GAMMA ANALYSIS OF ENVIRONMENTAL SAMPLES FROM THE MARSHALL ISLANDS

James L. Brunk
Health and Ecological Assessment Division

September 1995

Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract W-7405-Eng-48.
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, make 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

List of Tables..................................................................................................................ii
Abstract............................................................................................................................1
Introduction....................................................................................................................1
The Facility.......................................................................................................................1
   Analytical Systems.................................................................................................2
   Calibration..............................................................................................................3
Analysis and Data Reduction.........................................................................................4
   Routine Analytical Procedure...............................................................................4
   Non-Routine Analytical Procedure.......................................................................5
   Data Reduction.......................................................................................................5
   Sample Management...............................................................................................6
Quality Control.............................................................................................................6
   Sample Process Quality Control..........................................................................6
   Analytical Facility Internal Quality Control.......................................................6
   Interlaboratory Comparison....................................................................................7
References.....................................................................................................................7
Appendix A - Command Procedures..........................................................................A-8
Appendix B - ETAK Library Nuclide Listing.............................................................B-12
Appendix C - Data Backup Procedure.......................................................................C-19
Appendix D - Counter Log Sheet................................................................................D-21
Appendix E - Extract From an Action File.................................................................E-23

List of Tables

Table 1. Detectors currently in use...............................................................................2
Table 2. Container geometry designations....................................................................4
Abstract

Radiological studies of the fate of nuclear test related debris in the Marshall Islands conducted by members of the Lawrence Livermore National Laboratory generate large number of environmental samples. For more than 20 years, the Low-Level Gamma Spectroscopy Facility has been used to perform the analysis of gamma emitting radionuclides. A brief description of the facility, calibration, counting and analysis procedures is given.

Introduction

During 1946 to 1958 the United States conducted 66 nuclear tests in the Northern Marshall Islands. Several of these tests deposited near and intermediate range fallout on islands that have been historically inhabited or have been used for subsistence agriculture. On 1 March 1954, a nuclear weapons test code named BRAVO, was conducted at Bikini Atoll. The explosive yield greatly exceeded expectations resulting in Bikini, Rongelap, Rongerik, Ailinginae, Ailuk, Mejit and Utirik Atolls being contaminated with debris.

For more than 20 years, the Marshall Islands program at Lawrence Livermore National Laboratory (LLNL) has studied the fate of test debris in the tropical atoll environment. This program has been charged with characterizing the extent of the contamination, calculating radiological doses to man through various pathways and investigating remediation techniques. Several sampling trips per year are required to support this scope of work. Approximately 5000 environmental samples, representing constituents of the radiological pathway to man, are collected each year. Most of these samples are assayed for gamma emitting radioisotopes.

The Facility

The mission of the Low-Level Gamma Spectroscopy Facility (LLGSF) of the Health and Ecological Assessment (HEA) Division of LLNL is to provide the expertise and equipment to perform nondestructive assays of gamma emitting radionuclides contained in a variety of sample matrices. The HEA Division and its predecessors have had facilities since the 1960’s to determine the concentrations of gamma emitting radionuclides found in the environment (Allen, 1994). These facilities have evolved into the LLGSF.

The facility is housed in Building 379, which was specifically designed and constructed for the purpose of housing the equipment required to perform low-level radionuclide activity measurements. This building was constructed in 1983 with carefully chosen low background materials. The floor pad rests on 10 cm of black serpentine aggregate selected for its low levels of naturally occurring radionuclides. The concrete mixture also contains the same serpentine instead of the local gravel. Special attention was given to the thermal insulation and heating
and cooling equipment in the counting bay. This reduces the variation in
temperature and humidity, contributing to stability in the analytical systems. The
electrical service is on emergency generator backup and is filtered and conditioned
to lessen power disturbances.

The status of several conditions is monitored on a routine basis. The building
power is monitored by a power line disturbance meter. The temperature and
humidity are recorded. The detector background is checked weekly.

**Analytical Systems**

The current data collection system is the GENIE® system manufactured by Canberra
- Nuclear Data. This system is designed for the collection of spectral data from
several detectors while simultaneously being able to perform data reduction
calculations on a Digital Equipment Corporation (DEC) VAXStation® running
DEC’s VMS® operating system. Listed in Table 1 are the detectors currently in use.

