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**ACTINIDE ISOTOPIC ANALYSIS SYSTEM**  
**Users Manual**

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## PREFACE

This user's manual is addressed to the Los Alamos National Laboratory personnel (routine operators and supervisors) who perform measurements with the actinide isotope analysis system. Each chapter begins with a table of contents that lists the section titles, illustrations, and tabular data presented in that chapter.

The first chapter in this manual is an introduction to the system. Chapter 2 lists required settings for the system's commercial nuclear instrument modules. System operating procedures are given in Chapter 3. Chapter 4 contains routine and supervisorial operator interactions. Chapter 5 describes the system's short- and long-printout output formats. Chapter 6 gives instructions for changing system parameters. Error messages are listed and described in Chapter 7. Chapter 8 contains reference articles on measuring relative plutonium isotopics in solid samples.

In addition to this manual, two other manuals complete the description of the two-detector actinide isotope analysis system. The Actinide Analysis Hardware Manual (Vol. 2) describes the system components and provides service and maintenance information. In that volume are detailed instructions on required settings for the nuclear instrument modules. The Actinide Analysis Software Manual (Vol. 3) is presented in two parts. Part 1 describes the computer codes that control the instrument, analyze the spectral data, and determine the relative plutonium and other actinide abundances. Part 2 contains the software listings of the isotopics codes.

All commercial items mentioned in this manual are assumed to be functioning correctly for the purposes of system operation. Users are referred to individual equipment manufacturers' manuals for details of operation, troubleshooting, and maintenance of this commercial equipment.

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This manual contains cautions and notes set apart from the text by solid or dashed lines, respectively. A CAUTION precedes an operation in which the equipment is at risk. A NOTE provides important supplementary information to the reader.

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CHAPTER 1

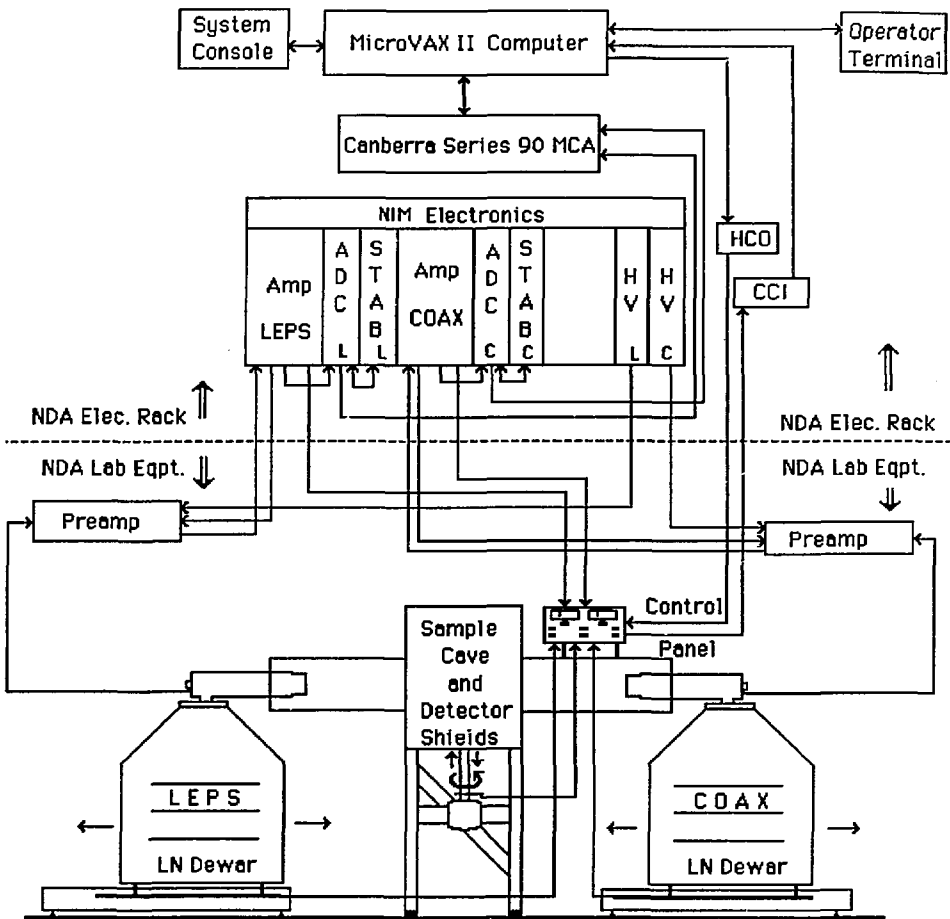
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1-1. Block diagram of the two-detector actinide isotope analysis system.

## Chapter 1

### INTRODUCTION

This manual provides instructions and procedures for using the Lawrence Livermore National Laboratory's two-detector actinide isotope analysis system to measure plutonium samples with other possible actinides (including uranium, americium, and neptunium) by gamma-ray spectrometry. The computer program that controls the system and analyzes the gamma-ray spectral data is driven by a menu of one-, two-, or three-letter options chosen by the operator. Provided in this manual are descriptions of these options and their functions, plus detailed instructions (operator dialog) for choosing among the options. Also provided are general instructions for calibrating the actinide isotopic analysis system and for monitoring its performance.

#### 1.1 SYSTEM PURPOSE

The inventory measurement of a sample's total plutonium and other actinides content is determined by two nondestructive measurements. One is a calorimetry measurement of the sample's heat or power output, and the other is a gamma-ray spectrometry measurement of its relative isotopic abundances. The isotopic measurements needed to interpret the observed calorimetric power measurement are the relative abundances of various plutonium and uranium isotopes and americium-241. The actinide analysis system carries out these measurements.

#### 1.2 SYSTEM OPERATION

Figure 1-1 is a block diagram of the two-detector actinide analysis system. The equipment is controlled by a Micro-VAX II computer with which the operator interacts through a remote VT320 terminal and LA75 printer. Data are acquired on a Canberra Series 90 multichannel analyzer from a small, high-resolution detector (LEPS) or simultaneously from the LEPS and a larger, more efficient, coaxial-type detector (COAX). The sample rotates and moves up and down inside the sample cave while the cave door is closed. The computer senses this rotation and up/down motion and suspends data acquisition if the sample stops. The green LED lights on the front of the control panel will also indicate that the sample is both rotating and moving up or down in addition to whether a count is in progress.

The instrument will scan the entire height of the container, up to 16 inches. The container moves down until the infra-red sensor at the gamma-ray detector level detects the top of the container and reverses direction to scan up to the bottom of the container where it reverses direction again to repeat its cycle. If the container is larger than 16 inches, then the container will reverse direction when the platform comes to the bottom of the chamber, that is before the top of the container gets to the level of the gamma-ray detectors. The oversize container when traveling upward, will also intercept the upper limit infra-red sensor and reverse direction before the bottom of the container reaches the gamma-ray detector level. This system will scan the entire container (and only the container) for those up to 16 inches high. For oversize containers, larger than 16 inches high, the maximum central region will be scanned. The scanning up/down motion can be disabled at any height by using the optional disable switch above the up/down motion light. The container will continue to rotate.

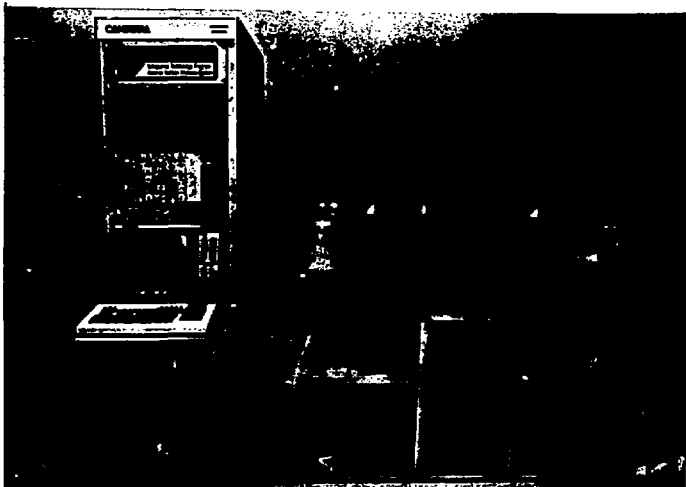


Fig. 1-2. Two-detector actinide isotope analysis system and sample cave. The control panel on the right-hand side of the sample cave is used to position the detectors for appropriate count rates.

LEPS and COAX are both germanium gamma-ray detectors. The  $\sim 2\text{-cm}^2$  LEPS, whose resolution is  $< 525$  eV FWHM at 122 keV, is mandatory, requiring that the gamma-ray spectra be taken at a gain of 0.075 keV/channel. The COAX is optional, requiring that the spectra be taken at a gain of 0.25 keV/channel. Inclusion of the second spectrum is required for heterogeneous samples and those containing uranium-238.

If the container stops rotating for any reason during a measurement a message to that effect is printed on the operator terminal. Once the fault is corrected, the measurement can be resumed by pressing the carriage return key on the operator terminal.

## CHAPTER 2

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## Chapter 2

### INITIAL SYSTEM SETTINGS

This chapter contains a checklist of initial settings for most components of the two-detector actinide isotope analysis system. The reader should be aware that the system is composed of two separate detector systems, LEPS and COAX, and that actual settings on the various electronic modules for both detector systems may vary from those specified when they were first installed in 1990 at the Los Alamos National Laboratory. Contact the appropriate supervisor before making any changes.

The checklists in this chapter should be adequate for experienced personnel (routine operators and supervisors) to ready the actinide analysis system components for operation. If in doubt, refer to the Actinide Analysis System Hardware Manual (Vol. 2, Chapter 3) and to the manufacturers' manuals for detailed instructions.

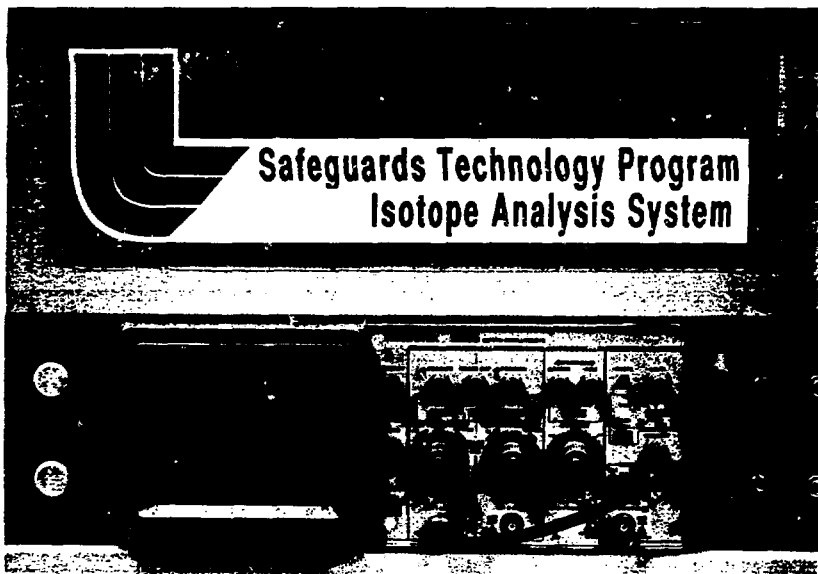


Fig. 2-1. Rack-mounted oscilloscope.

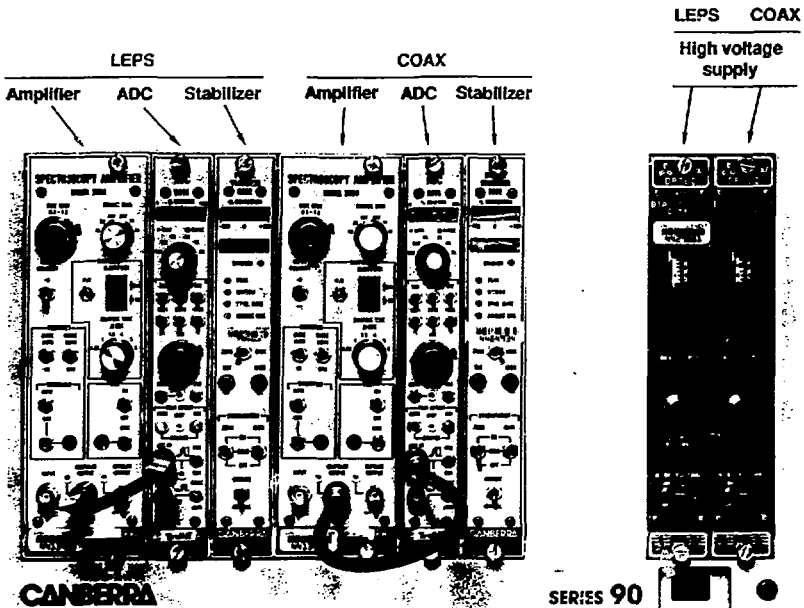
## 2.1 ROUTINE PREOPERATIONAL SETUP

Preoperational setup requires that controls be set and preliminary operations be performed on commercial components of the actinide analysis system: Tektronix rack-mounted oscilloscope, LEPS and COAX nuclear instrument module (NIM) bin components, Canberra Series 90 multichannel analyzer, Digital Equipment Corporation (DEC) Micro-VAX II computer, VT320 terminal, and LA75 printer. Perform routine preoperational setup in accordance with the following checklist.

### ROUTINE PREOPERATIONAL SETUP

Equipment	Control	Position
<u>OSCILLOSCOPE</u> (SEE FIG. 2-1)	POWER ON/OFF pushbutton	ON (observe green POWER LED on)
	TRIGGERING SOURCE switch	Vert Mode
	TRIGGERING MODE switch	NORM
	SLOPE switch	Up
	TIME BASE SEC/DIV rotary switch	2 microseconds
	VOLTS/DIV rotary switches (2) for 1X PROBE	2
	AC/GRD/DC switches (2)	DC
	CH 1/DUAL MODE/CH 2 pushbuttons	CH 1 (for LEPS) CH 2 (for COAX)



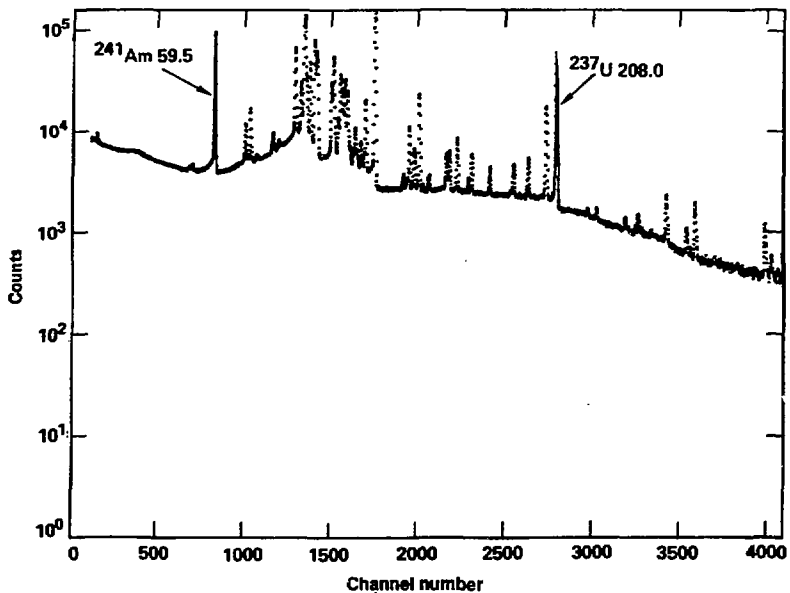


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Fig. 2-2. LEPS and COAX nuclear instrument module (NIM) bin modules.

