ARH-2021

This document classified by
W. H. Zimmer

THE Ge(Li) IV PLUTONIUM-239 PACKAGE COUNTER OPERATING AND SERVICING PROCEDURES

By

W. H. Zimmer

Separations Chemistry Laboratory
Research and Development
Chemical Processing Division

March 1971

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

ATLANTIC RICHFIELD HANFORD COMPANY
RICHLAND, WASHINGTON

UNCLASSIFIED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

TABLE OF CONTENTS

	<u>Page</u>
SECTION I: PROCEDURE FOR LOADING OR UNLOADING OF A Ge(Li) IV MINICRYOSTAT ASSEMBLY	1
SECTION II: PROCEDURE FOR REGENERATION OF MOLECULAR SIEVE IN A Ge(Li) IV MINICRYOSTAT	7
SECTION III: CALIBRATION CONSTANTS	10
SECTION IV: KEYBOARD COMMAND FOR NORTHERN SCIENTIFIC, INC., -NS-600 COMPUTER AIDED MEMORY SYSTEM	17
SECTION V: Ge(Li) IV INSTALLATION, OPERATION, AND MAINTENANCE	20

FOREWORD

This document confines itself to specific operating and servicing procedures for the Ge(Li) IV package counter system designed and evaluated in the Separations Chemistry Laboratory. The formal document ARH-1993 describes the theory, design, and evaluation in detail for this unit.

W. H. Zimmer

THE Ge(Li) IV PLUTONIUM-239 PACKAGE COUNTER
OPERATING AND SERVICING PROCEDURES

SECTION I

PROCEDURE FOR THE LOADING OR UNLOADING
OF A Ge(Li) IV MINICRYOSTAT ASSEMBLY

INTRODUCTION

The Ge(Li) IV detector assembly consists of four Ge(Li) detectors in a vertical array and each of the detectors is in its own minicryostat. If one of these detectors should lose resolution or vacuum, it can be detached for individual service by Princeton Gamma Tech at their own plant while the remaining detectors continued to be used.

DISCUSSION

Since the normal sequence will be the removal of a minicryostat assembly followed at a later date by the remounting of the repaired minicryostat, the following procedure will deal only with the removal of a minicryostat assembly. The changes in the procedure to remount an assembly are obvious.

There are two objects to this procedure--the removal of the minicryostat and the regeneration of the molecular sieve material in the main cryostat. A Vacion pump amperage reading of 200 μ amps indicates a pressure of 10^{-5} Torr. A higher amperage or pressure is intolerable--it indicates a leak which must be isolated and repaired. The 4 minicryostats can be isolated in turn by valving them out of the system. If vacuum control can be regained with a particular minicryostat valved out, that assembly is leaking and must be returned to Princeton Gamma Tech for repair. If all valves must be closed to regain control in the vacuum, the manifold is leaking.

The vacuum manifold can be removed and repaired without interfering with the detectors. If vacuum control cannot be regained with all the valves closed, the main cryostat is leaking. All 4 minicryostats can be removed and the main cryostat returned for repair to Princeton Gamma Tech.

TOOLS REQUIRED

1. Allen wrench for 5-40 cap screws.
2. Small-bladed screwdriver for electrical manifold screws.
3. Small soldering iron.
4. Needle-nose pliers.
5. Cold finger spanner wrench.
6. Cold finger extension--shop--made of copper or aluminum bar stock with a 3/8 inch NC x 1 inch threaded hole in one end.
7. A dewar of 15 liters or greater capacity--filled with liquid nitrogen.
8. Shop-made dummy cover.
9. High-performance roughing pump--with flexible linkage to 1/2 inch copper tubing.
10. Propane torch.

<u>Procedure</u>
1. Close all 5 vacuum valves and remove the Varion pump driver and magnet.
2. Remove external vacuum manifold by unscrewing the ten 5-40 cap screws. The manifold contains

<u>Caution</u>

Procedure

Caution

valve handles only. The valves are recessed into the main cryostat and each of the minicryostats; therefore the vacuum integrity of the system has not as yet been breached.