<table>
<thead>
<tr>
<th>System Number</th>
<th>System Name</th>
<th>Detector Manufacturer and Type</th>
<th>Size (diameter x length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Z094C09</td>
<td>Canberra HPGe</td>
<td>51 mm x 46.0 mm</td>
</tr>
<tr>
<td>2</td>
<td>S893A06</td>
<td>Canberra Ge(Li)</td>
<td>49.5 x 42.5</td>
</tr>
<tr>
<td>3</td>
<td>6F93A07</td>
<td>Canberra Ge(Li)</td>
<td>50.5 x 50.5</td>
</tr>
<tr>
<td>4</td>
<td>P794C09</td>
<td>Canberra HPGe</td>
<td>48.7 x 49.5</td>
</tr>
<tr>
<td>5</td>
<td>8P93A08</td>
<td>Ortec Ge(Li)</td>
<td>43 x 46</td>
</tr>
<tr>
<td>6</td>
<td>5Q93A08</td>
<td>Canberra Ge(Li)</td>
<td>49 x 42</td>
</tr>
<tr>
<td>7</td>
<td>7J93A08</td>
<td>Canberra Ge(Li)</td>
<td>53 x 52.5</td>
</tr>
<tr>
<td>8</td>
<td>DR93A08</td>
<td>Canberra HPGe</td>
<td>54.1 x 55</td>
</tr>
<tr>
<td>9</td>
<td>9T93A11</td>
<td>Canberra HPGe</td>
<td>52.2 x 57</td>
</tr>
<tr>
<td>10</td>
<td>4F94C08</td>
<td>Canberra HPGe</td>
<td>46.7 x 54</td>
</tr>
<tr>
<td>11</td>
<td>FE93A11</td>
<td>Canberra HPGe</td>
<td>51.3 x 44</td>
</tr>
<tr>
<td>12</td>
<td>0P94C08</td>
<td>Ortec HPGe</td>
<td>49.8 x 42.0</td>
</tr>
<tr>
<td>17</td>
<td>1B93A12</td>
<td>Canberra HPGe</td>
<td>50.4 x 51.3</td>
</tr>
<tr>
<td>18</td>
<td>U193A12</td>
<td>Canberra HPGe</td>
<td>50.5 x 50</td>
</tr>
<tr>
<td>19</td>
<td>II93A12</td>
<td>Princeton Gamma-Tech HPGe with reverse electrode and Be window</td>
<td>51 x 45</td>
</tr>
<tr>
<td>20</td>
<td>Y293A20</td>
<td>Ortec Ge(Li)</td>
<td>45.42 x 55</td>
</tr>
<tr>
<td>21</td>
<td>HK93A21</td>
<td>Canberra Ge(Li)</td>
<td>50.4 x 41.1</td>
</tr>
<tr>
<td>22</td>
<td>L493A21</td>
<td>Canberra Ge(Li)</td>
<td>49.5 x 38.5</td>
</tr>
<tr>
<td>23</td>
<td>2D93A22</td>
<td>Canberra HPGe</td>
<td>49 x 47.5</td>
</tr>
<tr>
<td>24</td>
<td>EG93A22</td>
<td>Canberra Ge(Li)</td>
<td>53 x 45.5</td>
</tr>
</tbody>
</table>

1 Canberra Industries Inc., Nuclear Data Systems Division, 150 Spring Lake Dr.,
Itasca, IL 60143-2096.

2 Digital Equipment Corporation, Maynard, Massachusetts.
There are currently 20 up looking lithium drifted germanium (Ge(Li)) and high purity germanium (HPGe) gamma detectors operating. These detectors are contained in steel shields to reduce environmental background radiation. The detectors are connected to high voltage bias supplies and spectroscopy amplifiers. The outputs from the amplifiers are connected to mixer routers that multiplex the signals and allow the use of one analog to digital converter (ADC) per mixer router. The ADC signal goes to the acquisition interface module (AIM) where the pulse height analysis occurs. Each AIM has the capacity to store $2^{31}-1$ counts in each of 63,488 channels. The AIM communicates with the VAX via Ethernet. The Genie software running on the VAX provides for the display and manipulation of the spectral data.

 Calibration

Calibration is the process of identifying and documenting the characteristic parameters of a detector and signal processing system. Our current calculation scheme relies on having the calibration standards as similar as possible in geometry and material composition as the samples of interest. With this system, there are two basic calibrations required for sufficient detector characterization. They are the energy versus channel number relationship that includes a full width at half peak maximum (FWHM) characterization and an efficiency versus energy calibration. Two characterizations that are not performed are the count pile-up correction and the coincidence summing error correction. Pulse pile up occurs when two gamma rays arrive at the detector within the width of the amplifier’s output pulse. The low emission rates of the typical environmental level samples (much less than the 1000 s$^{-1}$ specified in ANSI, 1991) allow us to neglect the error contributions from pulse pile-up. Coincidence summing is radionuclide, geometry and detector dependent. When analyzing samples that emit coincident gamma rays at window to sample distances less than 10 cm, a graph of summing correction versus detector to sample distance is constructed. The factors read from this graph are used to correct the activities (Brunk, 1995). The major isotope of interest, $^{137}$Cs, does not emit coincident gamma rays.

The energy versus channel number calibration describes the relationship between the channel number and the gamma energy. The calibration software provided with the GENIE system calculates offset, slope and quadratic factors. The FWHM describes the peak shape. This shape varies with peak energy and is a function of the physical construction of the detector and the bias voltage. The detector efficiency describes the relationship between number of gamma rays emitted at a particular energy that deposit all of their energy in the detector and number of the counts detected. The program calculates an efficiency for each of the described gamma rays in the standard and fits a curve to the set of energy - efficiency pairs. This efficiency curve may be described in one of two ways. The software vendor refers to these as empirical, which is calculated via cubic splines, and non-empirical, which is calculated using a least square fit routine. The spline method assumes that with N calibration energies, N-1 third order polynomials exist such that the first and second
derivatives are continuous at each of the energies. By definition, the resulting curve passes through each of the energy points. This method is very local in nature causing a maximum extrapolation of 10 keV at the ends of the curve. The least squares fit method does not have this extrapolation restriction. (Canberra, 1989)

Analysis And Data Reduction

Marshall Islands samples come to the facility in boxes of 72 to 100 samples depending on the sample container. The groups of samples have been separated by experiment or priority and contain blind quality control samples. They are contained in one of three containers. (See Table 2 for the list of the containers used.)