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>LEPS NIM BIN MODULES (SEE FIG. 2-2)</u>		
<u>LEPS AMPLIFIER</u> (See Vol. 2, paragraph 3.3.1, for further information)	----- NOTE: For proper operation, amplifier gain should be set to give 0.075 keV/channel. The initial settings given below assume correct pole-zero and pileup rejector adjustments, both of which are important to good high-count-rate energy resolution. -----	
	COARSE GAIN rotary switch	30
	FINE GAIN potentiometer	Approx. 628
	----- NOTE: Amplifier fine gain should be set such that the americium-241 59.5-keV peak is at channel 794 and the uranium-237 208.0-keV peak is at channel 2773 (see Fig. 2-3). This may require some adjustment of the ZERO potentiometer on the analog-digital converter. -----	
	INPUT POLARITY toggle switch	- (negative)
	SHAPING MULTIPLIER switch	X2 (pushbutton in)
	SHAPING TIME mSEC rotary switch	1.0 ms
	P/Z (pole zero)	See Vol. 2, paragraph 3.3.3, for setup.
	RESTORER RATE toggle switch	AUTO
	RESTORER MODE toggle switch	ASYM
	THRESHOLD toggle switch	AUTO
	PUR (pileup rejector) toggle switch	ON (observe red PUR LED on). See Vol. 2, paragraph 3.3.4, for setup.



21011-105

Fig. 2-3. Low-energy region of the plutonium gamma-ray spectrum, taken with the LEPS detector at 0.075 keV per channel. Note relative positions of the 59.5- and 208.0-keV peaks.

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

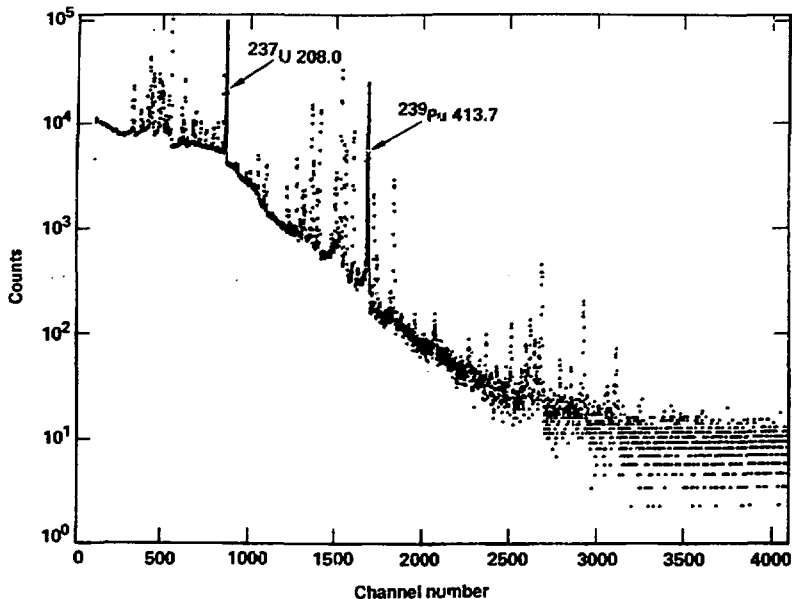
Equipment	Control	Position
<u>LEPS ANALOG-DIGITAL CONVERTER (ADC)</u> (See Vol. 2, paragraph 3.4.1, for further information)	Inner GAIN rotary switch	4K
	Outer RANGE rotary switch	4K
	OFFSET toggle switches (6)	Down
	LLD potentiometer	Approx. 0.10.
	ZERO potentiometer	Assuming that the amplifier gain is set properly, adjust so that channel zero is near zero energy: i.e., set the americium-241 59.5-keV peak at channel 794 and the plutonium-241 208.0-keV peak at channel 2773.
	PEAK DETECT toggle switch	AUTO
	PHA/SVA toggle switch	PHA
COINC/ANTI toggle switch	ANTI	

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>LEPS GAIN/ZERO STABILIZER</u> (See Vol. 2, paragraph 3.5.1, for further information)	ZERO/GAIN toggle switch	ZERO [enter ZERO PEAK value (794)]
	ZERO/GAIN toggle switch	GAIN [enter GAIN PEAK value (2773)]
	ZERO/GAIN toggle switch	ZERO [enter ZERO WINDOW value (13)]
	ZERO/GAIN toggle switch	GAIN [enter GAIN WINDOW value (20)]
	ZERO/GAIN toggle switch	ZERO [enter ZERO ANALOG RNG. value (0.125)]
	ZERO/GAIN toggle switch	GAIN [enter GAIN ANALOG RNG. value (0.125)]
	STABILIZATION ZERO ON/HOLD/OFF toggle switch	ON
	STABILIZATION GAIN ON/HOLD/OFF toggle switch	ON
	REMOTE/MANUAL toggle switch	MANUAL

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>LEPS HIGH-VOLTAGE SUPPLY</u> (See Vol. 2, paragraph 3.7.1, for further information)	-C A U T I O N-	
	Be absolutely sure that NEG ( <u>negative polarity</u> ) light is on. Incorrect high-voltage polarity may blow out input FET in preamplifier. Also make sure that OUTPUT VOLTAGE potentiometer is set to zero before turning on the high-voltage supply. Excessive voltage may damage or destroy germanium detector. Excessive voltage will surely blow out input FET.	
	HIGH-VOLTAGE ON/OFF toggle switch	ON (observe power indicator on)
	OUTPUT VOLTAGE potentiometer	1.00 (1000 V)



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Fig. 2-4. High-energy region of the plutonium gamma-ray spectrum, taken with the COAX detector at 0.25 keV per channel. Note relative positions of the 208.0- and 413.7-keV peaks.

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>COAX NIM BIN MODULES (SEE FIG. 2-2)</u>		
<u>COAX AMPLIFIER</u> (See Vol. 2, paragraph 3.3.2, for further information)	NOTE: For proper operation, amplifier gain should be set to give 0.25 keV/channel. The initial settings given below assume correct pileup rejector adjustment, which is important to good high-count-rate energy resolution.	
	COARSE GAIN rotary switch	100
	FINE GAIN potentiometer	Approx. 523
	NOTE: Amplifier fine gain should be set such that the uranium-237 208.0-keV peak is at channel 832 and the plutonium-239 413.7-keV peak is at channel 1655 (see Fig. 2-4). This may require some adjustment of the ZERO potentiometer on the analog-digital converter.	
	INPUT POLARITY toggle switch	- (negative)
	SHAPING MULTIPLIER switch	X2 (pushbutton in)
	SHAPING TIME mSEC rotary switch	1.0 ms
	(P/Z) (pole zero)	See Vol.2, paragraph 3.3.3, for setup.
	RESTORER RATE toggle switch	AUTO
	RESTORER MODE toggle switch	ASYM
	THRESHOLD toggle switch	AUTO
	PUR (pileup rejector) toggle switch	ON (observe red PUR LED on). See Vol. 2, paragraph 3.3.4, for setup.



ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>COAX ANALOG-DIGITAL CONVERTER (ADC)</u> (See Vol. 2, paragraph 3.4.2, for further information)	Inner GAIN rotary switch	4K
	Outer RANGE rotary switch	4K
	OFFSET toggle switches (6)	Down
	LLD potentiometer	Approx. 0.10.
	ZERO potentiometer	Assuming that the amplifier gain is set properly, adjust so that channel zero is near zero energy: i.e., set the plutonium-241 208.0-keV peak at channel 832 and the plutonium-239 413.7-keV peak at channel 1655.
	PEAK DETECT toggle switch	AUTO
	PHA/SVA toggle switch	PHA
COINC/ANTI toggle switch	ANTI	

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>COAX GAIN/ZERO</u> <u>STABILIZER</u> (See Vol. 2, paragraph 3.5.2, for further information)	ZERO/GAIN toggle switch	ZERO [enter ZERO PEAK value (832)]
	ZERO/GAIN toggle switch	GAIN [enter GAIN PEAK value (1655)]
	ZERO/GAIN toggle switch	ZERO [enter ZERO WINDOW value (11)]
	ZERO/GAIN toggle switch	GAIN [enter GAIN WINDOW value (15)]
	ZERO/GAIN toggle switch	ZERO [enter ZERO ANALOG RNG. value {0.125}]
	ZERO/GAIN toggle switch	GAIN [enter GAIN ANALOG RNG. value {0.125}]
	STABILIZATION ZERO ON/HOLD/OFF toggle switch	ON
	STABILIZATION GAIN ON/HOLD/OFF toggle switch	ON
	REMOTE/MANUAL toggle switch	MANUAL

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>COAX HIGH-VOLTAGE SUPPLY</u> (See Vol. 2, paragraph 3.7.2, for further information)	- C A U T I O N - Be absolutely sure that NEG (negative polarity) light is on. Incorrect high-voltage polarity may blow out input FET in preamplifier. Also make sure that OUTPUT VOLTAGE potentiometer is set to zero before turning on the high-voltage supply. Excessive voltage may damage or destroy germanium detector. Excessive voltage will surely blow out input FET.	
	HIGH-VOLTAGE ON/OFF toggle switch	ON (observe power indicator on)
	OUTPUT VOLTAGE potentiometer	2.00 (2000 V)

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
-----------	---------	----------

CANBERRA SERIES 90 MULTICHANNEL ANALYZER (SEE FIG. 2-5)

CANBERRA SERIES 90  
MULTICHANNEL  
ANALYZER

(See Vol. 2,  
paragraph 3.8,  
for further  
information)

NOTE: Data collection parameters are set by the computer program. No preliminary actions are required except routine setup unless the Series 90 "loses its memory." If so, the setup is more complex (see paragraph 2.2).

Setup configuration  
for Series 90

1 EXTENDED User (User #1)  
User #1 assigned to host computer  
Group #1 assigned to Unit (ADC) #1  
Group #2 assigned to Unit (ADC) #2  
Group #1 memory = 4K  
Group #2 memory = 4K

Verify setup  
configuration

Set CONTROL/STATUS key switch to SUPERVISOR

Touch MENU to get executive menu

Touch SUPERVISOR to get next  
line in menu

Touch USER SUMMARY and observe:

USER	TYPE	GROUP	MEMORY	INPUTS	PASSWD
H1*	EXTENDED	1	4K		0000
		2	4K		

RETURN

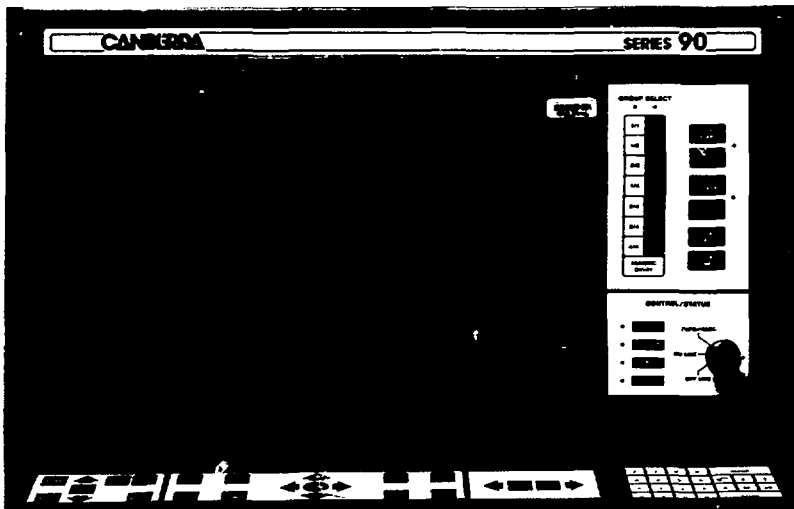
NOTE: Above asterisk after H1 denotes that Series 90 is enabled to communicate with the computer. If asterisk is not displayed, perform the following:

Touch MENU

Touch CURRENT USER

Observe that box labeled  
HOST ASSIGN is set to YES.  
If not, touch HOST  
ASSIGN to set it from [NO]  
to [YES].

Touch MENU EXIT



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Fig. 2-5. Canberra Series 90 display showing LEPS detector gamma-ray spectrum in Group 1. (Touch 2 under GROUP SELECT in upper right corner of analyzer to display the Group 2 spectrum.)

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>CANBERRA SERIES 90</u> <u>MULTICHANNEL</u> <u>ANALYZER</u> (continued)	Set CONTROL/STATUS key switch to	ON LINE (observe ON LINE LED on)

Verify Group-Unit  
setting (GROUP  
SUMMARY method)

NOTE: Group-Unit setting can be verified by either the  
GROUP SUMMARY method or the ACQ. SUMMARY method

Set CONTROL/STATUS key switch to SUPERVISOR

Touch MENU to get executive menu

Touch CURRENT USER to get next  
line in menu

Touch CONFIG GROUPS to get next  
line in menu

Touch GROUP SUMMARY and observe:

GROUP	SIZE	ACQ. UNIT	PRESET
1	4K	1 PHA+	T(True) = XX.X
2	4K	2 PHA+	T(True) = XX.X

Touch MENU EXIT

Verify Group-Unit  
setting (ACQ.  
SUMMARY method)

Set CONTROL/STATUS key switch to SUPERVISOR

Touch MENU to get executive menu

Touch SYSTEM to get next line  
in menu

Touch ACQ. SUMMARY and observe:

UNIT #	DESCRIPTION	USER	GROUP
1	Single-input C.I. Bd #1 ADC	1	1
2	Single-input C.I. Bd #2 ADC	1	2

Touch MENU EXIT

Set CONTROL/STATUS key switch to ON LINE (observe  
ON LINE LED on)

ROUTINE PREOPERATIONAL SETUP (CONTINUED)

Equipment	Control	Position
<u>CANBERRA SERIES 90</u> <u>MULTICHANNEL</u> <u>ANALYZER</u> (continued)	NOTE: Canberra Series 90 is now ready for operation by computer control. Set up soft keys and user-assigned fields, if desired, in accordance with paragraph 2.3. Implement x-axis display calibration, if desired, in accordance with paragraph 2.4. Consult Canberra Series 90 <u>Operator's Manuals</u> , Extended User Section, pp. 1-26, if a new MCA has to be installed. (Also see Vol. 2, paragraph 3.8.2, for further information.)	
<u>MICRO-VAX II COMPUTER</u>	ON/OFF switch	ON (observe green DC OK LED and green LED in Ready push-button on; verify green LED in Write Protect <u>not</u> on)
<u>DEC VT320 Terminal</u> <u>DEC LA75 Printer</u>	ON/OFF switch	ON (observe PWR LED and LINE RDY LED on)
	NOTE: Verify that supply and feed of printer paper at the terminal/printer are adequate (red-bordered paper means that the supply is running out).	

