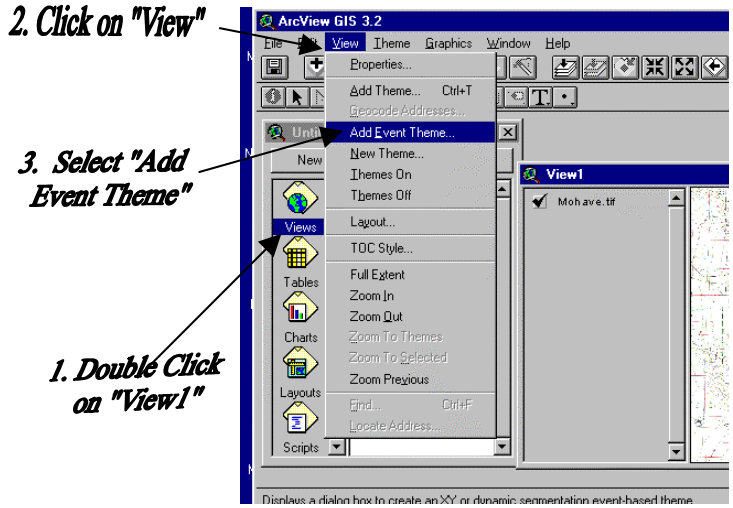


36. Using the File Browser, select the file to be added. Double click on the filename and click “OK”.

37. After clicking “OK”, the table is opened and its name is displayed in the “Table Listing”. Click “X” to exit the table.

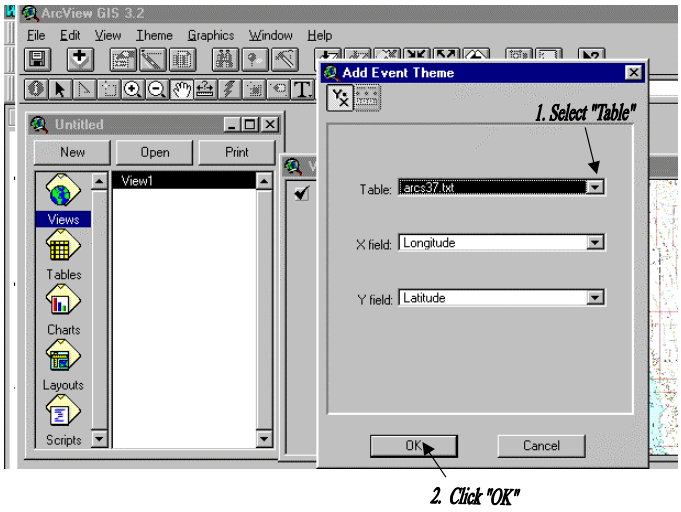


38. Double click on the view frame icon (*e.g.*, “View1”) where the table data is to be added as an overlay onto the base map.



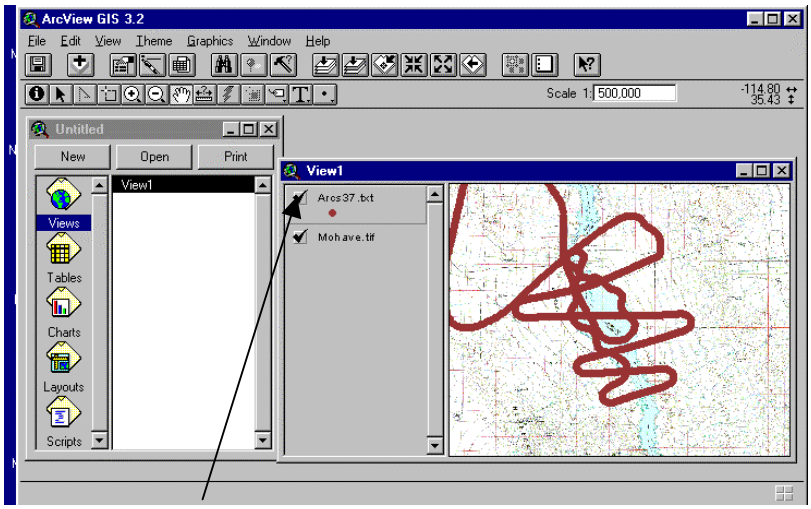
39. Click “View” from the ArcView GIS main menu toolbar.

40. Click the “Add Event Theme” option. Its pop-up window will be displayed.



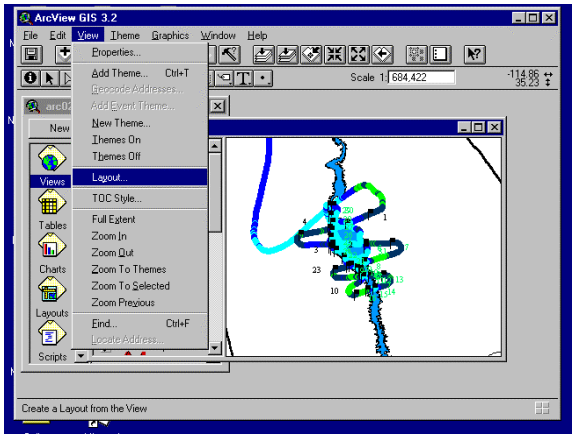
41. Verify that the “Table” (*e.g.*, arcsxxx.txt), “X Field” (*e.g.*, longitude) and “Y Field” *(e.g.*, latitude) entries are correct. Then Click “OK”.

42. The table’s name has now been added as a theme to the active project’s view window. The Operator can now edit the theme’s map legend in accordance with the procedures cited in Steps 5 to 11.



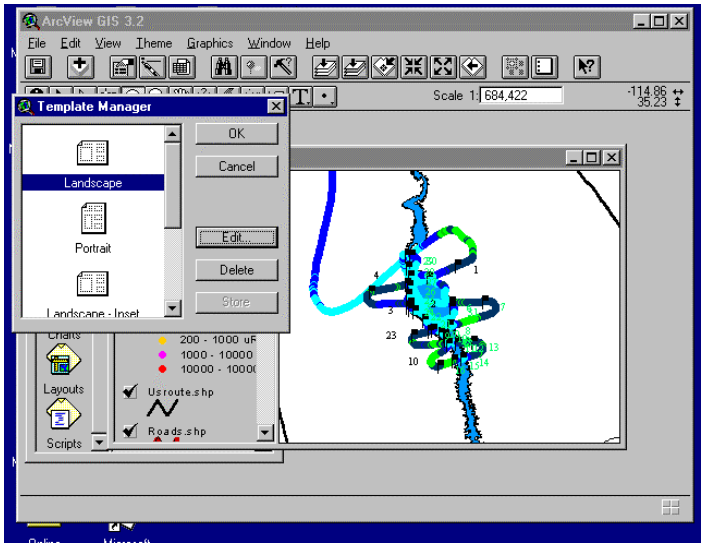
Layout and Printing

43. Prepare the view for printing by selecting a map layout, click "View" then "Layout" from the main toolbar menu.

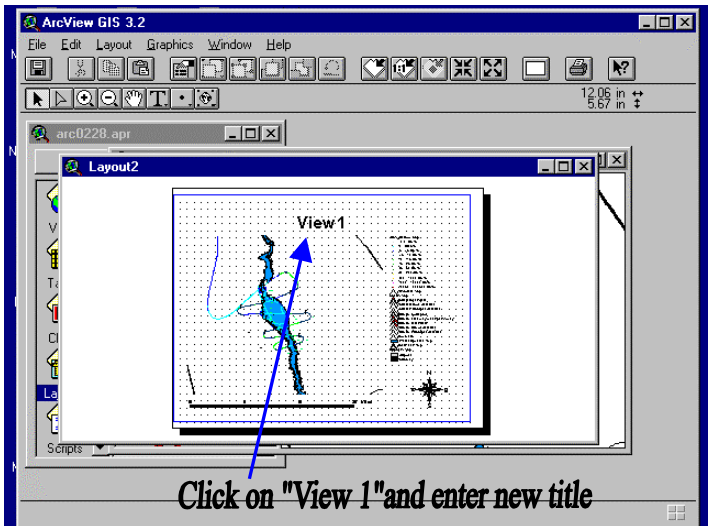


44. A Template Manager dialog box will be opened (see figure on next page). Select from one of the five layout presentation patterns presented, such as "Landscape" then click "OK".