Table 2. Container geometry designations.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Container Material</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>steel</td>
<td>8.4 cm diameter × 4.2 cm high</td>
</tr>
<tr>
<td>P</td>
<td>plastic</td>
<td>3.7 cm diameter × 4.4 cm high</td>
</tr>
<tr>
<td>T</td>
<td>plastic</td>
<td>2.8 cm diameter × 11.6 cm high</td>
</tr>
</tbody>
</table>

Routine Analytical Procedure

1. A limited number of samples are received and are stored away from the detector room prior to analysis. By keeping only a small inventory a distance from the detectors the possibility that radiation from the stored samples will raise the background is minimized.

2. Samples are selected for analysis. We prefer to analyze groups of samples that contain similar amounts of activity so that sample throughput can be maximized. The sample name, detector name, sample weight and zero time for each of the samples are entered on the log sheet. Any errors are lined out and initialed.

3. The sample data are keyed or scanned in to the computer and the samples are placed on the detectors. A Digital Command Language (DCL) command procedure, start_bk.com, starts the analyzers. (See Appendix A)

4. Generally, the samples are analyzed for a specific length of time or for a specified counting error for a particular peak. The routine preset count time is for a minimum of 1000 minutes or four percent counting statistic in the 137Cs peak. Samples that are suspected to contain an extremely low level of activity are counted for a longer time. This might be as long as 6000 minutes. Lower activity samples might require a longer count time to achieve the required statistical error if the samples are being counted to a specific counting error. (ASTM, 1987. NCRP, 1985)
5. After the time or statistical error criteria have been met, the analyzers are stopped and the data are transferred to disk storage. The analyzed samples are returned to the experimenter.

Non-Routine Analytical Procedure

Occasionally, the experimenter will specify special analysis conditions that are different from those used for the routine analysis. The flexibility of the data collection system allows for the rapid change in counting criteria. A common situation is the analysis of $^{40}$K in vegetation samples. The stopping parameter is to terminate the count after the counting statistic for the 1460 keV gamma ray goes below ten percent. Another common situation is the desire to analyze the sample multiple times for the same stopping criteria. In this case, the sample is simply added to the counting stream as many times as necessary. A third situation occasionally occurs when samples are contained in a non-standard geometry. In this case, the appropriate standard is constructed and a calibration is performed.

Data Reduction

The spectra are inspected for correct channel-energy relationship and the fit coefficients are adjusted if necessary with the calibration program supplied by Canberra. The DCL command files necessary for analysis are created so that the spectra are conveniently ordered and the file are submitted to the VMS batch processing facility for calculation. A nuclide library containing isotopes that have been found historically in samples from the Pacific Proving Grounds is used to identify the radionuclides in the sample spectra. (See Appendix B) The command procedure new_calc.com causes the nuclides to be identified, activities calculated, weighted means calculated for isotopes having more than one gamma ray and minimum detectable activity limits to be calculated. (See Appendix A) This procedure creates a printout and two disk files containing the activities and the minimum detectable activities in abbreviated form. The results are checked for data entry errors and defects in the measurement process. If the report appears correct, the data are released to the experimenter. If the sample input data are not correct, the incorrect information is replaced with an editing program supplied by Canberra and the spectrum is reanalyzed. If there has been a defect in the spectra due to equipment malfunction, the sample is reanalyzed.

As the VAX’s disks become full, the calculated data and spectra are archived. Before the archive process is started, the files produced by the analysis codes are checked for completeness. Results are recalculated for any sample not complete. The analytical result data files are transferred over the Ethernet to a local computer and to the group’s central file server. The spectra and the data files are written to magnetic tape and to the LLNL long term archive system. This multi-step archiving process is described in the check list found in Appendix C.
Sample Management

The main sample tracking mechanisms use the log sheet that is filled out as the sample count is started and an action file that the termination procedure makes as it executes. The log sheet contains space for the sample identifier, sample description, sample type, sample location, quantity and units, zero time, start date, detector, spectrum identification and the date the data was released to the experimenter. (See Appendix D) The action file created by the count terminating command procedure contains an electronic record of the count parameters. The spectrum identification, detector name, user code, sample identification, start date and time and the count live time are recorded. (See Appendix E)

Quality Control

Quality Control (QC) is the process undertaken to provide confidence that a process will produce a particular result. The quality control program in use at the facility has two major parts. The first part deals with the accuracy, precision and freedom from contamination of the whole sample process. The second deals with the consistency of the procedures and equipment used for the analysis. Each part is the responsibility of a separate group of individuals.

Sample Process Quality Control

The experimental program staff take steps to implement the first part, measuring how well the facility analyzes the sample set. Blind duplicates, blanks and external standards are added to the sample sets sent for analysis. This blind method provides a level of checking that thoroughly tests the facility's capabilities. The QC standards contain well-characterized amounts of isotopes chosen for their usefulness in testing channel-energy shifts and efficiency changes. The blanks contain extremely low levels of activity to test the level of contamination of the analytical systems. Usually several isotopes are included in the standard to give a range of gamma ray energies. The activities reflect those of the routine samples. The results of these standard determinations show how accurate the measurements are. The duplicate samples allow the experimenter to compare the precision of several measurements. The blanks show if contamination is present. Tabulated results are provided by the Quality Control Manager to close the information loop.

Analytical Facility Internal Quality Control

The other part of the QC program is performed at the analytical facility. Special attention is paid to the calibration process making sure that a detector system is not put into service until it performs consistently within the desired precision and accuracy levels. After a system is put into service, weekly measurements designed to detect deviations from these levels are made as part of the routine schedule. The purpose of the procedure is to monitor the performance of the detector systems and make any needed adjustments to the software parameters or electronics to produce
the correct results for known standards. Background counts are performed once a week to ensure that the detectors and caves are not contaminated by leaky samples.