## 2.2 NEW (FACTORY-DEFAULT) CANBERRA SERIES 90 SETUP

When a multichannel analyzer from the factory is powered up, it starts in a factory default status. This gives users a standard acquisition configuration by which to begin operation, but the touch screen does not display the usual fields. Before proceeding, users should familiarize themselves with the Canberra Series 90 manufacturer's manual, possibly starting with the tutorial section. Assuming that the multichannel analyzer is turned on and normal display is available on the screen, perform preoperational setup as follows:

---

Equipment	Control	Position
Obtain factory default summary	Set CONTROL/STATUS key switch to <u>        </u> Touch <u>MENU</u> to get executive menu <u>        </u> Touch <u>SUPERVISOR</u> to get next line in menu <u>        </u> Touch <u>FACTRY_DEFAULT</u> <u>        </u> Touch <u>CNFIRM</u> <u>        </u> Touch blinking dots to calibrate touch screen <u>        </u> Touch <u>USER_SUMMARY</u> to get factory default summary:  1 EXTENDED User (User #1) User #1 assigned to host computer Group #1 assigned to Unit (ADC) #1 Group #2 assigned to Unit (ADC) #2 Group #1 memory = 4K Group #2 memory = 4K	SUPERVISOR
Enter correct date and time	Touch TIME/DATE and observe:  YEAR      MONTH      DAY      HOUR      MINUTE  Enter appropriate numbers using console numeric keypad and STORE key <u>        </u> Touch <u>MENU_EXIT</u> <u>        </u> Set CONTROL/STATUS key switch to	ON LINE (observe ON LINE LED on)

---



### 2.3 CANBERRA SERIES 90 SOFT KEYS AND USER-ASSIGNED FIELDS SETUP

At this point the Canberra 90 soft keys and user-assigned fields have not been designated. Consulting the Series 90 Operator's Manuals, Extended Users Sections 2.0 and 3.0-3.2, for details, set up the soft keys and user-assigned fields as follows:

Equipment	Control	Position	
Setting up soft keys	Touch <u>MENU</u> to get executive menu		
	Touch <u>CURRNT USER</u> to get next line in menu		
	Touch <u>ASSIGN SOFKEY</u> to assign key functions:		
	NOTE: The following assignments have been found useful:		
	<u>Soft No.</u>	<u>Assignment</u>	<u>Soft No.</u> <u>Assignment</u>
	1	X-AXIS CALIB.	5 NORMALIZE
	2	XFER	6 SMOOTH (3-pt)
	3	PEAK SEARCH	7 STRIP
	4	SORT ROI	8 DIFFER
	Touch <u>MENU_EXIT</u>		
Setting up user-assigned fields	Touch <u>ASSIGN_FIELDS</u> to get next line in menu		
	Touch <u>OPTION_FIELDS</u> and then appropriate key to define function of that key:		
	NOTE: The following assignments have been found useful:		
	<u>Field No.</u>	<u>Option</u>	<u>Fixed places format</u>
	1	AREA	1
	2	% ERROR	3
	3	PEAK CENTER	3
	4	FWHM	3
	5	PRESET TIME	1
	6	TRUE TIME	1
7	% DEADTIME	2	
8	CPS INTEG	3	
Touch <u>MENU_EXIT</u>			
Set CONTROL/STATUS key switch to	ON LINE (observe on	LINE LED on)	

## 2.4 CANBERRA SERIES 90 X-AXIS ENERGY CALIBRATION

If the soft keys have been designated (paragraph 2.3) and x-axis (energy) calibration has been chosen as one of the soft keys, this feature may be used to calibrate the Canberra 90 display. Assuming the normal display on the touch screen, implement x-axis calibration as follows:

---

Equipment	Control	Position
Choosing appropriate calibration peaks	<p>NOTE: For LEPS, the usual choices are americium-241 peak at 59.5 keV and plutonium-241 peak at 208.0 keV. For COAX, the usual choices are uranium-237 peak at 208.0 keV and plutonium-239 peak at 413.7 keV.</p> <p>Place selected peaks in regions of interest (ROI) by positioning cursor window on peak and pressing ENTER ROI key on console</p> <p>Touch <u>X-AXIS CALIB.</u> soft key to obtain options</p> <p>Touch <u>COMPUTE COEFFS</u> to get next set of options</p>	
Entering energy value for each calibration peak	<p>Press INDEX RIGHT key until cursors are on first calibration peak</p> <p>Touch <u>PEAK</u>; observe that display shows channel position of peak and asks for its energy</p> <p>Type energy value using console numeric keypad</p> <p>Press STORE key</p> <p>If value is correct, touch <u>ACCEPT</u></p> <p>Repeat above procedure for other calibration peaks</p> <p>Touch <u>END</u> if gain and zero values appear to be correct</p>	

---

## CHAPTER 3

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### ILLUSTRATIONS

Fig. 3-1.	Actinide isotopic analysis system sample cave. The control panel at the right is used to load/unload the sample by opening/closing the sample cave lid and raising/lowering the sample turntable. Other controls provide for positioning the detectors closer to or away from the sample in order to adjust the detector count rate as indicated by the count-rate meters . . . . .	3- 5
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## Chapter 3

### SYSTEM OPERATION

#### 3.1 STARTING INSTRUMENT CONTROL PROGRAM

The instrument control program, ISOANAL, starts automatically from a start up command file when the system is turned on and a user is logged on as username "ASSAY". The start up command file will load and start the ISOANAL program on which every terminal you have logged onto.

If the ISOANAL program has been aborted, restart it by logging onto the terminal under the ASSAY account with ASSAY as the password to cause the start up command file to be executed (press the RTN key several times to get the keyboard to respond) and the program to be started.

When the ISOANAL program is first started on the system, messages similar to the ones shown below will be typed on the terminal:

08:11:26

18-SEP-90

LLNL Safeguards Technology Program

=====  
Actinide Isotope Analysis System

Revision 1.1  
14-September-1990

This version developed for :

LLNL Nuclear Materials  
Storage Facility (PF-41)

System Test Version:

- \* MGA2 method installed (Version 6.1 6/28/90)
- \* GRPANL (Pu-238) method installed

08:11:34

18-SEP-90

Assay options are:

- [1] obtain Pu isotopics (plus U and Np, if present)
- [2] obtain Pu isotopics on sample enriched in Pu-238
- [H] HELP
- [Q] QUIT or EXIT (SUPERVISOR ONLY)

Enter Choice (followed by <Enter>) :

Operator : WDR

was last logged into system at 08:11:18 on 18-SEP-90

Last analysis performed was : Pu isotopics (plus U and Np) using MGA2  
at 07:58:13 on 18-SEP-90

Press the number or letter associated with your selection

At this point, the instrument is ready for action by typing the appropriate option (see Chapter 4 for available options). The solids actinide analysis system is in an idle state whenever the previous message is being displayed on the terminal.

### 3.2 HALTING INSTRUMENT CONTROL PROGRAM

The ISOANAL program may only be halted by a supervisor using the operator terminal with the Q option. This option requires a password and halts the execution of the program. Other programs or the system cannot be accessed from the operator terminal.

### 3.3 ABNORMAL HALTS

When power is restored after a power failure, the computer system will automatically reboot and start the instrument control program. Note that if the power failure occurs in the middle of data acquisition, the data will be lost and the system will not resume the measurement automatically.

If the system does not boot after a power failure, turn computer power off and on to force the computer to reboot. If this fails, consult a VAX systems operator: the system disk may have to be reloaded from the backup tape provided with the instrument.

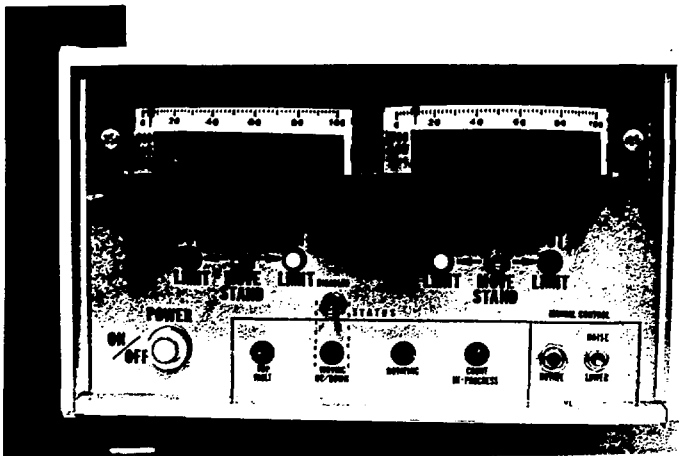
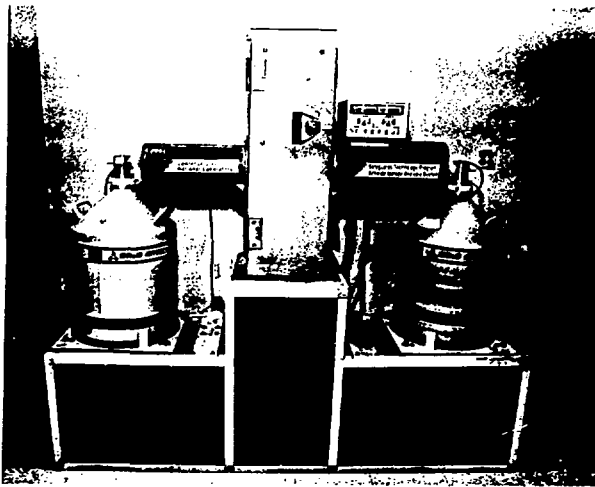


Fig. 3-1. Actinide isotopic analysis system sample cave. The control box at the right is used for manually raising/lowering or rotating the sample turntable. Other controls provide for positioning the detectors closer to or farther from the sample so as to adjust the detector count rate as indicated by the count-rate meters.

There may be other occasions when the instrument control program halts abnormally because of an error in a calculation, i.e., divide by zero, etc. In such cases, the instrument control program will have to be restarted as described above. Before restarting the program, try to determine the cause of the error. Check such counting parameters as the length of the count, etc. Were sufficient data collected? Was the sample loaded?

### 3.4 REMOTE OPERATOR TERMINAL

The remote terminal allows the operator to interact with the instrument through dialog generated by the ISOANAL program.

### 3.5 POSITIONING DETECTORS AND CHANGING ABSORBERS

Correct assays depend on proper positioning of the LEPS detector (left side of sample cave) and COAX detector (right side of cave), whose associated count-rate meters are on the control panel (left-hand meter for LEPS, righthand meter for COAX). Detector positions must be checked after the sample is loaded and may have to be adjusted to obtain optimum count rates. At optimum rates, dead time on the associated analog-digital converters should be about 30% (should never exceed 40%); the needles on the count-rate meters should be in the green area. If either needle is in the yellow area, the count rate is too low and the detector should be moved closer to the sample. If either is in the red area, the count rate is too high and the detector should be moved away from the sample. Detector positions and count rates must be verified as near optimum before an assay can begin.

If either detector is already at its IN limit, the analysis will have to be performed with count rates that are less than ideal. Absorbers for the LEPS or COAX detectors may have to be changed as described below to achieve an optimum count rate.

#### 3.5.1 Positioning Detectors

To move the left-hand (LEPS) detector, press and hold the position control IN or OUT toggle switch on the left side of the control panel. As the detector moves, its count rate changes. When it reaches its limit of travel, the IN or OUT yellow limit light will turn on.

Position the right-hand (COAX) detector similarly, using the appropriate position control IN or OUT toggle switch on the right side of the control panel.

### 3.5.2 Changing Absorbers

In normal operation, the LEPS detector at the left of the sample cave is shielded by a removable 0.040-in. cadmium attenuator. The COAX detector at the right is fronted by a 5-in. diameter lead attenuator of varying thickness (1/8, 1/4, 1/2 inch) depending on the amount of attenuation needed and 0.030-in. cadmium (the cadmium faces the detector). The function of the attenuators is to cut back the very intense low-energy radiation from a sample so that the higher-energy portion of the spectrum can be recorded with the COAX positioned as close as possible to the sample. Low-count-rate samples may require substituting a different attenuator on the LEPS (or none at all) by sliding the attenuator frame out of its holder and replacing the cadmium attenuator inside the frame. The COAX absorbers can be replaced by removing the thumb screw that holds the attenuators in place and replacing them with a different set.

Removing or changing an absorber requires removal of the sample. Consult a supervisor before removing or changing absorbers.

### 3.6 COUNTING TIME

Counting time is one of the default values read in from the PARMTR file when the program is loaded into memory. The counting time may be changed by the supervisor using the "T" option in the change parameters menu. It is specified in true clock seconds. The count duration should be determined by the count rate and the measurement precision required, which also depends on the isotopic abundance blend of the sample being assayed. For example, for typical weapons-grade plutonium, precisions of better than 1% can be obtained for most isotopes (except plutonium-238) in counting times of 30 to 60 minutes. The corresponding uncertainty (1 sigma) propagated into the specific power (watts per gram of plutonium) for such a sample is about 0.2%.

A recommended count time is calculated during the 60-sec. pre-check count (see Chap. 4) and may be used if desired.



## CHAPTER 4

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## Chapter 4

### OPERATOR INTERACTIONS AND PROCEDURES

Presented in this chapter are the routine measurements and analyses that can be performed by choosing the appropriate option from the menu of the resident instrument control and data analysis program. There are basic measurement (routine) options and supervisor options, distinguished in that supervisor options require a password to be entered before they can be performed.

#### 4.1 ROUTINE OPTIONS

The following dialog will be displayed on the operator terminal when the program is loaded and running in the computer system:

08:11:34

18-SEP-90

Assay options are:

- [1] obtain Pu isotopics (plus U and Np, if present)
- [2] obtain Pu isotopics on sample enriched in Pu-238
- [H] HELP
- [Q] QUIT or EXIT (SUPERVISOR ONLY)

Enter Choice (followed by <Enter>) :

Operator : WDR

was last logged into system at 08:11:18 on 18-SEP-90

Last analysis performed was : Pu isotopics (plus U and Np) using MGA2  
at 07:58:13 on 18-SEP-90

Press the number or letter associated with your selection

- [1] Obtain Pu isotopic analysis (plus U and Np, if present) by use of multiple group analysis (MGA) on a sample for example of HEPuO, MOX, and high Np-237 or high Pu-242. Pu must be present in sample.
- [2] Pu isotopic analysis of samples enriched in Pu-238
- [H] On-line screen help with brief description of options.

Once option 1 or 2 is chosen, the assay menu will be displayed. MGA2 or Pu-238 analysis, respectively will be displayed in the banner of most menus.

08:20:31

18-SEP-90

LLNL ISOTOPICS Assay Menu -- MGA2 analysis option

```
-----  
[A] Assay  
[MB] Measurement control - Bias  
[MP] Measurement control - Precision  
[H] Help - explain options  
[X] eXit this menu  
[SO] Supervisor Options - Password Required
```

Enter Choice (followed by <Enter>) :

The basic measurement (or routine) options (Assay, Measurement Bias and Measurement Precision) are allowed on the actinide isotopic analysis system without a password. The exit and supervisor options require a password. Examples of operator-interactive dialogue for each of these options are presented on the following pages.

The following menu for the basic measurement options is the same for all three basic options, yet some of the choices in the following menu may not be appropriate for all three options. In these examples, the responses typed by the operator follow the arrow.