3. Open the electrical manifold cover and unsolder the electrical lead of the detector to be removed from the common signal lead.
4. Remove both round threaded electrical manifold hold-downs from around the electrical pass-throughs. Re-attach the electrical manifold cover.
5. Remove the six 5-40 cap screws from the rear face of the detector manifold which are sealing the minicryostat to be removed to the manifold face.
6. Remove the four 5-40 cap screws from the cold finger access cover at the end of the minicryostat to be removed.
7. Break the vacuum at the cold finger access cover.

At this point a special check should be made of all tools and parts needed for all following steps until the main cryostat is closed and the molecular sieve regenerated.

Once the cryostat is open to atmosphere while still

Procedure

Caution

being cooled to liquid nitrogen temperature, liquid oxygen will be condensed. If enough time is allowed, the volume of condensed oxygen will exceed the capacity of the molecular sieve to absorb it and the cryostat will be converted to a bomb. Under no circumstance must the system be exposed to atmosphere for more than one-half hour before it is re-sealed and pumped.

8. With one member supporting the detector end of the minicryostat, a second member removes the retaining nut which secures the cold finger of the minicryostat to the cold finger manifold of the main cryostat. *A special spanner wrench is required*
9. Carefully remove minicryostat and immediately screw minicryostat cold finger into a cold finger extension. Cover at least one-half of cold finger extension with liquid nitrogen in a standby dewar.

Use leather gloves because of the intense cold of the parts in contact with the cryostat cold finger.

<u>Procedure</u>	<u>Caution</u>
10. Re-attach cold finger access plate using four 4-50 cap screws.	Wipe O-ring contact area and <u>do not</u> pinch O-ring.
11. Attach shop-made dummy cover with six 5-40 cap screws. The dummy cover must make a vacuum-tight closure of both the minicryostat opening and the minicryostat vacuum valve handle opening in the vacuum manifold.	Wipe O-ring contact area and <u>do not</u> pinch O-ring.
12. Re-attach vacuum manifold using ten 5-40 cap screws.	Wipe O-ring contact areas and <u>do not</u> pinch O-rings.
13. Attach a high-performance roughing pump to the one-half inch copper roughing line on the vacuum manifold. Open roughing valve and begin pumping.	
14. Open isolation valve to the main cryostat chamber only--the single valve handle at the rear of the vacuum manifold.	
15. Remove the entire detector cryostat from the liquid nitrogen dewar and support the detectors on a bench so that there is all-around access to the five inches of molecular sieve containing cryostat immediately above where the cold finger emerges from the cryostat.	If the exposure of the cryostat to the atmosphere has been excessive, remove the cryostat from the liquid nitrogen very slowly, allowing the pump to remove the accumulated liquid oxygen before it expands explosively at elevated temperatures.

Procedure

Caution

16. Using a propane torch, heat the five inches of cryostat above where the cold finger emerges to drive off excessive gases from the molecular sieve. Heat for 3 minutes only to a temperature where a moistened finger sizzles. Let the heat soak in for an additional 3 minutes. Return the cryostat assembly to the liquid nitrogen immediately.

17. While the molecular sieve is cooling to liquid nitrogen temperature, re-attach the Vacion magnet and driver.

18. Apply power to the Vacion pump and valve off the roughing pump.

19. Open the valves to the minicryostats. The Vacion pump should stabilize at amperage readings of less than 20 μ amps.

20. Return the minicryostate with its cold finger extension in a liquid nitrogen dewar to PGT for repair.

Do not heat the cold finger. The detectors must remain at liquid nitrogen temperatures. Reliance is being placed on thermal inertia to protect the detectors.

The Vacion pump will not pump while the roughing pump is on the same system or at pressures above 10^{-2} Torr. If the Vacion pump does not pump immediately, allow the molecular sieve to reduce the pressure. Do not proceed until the Vacion pump does pump.

SECTION. IIPROCEDURE FOR REGENERATION OF MOLECULAR SIEVE
IN A Ge(Li) IV MINICRYOSTAT

INTRODUCTION

This procedure is to be undertaken only under the expressed direction of Princeton Gamma Tech.¹ If for any reason the minicryostat assembly is losing or has lost vacuum, PGT shall be contacted prior to the return of the assembly to them for their specific instructions.

DISCUSSION

A preliminary step to the implementation of this procedure is the *Procedure for the Loading or Unloading of a Ge(Li) IV Minicryostat Assembly*, Appendix A. At the completion of the referenced procedure, the minicryostat had been attached to a shop-made cold finger extension and was being cooled in an individual liquid nitrogen dewar.

