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THE MARSHALL ISLANDS DATA MANAGEMENT PROGRAM

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Table of Contents

List of Tables

List of Figures

Abstract

This report is a resource document of the methods and procedures used currently in the Data Management Program of the Marshall Islands Dose Assessment and Radioecology Project. Since 1973, over 60,000 environmental samples have been collected. Our program includes relational database design, programming and maintenance; sample and information management; sample tracking; quality control; and data entry, evaluation and reduction. The usefulness of scientific databases involves careful planning in order to fulfill the requirements of any large research program. Compilation of scientific results requires consolidation of information from several databases, and incorporation of new information as it is generated. The success in combining and organizing all radionuclide analysis, sample information and statistical results into a readily accessible form, is critical to our project.

Introduction

The Marshall Islands Dose Assessment and Radioecology Project has been in existence at Lawrence Livermore National Laboratory (LLNL) since 1973. It is a program of the Health and Ecological Assessment Division (HEA), in the Environmental Programs Directorate at LLNL. The primary purpose of this program is to assess the radiological conditions in the Marshall Islands where sixty-six nuclear tests were conducted from 1946 to 1958 as part of the United States Nuclear Weapons Program. On March 1, 1954, the BRAVO test had an explosive yield that greatly exceeded expectations, with the result that heavy fallout was experienced at Bikini Island and at atolls east of Bikini. The radiological conditions are currently being studied at the atolls of Bikini, Enewetak, Rongelap, and Utirik. In 1978 a limited survey was conducted for the atolls of Taka, Bikar, Rongerik, Ailinginae, Likiep, Ailuk, Wotho and Ujelang and the two islands of Mejit and Jemo. The primary isotopes characterized for all atolls are ^{137}Cs, ^{90}Sr, $^{239+240}Pu$ and ^{241}Am. In addition, limited characterization has been done at the uncontaminated atolls of Kwajalein and Majuro.

The radiological dose via all exposure pathways is estimated for various living patterns at the atolls. Our project is also studying remedial measures for reducing ^{137}Cs uptake in vegetation, as part of the resettlement options at Bikini Atoll.

Table 1 shows the total number of samples that have been collected during the twenty-two year history of the program. The samples include soil, edible food crops, other vegetation, fish, invertebrates, water and animals. The samples are prepared for gamma spectroscopy and/or wet chemistry and analyzed. Databases were designed for all of the information associated with the samples.

Table 1. Total Number of Samples Collected in the Marshall Islands from 1973 to 1994.

	Soil and Vegetation Samples					
Year Taken	Bikini Atoll	Enewetak Atoll	Rongelap Atoll	Utirik Atoll	Other Northern Marshall Atolls	Total
1973	0	4474	0	0	0	4474
1974	0	0	0	0	0	0
1975	941	0	0	0	0	941
1976	0	991	0	0	0	991
1977	998	728	0	0	0	1726
1978	1556	124	728	463	2807	5678[a]
1979	1084	64	0	0	0	1148
1980	823	75	0	0	0	898
1981	288	53	0	0	121	462
1982	314	246	0	0	0	560
1983	1008	180	0	0	166	1354
1984	489	398	0	0	0	887
1985	3136	138	31	0	0	3305
1986	3015	121	811	0	0	3947
1987	3270	598	45	0	24	3937
1988	3201	498	201	0	0	3900
1989	1838	1102	1315	0	0	4255
1990	2629	576	524	0	137	3866
1991	3527	556	635	0	0	4718
1992	2859	365	819	0	0	4043
1993	2449	1498	832	1230	0	6009
1994	3810	966	39	522	0	5337
Others [b]	91	0	0		0	91
Total	37326	13751	5980	2215	3255	62527

[a] Includes marine samples from the Northern Marshall Island's Radiological Survey NMIRS)

[b] Others includes soil samples taken by the University of Washington.

History of Hardware and Software Use

The earliest of the Marshall Island's scientific databases were run on large mainframe super computers. The original mainframes in use were the Control Data Corporation 6600 and 7600's. Later , the databases were run on the CRAY 1, CRAY XMP and CRAY YMP super computers at LLNL. The database format was different in the early 1970's. The data were in American Standard Code for Information Interchange (ASCII) text

format. Several Formula Translation (FORTRAN) programs, written by programmers working on the project, were used to handle the data. In the late 1970's, the LLNL Computer Center offered an in house database system called FRAMIS. Although data handling was accomplished through this program, there were certain drawbacks to using the large mainframes. The computers were on a local time sharing system in another building, cumbersome to use, and on a secured system. Only personnel with a security clearance had access to the machines. Data management was very time consuming. All sample information was hand written into log books, transferred onto hand written data sheets, keypunched onto punch cards, and run through a card reader for input into the computer. The radionuclide data analysis program GAMANAL produced results for final analysis and input into FRAMIS.