ROUTINE OPTIONS

Option	Description
<u>ASSAY (A)</u>	<p>This option is for routine sample assay. Default values for the counting time and analysis parameters are read in from the PARMTR file when the program is loaded. The default values may be changed using the "SO" option (supervisory) described below.</p> <p>When the A option is selected, the program checks the measurement control file to determine the status of the last bias and precision measurements. If the time period since the last bias/precision measurements were performed exceeds the specified interval, the following messages are printed on the operator terminal:</p> <p>**** MEASUREMENT CONTROL BIAS RUN SHOULD BE MADE ****</p> <p>and/or</p> <p>**** MEASUREMENT CONTROL PRECISION RUN SHOULD BE MADE ****</p> <p>These messages indicate that the corresponding measurement has not been performed within a specified period of time. The period of time is contained in the PARMTR file and is specified or changed with the 'CHange parameter [CH] option under the Supervisor Option menu described later in this manual. The assay results will be flagged to indicate that measurement control conditions have not been met on the instrument.</p> <p>If the last bias/precision measurements were outside acceptable limits, the following messages are printed on the operator terminal:</p> <p>**** LAST MEASUREMENT CONTROL BIAS RUN WAS OUT OF LIMIT ****</p> <p>and/or</p> <p>**** LAST MEASUREMENT CONTROL PRECISION RUN WAS OUT OF LIMIT ****</p> <p>In this case, the user is queried as to whether to proceed with the assay. The user may choose to proceed, but the assay results will be flagged to indicate that measurement control conditions have not been met on the instrument.</p>

ROUTINE OPTIONS (CONTINUED)

Option	Description
ASSAY (A) (CONTINUED)	The following illustrates the operator menu for the Assay (A) option:

```
08:16:0518-SEP-90
LLNL ISOTOPICS OPERATOR Menu -- Assay Option -- MGA2 Analysis
=====
```

- [1] enter or change operator ID
- [2] enter or change sample ID
- [3] enter or change data filename
- [4] enter analysis(T0) date for sample
- [5] enter or change number of cycles for Autocycle
- [6] enter comment or remark describing this run
- [A] abort w/o performing assay [H] HELP
- [X] QUIT or EXIT (Leave this menu)

Enter Choice (followed by <Enter>) :

```
Operator is: WDRSAMPID is : STD6P
FILENAME is: Analysis Date for sample is 18-SEP-90
Number of cycles for autocycle is 1
```

Press the number or letter associated with your selection

Enter the number to enter or change any of the assay options [1-6], A to abort the assay, H for on line help and X to start the assay once all of the changes have been made.

- [1] Enter Operator ID (8 chars) -> WDR.
- [2] Enter Sample ID (20 chars) -> TEST
- [3] Filename entry is inappropriate for currently selected option (The sample ID will automatically be used for the filename)
- [4] Enter Date in the form 01-FEB-85: -> 01-JUL-86 (This is the decay correct date, T0)
- [5] Autocycle NOT selected - number of cycles will NOT be used (This option is available only through the SO menu)
- [6] Enter remark: -> This is a line for any remarks (This will be included in the printout)

ROUTINE OPTIONS (CONTINUED)

Option	Description
<u>ASSAY (A)</u> (CONTINUED)	[A] (This option aborts the assay and returns to the assay menu.)
	[H] (On line help screen with brief descriptions of each option)
	[X] (Leaves this menu once all of the parameters have been entered and starts the assay with a system pre-check)

Before pressing the X option to begin an assay, make sure that the sample has been loaded properly and that the door to the cave has been closed and locked

A system pre-check is started:

```

08:16:23                                     18-SEP-90
LLNL ISOTOPICS System Pre-Check -- Assay Option
-----
                                System Pre-Check in Progress

Press any key when detectors are SET and sample is ready for ASSAY

```

The operator must confirm that the detector count rates are optimized by positioning them and then press any key on the operator terminal.

08:16:25

18-SEP-90

LLNL ISOTOPICS System Pre-Check -- Assay Option

=====  
System Pre-Check in Progress

\*\* Sample elevator manually disabled by operator \*\*

This will indicate if the sample elevator has been manually disabled by the operator.

08:16:25

18-SEP-90

LLNL ISOTOPICS System Pre-Check -- Assay Option

=====

System Pre-Check in Progress

PLEASE WAIT 60 SECONDS WHILE ASSAY CHECK IN PROGRESS...

Both ADCs start for a 60-second preliminary measurement to examine detector count rates or dead times. The green LED lights will turn on for count in progress and rotation (and up/down if not disabled), indicating that the system is counting. If either detector ADC dead time is less than 5%, then messages for the LEPS, COAX, or both detectors are typed on the operator terminal as follows:

Low Count Rate Detected with LEPS Detector Preposition Detector(s).  
Press <A>bort, <I>gnore, or any other key to continue

Similar messages are printed for each detector or both detectors if the count rates in the detectors give ADC dead times greater than 40% requiring the operator to reposition the detector(s). If the detectors are at their limits (all the way in or all the way out) and a corresponding count-rate condition occurs, the operator will be warned of the condition but not required to reposition the detector. For example, if the count rate in the LEPS detector gives a dead time of less than 5% but the LEPS detector is positioned as close as possible to the sample (all the way in), then only a warning message will be typed on the terminal. In this case the operator is not required to reposition the LEPS detector.



08:16:25

18-SEP-90

LLNL ISOTOPICS System Pre-Check -- Assay Option

-----

System Pre-Check in Progress

Do you wish to count for recommended time? (Y or N):y

Recommended count time is : 466. sec  
Default count time is : 3000. sec

In the case of an assay measurement, the pre-check calculates a recommended count time in order to obtain good statistics for proper analysis. This is based on obtaining 10,000 counts in the 129 keV peak in the LEPS detector for an MGA analysis or 700,000 in the 152 keV peak of the COAX detector for the Pu-238 analysis. This shows the recommended and default count times along with the option to use the recommended count time or not.

Finish Pre-Check

Assay Beginning

08:19:30

18-SEP-90

Data Acquisition Options -- Assay Run -- MGA2 Analysis

=====  
Data Acquisition in Progress

- [Q] Quit and discard spectra
- [S] Suspend Run, pending restart
- [T] Terminate Run, saving and analyzing data
- [H] Help

Preset count time is : 466. sec  
08:27 on Today is when count will end

Press Q, S, T, or H

See "OPTIONS AVAILABLE DURING DATA ACQUISITION" for complete description of options

ROUTINE OPTIONS (CONTINUED)

Option	Description
<u>ASSAY (A)</u> (CONTINUED)	<p>Once the measurement has started successfully, the green LED lights will turn on for count in progress and rotation (and up/down if not disabled), indicating that the system is counting. At this point the sample cannot be removed from the cave unless the measurement is aborted with the "Q" option.</p> <p>If the sample cave door is not closed before or during an assay, the following message will be printed on the terminal:</p> <p>ERROR -- Door is open</p> <p>Verify that the sample cave door is closed and then press RETURN to retry. If the message persists even though the sample cave door is closed, this may indicate a failure in the door-closed detection switch. It may also indicate that the sensor cable between the equipment rack and the control panel is disconnected. Consult a supervisor in such a situation.</p>

ROUTINE OPTIONS (CONTINUED)

Option	Description
<u>ASSAY (A)</u> (CONTINUED)	<p>The following message will be typed on the operator terminal if the sample stops rotating during the measurement:</p> <p>SAMPLE NOT ROTATING. MEASUREMENT SUSPENDED AT HR:MN:SC To resume, press RETURN (press A to ABORT)</p> <p>The measurement will not continue until the RETURN key is pressed. When RETURN is pressed, the following message will be printed.</p> <p>Acquisition resumed at HR:MN:SC</p> <p>Once the RETURN key is pressed, the measurement resumes and stops when the specified number of clock seconds have elapsed on the analyzer. Note that the estimated completion time for the measurement is no longer correct. The only reason for the sample to stop rotating during an assay is failure in the rotation mechanism. Possible failures are the fuse in the rotation motor circuit, rotation motor power, and the rotation sensor (Vol. 2, paragraph 4.5).</p> <p>The LEPS detector spectrum is acquired in the Group #1 region of the Canberra Series 90 analyzer at 0.075 keV/channel. The COAX detector spectrum is acquired in the Group #2 region of the analyzer at 0.25 keV per channel.</p> <p>When the ADCs time out, the spectral data in the analyzer will be automatically dumped to disk and the following messages will be printed on the terminal:</p> <p>4096 channels starting at channel # 0</p> <p>Spectrum retrieval completed -- 33 blocks written to CURDTA.IS2</p> <p>4096 channels starting at channel # 0</p> <p>Spectrum retrieval completed -- 33 blocks written to CURDTA.JS2</p> <p>These messages indicate the successful transfer of the data from the analyzer to the disk. The data filenames are CURDTA if the "write data to disk" flag is set to FALSE. The "write data to disk" flag is set to FALSE when the program is loaded. It may be changed under the supervisory "SO" option. Although the data have been written to disk, they will be stored on disk only until the next assay is performed. If the "write data to disk" option is set to TRUE, the data filenames would be the same as the sample ID, e.g., TEST in this case.</p>

ROUTINE OPTIONS (CONTINUED)

Option	Description
<u>MEASUREMENT CONTROL -</u> <u>BIAS (MB)</u>	<p>An MGA assay may be done using the LEPS detector only. If the COAX detector is disconnected and no COAX detector data are collected, the data analysis uses the LEPS detector data only. The COAX ADC is turned on during data acquisition, and the nonexistent spectrum is dumped to a data file. The analysis program determines that there are no data in the COAX spectral data file. Note, however, that when the COAX spectral data are not available, the analysis program cannot determine the uranium-238 abundance or whether americium is distributed inhomogeneously in the sample.</p>
	<p>This option is used to measure the specific power output of a standard sample and to check the results (decay-corrected to some date) against the reference value (specific power) stored in the PARMTR file. [The reference value for the specific power of the standard should be determined with the measurement precision (MP) option.] This measurement must be performed at regular intervals. The permissible time period between bias measurements is also stored in the PARMTR file and can be changed by the supervisor using the Change parameters [CH] option in the "SO" menu. The operator menu for the "MB" option is similar to the assay option except that the sample ID [2] and data filename [3] are disabled and are obtained from the parameter file:</p>
	<p>The same pre-check is performed but this time only the default count time is used.</p>
	<p>The same comments about the sample and positioning the detectors for the assay option apply here. Before starting the assay, make sure that the sample is loaded and the detectors are positioned properly. Wait 60 seconds for the preliminary assay to finish, and verify that the actual assay starts. Sample rotation is monitored during data acquisition; acquisition is suspended if it stops. After acquisition is completed, the spectral data are dumped to disk and analyzed. Results of the analysis are printed out (see printout formats). At the end of the printout, the following information is printed:</p>
	<pre>Current value = 2.5960 Reference value = 2.6000 Difference = 0.0040</pre>
	<p>If the difference is greater than 1.96 times the standard deviation on the reference value (the standard deviation is stored along with the reference value in the PARMTR file), the following message is printed on the terminal:</p>
	<p>BIAS CHECK WARNING LIMITS EXCEEDED</p>

ROUTINE OPTIONS (CONTINUED)

Option	Description
<p><u>MEASUREMENT CONTROL -</u>  <u>BIAS (MB)</u>                      (continued)</p>	<p>If the difference is greater than 3.00 times the standard deviation on the reference value, the following messages are printed on the terminal:</p>
<p>BIAS CHECK ACTION LIMITS EXCEEDED                      Do you want to repeat bias check? (Y/N)</p>	<p>If this condition occurs, the user is given the option of repeating the measurement. If the measurement is not repeated or is repeated but does not satisfy conditions, the results are flagged in the measurement control results file. All further assay results are flagged, to indicate a problem with the system, until the bias measurement is repeated and measurement conditions are satisfied. In addition, at the beginning of each assay, a warning message is printed on the terminal, as described earlier.</p>
	<p>If all measurement control conditions are met, the bias results are stored in the measurement control results file MCLOGF and the flags are set indicating that the instrument has passed the bias check.</p>
	<p>If a bias measurement fails, then the system and results must be examined to determine the cause of failure. This should be done even if a second bias measurement passes the statistical tests. One possible cause for failure is using the wrong standard for the measurement. Another is that the bias measurement was not long enough. The difference between the measured value and reference value is compared against a "standard deviation" on the reference value which is dependent on the length of the count used to determine the reference value. Finally, failure to meet the bias check requirements may be due to a hardware failure in the detector or the electronics.</p>

ROUTINE OPTIONS (CONTINUED)

Option	Description
<u>MEASUREMENT CONTROL - PRECISION (MP)</u>	This option automatically makes a series of 5 or 15 measurements (as determined by the number of cycles set in the PARMTR file, see "Modify Measurement Control Parameters" menu under supervisor options). A precision check on the specific power results of these measurements is then made to determine whether they are in statistical agreement. The operator dialog is the same as for the bias measurement option described above.

At the end of the 5 or 15 runs, the following information is printed on the terminal:

```
Average result =          2.6058
Mean Sq sigma =          0.0438
Standard deviation =      0.2366
Chi-square =            1.2774
```

The average result is the average of the specific power results for the sample from the 5 or 15 measurements. The mean Sq sigma is the mean of the sigmas quoted on the specific power results squared. The standard deviation is derived from the specific power results of the 5 or 15 runs. The chi-square value is determined by dividing the square of the standard deviation by the mean Sq sigma.

If the chi-square value is below or above the specific limits shown below, a warning message is printed on the terminal as follows:

PRECISION CHECK WARNING LIMITS EXCEEDED

or

PRECISION CHECK ACTION LIMITS EXCEEDED

These chi-square limits have the following values:

	CHI-SQUARE LIMITS			
	Warning		Action	
	5 runs	15 runs	5 runs	15 runs
LOWER	0.12	0.40	0.05	0.29
HIGHER	2.79	1.87	3.72	2.24

If the chi-square value is less than the appropriate lower warning limits or greater than the appropriate high warning limits, a corresponding message is typed on the terminal. If the chi-square value does not fall

ROUTINE OPTIONS (CONTINUED)

---

Option	Description
<u>MEASUREMENT CONTROL - PRECISION (MP)</u> (continued)	within the appropriate action limits, the following query is typed on the terminal:  Do you want to repeat the precision check? (Y/N)  If the precision check is not repeated or fails a second time, the results are flagged in the measurement control results file and continue to be flagged until the system successfully passes the precision check. If the system fails the precision check, a message warning the user of that condition is typed on the terminal, as described earlier, at the beginning of each assay.  Even if the system passes the precision check on its second test, the user should determine the cause of the initial failure to meet test conditions. There is always a chance that the test failed due to a statistical fluctuation. However, the failure might also be due to an intermittent failure in the detector or the electronics. For example, an intermittent ground loop will cause the detector resolution to vary, producing variations in the results that are outside the allowed statistical limits.

---

## 4.2 OPTIONS AVAILABLE DURING DATA ACQUISITION

The following options are available to the operator during data acquisition:

---

Option	Description
<u>QUIT (Q)</u>	The quit option is available during data acquisition. If Q is pressed on the operator terminal during data acquisition, acquisition stops, and the system is ready for a new option. The data accumulated in the analyzer are not analyzed.
<u>TERMINATE (T)</u>	The terminate option is available during data acquisition. Pressing T on the operator terminal during data acquisition also stops the acquisition (same effect as the Q option), but data accumulated in the analyzer are analyzed. Once analysis is completed, the system is ready for a new option. The T option is ignored during the bias and precision measurement control options. Under the MB and MP options, only the Q option may be used to terminate a measurement.
<u>SUSPEND (S)</u>	The suspend option is also available during data acquisition. It causes suspension of the acquisition on both ADCs and then causes the following message to be typed on the terminal:  Acquisition suspended by S key at HR:MN:SC  When ready to resume, press RETURN  Pressing RETURN on the operator terminal causes the data acquisition on both ADCs to be resumed and the following message to be typed on the terminal:  Acquisition resumed at HR:MN:SC  Each of these three options may only be used during data acquisition. They will be ignored at any other time.
<u>HELP (H)</u>	On line help screen with brief descriptions of each option.