<u>Procedure</u>	<u>Caution</u>
1. Attached single valve handle-roughing stem assembly. One is available from W. H. Zimmer, 222-S Building, 200-West.	
2. Attach flexible hose coupling from the roughing stem to a	

¹Joseph A. Baicker, president, Princeton Gamma Tech, Inc., Private Communication, February 3, 1971.

Procedure

Cautions

- roughing pump, open the valve and begin pumping.
3. Monitor the internal diode resistance. In the forward direction, it should read approximately 20,000 ohms. This value is of no concern. In the back direction, it should be like an open circuit. Continue to monitor the back direction resistance.
 4. Remove shop-made cold finger extension.

Use leather gloves to prevent frostbite. Apply torque only at extreme end of minicryostat, not above stainless steel bellows. It may be necessary to apply heat to the top of the extension to free the thread.
 5. Plunge the cold finger end (only) of the minicryostat into a container of hot tap water.
 6. Monitor the back resistance for approximately 15 minutes or until the back resistance reaches 1000 ohms. Do not allow resistance to decrease below 1000 ohms. At this stage, the detector is close to room temperature and in imminent danger of losing its lithium drift.

Sweating of the cryostat detector is normal during this phase of the procedure.

Procedure	Caution
<p>7. Close the valve, re-couple the cold finger extension and <u>immediately</u> plunge into liquid nitrogen.</p> <p>8. Remove the valve handle- roughing stem assembly.</p> <p>9. Return minicryostat to PGT for repair.</p>	<p><u>Do not</u> break the procedure routine at any time, especially at this point.</p>

SECTION III

CALCULATION CONSTANTS

INTRODUCTION

The Nova Computer uses the 355.3 keV ^{133}Ba and the 413.7 keV ^{239}Pu peaks to calculate grams ^{239}Pu and the absorption correction used to derive it. The establishment of these areas and the determination and programming of the constants used to perform the calculations are the subject of this procedure.

DISCUSSION

The peak center location routine for the Northern-Nova relies on the successive determination of relative content on either side of the intensified peak, beginning with the leading edge of the intensified zone. It is, therefore, essential that the leading edge of the intensified zone be established on the gaussian section of the peak slope. The trailing edge is less important, but it should be allowed to trail lower on the reverse slope of the peak. There are also two types of intensified zones--the manual zone is an analog function whose boundaries may vary several channels and the computer zone is digital as it is set in the 24th bit of analyzer memory.

To establish the two intensified zones required for data reduction, do the following:

1. Set the gain to approximately 0.3 keV per channel.
2. Set the ADC bias controls to an analyzer range of approximately 300 keV to 600 keV.
3. Record a mixed ^{133}Ba - ^{239}Pu spectrum.

4. Identify the 355.3 keV and 413.7 keV peaks.
5. By changing the "X" zone control only, establish an intensified zone about the 413.7 keV peaks.

Type: I@NI@

6. With the manual zone control, establish an intensified zone about the 355.3 keV peak.

Type: I@NI@ (@=SPACE)

7. Switch from "Manual" to "Computer" on the zone control.
8. Type I@K@ followed by I@S@(ADDRESS)@(ADDRESS)@ using the addresses derived in Step 5.
9. Type I@S@(ADDRESS)@(ADDRESS)@ using the addresses derived in Step 6.
10. Type G@PA@.
11. Type C@B@. After *** printout, type N followed by the channel number from Step 10 and the corresponding energies in keV.

The two required intensified zones have now been established and the analyzer energy scale has been calibrated. Do not use the "ERASE" control on the analyzer or the intensified zones boundaries will be deleted. Manual zone controls are still available for non-"RF" program use.

The data reduction calculations utilize seven constants which are entered into the computer with the teletype command "F@". These constants are listed below together with their units and their definitions.

Il	Channels	Integer number of channels on either side of the highest content channel in a region of interest which will be the limit of search for the lowest content channel for use in the determination of noise continuum.
IX	Channels	Integer number of channels on either

side of the highest content channel in a region of interest which will be included in the integration of gross peak area.

R None Root value used in Absorption Correction (AC) calculations.