The computer codes and procedures are documented. Changes made during software development and maintenance are recorded to keep records of the algorithms in use and noting changes in coding or logic. This allows for tracking changes that may affect analytical results.

**Interlaboratory Comparison**

Between these two QC efforts, the probability of careless errors in the analysis process becomes less likely. To enhance the confidence level further, world wide intercomparison standards are analyzed. An external organization picks a material with the appropriate level of activity to use in the study. Participating laboratories receive aliquots for analysis. The laboratories analyze the sample and report the activity levels to the study's authors who then tabulate and distribute the results to the participants. Comparison of the data demonstrates the competence of a facility with respect to the other participants. (Kehl, 1995)

**References**

Allen, Michael J. (1994), Private communication.


Appendix A - Command Procedures
START_BK.COM

$! START_BK.COM - a command procedure to start detectors for Bikini type samples (Ones that have the sample name type of f9110spr42f000)
$! By Jim Brunk
$! Started 18 Feb 1993
$! Last Edit 17 Aug 1994
$! 17 Aug 1994 added preset live time
$!
$! First get online detectors
$!
$! detector_count= 1
$! max_detector = 0
$! start_count = 0
$!
$! detector_loop:
$! online = online_`detector_count`
$! detector = detector_`detector_count`
$! if online
$! then
$! inquire answer "Start detector 'f$extract(0,2,detector)' ?" ! type out the first two letters of the detector
$! if answer .eqs. "" then goto end ! <CR> means end...
$! if answer
$! then
$! max_detector = max_detector+1 ! Increment the maximum number
$! start_count = start_count + 1 ! Increment the start count
$! start_"start_count" = ""detector" ! If online put detector name in the list
$! endif
$! detector_count=detect or_count+1 ! Increment the number of detector
$! if detector_count .gt. 16 then detector_count=detector_count+1 ! There is no Detector 16
$! if detector_count .gt. 24 then goto endlist ! Exit the Loop
$! goto detector_loop
$!
$! endlist:
$! detector = 0 ! Initialize the detector number
$! outloop:
$! detector=detector+1
$! if detector .gt. max_detector then goto bye
$! start=start 'detector'
$! write sys$output "The sample type is: "type"
$! call startit 'start'
$! goto outloop
$!
$!
$! startit: subroutine
$! Command procedure to start spectra
$! by Jim Brunk
$! started 20 March 1992
$! last edit - 16 April 1993
$!******************************************************************************
$! det_name = pl ! Pass the detector name
$! inquire sample_name "Enter the sample name" ! Ask for the Sample name
$! geometry=f$extract(0,1,sample_name)+"="+f$extract(0,2,det_name) ! Get geometry
$! type =f$extract(5,3,sample_name) ! Get the sample type
$! location=f$extract(8,3,sample_name) ! Get the sample location
$!
$! if f$extract(3,2,sample_name) .eqs. "01" then mon = "jan"
$! if f$extract(3,2,sample_name) .eqs. "02" then mon = "feb"
$! if f$extract(3,2,sample_name) .eqs. "03" then mon = "mar"
$! if f$extract(3,2,sample_name) .eqs. "04" then mon = "apr"
$! if f$extract(3,2,sample_name) .eqs. "05" then mon = "may"
$! if f$extract(3,2,sample_name) .eqs. "06" then mon = "jun"
$! if f$extract(3,2,sample_name) .eqs. "07" then mon = "jul"
$! if f$extract(3,2,sample_name) .eqs. "08" then mon = "aug"
$! if f$extract(3,2,sample_name) .eqs. "09" then mon = "sep"
$! if f$extract(3,2,sample_name) .eqs. "10" then mon = "oct"
$! if f$extract(3,2,sample_name) .eqs. "11" then mon = "nov"
$! if f$extract(3,2,sample_name) .eqs. "12" then mon = "dec"
$! year= f$extract(1,2,sample_name)
$! tzero = "1-"mon"="f$string(year)"
$! write sys$output "The sample type is: "type" ! show the sample type
write sys$output "The sample location is: 'location'" ! Show the location
inquire sample_quan "Enter the sample quanity" ! Get the amount of the sample
write sys$output "The units of the quanity are gm." ! Show the units
write sys$output "The T-zero is: 'tzero'" ! Show the Zero Time
command 'det-name' stitle="Not_Finished!" ! Indicate that the sample has not been dumped
plive="0 00:00:00.0" ! reset infinite live time
pars/command 'det_name' sident='sample_name' ! Put the sample name in the sample identification
sgeometry='geometry' ! Put the first character of the sample name in geometry
type='type' ! Put in the type of sample
sloctn='location' ! Put in the location of the sample
squant='sample_quan' ! Put in the sample size
sunits='sample_unit' ! Put in the units
stime='tzero' ! Put in the zero time
mca off 'det_name' ! Stop the detector if it is going
mca on 'det_name' ! Turn the adc on
mca erase 'det_name' ! Clear the adc data
mca delete/region 'det_name' ! Delete all ROIs
mca create/region 'det_name' 650 670 1 /energy ! set a ROI around Cs-137 peak
write sys$output "Detector " + det_name + " started...." ! Let them know what happened
write sys$output "" ! Out a blank line
set noverify
return
NEW_CALC.COM

$set noverify
$! NEW_CALC.COM Calculation Command file
$!
$! Jim Brunk
$!
$! Started : 16 Apr 1993
$!
$! 16 Nov 1994 - changed the start channel to 90
$!
$! Changed the printer to tta: (laser que)
$!
$! Usage:
$!
$! new_calc p1 p2 p3 p4
$!
$! P1 is the sample configuration
$! P2 is the Library
$! P3 is the background configuration
$! P4 is the calibration configuration
$!
$! $set noon
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!