---



### 4.3 SUPERVISOR OPTIONS

Supervisor options require a password before they can be performed. The passwords are created and changed with the "change operator password" option in the "changes parameters" menu (See chapter 6).

```
08:20:3118-SEP-90  
LLNL ISOTOPICS Assay Menu -- MGA2 analysis option
```

```
-----  
[A] Assay  
[MB] Measurement control - Bias  
[MP] Measurement control - Precision  
[H] Help - explain options  
[X] eXit this menu  
[SO] Supervisor Options - Password Required
```

Enter Choice (followed by <Enter>) : SO

You have selected a supervisory option which requires a password.  
Enter password ->

Note that, to prevent unauthorized use of passwords, the password is not echoed on the terminal. When RETURN is pressed, the following menu is displayed on the operator terminal:

```
08:12:1918-SEP-90  
LLNL ISOTOPICS Assay Supervisor Menu -- MGA2 Analysis Option
```

```
-----  
[AU] Autocycle  
[AD] Assay data from Disk  
[C] Calibration  
[LA] List Assay log  
[ST] Status  
[R] Read data from disk  
[HS] Help Supervisor mode  
[P] input isotopic Power  
[CH] Change parameters  
[AC] Assay Current data in MCA  
[AUD] Autocycle from Disk  
[CD] Calibration from Disk  
[MGA] Adjust MGA analysis options  
[LM] List Measurement control log  
[W] Write data to disk  
[OU] change OUTPUT listing device  
[N] input Neutron data(Pu-240 eff)  
[X] eXit
```

Enter Choice (followed by <Enter>) :

Press the number or letter associated with your selection

Examples of operator-interactive dialog for the supervisor options are presented on the following pages. In these examples, the responses typed by the operator follow the arrow.

#### SUPERVISOR OPTIONS

Option	Description
<u>ASSAY CURRENT</u> <u>DATA IN MCA (AC)</u>	<p>This option analyzes the data currently stored in the analyzer. The data may have been accumulated automatically by a previous assay or accumulated manually. This option calls the operator menu where the dialog is the same as for the measurement assay option described above except the "[3] enter or change data filename" option accepts an input filename. The operator dialog is as follows after the operator menu:</p> <pre>4096 channels starting at channel # 0 Spectrum retrieval completed -- 33 blocks written to CURDTA.IS2 4096 channels starting at channel # 0 Spectrum retrieval completed -- 33 blocks written to CURDTA.JS2</pre> <p>Also note that the spectral filenames are CURDTA and are only temporary files. If the "write data to disk" flag had been set to TRUE, the filename <u>must</u> be entered with the "enter or change data filename" option:</p> <p>In this case the spectral data file would have the following name: TEST.IS2 (the TEST.JS2 file for the COAX data is read automatically). These spectral data files would be permanent.</p>

SUPERVISOR OPTIONS (CONTINUED)

Option	Description
<u>ASSAY DATA FROM DISK (AD)</u>	<p>This option allows the operator to repeat an analysis by recalling a previously stored spectrum from disk. This option calls the operator menu where the dialog is the same as for the assay measurement described above except the "[3] enter or change data filename" option accepts an input filename which <u>must</u> be entered.</p> <p>The program reads the LEPS spectral file and looks for a second file having the same name but a filename extension whose first character is the next letter in the alphabetic series. In this example, the program looks for a second file named TEST.JS2. COAX spectral data are expected in this second file. If this file is not found, the analysis proceeds with only the LEPS spectral data from the first file.</p>
<u>AUTOCYCLE (AU)</u>	<p>This option allows the operator to make a series of replicate measurements. This option calls the operator menu where the dialog is the same as for the assay measurement described above except now option [5] "number of cycles for autocycle" sets the number of cycles.</p> <p>The program automatically performs the number of measurements indicated by the number of cycles entered. The spectral filenames will be CURDTA if the "write to disk" flag is FALSE. The filename extensions will be I01, I02, . . . and J01, J02, . . ., etc. If the "write to disk" flag is TRUE, the filenames will be the sample ID with the extensions described above. At the end of the requested number of measurements, an average of the specific power results is printed together with its standard deviation.</p>

## SUPERVISOR OPTIONS (CONTINUED)

Option	Description														
<u>AUTOCYCLE FROM DISK (AUD)</u>	This option is similar to the AU option except that the spectra analyzed have been stored previously on disk. The dialog is similar except that the spectrum filename must be given. The option expects a sequence of files on the disk with the appropriate extensions.														
<u>CALIBRATION (C)</u>	This option is used to acquire spectra in the normal manner, but the analysis program also performs an iterative analysis on the low-energy (LEPS) spectrum to refine the gamma-ray peak short-term tail amplitude and the long-term tail constants to describe the peak shapes in the 100-keV region. In addition, the calibration analysis provides an option to redetermine the peak-shape characteristics of the COAX detector.  A calibration analysis can only be performed on an aged sample (when uranium-237 is in equilibrium with the plutonium-241) that does not contain uranium or neptunium-237. The calibration analysis should be performed whenever a detector is replaced or the gamma-ray peak-shape characteristics appear to have changed. Once data acquisition is completed, the data analysis iterates until the change in the long-term tail slope (Change for S(8)) is less than 0.015, or 20 iterations have occurred. After each iteration, the following is printed on the operator terminal:  <table> <thead> <tr> <th>QFIT</th> <th>S(3)</th> <th>Change</th> <th>S(7)</th> <th>Change</th> <th>S(8)</th> <th>Change</th> </tr> </thead> <tbody> <tr> <td>1.08</td> <td>-4.005</td> <td>0.000</td> <td>0.00565</td> <td>0.00217</td> <td>0.4456</td> <td>0.0849</td> </tr> </tbody> </table> The short-term tail amplitude is S(3), the long-term tail amplitude is S(7), and the long-term tail slope is S(8). The Change values are the changes in each corresponding parameter determined from the last iteration. Once the convergence criterion is met, the following query is printed on the terminal:  Store new shape constants? (Y/N)	QFIT	S(3)	Change	S(7)	Change	S(8)	Change	1.08	-4.005	0.000	0.00565	0.00217	0.4456	0.0849
QFIT	S(3)	Change	S(7)	Change	S(8)	Change									
1.08	-4.005	0.000	0.00565	0.00217	0.4456	0.0849									

## SUPERVISOR OPTIONS (CONTINUED)

---

Option	Description
<u>CALIBRATION (C)</u> (CONTINUED)	If the operator responds with Y, the newly determined values are written into the shape constants file SHAPC.IS2, which is the peak-shape constants file for the LEPS detector. Information similar to the following will be printed on the operator terminal:

Shape parameter file SHAPC.IS2 written.

Values =

1	5.141440E-02
2	1.673150E-03
3	-4.004291E+00
4	5.000000E-03
5	3.000000E+00
6	6.725688E+00
7	7.113660E-03
8	4.943465E-01
9	0.000000E+00
10	0.000000E+00
11	3.000000E+00
12	0.000000E+00
13	0.000000E+00
14	0.000000E+00
15	0.000000E+00

If the response is N, no changes are made to the LEPS detector shape constants file.

This listing of new shape constants for the LEPS detector is followed by the query

Determine new peak shape parameters for COAX detector? (Y/N)

If the response is yes, then a subroutine is called to fit the 451- and 208-keV peaks in the COAX spectrum for determination of the peak-shape constants. The user should check that these peaks have at least  $10^5$  counts ( $2 \times 10^4$  peak height) and that they are free from other interfering peaks (i.e., no other peaks within 2.5 keV of these peaks).

SUPERVISOR OPTIONS (CONTINUED)

---

Option

Description

---

CALIBRATION FROM  
DISK (CD)

This option is similar to the C option except that the calibration analysis is performed on a spectrum previously stored on disk. The dialogue is similar except that the spectral filename must be provided.

LIST ASSAY LOG (LA)

This option causes information stored in the assay log file to be printed on the operator terminal. The four options for listing the contents of the assay log file are given as:

08:12:37

18-SEP-90

Menu of Options for Listing Assay log  
=====

- [0] Return to main menu
- [1] List entries between two dates
- [2] List all entries
- [3] List n entries
- [4] List entries with specified sample ID
- [H] Help

Enter Choice (followed by <Enter>) : ->1

Press the number or letter associated with your selection

Enter start date (most recent) [09-AUG-84] -> 5-SEP-85

Enter stop date (oldest) [02-AUG-84] -> 1-SEP-85

Option 1 selected here causes a printout of the entries in the assay log file that fall between the dates entered. The listing has the following format:

Assay log as of 6-SEP-85 10:55:15

Entry Date	Time	Sample ID	Operator	File	Cycles	Results	VAX Flg	Err Flg
1.	2-SEP 10:30	TEST	WDR	TEST.IS2	1/ 1	2.567456E+00	F	F
						%238= 0.0110 %239=94.1158 %240= 5.6201 %241= 0.2131 %242= 0.0400 %AM= 0.27		
						%U235/PU= 5.9495		
2.	3-SEP 9:20	MOX	WDR	MOX.I01	2/ 2	2.554E+00	F	F
						%238= 0.0099 %239=94.0184 %240= 5.7161 %241= 0.2156 %242= 0.0400 %AM= 0.28		
						%U235/PU= 5.9495		
3.	3-SEP 10:15	MOX	WDR	MOX.I02	1/ 2	2.610009E+00	F	F
						%238= 0.0099 %239=94.0296 %240= 5.7054 %241= 0.2152 %242= 0.0400 %AM= 0.27		
						%U235/PU= 5.9495		

LIST ASSAY LOG (LA)  
(CONTINUED)

The assay log file contains 99 entries, the most recent being first. If the option to list a selected number of entries is chosen, the listing starts with the most recent entry and gets consecutively older.

The second (list all) option lists all 99 entries if the file is full. Note that this takes considerable time.

The third (list n) option is the same as the third except it lists n number of files starting from the last entry.

The fourth option lists entries with a specified ID.

ADJUST MGA  
ANALYSIS OPTIONS  
(MGA)

This option is NOT installed in this version of ISOANAL. When installed it will allow the operator to manually select MGA2 analysis options. Most of these options are currently selected automatically by MGA2, based on aspects of the data.

LIST MEASUREMENT  
CONTROL LOG (LM)

This option prints the contents of the measurement control log file. The options and the dialog are the same as in the List Assay log (LA) option. The format of the listing is as follows:

Measurement control log as 05-SEP-85 12:40:13

Ent Date	Time	Operator	Ty	Result	Fractional Error	Standard Value	No Run	VX Fg	Er Fg
1	14-AUG 12:07	WDR	MP	1.30840E+00	7.947E-05	6.074071E-05	5	F	F
2	15-AUG 14:10	WDR	MB	2.60580E+00	3.000E-03	2.600000E+00	1	F	F

## SUPERVISOR OPTIONS (CONTINUED)

Option	Description
<u>LIST MEASUREMENT CONTROL LOG (LM)</u> <u>(continued)</u>	<p>The values for the result, fractional error, and standard value take on a different meaning when precision measurement results are listed. In that case, the result value is the reduced chi-square, the fractional error value is the measured variance, and the standard value is the calculated variance.</p> <p>The third (list all) option lists all 99 entries if the file is full. Note that this takes considerable time</p>
<u>CHANGE OUTPUT LISTING DEVICE (OU)</u>	<p>This option allows the operator to direct the output to a file, printer or to both. The default is both.</p>

08:15:37

18-SEP-90

LLNL ISOTOPICS Select Output Listing Device Menu  
=====

- [1] Select output to printer
- [2] Select output to file
- [3] Select output to file and printer
- [4] Select NO output
- [H] HELP
- [X] QUIT or EXIT (Leave this menu)

Enter Choice (followed by &lt;Enter&gt;) :

The current output listing device is ISO\_ASSAY.PRN

Output will go to both disk and to the printer

Press the number or letter associated with your selection



## SUPERVISOR OPTIONS (CONTINUED)

Option	Description
<u>STATUS (ST)</u>	This option checks the status of the system hardware. If the system is not busy, the messages are printed on the terminal:  **** HARDWARE BUSY CHECKED ****  **** STATUS OF HARDWARE OKAY ****  If the Series 90 is busy, then the following messages are printed on the operator terminal:  **** !! SERIES 90 BUSY !! MANUAL USE?? ****  Press RETURN to retry (type [CR] to ABORT)  The Series 90 can be busy only if set to acquire manually. If so, it must be stopped manually before the instrument can proceed with an assay.
<u>READ DATA FROM DISK (RI)</u>	This option is used to read a spectrum from disk and send it to the Canberra Series 90 analyzer for display.

08:12:50

18-SEP-90

## LLNL ISOTOPICS READ DATA Menu

- ```

[1] select ADC 1
[2] select ADC 2
[F] enter spectral input filename
[R] read data from file into MCA
[H] HELP
[X] QUIT or EXIT (Leave this menu)

```

Enter Choice (followed by &lt;Enter&gt;) :

The current data filename is  
ADC 1 is selected

Press the number or letter associated with your selection

SUPERVISOR OPTIONS (CONTINUED)

| Option | Description                                                                                                                                                                                                                                              |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        | First ADC #1 or #2 must be selected, then the input filename must be entered (option F) and then the data read into the MCA (option R).                                                                                                                  |
|        | The data may be loaded into either the first or second ADC region of the analyzer. However, because each display region is set up for a particular gain, the LEPS detector spectra should be read into ADC #1 and the COAX detector spectra into ADC #2. |

WRITE DATA  
TO DISK (W)

This option is used to store a spectrum on disk that has been acquired by analyzer.

08:15:24

18-SEP-90

LLNL ISOTOPICS WRITE DATA Menu

- =====
- [1] select ADC 1
  - [2] select ADC 2
  - [F] enter spectral output filename
  - [W] write data to file from MCA
  - [H] HELP
  - [X] QUIT or EXIT (Leave this menu)

Enter Choice (followed by <Enter>) :

The current data filename is  
ADC 1 is selected

Press the number or letter associated with your selection

The dialog is the same as the "READ DATA" option.

The LEPS detector spectrum is stored in the ADC #1 region of the analyzer and the COAX is stored in ADC #2. Each must be stored separately with the corresponding extension.

## SUPERVISOR OPTIONS (CONTINUED)

| Option                                     | Description                                                                |
|--------------------------------------------|----------------------------------------------------------------------------|
| <u>HELP SUPERVISOR</u><br><u>MODE (Hs)</u> | On line help screen with brief descriptions of each option                 |
| <u>INPUT ISOTOPIC</u><br><u>POWER (p)</u>  | Entry of power measurement from calorimetry for gram isotopic calculation. |

08:13:06

18-SEP-90

Isotopic Power Entry  
-----

- [1] enter isotopic power (watts)
- [2] enter error in calorimetry measurement (percent)
- [3] enter date of calorimetry analysis
- [4] enter sample declaration(acquisition) date
- [H] HELP
- [X] QUIT or EXIT (Leave this menu)

Enter Choice (followed by &lt;Enter&gt;) :

```

Calorimetry data flag      = F
Calorimetry power value    = 0.00000E+00 watts
Error in power value       = 0.00 %
Date of power measurement  = 18-SEP-90
Press the number or letter associated with your selection

```

The date of calorimetry analysis is used for decay correcting the results. The sample declaration or acquisition date is the date that the isotopic analysis was done if different than the present date (i.e. analyze data from disk).

The calorimetry data flag is set to TRUE if both the isotopic power and power measurement date are entered. The error in the power value is not needed to set the flag true.

## SUPERVISOR OPTIONS (CONTINUED)

| Option                                                         | Description                                                       |
|----------------------------------------------------------------|-------------------------------------------------------------------|
| <u>INPUT NEUTRON</u><br><u>DATA (Pu-240 eff)</u><br><u>(N)</u> | Entry of neutron coincidence data for gram isotopics calculation. |

08:15:48

18-SEP-90

Neutron Measurement Data Entry  
=====

- [1] enter Pu-240(eff) value from neutron measurements (grams)
- [2] enter error in neutron measurement (percent)
- [3] enter date of neutron analysis
- [4] enter sample declaration(acquisition) date
- [H] HELP
- [X] QUIT or EXIT (Leave this menu)

Enter Choice (followed by &lt;Enter&gt;) :

Neutron data flag = F  
Mass of Pu-240(eff) = 0.00000E+00 grams  
Error in neutron value = 0.00 %  
Date of neutron measurement = 18-SEP-90  
Press the number or letter associated with your selection

The Pu-240 (eff) value (in grams) is entered from neutron coincidence measurements. The neutron analysis date is used for decay correction. The sample declaration or acquisition date is the date that the isotopic analysis was done if different then the present date (i.e. analyze data from disk).