BA counts/second Net area of the ^{133}Ba self-absorption source used without absorption.

BN g ^{239}Pu /c/s Calibration value for the geometry used.

BB None A ratio of the established, time-corrected BA value to the same value determined today.

BK g ^{239}Pu Background grams of ^{239}Pu .

If the 355.3 keV ^{133}Ba peak is designated with a subscript 1 and the 413.7 keV ^{239}Pu peak is designated with a subscript 2, the calculations are as follows:¹

T = time in seconds.

IP = highest content channel in region of interest.

Noise Continuum channel content lower in energy than the peak = NCL.

Noise Continuum channel content higher in energy than the peak = NCH.

$$\text{Noise Continuum} = \frac{(\text{NCL} + \text{NCH}) * (2\text{IX} + 1)}{2}$$

$$\text{Gross Peak Area} = \text{CG} = \sum \text{of channel contents of channels IP-IX through IP+IX}$$

¹W. H. Zimmer. *A Systematic Peak Reduction Method for Semiconductor Detector Spectra*, ARH-1877, December 1970.

$$\text{Net Peak Area} = \text{CN} = \text{CG} - \frac{((\text{NCL} + \text{NCH}) * 2\text{IX} + 1))}{2}$$

$$\text{Percent Precision at 95\% CL} = \frac{\pm 196 \sqrt{\text{CG} + ((\text{NCL} + \text{NCH}) * 0.5 (2\text{IX} + 1))}}{\text{CN}}$$

$$\text{Absorption Correction} = \text{AC} = \frac{R \sqrt{\frac{\text{BA} * \text{BB}}{\text{CN}_1 / \text{T}}}}{\text{CN}_1 / \text{T}}$$

$$\text{Grams } ^{239}\text{Pu} = \text{GP} = \left[\frac{\text{CN}_2 / \text{T} * \text{BN} * \text{AC}}{\text{BB}} \right] - \text{BK}$$

The program which determined the net peak areas per unit time utilizes the accumulated live time stored in channel zero. Since CN/T values are intermediate to the final reported value, they are not read out directly.

The values of the 7 constants entered through the "F" keyboard command are determined as follows [all data are smoothed prior to reduction]:

Il Four times IX.

IX The integer number of channels equal to the full width at half maximum amplitude of the 355.3 keV ^{133}Ba peak. Once set, IX and Il remain the same until the analyzer energy scale is changed.

R The root value used in the determination of absorption correction is determined experimentally using known standards in the same geometry and density configuration as the samples to be analyzed. In general, a root value of 3 is used for dispersed ^{239}Pu sources in media having a density less than iron. A root value of 6 has given the most linear response for gross quantities of plutonium, plutonium-oxide, and similar mixtures containing very high densities of the emitting source.

BA The zero absorption value of the ^{133}Ba self-absorption

source in use represents the decay time corrected average of several long analyses. Decay correction must be made on a weekly basis, correcting to time of count.

Set R = 1
 BA = 1
 BN = 1
 BB = 1
 BK = 0

$$BA = (AC)^{-1}$$

After the BA value of a source is established, it must be time-corrected to current time by the formula:

$$BA_{(current)} = BA_{(original)} e^{\frac{-0.69315 * \Delta t(\text{days})}{3893}}$$

BN The calibration value of ^{239}Pu in units of grams/ CN_2 /second. With the proper self-absorption source in place for the package size and ^{239}Pu content, place a known standard of ^{239}Pu in the geometric center of the package. Adjust the lower turntable oscillation control switch so that the lowest level of oscillation places the top of the packaging level with the top detector. If the package is less than 13 inches high, block the height of the turntable and adjust the package stage to place the package at the center of the detector array. Point self-absorption sources are used for short packages and line self-absorption sources are used for packages requiring oscillation as well as rotation. Packages containing 0 to 20 grams of ^{239}Pu should be analyzed with the detector cart in the precalibrated position which places the blinders approximately one inch from the circumference of the package. For packages

containing higher levels of ^{239}Pu , the detector cart should be at the furthest precalibrated position from the package. Note in the main document the procedure for setting the spread of the blinders.