- Landscape (preferred)
- Portrait
- Landscape – Inset
- Portrait – Neatlines (*i.e.*, map with outside border line)
- Landscape – Neatlines (*i.e.*, map with outside border line)



45. Choose the “New Layout” to open a new layout print frame. Then click “OK”. A new print frame window will be opened which displays the themes as shown in the “View1” frame window.



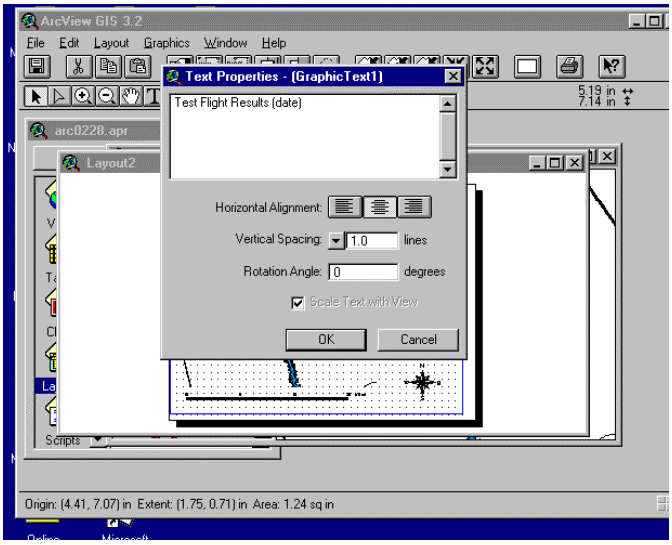
46. Edit the active layout print frame window by double clicking on the portion of the layout that needs to be changed.

    46.1. Double click on the center of the displayed map to change the print frame properties (such as User’s Specified Scale) and “Live Link” options.

    NOTE: By fixing the Map Scale, the Operator now has the option to display more of the map area by “clicking” and “dragging” the sides of print frame window.

46.2. Double click on the Map Title Box (*i.e.*, View 1)

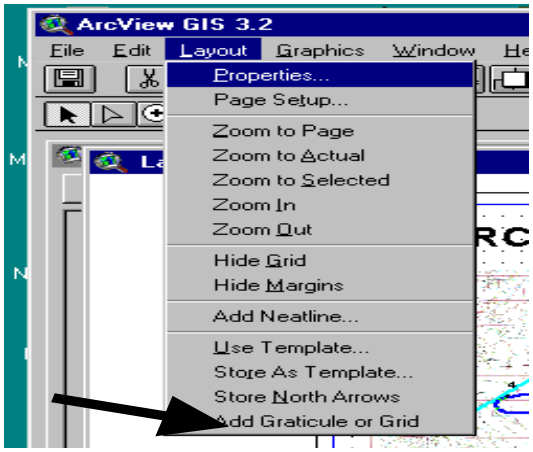
- Enter new title (as shown in the next figure)
- Click "OK" to exit the text box then re-center the title
- Keep the layout window open until after printing



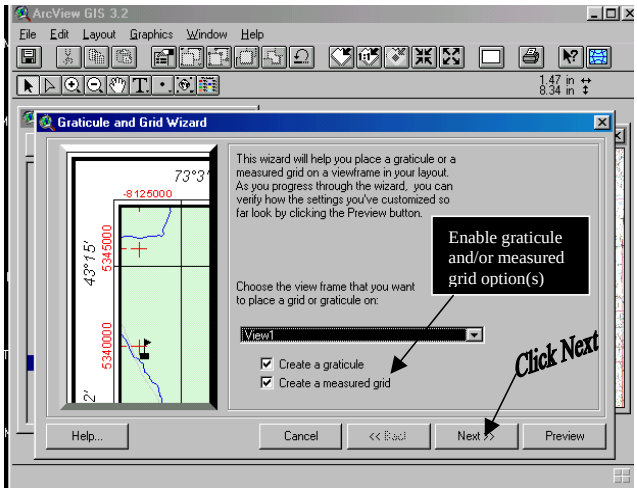
47. Add a graticule (*i.e.*, a network of lines of latitude and longitude) or measured grid onto the layout view frame.

CAUTION: Once the grid has been placed in the layout view frame, its various components (*i.e.*, gridlines, tick marks) may accidentally be **moved**! If these components are moved, they may no longer reflect their true latitude-longitude position.

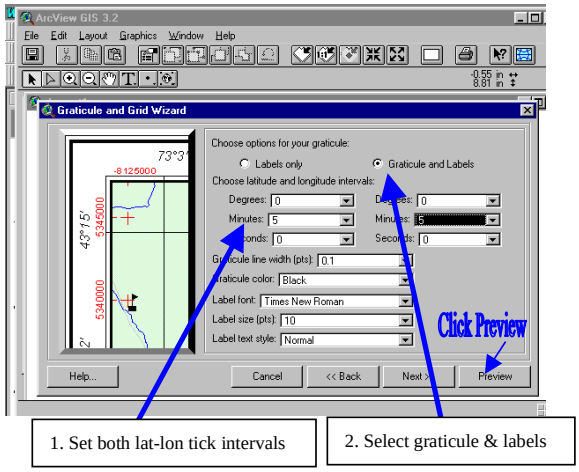
47.1. Click "Layout" then "Add Graticule or Grid" from the Layout main toolbar menu.



47.2. Enable the “graticule” and/or “measured grid” creation option(s) for the “View1” frame then click “Next”

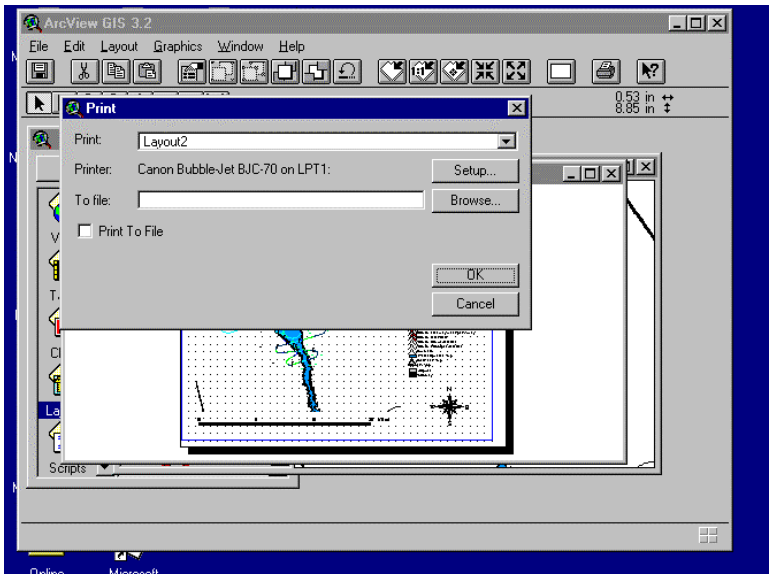


47.3. The graticule options dialog window will open.



- Enable the “Graticule and Labels” option
- Set the latitude/longitude tick mark interval to be displayed (*e.g.*, 2 or 5 minutes)
- Click “Preview” to review the layout map
- On the Preview screen, the “Preview” button is replaced by “Finish”. If satisfied with the preview, click “Finish”. If not, click “Back” and re-do the settings.

48. To print an active view, theme, or layout, click “File” from the main toolbar menu, then “Print”.



48.1. The layout view frame can be sent to a printer or saved as a file (*.prt). Select the appropriate printer or click the "Print to File" box and then select and enter the directory and filename. Click "OK" to start the printing.