Usage:
$!
$! new_calc p1 p2 p3 p4
$!
$! P1 is the sample configuration
$! P2 is the Library
$! P3 is the background configuration
$! P4 is the calibration configuration
$!
$! $set noon
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
$!
Appendix B - ETAK Library Nuclide Listing
<table>
<thead>
<tr>
<th>Nuclide Name</th>
<th>Half-Life</th>
<th>Nuclide Type</th>
<th>Line</th>
<th>Energy (keV)</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE-7</td>
<td>53.50D</td>
<td></td>
<td></td>
<td>477.40</td>
<td>10.30 %</td>
</tr>
<tr>
<td>NA-22</td>
<td>2.58Y</td>
<td></td>
<td></td>
<td>511.00</td>
<td>99.94 %</td>
</tr>
<tr>
<td>K-40</td>
<td>1.26E+09Y</td>
<td></td>
<td></td>
<td>1274.55</td>
<td>10.83 %</td>
</tr>
<tr>
<td>Mn-54</td>
<td>312.30D</td>
<td></td>
<td></td>
<td>1460.76</td>
<td>10.00 %</td>
</tr>
<tr>
<td>Co-60</td>
<td>5.27Y</td>
<td></td>
<td></td>
<td>834.82</td>
<td>100.00 %</td>
</tr>
<tr>
<td>Zn-65</td>
<td>245.00D</td>
<td></td>
<td></td>
<td>1173.23</td>
<td>100.00 %</td>
</tr>
<tr>
<td>Nb-95</td>
<td>35.10D</td>
<td></td>
<td></td>
<td>1332.51</td>
<td>100.00 %</td>
</tr>
<tr>
<td>Zr-95</td>
<td>65.00D</td>
<td></td>
<td></td>
<td>1115.52</td>
<td>49.00 %</td>
</tr>
<tr>
<td>Rh-101</td>
<td>3.01Y</td>
<td></td>
<td></td>
<td>204.11</td>
<td>2.34 %</td>
</tr>
<tr>
<td>Rh-102M</td>
<td>2.90Y</td>
<td></td>
<td></td>
<td>235.68</td>
<td>24.90 %</td>
</tr>
<tr>
<td>Ru-103</td>
<td>39.60D</td>
<td></td>
<td></td>
<td>724.20</td>
<td>43.00 %</td>
</tr>
<tr>
<td>Rh-106</td>
<td>30.36S</td>
<td></td>
<td></td>
<td>756.72</td>
<td>54.60 %</td>
</tr>
<tr>
<td>Ag-108M</td>
<td>126.99Y</td>
<td></td>
<td></td>
<td>766.80</td>
<td>99.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>767.00</td>
<td>99.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>767.00</td>
<td>99.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1046.80</td>
<td>31.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1103.30</td>
<td>4.50 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1112.90</td>
<td>18.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1112.90</td>
<td>18.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1112.90</td>
<td>18.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>418.80</td>
<td>11.20 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>475.10</td>
<td>93.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>628.20</td>
<td>7.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>631.40</td>
<td>52.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>697.60</td>
<td>43.20 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>767.00</td>
<td>33.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1046.80</td>
<td>31.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1103.30</td>
<td>4.50 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1112.90</td>
<td>18.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>497.09</td>
<td>90.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>610.31</td>
<td>5.60 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>616.30</td>
<td>0.81 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>622.10</td>
<td>9.80 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>873.80</td>
<td>0.44 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1050.70</td>
<td>1.40 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>79.12</td>
<td>5.20 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>433.61</td>
<td>92.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>614.04</td>
<td>92.00 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>612.74</td>
<td>0.11 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>722.73</td>
<td>92.00 %</td>
</tr>
<tr>
<td>Nuclide</td>
<td>Name</td>
<td>Half-Life</td>
<td>Type</td>
<td>Line</td>
<td>Energy</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>-----------</td>
<td>------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>AG-110M</td>
<td>253.00D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>446.20 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>620.10 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>657.60 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>677.50 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>686.80 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>706.60 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>744.20 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>763.80 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>817.90 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>884.50 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>937.30 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1384.30 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1475.90 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1505.20 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1562.50 keV</td>
</tr>
<tr>
<td>CD-113M</td>
<td>13.70Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 263.71 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 380.44 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 427.88 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 463.38 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 600.60 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 606.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 635.92 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 671.41 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 79.60 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 81.00 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 160.61 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 302.75 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 355.90 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 475.34 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 563.22 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 569.33 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 604.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 795.79 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>801.87 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1038.61 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1167.91 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1365.13 keV</td>
</tr>
<tr>
<td>CS-134</td>
<td>2.04Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 475.34 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 563.22 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 569.33 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 604.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 795.79 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>801.87 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1038.61 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1167.91 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1365.13 keV</td>
</tr>
<tr>
<td>CS-137</td>
<td>30.03Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 661.65 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 80.10 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* 133.50 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>696.50 keV</td>
</tr>
<tr>
<td>Name</td>
<td>Half-Life</td>
<td>Nuclide Key</td>
<td>Type</td>
<td>Line</td>
<td>Energy</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-------------</td>
<td>------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>EU-152</td>
<td>14.02y</td>
<td></td>
<td></td>
<td></td>