Set R = determined value based on
sample type

BA = current value

BN = 1

BB = current value

BK = 0

$$\text{BN} = \frac{\text{grams } ^{239}\text{Pu}}{\left(\frac{\text{GP}}{\text{AC}} - (\text{Bkg CN}_2/\text{T})\right) * \text{AC}}$$

The BN calibration may result from either a single determination or the average of many determinations within the prescribed weight range.

BB A recovery factor which corrects analyzed data on the basis of the established zero absorption self-absorption curve as compared with the current BA value. The BB value can be determined from any of the self-absorption sources with a known current BA value, but it must be established daily.

Without a package on the turntable:

Set R = 1

BA = current value

BN = current value

BB = 1

BK = 0

$$\text{BB} = (\text{AC})^{-1}$$

BK A background in units of grams ^{239}Pu . The background derives from two causes--the actual peaked background due to ^{239}Pu in the area of the package counter, and

secondly from the mode of peak area calculation. For the latter reason, the BK value will vary with count time. It must be determined anew each time a different counting interval is used. The peak area calculation method is programmed to seek the highest channel content in an area of interest for IP and for the lowest channel content for NCL and NCH. Consequently, there will always be a positive background from the source which will decrease in value as the statistics are improved through longer count times.

BK may be determined from the same spectrum as BB.

```
Set   R   = 1
      BA = current value
      BN = current value
      BB = current value
      BK = 0
```

BK = GP

To determine the "Bkg CN₂/T" used in the calculation of BN.

```
Set   R   = 1
      BA = current value
      BN = 1
      BB = current value
      BK = 0
```

$$\text{Bkg CN}_2/\text{T} = \frac{\text{GP} \times \text{BB}}{\text{AC}}$$

SECTION IVKEYBOARD COMMANDS FOR NORTHERN SCIENTIFIC, INC.
-NS-600 COMPUTER AIDED MEMORY SYSTEM

71-1700-04

FORMAT EXACTLY AS WRITTEN

NOTE: @ = SPACE CHARACTER
TO TERMINATE ANY OPERATION OR COMMAND STRING PREMATURELY,
DEPRESS THE "CTRL" KEY AND STRIKE THE LETTER "D".

C@B@ ENTRY TO THE CALIBRATE TABLE THE PRESENT TABLE (IF ANY)
WILL BE PRINTED FOLLOWED BY THREE ASTERISKS (***). IF
THE PRESENT TABLE IS SATISFACTORY, TYPE THE LETTER "K"
MEANING "KEEP", BUT IF A NEW TABLE IS DESIRED, TYPE THE
NUMBER "N". THE COMPUTER WILL THEN ASK FOR CHANNEL
NUMBER AND THE CORRESPONDING ENERGY.
NOTE: THE CHANNEL NUMBERS MUST BE IN ASCENDING ORDER.
UP TO TEN CHANNELS AND ENERGIES MAY BE ENTERED.

D@ ENTRY TO THE "DATA GENERAL" "DEBUG I" OCTAL DEBUT ROUTINE.
IN ADDITION TO THE STOCK COMMANDS LISTED BY THE "DEBUG I"
MANUAL, ONE MAY TYPE AN OCTAL ADDRESS FOLLOWED BY THE
LETTER "D" WHICH WILL INTRODUCE A DISPLACEMENT INTO THE
ADDRESS CALCULATIONS. THIS FEATURE ALLOWS ONE TO WORK
IN RELOCATABLE PROGRAMS WITH EASE
NOTE: THE "R" (RUN) COMMAND ALWAYS ASSUMES ZERO DIS-
PLACEMENT.

E@C@(ADDRESS)@ GIVES THE ENERGY OF THE DESIGNATED ADDRESS AS
CALCULATED FROM THE ABOVE TABLE.

E@PA@ GIVES THE ENERGY OF THE INTENSIFIED PEAKS IN MEMORY AS
CALCULATED FROM THE ABOVE TABLE

E@PO@ FIRST PLACES THE MEMORY IN THE "CRT" MODE SO THAT INTENSI-
FICATION MAY BE PLACED AS DESIRED. PRESSING THE SPACE BAR
WILL TYPE THE ENERGY OF THAT PEAK AND PLACE THE MEMORY
BACK IN "CRT" MODE SO THAT THE INTENSIFICATION MAY BE
REPOSITIONED. ONE MAY THUS STEP FROM PEAK TO PEAK FROM
ONE END OF THE MEMORY TO THE OTHER

F@ IS THE COMMAND GIVEN TO RESET THE FUNCTION TABLE. ALL
CONSTANTS ENTERED MUST BE TERMINATED BY A SPACE COMMAND.
ALLOWABLE RANGES ARE AS FOLLOWS.