The neutron data flag is set to TRUE if both the Pu-240 (eff) value and measurement date are entered. The error in the value is not needed to set the flag true.

SUPERVISOR OPTIONS (CONTINUED)

| Option | Description |
|--------|-------------|
|--------|-------------|

Change Parameters(CH)      This option allows the operator to change the parameter default flags or values used in controlling the instrument or analyzing the data. The default values are stored in the PARMTR file and are read into memory when the actinide isotopics assay program is loaded. These changes will only affect the resident memory values. To make these changes permanent, they must be written with the write option [W].

08:13:20

18-SEP-90

LLNL ISOTOPICS CHANGE PARAMETERS Menu

=====

- |                                           |                                    |
|-------------------------------------------|------------------------------------|
| [M] change measurement control parameters | [P] change operator passwords      |
| [C] change VAX communications parameters  | [T] change preset count time       |
| [A] change declared Pu-242/240 abundance  | [I] change input/output flags      |
| [F] change constants file                 | [W] Write these changes            |
| [H] HELP                                  | [X] QUIT or EXIT (Leave this menu) |

Enter Choice (followed by <Enter>) :

```

Pu-242 abundance (wt. %) = 0.22      Pu-240 abundance (wt. %) = 0.00
Preset assay time : 3000.00      Constants file = PARMTR.IS2
FLAGS : VAX comm = F      Long printout = F      Write to disk = F
    
```

Press the number or letter associated with your selection

See Chapter 6 for complete listing of each option.

EXIT FROM MENU (X)

This option is used to exit from the supervisor menu. This brings the operator back to the routine measurement menu.

CHAPTER 5

CONTENTS

|     |                          |      |
|-----|--------------------------|------|
| 5.  | OUTPUT FORMATS . . . . . | 5- 3 |
| 5.1 | Short Printout . . . . . | 5- 4 |
| 5.2 | Long Printout . . . . .  | 5- 6 |

Chapter 5

OUTPUT FORMAT

The first portion of the printout is a general summary of the measurement, as shown by the following example:

```
*****
LLNL Actinide Isotopics Analysis System, Version 1.00 -- performing:
Pu isotopics (plus U and Np) using MGA2

from instrument F03 at the
LANL Nuclear Materials Storage Facility (PF-41)

*****

Solid isotopic gamma assay -      Run Type: MC Bias

Sample ID      : std12          This analysis performed on: 25-SEP-90  16:54:29
Operator ID    : zmk           Measurement Date: 25-SEP-90  16:54:29
Data file     : std12.IS2
Constants File: parmtr.is2     Constants Date: 17-SEP-90  10:48:37
Live time (sec): 2733.         Clock time (sec): 3000.

meas. bias on stdiso12

*****
```

The information shown here is self-explanatory. The live time value is for the LEPS detector only. The measurement date is the date the data were collected, which may be different than the analysis date if analyzed later. The last line is the comments entered by the operator just before an assay.

Short and long printouts of the analysis results are available and can be selected with the default options described in chapter 6. The short printout does not show the channel-by-channel results of the fit to the data in the 100-, 300-, and 600-keV regions of the two spectra.

## 5.1 SHORT PRINTOUT

Short and long printouts of the analysis results are available and can be selected with the default options described earlier. The short printout does not show the channel-by-channel results of the fit to the data in the 100-, 300-, and 600-keV regions of the two spectra. The following is an example of the short printout, which is in addition to the summary printout that occurs in each assay:

```

Calc. 122keV FWHM = 0.504 Measured FWHM = 0.504 Slope = 0.00171
Det. #2 Shapc(1) =0.7546 Shapc(2) =0.00195 Zero Chan.= 0.890 Gain = 0.24995

PU g/cm2 = 2.9310 CDABS = 1.009 Tail Amp= 3.69E-07 Res. slope= 2.97E-05
QFIT = 1.00 Bkgrd Slope = 0.098%/Ch.
NQFIT= 1.000 ISOTOPIIC ANALYSIS AT
RELATIVE % %* COUNT TIME ZERO TIME SPECIFIC POWER
ABUNDANCE ERR ERR WT.PCT. %ERR WT.PCT. %ERR (WATTS/GM)
Pu238 = 0.0006577 1.8 1.8 0.057347 1.78 0.05918 1.72 0.33592E-03
Pu239 = 1.0000000 0.4 0.0 87.195602 0.09 87.03935 0.09 0.16788E-02
Pu240 = 0.1348616 0.7 0.7 11.759340 0.63 11.74209 0.63 0.83162E-03
Pu241 = 0.0087833 0.3 0.4 0.765866 0.40 0.93796 0.38 0.32003E-04
Pu242 = (DECLARED) 0.221844 0.22142 0.25375E-06
Am241 = 0.0035400 0.5 0.7 0.308673 0.63 0.13670 1.50 0.15611E-03
NP237 = 0.0085 7.42
* = Error in Ratio TOTAL SPECIFIC POWER = 0.30347E-02+/-0.26%

241Am Separated About 7.011+/-0.222 Years Ago.

Pu-240 effective = 12.250 +/- 0.61%

```

The first line of the printout shows the calculated FWHM for the 122-keV peak from the shape constants file (SHAPC.IS2) for the LEPS detector vs the measured FWHM. These two values should be in close agreement. If they differ by more than 10%, a warning message is printed on the terminal stating that the energy resolution is excessive. The slope is the new value determined from SHAPC(2) for the LEPS detector. It gives the resolution slope or the change in energy resolution as a function of energy for the LEPS detector. Its value should be around 0.0017.

The next line of the printout shows the change in the SHAPC(1) value (noise term related to the FWHM) for the COAX detector. This value is changed from the value read in from the shape constants file (SHAPC.JS2) to the value shown to adjust the FWHM for count-rate effects. SHAPC(2) is the value read in from the shape constants file for the COAX detector. The zero and gain values for the COAX spectrum are also printed out. The gain value should be very near 0.25. This information is not displayed if the COAX spectrum has no data in it.

The value for PU g/cm<sup>2</sup> is the estimated plutonium sample thickness (g/cm<sup>2</sup>) determined from the relative intensities of gamma rays in the low-energy spectrum. The lower limit for PU g/cm<sup>2</sup> is 0.002; the upper limit is 5.00. At 5 g/cm<sup>2</sup> of plutonium, the sample is infinitely thick for 100-keV gamma rays.

The reduced chi-square or "QFIT" is shown on the next line of the printout. It is calculated for each analysis as an indication of the quality of the least-squares fit. An ideal value of 1.0 is rarely obtainable, but values below 5.0 are



reasonable. The value of QFIT depends on the total counts accumulated. That is, the QFIT value will increase with increasing total count. To remove this dependency, we have devised a "normalized QFIT," (called NQFIT in the printout). This will be a more consistent indicator of the quality of the fit. Its value should be close to 1.0; a value less than 1.05 is acceptable. A warning message is printed on the user terminal, and a diagnostic flag is set if the NQFIT value exceeds 1.05.

The isotopic weight percent values given for the count time and zero time will always be the same except for the bias and precision measurements or when a decay correction date (T0) has been declared, where results are decayed to the date specified by the operator, and the specific power is calculated for that date. This is done to remove any decay effects from the bias measurement when the results are compared to a standard value.

This printout may include diagnostic messages that occur such as when an imbalance is detected between the americium-241 results from the 100-keV region and the 660-keV region. If this imbalance is significant (i.e., americium-241 result from the 100-keV region differs from the 662-keV result by 10%), this is an indication of inhomogeneous distribution of the americium-241 in the sample. If the difference between the two americium-241 results is greater than 3 std dev, the 662-keV result is reported; otherwise, a weighted mean of the two results is reported.

Following this portion of the printout is a general summary of the measurement on the next page, as shown by the following example:

```
*****
Results from :   Pu isotopics (plus U and Np) using MGA2

TOTAL SPECIFIC POWER in watts/gram = 0.3035E-02 +/- 0.778E-05 ( 0.256%)
Decay corrected to: 01-JUL-86
*****
```

The information shown here is self-explanatory.

## 5.2 LONG PRINTOUT

The long printout option gives a listing of the plutonium sample thickness, cadmium absorber thickness, and detector efficiency values during the iterative fitting process to determine these quantities from the gamma-ray peak areas in the low-energy spectrum. Following this listing is a listing of the peak energies, areas, and their relative weights that were used in the fitting process. This information is used for diagnostic purposes only and is not required for normal analyses.

The long printout also includes a channel-by-channel listing of the results of the fit to the 100-, 300-, and 600-keV regions. The long printout is shown below.

| CD    | DELCD  | PU    | DELPU  | ESLP       | DELSLP     | ECURV     | DELCURV   |
|-------|--------|-------|--------|------------|------------|-----------|-----------|
| 0.856 | 0.000  | 4.537 | 0.000  | 0.0000000  | 0.0000000  | 0.0000000 | 0.0000000 |
| 0.951 | 0.105  | 5.000 | 2.738  | 0.0000000  | 0.0000000  | 0.0000000 | 0.0000000 |
| 0.992 | 0.042  | 5.000 | 2.371  | 0.0000000  | 0.0000000  | 0.0000000 | 0.0000000 |
| 0.995 | 0.003  | 5.000 | 1.994  | 0.0000276  | 0.0000284  | 0.0000000 | 0.0000000 |
| 1.027 | 0.033  | 4.260 | -1.963 | -0.0006894 | -0.0023722 | 0.0000067 | 0.0000199 |
| 1.020 | -0.008 | 3.361 | -1.085 | -0.0013919 | -0.0012026 | 0.0000131 | 0.0000105 |
| 1.011 | -0.008 | 3.123 | -0.251 | -0.0016771 | -0.0003237 | 0.0000163 | 0.0000037 |
| 1.006 | -0.005 | 3.075 | -0.049 | -0.0016781 | -0.0000010 | 0.0000172 | 0.0000009 |
| 1.006 | 0.000  | 3.073 | -0.003 | -0.0016740 | 0.0000042  | 0.0000173 | 0.0000001 |
| 1.006 | 0.000  | 3.073 | 0.000  | -0.0016748 | -0.0000008 | 0.0000173 | 0.0000000 |
| 1.006 | 0.000  | 3.073 | 0.000  | -0.0016747 | 0.0000001  | 0.0000173 | 0.0000000 |

| Energy  | Counts  | % Err | Residual | Tot. Eff. | Det. Eff. |
|---------|---------|-------|----------|-----------|-----------|
| 59.536  | 402636. | 2.30  | 0.0      | 1.525E-04 | 1.398E+00 |
| 94.660  | 94922.  | 1.11  | 0.1      | 2.896E-02 | 1.072E+00 |
| 101.063 | 145955. | 0.95  | -0.2     | 4.166E-02 | 9.869E-01 |
| 103.000 | 67898.  | 1.36  | 0.0      | 4.580E-02 | 9.622E-01 |
| 111.000 | 122339. | 0.88  | 0.1      | 6.294E-02 | 8.654E-01 |
| 129.290 | 65119.  | 0.66  | 0.0      | 2.825E-02 | 6.782E-01 |
| 148.567 | 39263.  | 0.90  | 0.1      | 3.854E-02 | 5.280E-01 |
| 164.580 | 11367.  | 2.81  | -0.3     | 4.608E-02 | 4.331E-01 |
| 203.540 | 11742.  | 2.38  | -0.2     | 5.726E-02 | 2.801E-01 |
| 208.000 | 169381. | 0.39  | 0.0      | 5.783E-02 | 2.677E-01 |
| 267.540 | 5934.   | 2.81  | -0.2     | 5.964E-02 | 1.577E-01 |

Det. #2 Shapc(1) = 0.7591 Shapc(2) = 0.00195 Zero Chan. = 0.868 Gain = 0.24995  
 PU g/cm2 = 3.0727 CDABS = 1.006 Tail Amp = 2.20E-06 Res. slope = -1.14E-06  
 QFIT = 1.00 Bkgrd Slope = 0.104%/Ch.  
 NQFIT = 1.000

| ISOTOPIC ANALYSIS AT |   |            |     |            |           |           |          |                |             |
|----------------------|---|------------|-----|------------|-----------|-----------|----------|----------------|-------------|
| RELATIVE             |   | %          | %*  | COUNT TIME |           | ZERO TIME |          | SPECIFIC POWER |             |
| ABUNDANCE            |   | ERR        | ERR | WT.PCT.    | %ERR      | WT.PCT.   | %ERR     | (WATTS/GM)     |             |
| Pu238                | = | 0.0006518  | 1.8 | 1.8        | 0.056799  | 1.81      | 0.05863  | 1.75           | 0.33275E-03 |
| Pu239                | = | 1.0000000  | 0.4 | 0.0        | 87.144005 | 0.09      | 86.98711 | 0.09           | 0.16778E-02 |
| Pu240                | = | 0.1355416  | 0.7 | 0.7        | 11.811637 | 0.64      | 11.79423 | 0.64           | 0.83531E-03 |
| Pu241                | = | 0.0087866  | 0.3 | 0.4        | 0.765701  | 0.40      | 0.93862  | 0.38           | 0.32026E-04 |
| Pu242                | = | (DECLARED) |     |            | 0.22184   |           | 0.22142  |                | 0.25375E-06 |
| Am241                | = | 0.0035181  | 0.5 | 0.7        | 0.306582  | 0.64      | 0.13376  | 1.54           | 0.15276E-03 |
| NP237                | = |            |     |            | 0.0086    | 7.44      |          |                |             |

\* = Error in Ratio TOTAL SPECIFIC POWER = 0.30309E-02+/-0.26%

241Am Separated About 6.972+/-0.223 Years Ago.