48.2. Close the Layout menu by clicking the "X" symbol, then click "Yes" to save your changes, when prompted.

49. The layout view frame may also be exported as a "JPEG" file.

49.1. Click "File" then "Export".

49.2. Select the output file format (*e.g.*, "JPEG), filename, and the location where to store the new file, then click "OK".

50. To exit the ArcView GIS program, press "File" then "Exit" from the main toolbar menu.

Appendices

System Algorithms This section lists and describes the algorithms incorporated and used by the ARCS-II data acquisition program: None (counts), the Alpha Algorithm, and the Beta Algorithm (which has not been enabled).

Detector Characterization Results Results of the (IAEA) gamma detector pod calibration flight conducted on March 8, 2000 over the Lake Mohave Test Line are presented. The results include the GC rate to exposure rate conversion factor equations for each of the three NaI(T*l*) detectors and also their corresponding GC rate ratio results.

Data File Formats Provides a description and sample listing of the formats of the logged data files generated by the ARCS-II data acquisition program.

Technical Information Provides a brief description of the system hardware and components and includes troubleshooting tips. Detail hardware information can be found in the supplemental vendor catalogues and manuals. The following topics are discussed in this appendix:

- Troubleshooting Tips
- ARCS-II Schematics and Parts List
- ARCS-II Power Supply System
- PC/104 Standard
- RTD Technologies 1GHz Processor
- GPS Receiver Board
- Counter/Timer Interface Board
- CyberResearch LCD display
- Gamma Amplifier/Discriminator Modules
- USB CD-ROM Drive
- USB Floppy disk drive
- USB Zip Drive
- Supplemental Information
- List of Manufacturers

System Algorithms

Overview

A general description of the exposure calculation algorithms incorporated and used by the ARCS-II data acquisition program is described in this section. During the setup phase of the ARCS2.EXE program (refer to "ARCS-II Field Operation Setup" section of this manual), the User is asked to select the exposure calculation algorithm to be used (*i.e.*, None, Alpha, or Beta). Upon selection of the Alpha or Beta algorithms, the User is further asked to enter the exposure rate conversion factor equation coefficients and the quality assurance and verification data parameters for each of the three primary gamma detectors. It should be noted that the Beta algorithm is not operational and if enabled no exposure rate calculations will be performed.

None (counts)

This option does not enable the exposure rate algorithm routines. The displayed data will be the GC rates of the 2x4x16-inch NaI(T*l*) detector. Since the exposure rate calculations are not performed, no data verification tests will be performed. Also, the best and the 2x4x16-inch detector's exposure rate variables (Exp and Exp1) will be set equal to the 2x4x16-inch detector's gross count rate. The value of the other two detectors' exposure rate variables (Exp2 and Exp3) are set equal to zero.

Alpha Algorithm

Selection of this option will enable the exposure rate calculation routines and the first phase testing of the detector quality assurance and verification routines.

Exposure Rate Calculations

As stated in the "Detector Characterization Results" section of this manual, a set of terrestrial exposure rate conversion factor equations for each of the three primary NaI(T*l*) detectors have been derived. The basic exposure rate conversion factor equation that is used by the ARCS-II program to convert the detector's GC rate data to an exposure rate is expressed as:

$$CF_{\text{det}} = A_{\text{det}} e^{(B_{\text{det}} * <alt>)}$$

where

CF_{det} Detector's terrestrial external exposure rate (less contributions from airborne radon and cosmic rays) conversion factor at the survey altitude (counts per second per microroentgens per hours [cps/μR/h)]

A_{det} Detector's terrestrial exposure rate conversion factor at one meter (AGL)(cps/μR/h)

B_{det} Detector's gamma ray air attenuation coefficient (ft^{-1}). The value of B_{det} is negative, which implies that the count rate or conversion factor for the higher altitudes will be smaller than those at low altitudes.

<*alt*> Average vehicle's altitude AGL (ft)

The values of each of the three primary detectors' exposure rate conversion factor equation coefficients, A_{det} and B_{det}, are deduced empirically from the aerial characterization flight data as shown in the "Detector Characterization Results" section of this manual.

Since the ARCS-II is not equipped with a radar altimeter, the User is required to enter an averaged flight altitude value, <*alt*>, (in feet AGL) in the exposure rate setup submenu (refer to the "ARCS-II Field Operation Setup" section of this manual).

Once the terrestrial exposure rate conversion factors have been calculated for each detector, the program will calculate the exposure rates for each of the detectors using the following expression:

$$EXP_{\text{det}} = GC_{\text{det}} / CF_{\text{det}}$$

where

EXP_{det} Detector's terrestrial external exposure rate (less contributions from airborne radon and cosmic rays) at one meter AGL (μR/h).

GC_{det} Detector's gross count rate at the survey altitude (cps)

It should be noted that a test is made to assure that the CF_{det} is a non-zero number. If the CF_{det} is zero, the EXP_{det} is set to **zero**. After this test is made, the program will compute the exposure rate for all three detectors and will write the calculated exposure rates to the *EXP1*, *EXP2*, and *EXP3* columns of the output logged data string.

GC Data Validation Phase-I Test

A simple test is performed to assure and verify that each detector's GC rate, GC_{det}, value is valid. The User is asked to enter the minimum, *F*, and maximum, *M*, acceptable ranges for each detector in the exposure rate setup submenu. If a specific

detector's GC rate fails the min-max test, the program will check the GC data from the next smaller detector (*i.e.*, *GC2* then *GC3*) and so forth until it finds a "good" detector. If all three detectors fail the min-max test, then a value of **"-1**" will be written to the best available exposure rate, *EXP*, column of the output logged data string.

Beta Algorithm

Selection of this option will enable the exposure rate calculation routines and the first and second phase testing of the detector quality assurance and verification routines. [Note: this feature is not operational and no exposure calculations are performed– future development.]

The Beta Algorithm will perform the same exposure rate calculations and (GC) data verification and validation tests as used by the Alpha Algorithm (refer to the "Alpha Algorithm" section of this appendix).

GC Data Validation Phase-II Test

The second phase testing of the validity of each detectors' GC rate data involves a comparison of the detectors' measured gross count rate ratio values with a set of predetermined (*i.e.*, typical) detector ratio values. It should be noted that the second phase validation test routines **have not been** incorporated into the current version of the ARCS2.EXE program [future development].

The proposed test:

1. Derive the following set of measured GC ratio values for each data sampling interval:

$$R_{21} = \frac{GC_2}{GC_1}$$

$$R_{31} = \frac{GC_3}{GC_1}$$

$$R_{32} = \frac{GC_3}{GC_2}$$

where

1, 2, 3 Represent the following: 1: 2x4x16-inch detector; 2: 2x4x4-inch detector , and 3: 1x1-inch diameter detector.

R_{ij} Detector's GC rate ratio values at the survey altitude, where "*i*" and "*j*" represent the individual detectors used in the numerator and denominator, respectively.

GC_{det} Detector's GC rate at survey altitude (cps)

2. Compare the measured GC ratio values with a minimum and maximum range of predetermined typical ratio values.

$$Max_{Range} = R_{ij} * b * \left[1 + \frac{n}{\sqrt{GC_i}} \right]$$

$$Min_{Range} = \frac{R_{ij}}{b} * \left[1 - \frac{n}{\sqrt{GC_i}} \right]$$

where

R_{ij} Predetermined set of detector's GC rate ratio values, where "*i*" and "*j*" represent the individual detectors used in the numerator and denominator, respectively.

GC_i Detectors gross count rate at the survey altitude (cps)

b An acceptable bias error limit used to determine the maximum possible size of the ratio value comparison range. Default: 2

n An acceptable statistical error limit in the calculation of the detector ratios. Default: 3

3. Check to ensure that the GC_1 data passes its individual detector's minimum and maximum GC rate limits test. If the GC_1 passes the min-max limit test, the R_{21} ratio test will be performed. If the R_{21} ratio test is within the acceptable limits, the program will use the GC_1 detector exposure rate results.