Il and IX	1-511
Il => IX.	
R	1-9
BA	100-100000
BN	.00001-2.0
BB	SAME AS BN
BK	SAME AS BN

THESE FUNCTIONS NEED BE GIVEN ONLY ONCE.

G@PA@ FINDS THE CENTROID OF THE INTENSIFIED PEAKS IN MEMORY.

G@PO@ FINDS THE CENTROID OF THE INTENSIFIED PEAKS ONE BY ONE EVERY TIME THE SPACE BAR IS DEPRESSED. (SEE "E@PO")

H@ HALTS THE MEMORY UNIT FROM ANY UNASSISTED OPERATION.

I@NC@ (START)@ (STOP)@ GIVES THE SUM OF THE CONTENTS OF ADDRESSES START THROUGH STOP.

I@NI@ GIVES THE ADDRESS BOUNDARIES AND THE SUM OF THE CONTENTS OF THE DISPLAYED INTENSIFIED REGIONS.

I@D@ (ADDRESS)@ DELETES THE COMPUTER SET INTENSIFICATION FROM THE NAMED ADDRESS TO THE END OF THAT INTENSIFIED GROUP.

I@DI DELETES COMPUTER INTENSIFICATION FROM ALL REGIONS PRESENTLY INTENSIFIED BY ANY MEANS.

I@K@ REMOVES ALL COMPUTER SET INTENSIFICATION.

I@M@ (PRESENT)@ (FUTURE)@ MOVES THE INTENSIFIED GROUP STARTING AT "PRESENT" TO THE LOCATION STARTING AT "FUTURE".

I@S@ (START)@ (STOP)@ INTENSIFIES THE CHANNELS FROM START THROUGH STOP.

I@SI SETS COMPUTER INTENSIFICATION AT THOSE REGIONS PRESENTLY INTENSIFIED BY ANY MEANS.

J@ ENTRY TO DISPLAY EXPANSION PROGRAM. THE LENGTH GIVEN BY THE OPERATOR ON THE KEYBOARD WILL DETERMINE THE NUMBER OF CHANNELS DISPLAYED. THE START OF THE REGION IS THE FIRST INTENSIFIED POINT IN MEMORY. IF THERE IS NO INTENSIFICATION THE REGION WILL START AT ZERO. TO CHANGE THE LENGTH TYPE THE CHARACTER "/". TO FIND THE ABSOLUTE START AND STOP CHANNEL ADDRESSES BEING DISPLAYED TYPE THE CHARACTER ".". POSITION SAMPLING RATE MAY BE CHANGED FROM THE NORMAL 40:1 TO ANY RATE FROM 1:1 to 65535:1 BY FIRST TYPING "--" AND THEN THE RATE DESIRED.
NOTE: A RATE OF 0 = 65535:1.

K@ KILLS THE DATA IN ALL CHANNELS. DOES NOT AFFECT INTENSIFICATION.

MMA@ PLACES MEMORY IN MULTI-CHANNEL-SCALING MODE.

MMS@ PLACES MEMORY IN MCS SUBTRACT MODE.

MPA@ PLACES MEMORY IN PHA ADD ACQUISITORY MODE.

MPS@ PLACES MEMORY IN PHA SUBTRACT MODE.

N@(START)@(STOP)@(FUNCTION)(CONSTANT)@ NORMALIZES THE GROUP OF CHANNELS FROM START TO STOP BY THE GIVEN FUNCTION AND CONSTANT. THE CONSTANT NEED NOT BE A WHOLE NUMBER. ACCEPTABLE FUNCTIONS ARE; + = ADD; - = SUBTRACT; * = MULTIPLY; / = DIVIDE.

P@A@ PRINTS THE ADDRESSES OF THE BOUNDARIES OF THE INTENSIFIED REGIONS.

P@G@(START)@(STOP)@ PRINTS THE CONTENTS OF THE ADDRESSES FROM START THROUGH STOP.

P@I@ PRINTS THE CONTENTS OF THE INTENSIFIED REGIONS.