With the increased affordability of personal computers in the early 1980's, the DMG recognized the need to convert from the mainframes to the personal computers. To convert to a database that could be accessed by different users simultaneously, a network operating system and database software was needed. The first personal computers were not networked. Data was shared by floppy disk exchange. The first network system was put in place in 1986, running Novell Netware version 2.12 for a group of five personal computers. All database design and network administration were done by members of the DMG. The database software chosen to run on the network was Ashton Tate's dBase III Plus®. It was chosen for ease of use and programming.

Data processing procedures are continually being updated through programming and automation. The addition of a bar code system for sample tracking is an example of an automated process developed in the last few years. Currently, there are two network servers running Novell Netware version 3.11 and 3.12. Over the years, dBase has been upgraded as new versions were released. The present version in use is 5.0. Several commercially available software packages are also used for data manipulation. See Appendix A for a list of the software currently in use.

Database Design and Structure

In the early versions of the computer databases, only the field log number, sample identification (sample ID) number, location, sample description and radionuclide data for each sample were entered. The laboratory sample wet and dry weights, and sample can information was recorded in log books. Much of the data reduction was still done by hand. Dose assessments and summaries were produced using FORTRAN programs developed by a programmer within the group. Over the last ten years, steps have been taken to improve the data acquisition and management techniques. These include use of commercially available software, and increasing the automation of data transfer where possible.

Different types of information are utilized in our data management program. We have six dBase databases for each sampling year. These include the Sample Information,

Vegetation Processing, Soil Processing, Canned Samples, Radionuclide Gamma and Radionuclide Wet Chemistry databases. All of the databases are related with one key field -- the sample ID number field. The naming convention for each database is designed to quickly identify the year in which the samples are taken. For example, information for all samples taken in 1994 will be included in the following six databases, based on the order shown above: 94SAMP, 94LAB, 94SOILWR, 94CANS, 94CONTPR and 94WETCHM. In this document, all actual database names will appear capitalized. For a general series of databases, without reference to a specific one, the name will appear with first letters capitalized only.

The Sample Information database is the main database. Working out in the field, this database is called FIELDSMP. When it is copied to the networked dBase system, the name is changed to XXSAMP (XX replaced with the sampling year code, for example 94SAMP). It contains the field log number, sample ID, sample descriptions, sampling locations and date and field notes. The difference between the current version of the Sample information database and the databases used on the mainframes for earlier sampling trips is the inclusion of all field information about the sample.

The Vegetation Processing database series contains the sample wet and dry weight information generated in the sample processing laboratories for all vegetation and animal samples. The database series names also reflect the sampling date (for example, 94LAB for all processing information for samples, other than soils, taken in 1994). The Soil Processing database, generated in the soil processing laboratory, contains similar information to the Vegetation Processing database, but for soil samples only. This database is called 94SOILWR for all soils taken in 1994. The Canned Sample database has the information generated for prepared and canned soil and vegetation samples. Information about all samples canned from the 1994 sampling trips is found in the 94CANS database. The information found in these three databases was not input into the computer prior to the implementation of the dBase system.

The Radionuclide Gamma database contains the radionuclide data generated from a Gamma Analytical Facility, either at LLNL or by an outside contractor. The gamma spectroscopy radionuclide results for all samples taken in 1994 are found in the 94CONTPR database. Similarly, the Radionuclide Wet Chemistry database contains the radionuclide data generated from a Radiochemistry Facility. The radiochemistry radionuclide results for all samples taken in 1994 are found in the 94WETCHM database.

Figure 1 shows the relationship among the six yearly databases. An arrow between boxes indicates a flow of information from one database to another.

Other databases included in the program are the DUP_QC, SAMPCODE and ISCODE databases. The DUP_QC database contains all duplicate and standard sample information. The SAMPCODE and ISCODE databases, contain sample identification number coding information used by many of the dBase programs.