Pu-240 effective = 12.301 +/- 0.618

241/239 ratio based on 148/129 kev peaks = 0.008831. Diff. = 0.5093%

| kev  | NETCNTS | RES  | kev  | NETCNTS | RES  | kev   | NETCNTS | RES  | kev   | NETCNTS | RES  | kev   | NETCNTS | RES |
|------|---------|------|------|---------|------|-------|---------|------|-------|---------|------|-------|---------|-----|
| 92.7 | 226     | 0.0  | 96.2 | 758     | 0.6  | 99.7  | 6323    | 0.1  | 103.3 | 6784    | 0.2  | 106.7 | 6519    | 0.2 |
| 92.8 | 266     | 0.0  | 96.3 | 791     | -0.1 | 99.8  | 5144    | 0.1  | 103.3 | 8960    | 0.5  | 106.8 | 6519    | 0.2 |
| 92.8 | 204     | -0.4 | 96.4 | 969     | 0.3  | 99.9  | 4157    | 2.0  | 103.4 | 12281   | 0.7  | 106.9 | 6519    | 0.2 |
| 92.9 | 227     | -0.2 | 96.5 | 1299    | 0.8  | 100.0 | 2894    | -0.4 | 103.5 | 15678   | 0.8  | 107.0 | 6519    | 0.2 |
| 93.0 | 184     | -1.0 | 96.5 | 1850    | 1.0  | 100.1 | 2090    | -0.2 | 103.6 | 18029   | -0.2 | 107.1 | 6519    | 0.2 |
| 93.1 | 315     | 0.9  | 96.6 | 2576    | -1.1 | 100.1 | 1524    | -0.3 | 103.6 | 18751   | -0.9 | 107.2 | 6519    | 0.2 |
| 93.1 | 274     | 0.1  | 96.7 | 4018    | 0.1  | 100.2 | 1309    | 0.6  | 103.7 | 18102   | 0.3  | 107.3 | 6519    | 0.2 |
| 93.2 | 304     | 0.3  | 96.7 | 5575    | -1.5 | 100.3 | 1195    | -0.3 | 103.8 | 16149   | -0.2 | 107.4 | 6519    | 0.2 |
| 93.3 | 286     | -0.2 | 96.8 | 7375    | -1.6 | 100.3 | 1388    | -0.6 | 103.9 | 14012   | 0.3  | 107.5 | 6519    | 0.2 |
| 93.4 | 329     | 0.2  | 96.9 | 9094    | 0.5  | 100.4 | 1266    | 0.5  | 103.9 | 12481   | -1.1 | 107.6 | 6519    | 0.2 |
| 93.4 | 302     | -0.6 | 97.0 | 9620    | -0.4 | 100.5 | 2868    | 0.5  | 104.0 | 11983   | 0.2  | 107.7 | 6519    | 0.2 |
| 93.5 | 302     | -1.0 | 97.0 | 9218    | -0.6 | 100.6 | 4942    | 0.5  | 104.1 | 11880   | 0.6  | 107.8 | 6519    | 0.2 |
| 93.6 | 318     | -1.2 | 97.1 | 8113    | 0.8  | 100.6 | 6516    | 0.2  | 104.2 | 10710   | 0.6  | 107.9 | 6519    | 0.2 |
| 93.7 | 513     | 1.2  | 97.2 | 6121    | -1.3 | 100.7 | 10040   | -0.6 | 104.2 | 8961    | -0.7 | 108.0 | 6519    | 0.2 |
| 93.7 | 500     | 0.3  | 97.3 | 4536    | 0.1  | 100.8 | 16522   | -0.7 | 104.3 | 7037    | -1.2 | 108.1 | 6519    | 0.2 |
| 93.8 | 504     | -0.8 | 97.3 | 3086    | -0.7 | 100.8 | 16522   | -0.7 | 104.4 | 4951    | -0.9 | 108.2 | 6519    | 0.2 |
| 93.9 | 730     | 0.9  | 97.4 | 2267    | 0.3  | 100.9 | 18033   | -0.8 | 104.5 | 2690    | -1.7 | 108.3 | 6519    | 0.2 |
| 94.0 | 919     | 0.5  | 97.5 | 1622    | -1.4 | 101.0 | 17872   | 0.6  | 104.5 | 1587    | 0.5  | 108.4 | 6519    | 0.2 |
| 94.0 | 1288    | 0.2  | 97.6 | 1486    | -0.5 | 101.1 | 15758   | 1.4  | 104.6 | 835     | 0.6  | 108.5 | 6519    | 0.2 |
| 94.1 | 2004    | 0.2  | 97.6 | 1687    | 1.9  | 101.2 | 12183   | 0.0  | 104.7 | 465     | -0.8 | 108.6 | 6519    | 0.2 |
| 94.2 | 3110    | -1.0 | 97.7 | 1775    | -0.3 | 101.3 | 8690    | 0.3  | 104.8 | 218     | -0.3 | 108.7 | 6519    | 0.2 |
| 94.3 | 4913    | -0.8 | 97.8 | 2401    | 0.1  | 101.3 | 5640    | -0.4 | 104.8 | 177     | 0.2  | 108.8 | 6519    | 0.2 |
| 94.3 | 7319    | 0.3  | 97.9 | 3524    | -0.1 | 101.4 | 3624    | 0.8  | 104.9 | 123     | 0.0  | 108.9 | 6519    | 0.2 |
| 94.4 | 9776    | 0.9  | 97.9 | 5457    | -0.8 | 101.5 | 2218    | 0.2  | 105.0 | 83      | -0.6 | 109.0 | 6519    | 0.2 |
| 94.5 | 11662   | 1.2  | 98.0 | 8837    | 1.5  | 101.5 | 1521    | 1.2  | 105.1 | 72      | -0.6 | 109.1 | 6519    | 0.2 |
| 94.6 | 12289   | 0.9  | 98.1 | 12850   | -0.2 | 101.6 | 1060    | 1.7  | 105.1 | 142     | -0.7 | 109.2 | 6519    | 0.2 |
| 94.6 | 11269   | -1.3 | 98.2 | 17638   | -0.2 | 101.7 | 819     | 0.4  | 105.2 | 96      | 0.2  | 109.3 | 6519    | 0.2 |
| 94.7 | 9586    | -0.1 | 98.2 | 22001   | 0.1  | 101.8 | 588     | -1.2 | 105.3 | 70      | -0.2 | 109.4 | 6519    | 0.2 |
| 94.8 | 7161    | -0.3 | 98.3 | 24573   | -0.4 | 101.8 | 348     | 0.2  | 105.4 | 123     | 0.8  | 109.5 | 6519    | 0.2 |
| 94.9 | 4884    | -0.2 | 98.4 | 25069   | 0.2  | 101.9 | 512     | -0.6 | 105.4 | 91      | 0.3  | 109.6 | 6519    | 0.2 |
| 94.9 | 2974    | -1.8 | 98.5 | 23517   | 0.6  | 102.0 | 499     | 2.0  | 105.5 | 108     | 0.7  | 109.7 | 6519    | 0.2 |
| 95.0 | 1923    | -0.3 | 98.5 | 20592   | -0.5 | 102.1 | 553     | 0.1  | 105.6 | 76      | 0.2  | 109.8 | 6519    | 0.2 |
| 95.1 | 1224    | -0.3 | 98.6 | 18155   | 0.7  | 102.1 | 478     | -0.3 | 105.7 | 37      | -0.3 | 109.9 | 6519    | 0.2 |
| 95.2 | 836     | -0.6 | 98.7 | 16147   | 0.3  | 102.2 | 489     | -0.6 | 105.7 | 13      | -0.0 | 110.0 | 6519    | 0.2 |
| 95.2 | 766     | 1.2  | 98.8 | 14767   | 0.2  | 102.3 | 631     | -0.2 | 105.8 | 66      | 0.2  | 110.1 | 6519    | 0.2 |
| 95.3 | 557     | -0.4 | 98.8 | 13658   | 1.7  | 102.4 | 955     | 0.3  | 105.9 | -24     | -1.2 | 110.2 | 6519    | 0.2 |
| 95.4 | 496     | -0.6 | 98.9 | 11890   | 0.9  | 102.4 | 1502    | -0.7 | 129.3 | 65119   | -0.5 | 110.3 | 6519    | 0.2 |
| 95.5 | 498     | -0.1 | 99.0 | 9944    | 0.6  | 102.5 | 2602    | -1.1 | 152.7 | 3045    | 1.8  | 110.4 | 6519    | 0.2 |
| 95.5 | 454     | -0.5 | 99.1 | 8340    | 1.4  | 102.6 | 4330    | -1.2 | 203.5 | 11742   | -0.1 | 110.5 | 6519    | 0.2 |
| 95.6 | 445     | -0.6 | 99.1 | 7242    | 0.4  | 102.7 | 6661    | 0.1  | 311.9 | 12288   | 0.0  | 110.6 | 6519    | 0.2 |
| 95.7 | 524     | 0.5  | 99.2 | 7121    | -0.1 | 102.7 | 8762    | -0.6 | 332.3 | 150770  | 0.1  | 110.7 | 6519    | 0.2 |
| 95.8 | 571     | 1.0  | 99.3 | 7840    | 0.8  | 102.8 | 10275   | -0.5 | 335.4 | 43219   | 0.6  | 110.8 | 6519    | 0.2 |
| 95.9 | 426     | -1.6 | 99.4 | 8700    | 1.5  | 102.9 | 10445   | -1.7 | 336.6 | 21120   | -0.7 | 110.9 | 6519    | 0.2 |
| 96.0 | 702     | 2.0  | 99.4 | 8914    | -0.7 | 103.0 | 9816    | 0.4  | 370.9 | 18928   | 0.3  | 111.0 | 6519    | 0.2 |
| 96.1 | 621     | 0.4  | 99.5 | 8810    | -1.1 | 103.1 | 7982    | -1.3 | 642.6 | 2921    | 0.5  | 111.1 | 6519    | 0.2 |
| 96.1 | 609     | 0.1  | 99.6 | 8174    | -1.6 | 103.1 | 6710    | 1.0  | 662.4 | 32722   | -0.3 | 111.2 | 6519    | 0.2 |
| 96.1 | 739     | 0.6  | 99.7 | 7286    | -1.2 | 103.2 | 5984    | 0.0  | 0.0   | 0.0     | 0.0  | 111.3 | 6519    | 0.2 |

## CHAPTER 6

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## Chapter 6

### CHANGE PARAMETER

#### 6.1 CHANGE PARAMETER MENU

The change parameters menu allows the user (supervisor) to change the constant values in the PARMTR.IS2 or any other specified file. The it is menu-driven and operated from the terminal. It is an option in the supervisor menu [CH]. A password is required to get to the supervisor menu. The passwords are stored in the BACKGR.IS2 file.

08:13:20

18-SEP-90

#### LLNL ISOTOPICS CHANGE PARAMETERS Menu

```
-----  
[M] change measurement control parameters [P] change operator passwords  
[C] change VAX communications parameters [T] change preset count time  
[A] change declared Pu-242/240 abundance [I] change input/output flags  
[F] change constants file [W] Write these changes  
[H] HELP [X] QUIT or EXIT (Leave this menu)
```

Enter Choice (followed by <Enter>) :

```
Pu-242 abundance (wt. %) = 0.22 Pu-240 abundance (wt. %) = 0.00  
Preset assay time : 3000.00 Constants file = PARMTR.IS2  
FLAGS : VAX comm = F Long printout = F Write to disk = F
```

Press the number or letter associated with your selection

This menu also includes a summary of the parameter values and states.

#### 6.2 PARAMETER CHANGE OPTIONS

After entering the one-letter code that corresponds to the option desired, the next level of menu is displayed which will allow the operator to enter the new values. Any changes are made only to the resident memory, permanent changes must be made with the "Write these changes" [W] option. Descriptions of each of the options and menus follow.

PARAMETER CHANGE OPTIONS

| Option                                                                            | Description                                                                                                                                           |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Change</u><br><u>Measurement</u><br><u>Control</u><br><u>Parameters</u><br>(M) | This option allows the user to modify the bias or precision measurement control information. The menu for the bias measurement control is as follows: |

```

08:13:30                                     18-SEP-90
                Modify Measurement Control Parameters
                =====
[1] enter bias interval (days)
[2] enter precision interval (days)
[3] enter analysis(T0) date for reference material
[4] enter bias reference value
[5] enter bias standard deviation
[6] enter number of cycles for precision (5 or 15)
[7] enter sample ID for reference material
[H] HELP
[X] QUIT or EXIT (Leave this menu)

Enter Choice (followed by <Enter>) :

Measurement Control: Bias           Precision           Reference date : 01-JUL-86
Interval =           1.00000           10.0000           ID :
Reference =           0.303640E-02       Cycles = 15
Standard Dev. =       0.151000E-04

                Press the number or letter associated with your selection
    
```

All entries in this case should be input in F or floating-point format: that is, a whole number, a decimal fraction, or a combination of the two.

- [1] The bias interval value is the allowed interval in days between bias control measurements.
- [2] The precision interval value is the allowed interval in days between precision measurements.
- [3] The analysis (T0) date is the decay correction date for the standard reference material used. The specific power value obtained in a bias or precision measurement is always decayed back to this date.

PARAMETER CHANGE OPTIONS (continued)

| Option | Description                                                                                                                                                      |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [4]    | The bias reference value is the expected specific power value for the standard sample at the analysis (T0) date.                                                 |
| [5]    | The bias standard deviation value is the expected standard deviation on the measured value for some specified count time.                                        |
| [6]    | This is the number of cycles for the precision control check. This value must be 5 or 15 and in integer format: that is, a whole number without a decimal point. |
| [7]    | The sample ID is the ID used in a bias or precision measurement for the operator menu ID and (if write to disk is TRUE) used for the filename to store the data. |
| [H]    | On-line screen help with brief description of options                                                                                                            |
| [X]    | Leaves this menu and returns to the "Change Parameters" menu.                                                                                                    |

Change  
Operator  
PassWords (P)

This option allows the user to change any of the passwords. The program allows three different passwords. The menu to change the passwords is:

08:14:38

18-SEP-90

Modify passwords

-----

This routine will change all three operator passwords. Press :

- [1] to change passwords (they will not be echoed)
- [X] to QUIT or EXIT (Leave this menu)

Enter Choice (followed by <Enter>) :

Press the number or letter associated with your selection

PARAMETER CHANGE OPTIONS (continued)

| Option                                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Change VAX Communication Parameters [C]</u>   | This option is NOT relevant to this release. It will allow communication with a network. This option sets the communication to the VAX flag either TRUE or FALSE. If set to TRUE, the ISOANAL program attempts to communicate with another networked VAX. Two other constants sets are also under this option. The TIMEOUT value is the amount of time in seconds that the communications subroutine waits for a response from the VAX. The RETRY value is the number of times that the communications routine tries to contact the VAX if the attempts are not successful. |
| <u>Change Preset Count Time (T)</u>              | This option allows the user to change the default clock time for all assays. The new value should be entered in F format.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <u>Change Declared Pu-242/240 Abundances (A)</u> | This option allows the user to change the plutonium-242 and plutonium-240 default values. The Pu-240 abundance is declared only in Pu-238 enriched samples. The menus to change these values follows:                                                                                                                                                                                                                                                                                                                                                                       |

08:14:03

18-SEP-90

LLNL ISOTOPICS CHANGE Abundances Menu

\*\*\*\*\*

- [2] change declared Pu-242 abundance
- [0] change declared Pu-240 abundance
- [H] HELP
- [X] QUIT or EXIT (Leave this menu)

Enter Choice (followed by <Enter>) :

Pu-242 abundance (wt. %) = 0.04  
 Pu-240 abundance (wt. %) = 0.00

Press the number or letter associated with your selection



The menu for changing the declared Pu-242 abundance is:

08:13:41

18-SEP-90

LLNL ISOTOPICS CHANGE Abundances Menu

-----

- [2] change declared Pu-242 abundance
- [0] change declared Pu-240 abundance
- [H] HELP
- [X] QUIT or EXIT (Leave this menu)

Enter PU-242 abundance (Wt.%) :

- Enter 0 for a declared Pu-242 wt% of 0.04
- 1 to calculate the Pu-242 wt%
- M to measure the Pu-242 wt% in a sample  
enriched in Pu-242 (or any value > 50%)
- any other value as the declared Pu-242 wt%

Because the plutonium-242 abundance cannot be used by gamma-ray spectrometry, its value must be specified to the system so that the relative abundances of all plutonium isotopes can be determined. The relative abundance of plutonium-242 for weapons-grade plutonium is about 0.04, so a 0 entry defaults to 0.04. If a negative value is entered, the plutonium-242 relative abundance is calculated using the plutonium-239, -240, and -241 relative abundances. However, the calculated value will only be an approximation because the plutonium-241 abundance should be corrected for decay since its removal from the reactor.

Declared Pu-240 abundance:

The Pu-240 abundance is declared only for Pu-238 enriched samples. A 0 entry defaults to 2.0 wt% where as a negative value calculates the Pu-240 abundance.