4. If the R_{21} ratio test fails, then the R_{31} ratio test will be performed. If the R_{31} test also fails, the program will flag the GC_1 data as being bad and the GC_2 detector data will be tested.

5. Check to ensure that the GC_2 data passes its individual detector's minimum and maximum gross count rate limits test. If GC2 passes the min-max limits test, then the R_{32} ratio test will be performed. If the R_{32} ratio test is within the acceptable limits, the program will use the GC_2 detector exposure rate results.

6. If the R_{32} ratio test fails, the program will check the GC_3 data to see if it passes its individual detector's minimum and maximum gross count rate limits test. If GC_3 passes the min-max limits test, the program will randomly select which data set it will use: either GC_2 or GC_3.

7. If GC_3 fails the min-max limits test, the program will write a value of **"-1"** to the best available exposure rate, *EXP*, column of the output logged data string.

Detector Characterization Results

Overview

The results of the IAEA gamma detector pod calibration flight conducted over the Lake Mohave Test Line (LMTL) is provided in this section. The presented results include the GC rate to exposure rate conversion factor equations for each of the three NaI(T*l*) detectors and also the detector's GC ratio results.

Lake Mohave Test Line (LMTL)

The LMTL is located in the Lake Mead National Recreation Area approximately 12.4 miles (20 kilometers) east of Searchlight, Nevada. The LMTL is entirely within the confines of the recreational area, which is maintained and operated by the United States Department of Interior's National Park Service. The LMTL is oriented in a southerly-to-northerly direction and is approximately 2.8 miles (4.6 km) in length. In May 1995, a series of total exposure rate measurements and a set of soil samples were acquired along a portion of the LMTL. The results of those measurements indicated that the LMTL was comprised of only the naturally occurring radionuclides (*i.e*., uranium, thorium and radioactive potassium) and has an estimated net surface terrestrial exposure rate of 8.5 microroentgen per hour (μR/h) at a height of 1 meter AGL.

Aerial Measurements

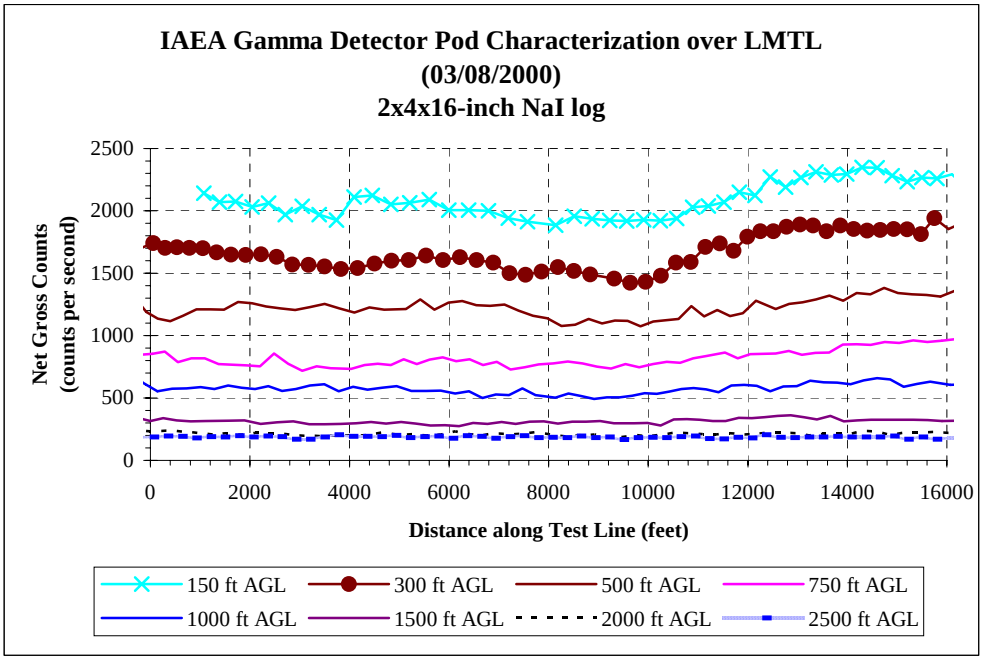
A series of altitude profile measurements were conducted over the LMTL on March 8, 2000. The LMTL was flown at a constant ground speed of 80 knots (41 meters per second [mps]) at a nominal altitude of 150 ft (46 m) 300 ft (91 m), 500 ft (152 m), 750 ft (229 m), 1000 ft (305 m), 1500 ft (457 m), 2000 ft (610 m), and 2500 ft (762 m) AGL). The LMTL was flown in a southerly to northerly direction. In order to assure the integrity of the data and to monitor and correct for variations in the gamma detectors' background radiation levels due to the aircraft induced electronic noise, airborne radon, and cosmic rays, repeated measurements were also flown over Lake Mohave (water line) prior to each of the altitude passes over the LMTL.

Aerial Results

The aerial radiation data consists of contributions from the naturally occurring radionuclides, airborne radon, cosmic rays, and the aircraft induced electronic noise. For these aerial measurements, the major emphasis was placed on mapping the gamma radiation environment of the LMTL and then deriving a set

of terrestrial exposure rate conversion factors for each gamma detector using the altitude profile data.

The gamma radiation environment of the LMTL was obtained by calculating the net GC rate data, measured in counts per second (cps), from the aerial data acquired between the 4000 foot to 11000 foot LMTL ground reference marker locations for each flight altitude (*e.g.*, refer to the net gross count profile data plot for the 2x4x16-inch gamma detector).



Terrrestial Exposure Rate Conversion Factor Equation

The resulting net gross GC, GC_{alt}, which is the measured LMTL GC rate minus the non-terrestrial background gross count rate (*i.e.*, water line results) for each flight altitude, was plotted versus altitude on a semi-log plot and exponentially fitted to the following expression, which is the terrestrial exposure rate conversion factor equation:

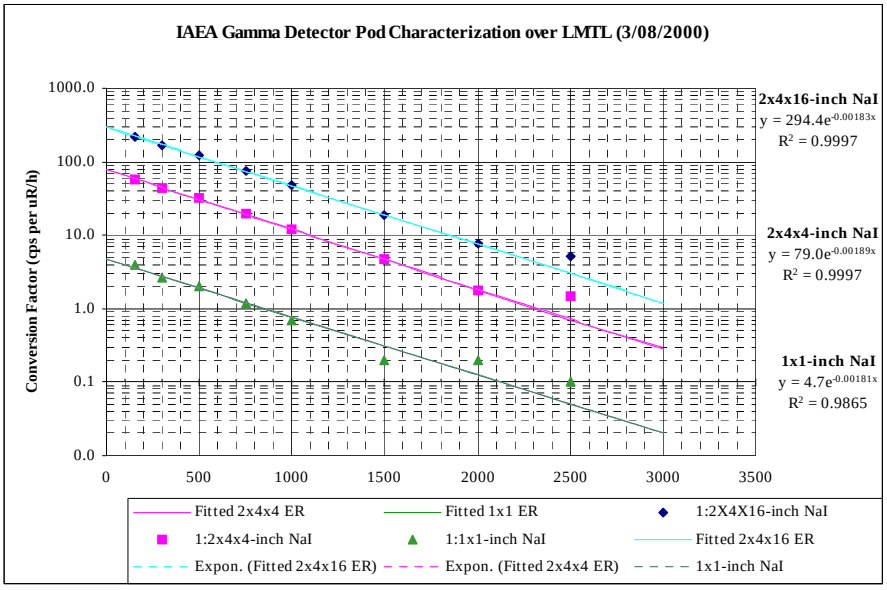
$$CF_{\text{det}} = \frac{GC_o}{8.5} * e^{-(\mu_{air} * <alt>)}$$

where

CF_{det} Terrestrial external exposure rate conversion factor at the survey altitude (cps/μR/h)

GC_o	Gamma detector's normalized net GC rate for the LMTL at one meter above ground level (cps)
8.5	Baseline terrestrial external exposure rate (less contributions from radon and cosmic rays) of the LMTL at 1m AGL (μR/h)
μ_{air}	Detector's gamma ray air attenuation coefficient (ft^{-1}).
$<alt>$	Average vehicle's altitude AGL (ft)

The value of the gamma ray attenuation coefficient, μ_{air}, was deduced empirically from the altitude profile data over the LMTL.