<td>121.76 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>244.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>251.60 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>271.00 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>295.97 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>315.40 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>324.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>329.30 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>344.27 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>367.76 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>385.92 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>411.10 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>416.00 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>443.94 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>488.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>503.45 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>563.80 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>566.20 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>586.20 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>656.40 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>674.35 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>678.60 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>688.80 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>712.90 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>719.30 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>764.90 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>769.00 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>778.85 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>810.24 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>841.40 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>867.30 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>896.92 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>919.10 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>930.20 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>964.00 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1005.10 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1085.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1089.50 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1111.90 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1212.80 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1249.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1292.60 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1298.97 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1407.92 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1457.60 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1528.20 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1606.70 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1648.20 keV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1769.90 keV</td>
</tr>
<tr>
<td>Nuclide Name</td>
<td>Half-Life</td>
<td>Nuclide Key</td>
<td>Energy</td>
<td>Abundance</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
<td>-------------</td>
<td>--------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>EU-154</td>
<td>7.84Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU-155</td>
<td>4.68Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PB-XRAY</td>
<td>32.41Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BI-207</td>
<td>32.03Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PB-210</td>
<td>22.30Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RA-226</td>
<td>1621.10Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 123.14 keV, 40.50 %
- 248.04 keV, 6.59 %
- 591.74 keV, 4.84 %
- 692.41 keV, 1.70 %
- 723.30 keV, 19.70 %
- 756.87 keV, 4.34 %
- 873.19 keV, 11.50 %
- 996.32 keV, 10.30 %
- 1004.76 keV, 17.30 %
- 1274.39 keV, 33.50 %
- 1596.48 keV, 1.67 %
- 60.01 keV, 1.32 %
- 86.55 keV, 32.20 %
- 105.32 keV, 22.80 %
- 72.80 keV, 59.88 %
- 94.80 keV, 34.89 %
- 87.30 keV, 10.96 %
- 569.62 keV, 98.00 %
- 1063.65 keV, 77.00 %
- 1770.18 keV, 6.82 %
- 46.50 keV, 4.10 %
- 186.14 keV, 4.00 %
- 241.96 keV, 7.90 %
- 295.20 keV, 20.20 %
- 351.92 keV, 40.10 %
- 609.27 keV, 48.40 %
- 742.48 keV, 1.65 %
- 768.35 keV, 5.32 %
- 785.80 keV, 1.21 %
- 806.16 keV, 1.31 %
- 934.06 keV, 3.34 %
- 1120.28 keV, 16.00 %
- 1155.17 keV, 1.82 %
- 1238.13 keV, 6.20 %
- 1280.98 keV, 1.56 %
- 1377.64 keV, 4.18 %
- 1401.44 keV, 1.44 %
- 1407.98 keV, 2.60 %
- 1509.22 keV, 2.30 %
- 1661.24 keV, 1.21 %
- 1729.55 keV, 3.07 %
- 1764.49 keV, 16.60 %
- 1838.33 keV, 0.41 %
- 1847.44 keV, 2.20 %
- 2118.52 keV, 1.23 %
- 2204.14 keV, 5.30 %
- 2447.63 keV, 1.65 %
<table>
<thead>
<tr>
<th>Nuclide Name</th>
<th>Half-Life</th>
<th>Energy</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-228</td>
<td>6.13D</td>
<td>123.04 keV</td>
<td>2.67%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>153.95 keV</td>
<td>0.84%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>209.23 keV</td>
<td>4.38%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>270.23 keV</td>
<td>3.80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>327.95 keV</td>
<td>0.34%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>338.31 keV</td>
<td>12.60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>340.91 keV</td>
<td>0.48%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>409.42 keV</td>
<td>2.18%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>462.99 keV</td>
<td>4.88%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>562.50 keV</td>
<td>0.92%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>726.83 keV</td>
<td>0.75%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>755.23 keV</td>
<td>1.12%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>772.25 keV</td>
<td>1.58%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>794.89 keV</td>
<td>4.70%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>830.38 keV</td>
<td>0.60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>835.64 keV</td>
<td>1.78%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>840.30 keV</td>
<td>0.98%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>904.13 keV</td>
<td>0.79%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>911.14 keV</td>
<td>28.40%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>964.69 keV</td>
<td>5.45%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>968.91 keV</td>
<td>17.30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1244.70 keV</td>
<td>0.06%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1247.10 keV</td>
<td>0.57%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1459.04 keV</td>
<td>0.80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1495.84 keV</td>
<td>0.95%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1501.50 keV</td>
<td>0.51%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1557.10 keV</td>
<td>0.20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1580.43 keV</td>
<td>0.64%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1588.05 keV</td>
<td>3.44%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1624.84 keV</td>
<td>0.27%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1630.52 keV</td>
<td>1.72%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1638.15 keV</td>
<td>0.50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1666.30 keV</td>
<td>0.19%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1685.70 keV</td>
<td>0.11%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1887.26 keV</td>
<td>0.10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>238.63 keV</td>
<td>44.80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>240.98 keV</td>
<td>4.14%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>277.34 keV</td>
<td>2.30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300.11 keV</td>
<td>3.42%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>510.72 keV</td>
<td>8.34%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>583.14 keV</td>
<td>30.90%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>727.27 keV</td>
<td>6.65%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>785.46 keV</td>
<td>1.10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>880.49 keV</td>
<td>4.53%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1592.69 keV</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1620.62 keV</td>
<td>1.51%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2614.71 keV</td>
<td>35.96%</td>
</tr>
<tr>
<td>Nuclide Name</td>
<td>Half-Life</td>
<td>Nuclide Key</td>
<td>Type Line</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>U-235</td>
<td>7.13E+08Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U-238</td>
<td>4.51E+09Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NP-239M</td>
<td>27.40Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU-239</td>
<td>24405.00Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM-241</td>
<td>433.42Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU-241</td>
<td>14.50Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM-243</td>
<td>7665.80Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reference