PARAMETER CHANGE OPTIONS (continued)

| Option                                         | Description                                                                                                                        |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <u>CHANGE INPUT/OUTPUT</u><br><u>FLAGS [1]</u> | This option set the flags TRUE or FALSE for both long printouts of MGA and for write to disk<br>The default values are both FALSE. |

```

08:14:49                                     18-SEP-90
                LLNL ISOTOPICS CHANGE I/O PARAMETERS Menu
                -----
[L] change long printout flag
[W] change write to disk flag
[H] HELP
[X] QUIT or EXIT (Leave this menu)

Enter Choice (followed by <Enter>) :

FLAGS :   Long printout = F
         Write to disk = F

Press the number or letter associated with your selection
    
```

The long printout flag must be set to TRUE in order to get long (detailed) printout from MGA, see Chapter 5.

The write to disk flag must be set to TRUE in order to write the spectral data to disk with the sample ID filename.

PARAMETER CHANGE OPTIONS(continued)

| Option                           | Description                                                                                                                                                                                                                                                                                         |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Change Constants File [F]</u> | This option allows the user to change the constant's file that contain the stored parameters of a given standard. It will be necessary to use a different constants file for each standard. The default constants file is PARMTR.IS2. The option first asks is if the present constants file is OK: |

08:14:16

18-SEP-90

Select Constants Filename

=====

Is this constants file OK? (Y or N):

The constants file selected was: PARMTR.IS2

PARAMETER CHANGE OPTIONS (continued)

| Option | Description |
|--------|-------------|
|--------|-------------|

If it is not, then the menu to change the constants file is

```

08:14:16                                     18-SEP-90
                                     Select Constants Filename
                                     =====

The current constants files are:

1  PARMTR.IS2      TEST CONSTANTS FILE FOR FIRST
2  PARAMTR.001    CONSTANTS FROM TKLI
3  PARMTR.002     DUMMY FILE
4  PARMTR.003     DUMMY FILE
5  PARMTR.004     DUMMY FILE

Enter constants file selected (1-5) or 6 for new file :

The constants file selected was: PARMTR.IS2
    
```

A new constants file can be picked from a list of five different files or a new file name can be typed in.

The constants file contains the Pu-242/240 abundances, present assay time, measurement bias interval, reference and std. dev. values, and measurement precision interval and number of cycles.

WRITE THESE  
CHANGES [W]

This option writes these changes to a constants file on disk for permanent storage and retrieval. It asks if you want to change the new constants filename.

Help [H]

On-line screen help with brief description of options

EXIT [X]

This option leaves the "change parameters" menu and returns to the supervisor [SO] menu.

## CHAPTER 7

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## Chapter 7

### ERROR MESSAGES

Error messages for the actinide isotopics analysis system are of two kinds: action error messages and instrument diagnostic messages.

#### 7.1 ACTION ERROR MESSAGES

A file named ERRMSG.INS contains a set of error messages that are accessed by the ERRMSG subroutine whenever an error or condition occurs that requires action by the operator or supervisor. The following is a list of these errors and a brief description of each.

#### ACTION ERROR MESSAGES

---

| Message                             | Description                                                                                                                                                                                                                                                                                                              |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ERROR IN OPENING FILE               | A problem occurs in accessing a file. Usually the file name is listed along with the error message. The most probable cause of this message is that the file is missing. Correct this problem by creating the file or copying it from the backup tape. Consult VAX system operator for copying files from a backup tape. |
| ERROR IN READING FILE               | A problem occurs in reading a file. The most probable cause is an improperly formatted file. Correct this problem by creating a new file or copying a backup.                                                                                                                                                            |
| ERROR IN WRITING FILE               | A problem occurs in writing a file. The most probable cause is insufficient writing space on the disk. Consult the supervisor about creating additional space on the disk. Additional space may be obtained by copying files that need to be archived onto a TK50 tape and deleting them from the system disk.           |
| RECORD POINTER INVALID              | The MLOGF and ASYLOG files contain pointers in the first record of the file to indicate the positions of the first and last entries. If the values of these pointers are less than or more than certain specified limits, this error message will occur. To correct the problem, delete the file indicated.              |
| SUPERVISOR NEEDS TO CORRECT PROBLEM | The error or condition that has occurred requires supervisory action to correct.                                                                                                                                                                                                                                         |

## ACTION ERROR MESSAGES (CONTINUED)

---

| Message                                    | Description                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PRECISION CHECK WARNING<br>LIMITS EXCEEDED | This message is displayed if the chi-square value calculated from the precision check measurements exceeds certain warning limits. These limits are specified under the description of the MP option in this manual. Consult the supervisor to determine course of action.                                                                                                  |
| PRECISION CHECK ACTION<br>LIMITS EXCEEDED  | This message occurs when the results of the precision measurement check exceed certain action limits. These limits are specified under the description of the MP option in this manual. If this condition occurs, the operator is asked if the measurement is to be repeated. Consult the supervisor before proceeding.                                                     |
| BIAS CHECK WARNING<br>LIMITS EXCEEDED      | This message occurs when the difference between the measurement result and the reference value is greater than 1.96 times the standard deviation on the reference value. Before proceeding, check that the correct reference standard sample was used and then consult the supervisor.                                                                                      |
| BIAS CHECK ACTION<br>LIMITS EXCEEDED       | This message is displayed when the difference between the measurement result and the reference value is greater than 3.0 times the standard deviation on the reference. If this condition occurs, the operator is asked if the measurement is to be repeated. Before proceeding, check that the correct reference standard sample was used and then consult the supervisor. |

---

## 7.2 INSTRUMENT DIAGNOSTIC MESSAGES

Diagnostic messages may occur during analysis of the spectral data. These messages indicate that a parameter determined from the spectral data exceeds a specified limit. The messages and limits are given below.

### INSTRUMENT DIAGNOSTIC MESSAGES

| Message                                                                                                     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Do not calibrate with sample containing 235U. Calibration option will be turned off and analysis continued. | If the calibration option is being used and the analysis detects uranium-235 in the sample, this message will occur. The calibration option will be turned off and a normal analysis will be performed. The calibration option is to be used only on samples that do NOT contain uranium (uranium-235 or uranium-238).                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| ***WARNING: Pb x-rays being produced by surroundings.                                                       | This message will occur if significant amounts of lead x-rays are detected in the spectrum. These x-rays interfere with the analysis for neptunium-237. Lead x-rays should not be significantly present in a spectrum if properly graded shielding is used (i.e., lead absorber followed by cadmium and copper absorbers). Check for the presence of lead, and either remove it or add cadmium and copper absorbers.                                                                                                                                                                                                                                                                                                                                           |
| ***WARNING: High-side tail = 5.3% of peak area.                                                             | If this message indicates that the high-side tail is greater than 3% of the peak area, action should be taken to reduce high-side tailing on the gamma-ray peaks. High-side tailing results from pulse pileup, which is due to improper pole-zero adjustment of the amplifier or an input count rate that is too high. First check the detector dead time or the reading on the count-rate meter. If it is too high, move the detector away from the sample or add more absorber between the detector and sample.                                                                                                                                                                                                                                              |
| !WARNING! Energy resolution excessive. Call supervisor.                                                     | If the FWHM of the 122.0-keV peak in the LEPS spectrum exceeds 600 eV, this message is displayed and DGFLG(1) is set to TRUE. This message is also displayed if the measured 122.0-keV resolution differs from the expected value by more than 10%; however, DGFLG(1) is not set to TRUE in this case. The value of DIAVAL(1) is set to the FWHM of the 122.0-keV peak. If this condition occurs, check the count rate. If the count rate produces an analyzer dead time greater than 50%, then the 122.0-keV resolution may exceed 600 keV. Adjust the LEPS detector position or add absorber to lower the count rate. If the rate is reasonable, check the amplifier pole zero and the amplifier signal baseline for noise and indications of a ground loop. |



INSTRUMENT DIAGNOSTIC MESSAGES (CONTINUED)

| Message                                                                                                                                                                                                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>***WARNING: Zero-channel intercept or gain is incorrect. Please center 59.5-keV peak at channel 794 and the 208-keV peak at channel 2773. Check stabilizers. Analysis is aborted. See supervisor.</p> | <p>If the absolute value of the zero-channel energy is greater than 5 or the gain differs from 0.075 keV per channel by 0.002 keV/channel, then this message will occur. The analysis is aborted. DGFLG(2) is set to TRUE. The value of DIAVAL (2) is set to the position of the 59.5-keV peak. To have a gain of 0.075 keV per channel and a zero-channel energy near 0, the position of the 59.5-keV peak must be at channel 794 and the position of the 208-keV peak must be at channel 2773. Because these peaks are used for zero and gain stabilization of the LEPS detector system, the LEPS stabilizer should be checked to see that it is performing properly.</p> |
| <p>WARNING: Did not converge in "MGAABS" routine.</p>                                                                                                                                                    | <p>This message indicates that the iterative analysis in the subroutine MGAABS to determine the relative detection efficiency in the 100-keV region of the LEPS detector spectrum did not converge. The results of the analysis may be suspect. Check the magnitude of the QFIT value. If it is reasonable, the results are okay even though this message occurred. Verify that there are sufficient data in the spectrum. This message may also indicate that there are absorbing materials in the sample that cannot be corrected for.</p>                                                                                                                                |
| <p>Presence of U detected in "MGAABS" routine.</p>                                                                                                                                                       | <p>The presence of uranium in a sample is first determined by testing for significant uranium-235 or -238 gamma rays. If the gamma rays are not statistically significant but there is uranium in the sample, it may be detected by the iterative analysis used to determine the relative detection efficiency for the LEPS detector. If uranium is detected in this manner, the above message will occur.</p>                                                                                                                                                                                                                                                              |
| <p>237U-241Pu equilibrium imbalance detected in MGAABS. Analysis program will assume a non-equilibrium condition.</p>                                                                                    | <p>The analysis program initially assumes that the uranium-237 is in equilibrium with the plutonium-241. The iterative analysis in MGAABS will detect if they are not, and the above message will be printed. The analysis program will treat the spectral data accordingly.</p>                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>WARNING: Eff. slope in 208-keV region too shallow. Analysis aborted.</p>                                                                                                                              | <p>This message indicates that there is a problem with determining the relative efficiency curve for the LEPS detector. Check that there are sufficient data in the spectrum. It may also indicate the presence of some absorbing materials in the sample that cannot be corrected for.</p>                                                                                                                                                                                                                                                                                                                                                                                 |

INSTRUMENT DIAGNOSTIC MESSAGES (CONTINUED)

| Message                                                                                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ***WARNING: 59-keV peak is weak compared to the 100-keV peaks. Please reduce absorbers if possible.   | This message indicates that too much cadmium absorber is being used on the LEPS detector, resulting in a weak 59-keV peak. The intensity of the 59-keV peak in the spectrum should be equivalent to the peaks in the 100-keV region.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| ***WARNING: 59-keV peak is quite intense compared to 100-keV peaks. Please use more cadmium absorber. | This message indicates that too little cadmium absorber is being used on the LEPS detector, resulting in an intense 59-keV peak. Add more cadmium absorber to reduce the 59-keV peak intensity to approximately equivalent to the 100-keV peaks.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Failed to open SHAPC2 file. Default values will be used.                                              | The shape-constants file for the COAX file was not found, so default values will be used. Use the calibration option to determine peak-shape constants and create the appropriate file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| !WARNING! COAX energy resolution exceeds 1.1 keV.                                                     | If the FWHM of the 208.0-keV peak in the COAX spectrum exceeds the expected value by more than 10%, this message is displayed and the DGFLG(3) is set to TRUE. The value of DIAVAL(3) is set to the FWHM of the 208.0-keV peak. If this condition occurs, check the count rate. If the count rate produces an analyzer dead time greater than 50%, the 208.0-keV resolution may exceed the original calibration value by more than 10%. Adjust the COAX detector position or add more absorber to give a lower count rate. If the rate is reasonable and the problem persists, check the amplifier pole zero and amplifier signal baseline for noise and indications of a ground loop. |
| 414-keV peak outside limit. Check COAX stabilizer.                                                    | The position of the 413.7-keV peak is expected at channel 1655 for the COAX detector. If the position of the peak is greater or less than three channels from channel 1655, this message is printed on the terminal, and DGFLG(3) is set to TRUE. The value of DIAVAL(4) is the position of the 413.7-keV peak. Because this peak is used for gain stabilization of the COAX detector system, the COAX stabilizer should be checked to ensure that it is performing properly.                                                                                                                                                                                                          |
| Matrix is singular in MGAOUT. Analysis aborted.                                                       | Because the matrix of equations set up to determine the relative isotopic abundances is singular, it can not be inverted for solution of the problem. The analysis is aborted. Check the spectra to ensure that there are sufficient data in them.                                                                                                                                                                                                                                                                                                                                                                                                                                     |

INSTRUMENT DIAGNOSTIC MESSAGES (CONTINUED)

| Message                                                                                                                                                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SHAPC(8) bounds or iterations exceeded. Abort.                                                                                                             | This message will occur only during a calibration analysis if the analysis does not converge, or if SHAPC(8) exceeds a limit. This indicates that the calibration is suspect and that a different spectrum should be used for the calibration. It may indicate that the count rate was too high for the spectrum being analyzed.                                                                                                                                                                                                                                                                                                                                      |
| Analysis indicates alpha-induced U x-ray is not present.                                                                                                   | This message occurs if the analysis program detects uranium-235 or -238 gamma-ray peaks but subsequent analysis of the 100-keV region shows no significant uranium x-rays from alpha-induced fluorescence that also indicate the presence of uranium. The analysis is repeated without an analysis for uranium.                                                                                                                                                                                                                                                                                                                                                       |
| WARNING!! QFIT indicates poor fit. See supervisor.                                                                                                         | If the value of NQFIT exceeds 1.06, this message is printed on the terminal. NQFIT is a normalized QFIT that indicates the quality of the fit to the 100-keV region. A large NQFIT value may be due to a change in the detector peak shape, a shift in the system gain or zero, or a gamma-ray interference in the 100-keV region that is not being taken into account. Check the system energy resolution and peak positions of both detectors first. Absorbing materials or inhomogeneities in the sample could also cause peaks in different regions of the spectrum to be severely out of balance, and the analysis code cannot make the appropriate corrections. |
| The 100-keV 241Am peak result is 6.4 std dev or 3.2% different from the 662-keV result. The 100-keV result corresponds to a count-time wt. pct. of 2.3346. | This message indicates the possibility of inhomogeneity of the americium-241 distribution in the sample. The possibility of inhomogeneity is indicated by a difference in the relative americium-241 abundances determined from the 100- and 660-keV regions. If the difference between the two results is greater than 3 standard deviations, the 660-keV result is reported; otherwise, a weighted average of the two results is given.                                                                                                                                                                                                                             |
| 137Cs was detected. Will repeat analysis.                                                                                                                  | This message indicates that an interference with the americium-241 662-keV gamma ray was detected at 661.6 keV. The interference is assumed to be due to cesium-137. Because it causes a problem in analyzing the americium-241 662-keV gamma ray, the analysis is repeated to correct for the interference.                                                                                                                                                                                                                                                                                                                                                          |

INSTRUMENT DIAGNOSTIC MESSAGES (CONTINUED)

| Message                                             | Description                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Th x-rays were detected. Analysis will be repeated. | This message will occur if thorium is present in the sample. The thorium is fluoresced, and thorium x-rays are produced which interfere with the analysis of the 100-keV region in the LEPS spectrum. If thorium x-rays are detected, the analysis is repeated with thorium x-rays included in the analysis. |