RF@ ENTERS THE PROGRAM USED TO CALCULATE THE FOLLOWING INFORMATION BASED ON THE DATA GIVEN WHEN SETTING THE FUNCTIONS, THE DATA IN THE MEMORY, AND THE INTENSIFICATION PRESENT. BEFORE TYPING THE SPACE CHARACTER AFTER "RF" ONE MAY TURN THE TTY TO "LOCAL" TO GENERATE SOME TAPE LEADER. RETURNING TO "LINE" AND TYPING THE SPACE CHARACTER WILL INITIATE THE PROGRAM. FOR SAMPLE I.D. PURPOSES ONE MAY INSERT ANY SEQUENCE OF CHARACTERS WHEN THE COMPUTER REQUESTS THIS INFORMATION. TERMINATING THE STRING WITH A SPACE CHARACTER WILL RE-ACTIVATE THE PROGRAM AND ALLOW IT TO CALCULATE "P1", "P2", "AC", AND "GP". "ER1" WILL BE TYPED IF A PEAK ADDRESS IS LESS THAN "IX". "ER2" WILL BE TYPED IF A PEAK ADDRESS + "IX" IS GREATER THAN FULL SCALE (1023).

RP@ PRINTS THE PEAK ADDRESS AND ENERGY OF THE FIRST INTEISIFIED PEAK IN MEMORY IF THE SPECTRUM HAS BEEN CALIBRATED.
NOTE: DO NOT CONFUSE WITH "E@P" ROUTINE.

S@ SMOOTH THE SPECTRUM IN MEMORY.
NOTE: IF, BY SMOOTHING, A NEGATIVE NUMBER WOULD BE GENERATED AS THE CONTENTS OF AN ADDRESS, THE NUMBER ZERO WILL BE ENTERED AS THE FINAL RESULT.

T@R@(START)@(STOP)@(NEW START)@ TRANSFERS THE GROUP BOUNDED BY START AND STOP TO THE REGION DEFINED BY "NEW START".

V@ PLACES THE MEMORY IN VISUAL (CRT) DISPLAY MODE.

Z@(START)@(STOP)@ ZEROS (ERASES) THE GROUP OF ADDRESSES FROM START TO STOP.

SECTION V

Ge(Li) IV INSTALLATION, OPERATION, AND MAINTENANCE

INTRODUCTION

Ge(Li) IV consists of three major components: the detectors, the turntable, and the self-absorption stand. The turntable is designed to operate through the floor with each of the remaining units oriented at 180° to each other and guided on 1 x 2 inch aluminum rails. Detailed engineering drawings of all components not purchased to published specifications are contained in Drawing No. SK-2-22152.

DISCUSSION

TURNTABLE

The base of the turntable must be installed 50.5 inches below floor level to permit the turntable to rest on the floor for loading of 55 gallon drums. If a basement exists under the operating floor, a 13 inch diameter hole to clear the rotating "cylinder" is all the access area needed. If installation is to be made into a pit, it should be approximately four feet in diameter. Note that the circles are not concentric. A solid grating with a 13 inch diameter hole should be provided to minimize debris in the pit

Either mode of installation will require a ring 1/8 inch thick and 28-1/8 inches inside diameter, anchored to the floor (or grating) to prevent lateral movement of the turntable while in the full down position. A secondary electrical pass-through hole is needed outside the approximately 28 inch diameter circle.

Lift rings have been provided to lift the rotating portion of the turntable from the base. The base should be blocked to prevent walking. Once a year greasing of the main ball race should be the only service required for the turntable assembly.

SELF-ABSORPTION STAND

The self-absorption stand is designed to run on a short length of 1 x 2 inch aluminum bar which has been anchored to the floor on a line which passes through the center of the turntable. One-half inch diameter pin position holes should be drilled to position the self-absorption stand to within an inch of the package circumference. Sufficient rail should be provided to wheel the stand out of the way several feet, even though no calibration location will be needed.