The derived terrestrial exposure rate conversion factor expressions for the three IAEA gamma detectors are:

$$CF_{2x4x16} = 294.4 * e^{-(0.001829*<alt>)}$$

$$CF_{2x4x4} = 79.0 * e^{-(0.001887*<alt>)}$$

$$CF_{1x1cylinder} = 4.7 * e^{-(0.001810*<alt>)}$$

Thus, the terrestrial exposure rate at me 1m AGL can now be easily derived from the aerial data by dividing the measured net GC rate data by the conversion factor (CF) that has been derived for a specific flight altitude.

NOTE: It should be noted that the above cited CF equations will be valid for another area provided that the area being surveyed has a uniformly distributed radiation source which covers an area that is large compared to the field of view of the detector system and has a gamma energy distribution similar to that of the natural background radiation of the LMTL.

Gamma Detector Ratio Results

One of the data quality and validity checks being proposed is a comparison of the ratios of the detector's GC rates. If the detector ratios are in agreement with their background radiation test results, then the resulting detector data is deemed usable. Listed below is the LMTL detector ratio test results for the IAEA gamma detectors, where GC1 represents the 2x4x16-inch detector, GC2 represents the 2x4x4-inch detector, and GC3 is the 1x1-inch detector:

IAEA Gamma Detector LMTL Ratio Results				
Ratio	**Average**	**Minimum**	**Maximum**	**Standard Deviation**
GC2/GC1	0.269	0.173	0.385	0.027
GC3/GC1	0.014	0.003	0.044	0.006
GC3/GC2	0.053	0.012	0.167	0.023

ARCS-II Exposure Rate Setup Table

In the "ARCS-II Field Operation Setup" section of this manual, the User is asked to fill in the detector parameter table for the "Alpha" or "Beta" exposure rate calculation algorithms. From the data characterization results, the following table was generated for the IAEA ARCS-II.

2x4x16:		**2x4x4:**		**1x1:**	
A1:	**294.4**	A2:	**79.0**	A3:	**4.7**
B1:	**-0.0018**	B2:	**-0.0019**	B3:	**-0.0018**
F1:	**10**	F2:	**10**	F3:	**1**
M1:	**100000**	M2:	**50000**	M3:	**25000**
r21:	**0.269**	r31:	**0.014**	r32:	**0.053**
b:	**2**	n:	**3**		

where

A and B — Exposure rate CFquation coefficients for the three detectors (*i.e.*, 1= 2x4x16, 2= 2x4x4, and 3= 1x1). Equation format: $CF_{det} = A_{det} * \exp(B_{det} * <alt>)$

F	Minimum acceptable GC rate value for the three detectors.
M	Maximum acceptable GC rate value for the three detectors.
r21, r31, r32	Typical detector GC rate ratio values: r21 represents the ratio of GC2 to GC1, r31 represents the ratio of GC3 to GC1 and r32 represents the ratio of GC3 to GC2.
b	Bias or acceptable error limits to pass ratio test (BETA ALGORITHM IS NOT ENABLED)
n	Acceptable statistical error limit to pass ratio test (BETA ALGORITHM IS NOT ENABLED)

NOTE: Detail definitions of the parameters cited in the above table can be found in the “System Algorithm” section of this appendix.

Data File Formats

Overview

A description of the seven logged data files generated by the ARCS-II data acquisition program is provided. Also provided is a sample listing and description of the formats of 5 of the 7 files.

NOTE: “xxx” is the sequence number that is sequentially generated upon each execution of the data acquisition program.

The seven files are:

- arcsxxx.dat
- arcsxxx.dbf
- arcsxxx.shp
- arcsxxx.shx
- arcsxxx.dbf
- arcsxxx.shp
- arcsxxx.shx

arcsxxx.dat

This is a history of the actual data collected during each acquisition run. The data is stored in an ASCII, comma-delimited, file format. The data collected (*i.e.*, 16 variables collected per sampling interval) include:

- Events counter
- On-top marker
- Date(mm/dd/yy)
- Time tag for each event (hh:mm:ss)
- Vehicle’s GPS latitude coordinate (decimal degrees)
- Vehicle’s GPS longitude coordinate (decimal degrees)
- Vehicle’s vertical altitude above a “GPS sphere” model of the earth (feet)
- Data sampling interval (seconds)
- Gross count rate for spare detector (counts per second)
- Gross count rate for 2x4x16-inch NaI(T*l*) detector (counts per second)
- Gross count rate for 2x4x4-inch NaI(T*l*) detector (counts per second)
- Gross count rate for 1x1-inch NaI(T*l*) detector (counts per second)
- Exposure (or gross count) rate for 2x4x16-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection

- Exposure (or gross count) rate for 2x4x4-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection
- Exposure (or gross count) rate for 1x1-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection
- Exposure (or gross count) rate of the best detector data (*i.e.*, 2x4x16, or 2x4x4 or 1x1)) – dependent on algorithm selection

Sample "Arcsxxx.dat" Listing

```
Event,OTM,Date,Time,Latitude,Longitude,Altitude,LiveTime,Spare,GC1,GC2,GC3,Exp1,Exp2,Exp3,Exp
0,0,09/06/00,07:35:17,36.241287,-115.016262,0.00,1.43,0,3172,908,35,11.06,12.16,7.65,11.06
1,0,09/06/00,07:35:19,36.241553,-115.019223,1948.84,2.09,0,3084,886,37,10.75,11.87,8.09,10.75
```

arcsxxx.dbf

This file contains an abbreviated sampling of the data saved in the "arcsxxx.dat" file. The data is stored in an ASCII database file format and contains a header record row and then the collected data. The collected data include only 11 of the 16 variables collected per each sampling interval:

- Events counter [Event]
- Vehicle's GPS longitude coordinate (decimal degrees) [Longitude]
- Vehicle's GPS latitude coordinate (decimal degrees) [Latitude]
- Exposure (or gross count) rate for 2x4x16-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection [Exp1]
- Exposure (or gross count) rate for 2x4x4-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection [Exp2]
- Exposure (or gross count) rate for 1x1-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection [Exp3]
- Exposure (or gross count) rate of the best detector data (*i.e.*, 2x4x16, or 2x4x4 or 1x1)) – dependent on algorithm selection [Exp]
- Gross count rate for spare detector (counts per second) [Spare]
- Gross count rate for 2x4x16-inch NaI(T*l*) detector (counts per second) [GC1]
- Gross count rate for 2x4x4-inch NaI(T*l*) detector (counts per second) [GC2]
- Gross count rate for 1x1-inch NaI(T*l*) detector (counts per second) [GC3]

Sample "Arcsxxx.dbf" Listing

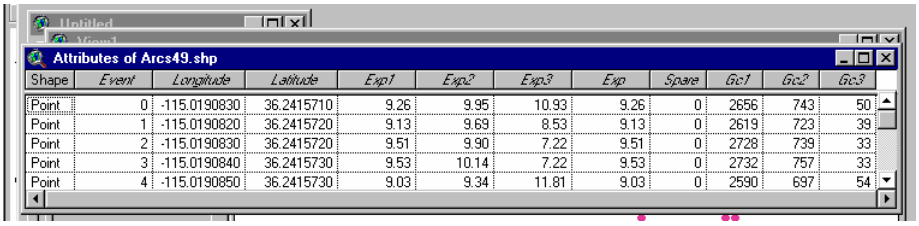
Event	LONGITUDE	LATITUDE	Exp1	Exp2	Exp3	Exp	Spare	GC1	GC2	GC3
0	-115.019083	36.241571	9.26	9.95	10.93	9.26	0	2656	743	50
1	-115.019082	36.241572	9.13	9.69	8.53	9.13	0	2619	723	39

arcsxxx.shp

This file contains an abbreviated sampling of the data saved in the "arcsxxx.dat" file. The data is stored as a binary formatted shapefile, which can be easily imported into the ArcView GIS mapping program. The file includes a header record row and then the collected data. Each row of the collected data is preceded by a shape type identifier, which is followed by the 11 variables collected per each sampling interval:

- Shape type (*i.e.*, Point)[Shape]
- Events counter [Event]
- Vehicle's GPS longitude coordinate (decimal degrees) [Longitude]
- Vehicle's GPS latitude coordinate (decimal degrees) [Latitude]
- Exposure (or gross count) rate for 2x4x16-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection [Exp1]
- Exposure (or gross count) rate for 2x4x4-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection [Exp2]
- Exposure (or gross count) rate for 1x1-inch NaI(T*l*) detector (counts per second) – dependent on algorithm selection [Exp3]
- Exposure (or gross count) rate of the best detector data (*i.e.*, 2x4x16, or 2x4x4 or 1x1)) – dependent on algorithm selection [Exp]
- Gross count rate for spare detector (counts per second) [Spare]
- Gross count rate for 2x4x16-inch NaI(T*l*) detector (counts per second) [GC1]
- Gross count rate for 2x4x4-inch NaI(T*l*) detector (counts per second) [GC2]
- Gross count rate for 1x1-inch NaI(T*l*) detector (counts per second) [GC3]

Sample "Arcsxxx.shp" Attributes Listing Table



Attributes of Arcs49.shp

Shape	Event	Longitude	Latitude	Exp1	Exp2	Exp3	Exp	Spare	Gc1	Gc2	Gc3
Point	0	-115.0190830	36.2415710	9.26	9.95	10.93	9.26	0	2656	743	50
Point	1	-115.0190820	36.2415720	9.13	9.69	8.53	9.13	0	2619	723	39
Point	2	-115.0190830	36.2415720	9.51	9.90	7.22	9.51	0	2728	739	33
Point	3	-115.0190840	36.2415730	9.53	10.14	7.22	9.53	0	2732	757	33
Point	4	-115.0190850	36.2415730	9.03	9.34	11.81	9.03	0	2590	697	54

arcsxxx.shx

This file is a cross-reference index file that must accompany the "arcsxxx.shp" shapefile before the ArcsView GIS program can be run. No sample listing for this type of file is available, and hence, it is not presented.

arcs_ontopxxx.dbf This file contains the on-top marker information. If the on-top marker function is not used (executed) during the acquisition run, then this file will not contain any data. The data is stored in an ASCII database file format and contains a header record row and then the on-top marker information.

- Events counter [Event]
- On-Top Marker Number
- Vehicle's GPS longitude coordinate (in decimal degrees) [Longitude]
- Vehicle's GPS latitude coordinate (in decimal degrees) [Latitude]

Sample "Arcs_ontopxxx.dbf" Listing

Event	OnTopNum	Longitude	Latitude
872	1	-114.6042490	35.4853360
903	2	-114.6473050	35.4661300
925	3	-114.6786430	35.4566950
962	4	-114.7333930	35.4454850
1020	5	-114.6745850	35.4284610

The **arcs_ontopxxx.shp**, and the **arcs_ontopxxx.shx** data files have similar formats as those cited for the "arcsxxx.shp" and "arcsxxx.shx files above, except they contain only the on-top marker information (see the "arcs_ontopxxx.dbf" file format). Hence, a sample listing of the formats of those files will not be presented.

Technical Information

Overview

This appendix provides a brief description of the system hardware and components and includes troubleshooting tips. Detailed hardware information can be found in the supplemental vendor catalogues and manuals.

Trouble Shooting Tips

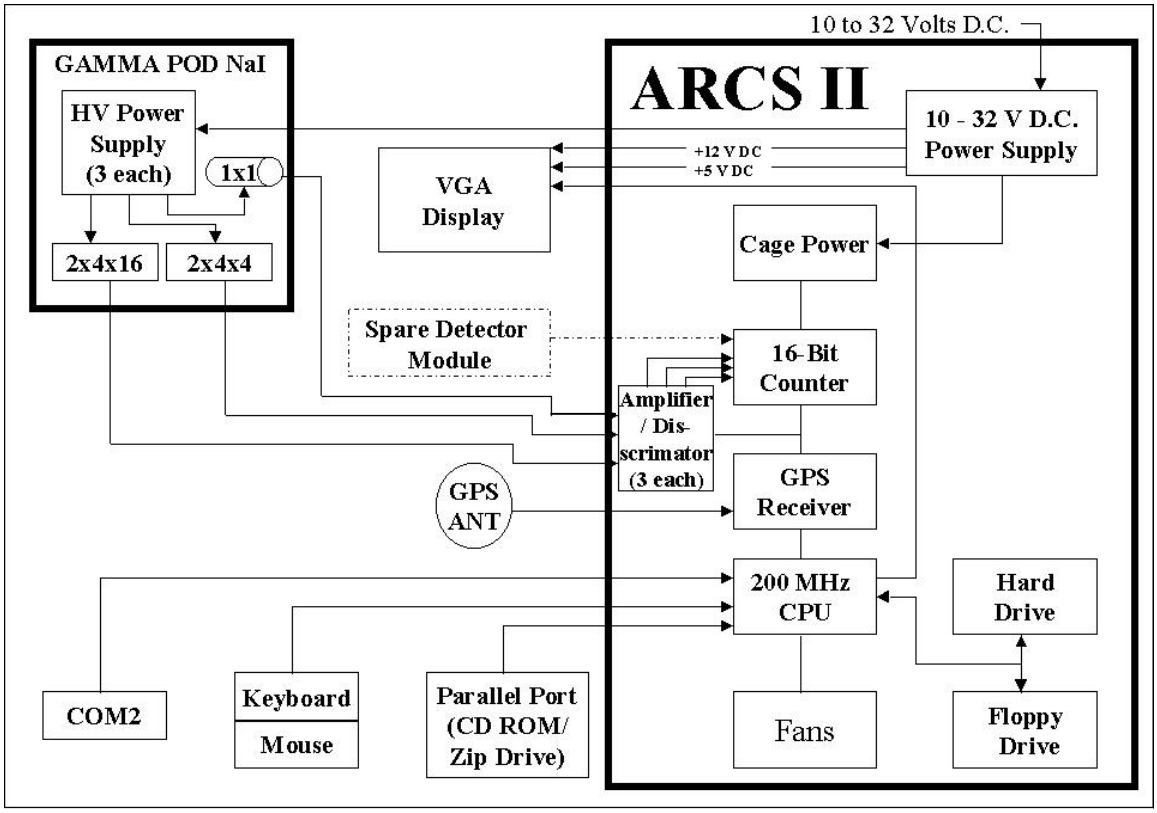
ARCS-II unit is not powering up	If the unit is not powering up, check the: (1) Circuit breaker located on the front panel; or (2) the 10-amp internal battery fuse located inside the ARCS-II unit.
ARCS-II power failure light is "on"	If the "Power Fail Light", located to the right of the power switch is "ON", the input voltage is either below 10 Volts or the voltage is not present. Check your external power source, because the system is only operating on the internal backup battery.
Count rate display changed color	If the gross count rate for any detector exceeds 30,000 counts per second, the number being displayed in the value box will change colors from green (okay) to yellow (warning). If the count rates should exceed 60,000 counts per second, the color will change from yellow (warning) to red (high).
Data displayed outside of strip chart plot window	Check and change the maximum strip chart plot scale level The maximum plot scale level is specified during setup under the Settings—Plot submenu (refer to the "Collecting the Data" section).
Flashing disk usage display	Below the detector strip chart plots, the ARCS-II software displays the percentage of the disk used. If this number exceeds 99%, the status box will start flashing. It is recommended that the User delete all unnecessary files from the data log directory and to empty the "trash bin" to prevent system failure.
GPS will not start (first time use)	For first time use, the User needs to set up the internal GPS receiver board. Refer to the Trimble and Zeli Systems User Manuals.
GPS is not updating	If this is not a first-time startup situation, the GPS may need to have its almanac updated. Move the unit outside and far away from any buildings or obstacles and allow the system sufficient time to update its almanac.