Appendix C - Data Backup Procedure
<table>
<thead>
<tr>
<th>Archive</th>
<th>Action</th>
<th>Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run the batch file ARCH_DIR to make the file ARCH.TXT. This runs the VAX directory command with the date and time qualifiers and creates an output file (ARCH.TXT).</td>
<td>On the VAX: <code>$ @ARCH_DIR&lt;cr&gt; [To watch it happen]</code> or <code>$ submit ARCH_DIR&lt;cr&gt; [To run it as a batch]</code></td>
<td></td>
</tr>
<tr>
<td>Get the ARCH.TXT file on the PC with FTP. Rename the arch file to ARCHxx.TXT, where xx is the archive number.</td>
<td>On the PC: <code>FTP envvllg&lt;cr&gt; username gamma&lt;cr&gt; password &lt;password&gt;&lt;cr&gt; FTP&gt; get arch.txt &lt;cr&gt; FTP&gt; quit&lt;cr&gt;</code></td>
<td></td>
</tr>
<tr>
<td>Run the PC program ARCHIVE to create the ARCHxx.COM and ARCHxx.DB files. The program will ask for the archive number. This is the next serial number in line. (check the log book.)</td>
<td>On the PC: <code>&gt; ARCHIVE ARCHxx.TXT&lt;cr&gt;</code></td>
<td></td>
</tr>
<tr>
<td>Use FTP to put the file ARCHxx.COM on the VAX.</td>
<td>On the VAX: <code>$ @archxx&lt;cr&gt; [To run it as a batch]</code></td>
<td></td>
</tr>
<tr>
<td>Run the ARCHxx.COM on the VAX. This renames the various files from their original subdirectories to the DISK$DATA:[GAMMA.DONE] subdirectory.</td>
<td>On the VAX: <code>$ @archxx&lt;cr&gt; [To run it as a batch]</code></td>
<td></td>
</tr>
<tr>
<td>Check to make sure that there is a .MDA file for every .txt file. Copy the .TXT and .MDA files from the various VAX subdirectories to the appropriate subdirectories on the PC with FTP. The list of files may have to be broken up into smaller jobs due to FTP limitations on the number of files to be brought over in a batch. One may use the -e filename switches to use a batch file.</td>
<td>On the PC: <code>&gt; FTP envvllg&lt;cr&gt; username gamma&lt;cr&gt; password &lt;password&gt;&lt;cr&gt; FTP&gt; cd disk$data:[gamma.xx]&lt;cr&gt; FTP&gt; mget *.txt&lt;cr&gt; FTP&gt; mget *.mda&lt;cr&gt; FTP&gt; bye&lt;cr&gt;</code></td>
<td></td>
</tr>
<tr>
<td>Copy the .TXT and .MDA files from the various subdirectories on the PC to the appropriate subdirectories on the file server.</td>
<td>Log on to the file server (You may have to reboot the computer the Ethernet connection.) Get into the proper subdirectory on the file server (You may have to reboot the computer the Ethernet connection.) Get into the proper subdirectory on the PC. Use the protected copy function of DF. Rename the .TXT and .MDA files from the various VAX subdirectories (DISK$DATA:[GAMMA.xx]) to the DISK$DATA:[GAMMA.DONE] subdirectory.</td>
<td>On the PC: <code>NCOPY/S *.txt&lt;cr&gt;</code> Create the ARCHxx.DB file. Add the data to the ARCHIVE data base on the file server from the file ARCHxx.DB. The ARCHIVE data base is found in the /datafiles/counting directory. Print out the Archive report and put into the binder.</td>
</tr>
<tr>
<td>Recheck all the VAX subdirectories to make sure something is not being left out.</td>
<td>On the VAX: <code>$ dir *.txt&lt;cr&gt;</code> <code>$ dir *.mda&lt;cr&gt;</code> <code>$ dir *.cnf&lt;cr&gt;</code></td>
<td></td>
</tr>
<tr>
<td>Using VMS BACKUP, copy the [gamma.done] subdirectory to magtape. Make sure that the tape name is a maximum of six characters.</td>
<td>On the VAX: <code>$ backup really/log DISK$DATA:[GAMMA.DONE]:MKBB5000.REVERSED.BCK label=arch0000/rewind/ignore=label_processing&lt;cr&gt;</code></td>
<td></td>
</tr>
<tr>
<td>Use the BACKUP/LIST command to make a listing of the tape for the hard copy record book. Put the list in the binder.</td>
<td>Fill in the appropriate number for 0000.</td>
<td>On the VAX: <code>#backup/mkbb500&lt;cr&gt;</code> then [To watch it happen] <code>$ Backup/list=sprinter mkbb500/rewind&lt;cr&gt;</code> or [To run it as a batch] <code>$ submit list_backup&lt;cr&gt;</code></td>
</tr>
<tr>
<td>Use FTP to write the data to the long term archive, OCFARCH. Make sure the transfer is the type binary. Use the MKDIR command to make a sub directory for the new set of files.</td>
<td>On the VAX: <code>$ FTP OCFARCH.LINL.GOV&lt;cr&gt; (128.115.1.16)</code></td>
<td></td>
</tr>
<tr>
<td>Delete the files from the DISK$DATA:[GAMMA.DONE] subdirectory.</td>
<td>On The VAX: <code>DelLog disk$data:[gamma.done]&lt;cr&gt;</code></td>
<td></td>
</tr>
<tr>
<td>Record the archive number and date in the log book.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix D - Counter Log Sheet
### B379 Genie Sample Log Sheet