Three sources of γ Ba have been provided--a line source for 0 to 20 grams γ Pu in large packages, a line source for 20+ grams γ Pu in large packages, and a point source for 0 to 20 grams γ Pu in small packages. If additional sources are needed they are standard "T" mounts (see standard Separations Chemistry Laboratory gamma energy analyses sample mounts). A line source consists of nine equal activity mounts in the brass source tube. A point source is one mount flanked top and bottom by four empties

All electrical connections for the self-absorption stand and the turntable are made through the junction box mounted on the base of the stand. A wiring diagram is included on Sheet No. 1 of Drawing No. SK-2-22152. The support for the turntable oscillation limiting switches is hinged to permit it to be moved out of the way when not needed. Triggering of the upper switch causes the turntable to fall. It will not start to rise again until the lower switch is triggered. Never operate the turntable so that it can rise without triggering the upper switch. The piston can be caused to rise right off the end

of the screw it climbs on which will result in the loss of the ball bearings from the ball nuts.

To load a heavy package:

1. Unclamp the oscillation limiting switch support and move it out of contact with the turntable.
2. Trigger the upper switch.
3. Turn off the turntable and load the package.
4. Turn on the turntable and trigger the lower switch.
5. As soon as the turntable clears the lower switch, swing the support back to its original position, and clamp.
6. Start the analysis.

To rotate a package less than 13 inches high:

1. Allow the turntable to rise until the cuts in the piston wall show above floor level.
2. Stop the turntable.
3. Insert the piston stops provided.
4. Turn on the turntable and trigger the upper switch.
5. Unclamp the oscillation limiting switch support and swing it out of the way.

To resume oscillation of the turntable:

1. Trigger the lower switch
2. Stop the turntable.
3. Remove the piston stops.
4. Clamp the oscillation limiting switch support.
5. Start the turntable.

DETECTORS

Ge(Li) IV detectors must be operated at liquid nitrogen

temperature in a high-grade vacuum and with a high quality 120 AC voltage supply.

To ensure an adequate supply of liquid nitrogen, a Stratham strain gauge metering and alarm system has been provided. Fill the dewar through the self-fill collar from a pressurized liquid nitrogen supply. It will overflow out of the vent when full. Operate normally and at the end of eight days, set the meter limit as the indicated meter reading. Thereafter, fill the liquid nitrogen dewar twice weekly. If an excess of liquid nitrogen is used, it will always indicate trouble, usually vacuum loss. The alarm will sound if the dewar weight falls below the set value. If this occurs, first refill with liquid nitrogen and then determine the cause of the high use rate. The dewar must be at least one-third full to function properly.

Vacuum is provided by a 2 liter per second Vacion vacuum pump. The vacuum level must be maintained below 10^{-5} Torr, which is indicated on the Vacion power supply meter by an amperage of 200 μ amps. Do not ground any part of the Vacion pump except through the ground strap provided between the power supply console and the permanent magnet. If another ground is made, a ground loop will be induced on the system and the detector resolution will be sharply degraded.

All AC power supplied to the detector-analyzer-computer assembly must be from one well-regulated source. In addition, the preamp supply, the AC-DC bias supply, the amplifier, the baseline restorer, and the analog to digital converter must be supplied through the Elgar Line Conditioner. An effort should be made to operate the turntable out of an entirely different supply panel

The detector cart is designed to run on a 1 x 2 inch aluminum bar anchored to the floor and oriented in a direct line with the rail for the self-absorption source stand, but on the opposite side of the turntable. One-half inch indexing holes

are to be drilled in the rail such that the indexing pin locates the cart at pre-calibrated distances from the turn-table. The furthest index position should place the detector face approximately 1.3 meters from the center of the turn-table. Closer positions should place the blinders approximately four centimeters from the circumference of the package being analyzed.

The table supporting the Vacion vacuum power supply console and the blinders is supported on the self-fill collar of the dewar and pivoted on the main cryostat. It is purposely nose-heavy and must be leveled with a "Little Jack" placed between the dewar handle and the bottom of the support table. Do not bind the two together. The detectors must be free to rotate out of the way if hit from the side.

The bias level for the detector is - 1550 VDC.

DISTRIBUTION

Atlantic Richfield Hanford Company

L. I. Brecke
L. E. Bruns
M. H. Campbell (5)
H. L. Caudill
C. A. Colvin
G. L. Gurwell
J. W. Jordan
L. M. Knights (5)
M. L. Madeen
C. P. Sutter
R. W. Szempruch
R. E. Tomlinson
W. H. Zimmer (50)
ARHCO Document Control (3)