No input detector count rate value is being displayed	If no value is shown in any of the detectors' gross count display window, check (1) the detector input cable, and/or (2) the detector power cable. NOTE: the spare detector input port will only accept a 0 to mv signal.
Reported "EXP" result is "-1"	If all three of the primary detectors fail the data quality checks, then a "-1" value will be written to the 16th data variable position in the "arcsxxx.dat" file and under label "EXP" in the "arcs_dataxxx.shp" file. Refer to the "System Algorithms" section of the appendix. Check the detectors' setup parameters assigned in the Settings—Exposure Rate submenu.

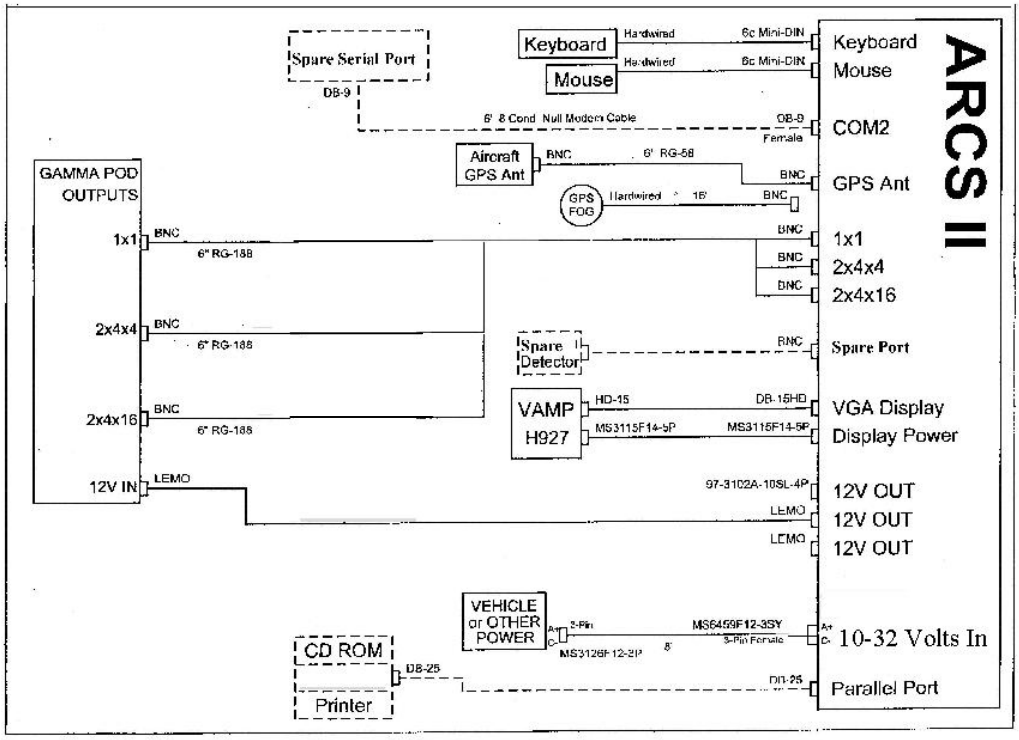
ARCS-II Schematics and Parts List

Schematics The following schematics are provided in this section

- Functional Block Diagram
- Interconnection Diagram



Functional Block Diagram



Interconnection Diagram

NOTE: The detector's amplifier/discriminator modules reside inside of the ARCS-II unit.

ARCS-II Parts List

Item	Manufacturer/Supplier	Model #	Number
Panel/Screen Connectors			
BNC female	Amp	225395-7	5
3-pin (+12V output)	Amphenol	PT02A-8-3S	1
3-pin (28 V input)	Burndy	MS3122E12-3	1
6-pin (on screen)	Amphenol	PT02A-10-98P	1
5-pin (on screen)	Amphenol	MS3112E14-5S	1
On/Off Switch			1
Floppy Disc Drive			1
Hard Drive 2.5-inch	Toshiba	MK1403MAV	1
Screen	Cyber Research		1
Keyboard	Adesso	PCK-302P	1
Mouse, Mini Trackball	Fellowes	Thumbelina	1
Power Supply (converter: 12/28V to 12V)	Integrated Power Designs		1
PC/104 Stack			
Power Supply Card	Tri-M		1
Counter Card	Diamond Systems	Quartz MM	1
GPS Carrier Board	Zeli Systems	Satpak-104Plus-Tdev	1
GPS Receiver Board	Zeli Systems	ACE-2	1
CPU Card and Cables	Parvus		1
Fan	Parvus		1
Half-height adaptors	Parvus		2
PC/104 Cage	Parvus		1
Battery Backup for CPU card			1
Magnetic Mount Antenna	Zeli Systems	Trimble FOG	1
Windows XP	Microsoft		1
ARCS-II Software	Bechtel Nevada	Version: 1	1
NaI(T*l*) Detectors			
Amplifier/Discriminator Card	Bechtel Nevada		4
High Voltage Power Supplies	Video Optics	RPS2000W	3
2x4x16-inch NaI(T*l*) Detector	Alpha Spectral		1
2x4x4-inch NaI(T*l*) Detector	Alpha Spectral		1
1- x 1-inch NaI(T*l*) Detector	Alpha Spectral		1
USB CD-ROM Drive	Micro Solutions	1677550	1
Color Graphics Printer	Hewlett Packard	HP DeskJet 340	1
Notebook Computer			1
USB Floppy drive			
USB Zip drive			

ARCS-II Power Supply System

The ARCS-II will accept an input DC voltage ranging from +10 to +32 DC volts at the respective connector on the face of the ARCS-II panel. The computer power supply is an Parvus SER104 , accepting an input voltage ranging from 10 to 32 volts, and producing a maximum 75watts output. The SER104 will convert the input voltage to +12V and +5V, and it will distribute this voltage to the ARCS-II circuitry and associated modules.

PC/104 Standard

The PC 104 architecture has become one of the most popular bus architects over the past decade surpassing the traditional STD, VME, and Multibus architects. A plethora of hardware and software has been standardized around the PC architecture, enabling embedded system designers to substantially reduce development time, costs and risks. One drawback to this architecture, however, is that the standard PC bus form factor of 12.4-inch x 4.8-inch and the associated card cages and backplanes are too bulky and expensive for most dedicated control applications.

Previously, the only practical way to embed the PC architecture was to design a PC chip-by-chip directly into the application to arrive at a more compact form of the PC bus. PC/104 was developed to meet this need for reduced space and power, without losing full hardware and software compatibility with the original PC bus standard. Besides the reduced form factor, PC/104 also uses a self-stacking bus, pin and socket connectors in place of edge connectors, and a relaxed bus drive of 4 milliamperes to lower the power consumption to 1 to 2 watts per module.

PC/104 fulfills the need for a smaller version of the PC bus architecture. It offers full PC hardware and software compatibility with the PC bus on 3.6-inch x 3.8-inch stackable boards (or modules). In 1992, a formal specification was published for the PC/104 bus which had become the de facto standard for the industry. There is a proposed extension to IEEE-P996 “Standard for PC Bus” which will use the PC/104 specification as the base document for the IEEE project to write a draft standard called P996.1 “Standard for Compact Embedded PC Modules.”