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Sample Description</th>
<th>Sample Type</th>
<th>Sample Location</th>
<th>Quantity</th>
<th>Units</th>
<th>Zero Time DD-MMM-YYYY</th>
<th>Start Date</th>
<th>Detector</th>
<th>Spectrun ID</th>
<th>Printout Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The action file is a record generated at the time a sample count is terminated. The essential counting particulars are recorded. The spectrum identification, detector name, sample name, count start date and time, and count live time.

**Extract**


224926 S893A06 BK F9411SPR24E04714 2-JUL-1995 10:48:42.38 0 20:49:32.00

224927 6H93A07 BK F9411SPR24E04717 2-JUL-1995 10:48:58.21 0 20:49:06.00

224928 8P93A08 BK F9411SPR24E04719 2-JUL-1995 10:49:08.87 0 20:49:12.00

224929 5Q93A08 BK F9411SPR24E04728 2-JUL-1995 10:49:26.29 0 20:49:17.00

224930 7J93A08 BK F9411SPR24E04736 2-JUL-1995 10:49:42.09 0 20:48:56.00

224931 DR93A08 BK F9411SPR24E04740 2-JUL-1995 10:49:54.40 0 20:49:02.00

224932 9T93All BK F9411SPR24E04746 2-JUL-1995 10:50:13.06 0 20:48:52.00

224933 FE93All BK F9411SPR24E04753 2-JUL-1995 10:50:27.19 0 20:49:01.00

224934 UL93A12 BK F9411SPR24E04757 2-JUL-1995 10:50:38.99 0 20:48:47.00

224935 V293A20 BK F9411SPR24E04760 2-JUL-1995 10:51:02.61 0 20:48:33.00


224938 2094C09 BK F9411SPR24E04770 2-JUL-1995 10:51:47.06 0 20:48:15.00

224939 EG93A22 BK F9411SPR24E04772 2-JUL-1995 10:51:57.80 0 20:48:08.00

224940 2094C09 QA BACKGROUND 3-JUL-1995 13:08:26.45 1 18:33:44.00

224941 S893A06 QA BACKGROUND 3-JUL-1995 13:08:34.11 1 18:33:28.00

224942 6H93A07 QA BACKGROUND 3-JUL-1995 13:08:41.11 1 18:33:42.00

224943 P793C09 QA BACKGROUND 3-JUL-1995 13:08:48.19 1 18:32:15.00

224944 8P93A08 QA BACKGROUND 3-JUL-1995 13:08:56.02 1 18:33:40.00

224945 5Q93A08 QA BACKGROUND 3-JUL-1995 13:09:03.06 1 18:33:57.00

224946 7J93A08 QA BACKGROUND 3-JUL-1995 13:09:10.46 1 18:33:38.00

224947 DR93A08 QA BACKGROUND 3-JUL-1995 13:09:17.62 1 18:33:41.00

224948 9T93All QA BACKGROUND 3-JUL-1995 13:09:25.06 1 18:33:44.00

224949 FE93All QA BACKGROUND 3-JUL-1995 13:09:32.08 1 18:34:12.00

224950 OP94C08 QA BACKGROUND 3-JUL-1995 13:09:45.46 1 18:34:09.00

224951 DP94C08 QA BACKGROUND 3-JUL-1995 13:09:52.49 1 18:34:03.00

224952 UL93A12 QA BACKGROUND 3-JUL-1995 13:10:29.33 1 18:33:26.00

224953 Y293A20 QA BACKGROUND 3-JUL-1995 13:10:44.11 1 18:33:16.00

224954 HK93A21 QA BACKGROUND 3-JUL-1995 13:10:51.15 1 18:33:31.00

224955 L493A21 QA BACKGROUND 3-JUL-1995 13:10:58.11 1 18:33:30.00

224956 ZD93A22 QA BACKGROUND 3-JUL-1995 13:11:05.22 1 18:33:26.00

224957 EG93A22 QA BACKGROUND 3-JUL-1995 13:11:13.00 1 18:33:17.00

224958 2094C09 BK F9411SPR24E04713 5-JUL-1995 08:00:01.10 0 23:47:16.00

224959 S893A06 BK F9411SPR24E04718 5-JUL-1995 08:00:09.41 0 23:46:55.00

224960 6H93A07 BK F9411SPR24E04748 5-JUL-1995 08:00:17.57 0 23:47:16.00

224961 8P93A08 BK F9411SPR24E04739 5-JUL-1995 08:00:25.89 0 23:47:11.00

224962 5Q93A08 BK F9411SPR24E04729 5-JUL-1995 08:00:34.06 0 23:47:15.00

224963 7J93A08 BK F9411SPR24E04720 5-JUL-1995 08:00:42.20 0 23:46:57.00

224964 DR93A08 BK F9411SPR24E04750 5-JUL-1995 08:01:15.08 0 23:46:46.00

224965 HK93A21 BK F9411SPR24E04755 5-JUL-1995 08:01:06.94 0 23:47:32.00

224966 2094C09 BK F9411SPR24E04709 5-JUL-1995 08:00:58.83 0 23:47:50.00

224967 UL93A12 BK F9411SPR24E04756 5-JUL-1995 08:00:50.40 0 23:48:12.00

224969 Y293A20 BK F9411SPR24E04705 5-JUL-1995 08:01:23.20 0 23:47:36.00