RTD embedded 1GHZ CPU

The ARCS-II uses a RTD Technologies 1GHz CPU II PC/104 The card includes VGA/SVGA, 2-1.1 USB ports, RG45 Ethernet port an enhanced IDE/ATA interface, floppy drive interface, two high-speed serial ports, and one EPP/ECP-capable parallel port. The power supply card used is supplied by Tri-M.

GPS Receiver Board

The ARCS-II uses a Zeli SATPAK-104PLUS-TS Carrier board with a Trimble ACE II GPS Receiver. The ACE II GPS is a complete 8-channel parallel tracking GPS receiver designed to operate with the L1 frequency, Standard Position Service, Coarse Acquisition code. Using two highly integrated Trimble custom integrated circuits, the receiver is designed in a modular format especially suited for embedded applications.

The ACE II GPS features Trimble's latest signal processing code, a high-gain RF section for compatibility with standard 25 dB active gain GPS antennas, and a CMOS TTL level pulse-per-second (PPS) output for timing applications or as a general purpose, synchronization signal. The ACE II GPS acquires a position fix with minimal delay after power cycling. The information necessary to help track satellites is stored in RAM using backup power for the Almanac, Ephemeris, Real-time clock, and Last position. User settings, including port parameters and receiver processing options, are stored in a non-volatile electrically erasable ROM (EEROM) that does not require backup power.

The ACE II GPS supports the Trimble Standard Interface Protocol (TSIP) and Trimble ASCII Interface Protocol (TAIP). The ARCS-II uses the TAIP protocol which provides position, speed, heading, and time in a message. TAIP allows the user to schedule automatic message reports or poll for information. During the ARCS-II bootup, if the GPS does not start, refer to the section "GPS Initialization" section in this appendix.

Counter/Timer Interface Board

The ARCS-II uses a Diamond Systems Corporation Quartz-MM Counter/Timer module. The Quartz-MM is a 5 channel counter used to collect the output from the gamma detectors. The module features a AM9513A counter/timer chip, providing a wide range of counting, sequencing, and timer functions; all programmable through software. External +5V power is applied through the PC/104 bus to the module.

CyberResearch LCD Display

The LCD Display from CyterResearch is an analog VGA CRT replacement. The LCD system features a high performance VGA display with 640 x 480 resolution, offers gray scales or color, and is designed for the rigors of the industrial environment.

The LCD system has four front panel control that are used to alter the display parameters.

Gamma Amplifier/Discriminator Modules

The four amplifier/discriminator modules located in the upper right-hand corner and directly behind the front panel of the ARCS-II unit. Each module is approximately 4.735-inches long x 2.5-inches wide x 1.25-inches thick and they provide the additional amplification required by the counter card in the ARCS-II unit. The inputs to the modules are 600 nanosecond (ns) negative pulses with a repetition rate determined by the level of radiation that is sensed by the three NaI(T*l*) detectors in the gamma detection pod.

Detector Pod

The detector pod contains 3 NaI(Tl) detectors. A cable bundle containing four separate cables connects the pod to the front panel. +12V DC power is supplied to the pod by the 8 ft. cable bundle connected between the +12V output connector on the ARCS-II front panel and the input to the pod. Three of the four cables connect the output signals of the 2- x4- x16-inch, the 2- x4- x4-inch, and 1- x1-inch NaI detectors in the gamma detector pod to the detector inputs on the ARCS-II front panel.
CAUTION; The pod contains high voltage power supplies that can output as much as 1500vdc.

USB CD-ROM Drive

The USB CD-ROM drive is from MicroSolutions and it can be used to download the geographically referenced base map imagery files for use by the ARCS2 software. The CD-ROM drive is attached to the system by connecting the UBS cable to the ARCS-II USB port.

USB Zip Drive

The USB Zip drive is from Iomega and it can be used to download the geographically referenced base map imagery files for use by the ARCS2 software. The zip drive is attached to the system by connecting the UBS cable to the ARCS-II USB port.

USB Floppy Drive

The floppy drive is attached to the system by connecting the UBS cable to the ARCS-II USB port.

Supplemental Information

The following is a list of manuals and documents for the components in the ARCS-II system:

Diamond Systems Corporation, Quartz-MM PC/104 Format Counter/Timer & Digital I/O Module User Manual V1.3, 1995. , April, 1995

RTD Technologies User Manual (on CD)

Trimble Navigation Limited, ACE II GPS Core Module System Design Reference Manual, Part #36916-00, Firmware 7.68, June 1998.

Zeli Systems, Operation Manual for the SATPAK-104PLUS GPS Receiver Carrier Boards, Revision C, January 1, 1998.

List of Manufacturers

This list provides the addresses and telephone numbers of the vendors of the major items used in the fabrication of the ARCS-II. Additional information can be found in the documentation manuals supplied by each manufacturer.

Diamond Systems Corporation
450 San Antonio Road
Palo Alto, CA 94306
USA
Telephone: (415) 813-1100
Fax: (415) 813-1130

Hewlett-Packard Company
5161 Lankershim Blvd
North Hollywood, CA 91601
USA
Telephone: (818) 505-5600

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
USA
Telephone: (800) 426-9400

Micro Solutions
132 W. Lincoln Highway
DeKalb, IL 60115, USA
Telephone: (815) 756-3411
Fax: (815) 756-2928
Web Site: http://www.micro-solutions.com

RTD Technologies
103 Innovation Blvd.
State College, PA 16803
USA
Telephone: (814) 234-8087
Fax: (814) 234-5218
www.rtd.com

Trimble
645 North Mary Avenue
Sunnyvale, CA 94088-3642
USA
Telephone: (800) 827-8000
Fax: (408) 730-2082
European Assistance: 44-1256-1622-858-421
Web Site: http://www.trimble.com

Tri-M	Unit #6 –1301 Ketch Court Coquitlam, British Columbia Canada V3R6X7 Telephone: (604) 527-1100
Zeli Systems	3233 Pagosa Court El Paso, TX, USA Telephone/Fax: (915) 751-3222 Email: gps@zeli.com
Iomega Corp.	1821 West Iomega Way Roy, Utah 84067 Email: WWW.iomega.com
CyberResearch Systems	25 Business Park Drive Branford, ct 06405 USA 800 341-2525 Email: WWW.cyberresearch.com

Acronym List

AC	Alternating Current
AGL	Above ground level
ARCS-II	Airborne Radiological Computer System, Model II
Cd	Cadmium
CF	Conversion factor
cps	counts per second
Cs; Cs-137	Cesium; Cesium-137
DC	Direct current
ft	foot/feet
ft/s	feet per second
GB	Gigabyte
GC	Gross count
GIS	Geographic Information System
GPS	Global Positioning System
IAEA	International Atomic Energy Agency
keV	kiloelectron Volt
LMTL	Lake Mohave Test Line
m	meter(s)
MB	Megabyte
μCi	microcuries
mph	miles per hour
mps	meters per second

μR/hr	microroentgen per hour
mV	millivolts
NaI(T*l)*	Thallium-activated sodium-iodide
V	Volt(s)
VAC	Volts alternating current
V/cm	Volts per centimeter
VDC	Volts direct current
VGA	Video graphics array

List of Acronyms and Abbreviations

AC	Alternating Current
AGL	Above ground level
ARCS-II	Airborne Radiological Computer System, Model II
Cd	Cadmium
CF	Conversion factor
cps	counts per second
Cs; Cs-137	Cesium; Cesium-137
DC	Direct current
ft	foot/feet
ft/s	feet per second
GB	Gigabyte
GC	Gross count
GIS	Geographic Information System
GPS	Global Positioning System
IAEA	International Atomic Energy Agency
keV	kiloelectron Volt
LMTL	Lake Mohave Test Line
m	meter(s)
MB	Megabyte
μCi	microcuries
mph	miles per hour
mps	meters per second

μR/hr	microroentgen per hour
mV	millivolts
NaI(T*l)*	Thallium-activated sodium-iodide
V	Volt(s)
VAC	Volts alternating current
V/cm	Volts per centimeter
VDC	Volts direct current
VGA	Video graphics array