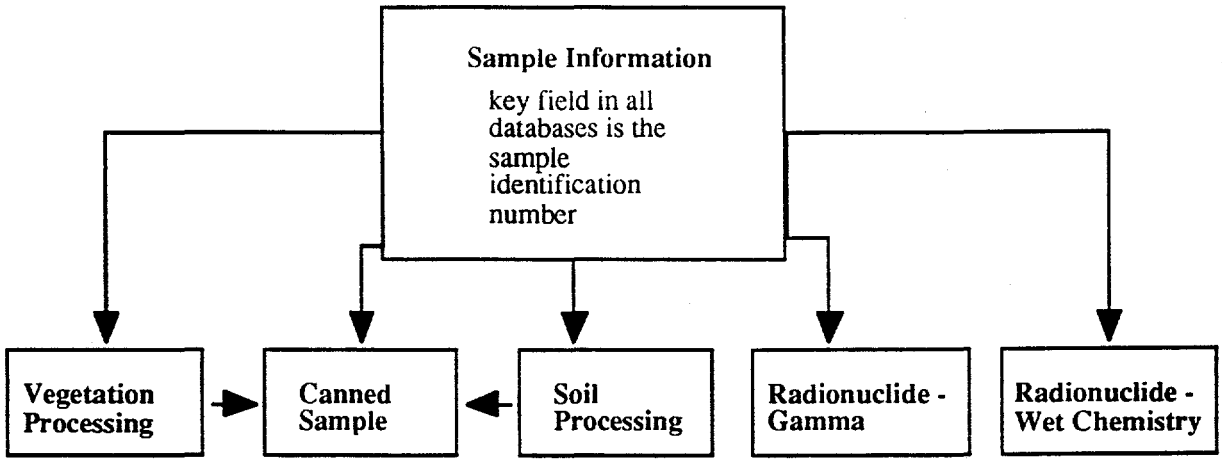

Figure 1. Relationship between dBase database series.

Entering Information in the Field

In the Marshall Islands the field crew is working in a remote location, currently averaging two sample collection trips a year. Mistakes made in the field can affect subsequent analytical data. The information about each sample is recorded in the field log book by the field crew manager. The same information is written on the sample package. Each sample is given a unique identification number, known as the field log number. The field log number is 10 characters long. The first two characters are the sampling year (for example "94" for samples taken during 1994). This is followed by an atoll designation (for example "B" for Bikini Atoll), and an island designation (for e.g. "E" for Eneu Island) and a dash. Some islands have a two character designation. For samples taken on these islands, the dash is eliminated is the field log number. Following the dash is a 5 digit sequence number beginning at 00001 each year. The field log number given to the first sample taken in 1994 would be 94BE-00001, for a sample taken on Eneu Island, Bikini Atoll. Appendix B lists the atoll and island designations used for the field log numbers, as well as for the sample ID numbers discussed below.

The sampling date, depth of soil or description of vegetation, number of fruit if applicable, location and any other special notes that makes the sample unique are also included in the field log book. The field log number has been used to identify samples since the beginning of the program. It is short and easy to formulate in the field. The only letter designations used are for the island and atoll, and these are easily remembered, eliminating the need to look up sample codes in the field. A number known as the sample ID, which conveys more information, is generated from the information recorded in the log book, but is not recorded on the sample package itself. The use of the field log number is a convenience for the field crew members.

The information entered into the field log book is also entered into the field sample database on a lap top computer, either back on the support ship or upon return to LLNL. Work in the field is dirty and the humidity is high. Taking the lap top computer into the field is therefore not desirable.

From the field log number, and the information in the log books, a sample ID number is created. A series of sample type and island location designations are used to include the information in the sample ID number. The early plant samples were all given the same designation, with no distinction being made between types of plant. Similarly, the soils were all coded as soil profile or soil surface samples. As the number of samples increased, a more detailed set of designations was developed. Appendix B contains the island and atoll location codes, and Appendix C has the sample type codes.

In the sample ID number, the first two characters are the year the sample was taken (i.e. "94" for 1994). The next two characters are the month the sample was taken (i.e. "04" for April). The next three characters are the sample type designation (example "PFA" for Copra Meat). The following three characters are the island and atoll the sample was taken on (i.e. "12B" for Eneu Island on Bikini Atoll), and finally the sequence number (example "00001"). As an example, the sample ID number given to a copra meat from Eneu Island, taken in April 1994 as the first sample of the year, would be:

9404PFA12B00001

The sample ID number field is the key field in every database generated. This allows relationships of information between databases to be established.

Sample Information Databases

Along with the sample and field identification numbers described above, all information collected in the field is entered into the temporary FIELDSMP database. When all records have been entered and corrected, the database is transferred to the Sample Information database for that sampling year. All records in the FIELDSMP database are deleted after the data is transferred, and before the next sample trip. Below in Tables 2 & 3 are the structures of the databases, and descriptions of the fields. There are currently over 60,000 records in the 1973 to 1994 Sample Information databases. The experiment name field uses the designations found in Appendix D.

Prior to 1986, when FRAMIS was used on the mainframe computers, there were no vegetation or soil laboratory information databases. The early sample information data has been transferred from FRAMIS to dBase. Because less information about the samples was originally input, there are fewer fields in the Sample Information databases for the early samples. When dBase software was introduced on the personal computer platform, the entire database system was redesigned to handle other types of information not previously included as part of the database. In addition, the logical separation of types of information was used as the criteria in designing these databases.

Table 2. Structure of Sample Information Database for Samples prior to 1986.

Field Name	Type of Field	Description of Field Name
GAMMA_NUM	Character	Sample ID number
FIELD_LOG	Character	Field log number
ASSOC_NUM	Character	Association number that correlates data to location
XREF_NOTES	Character	Description of sample taken in field
LOC_CODE	Character	Location where sample was taken
SAMP_WT	Numeric	Weight in grams of sample canned into a container
NORM_WT	Numeric	Dry weight/wet weight ratio representing % water
LEFT_SAMP	Numeric	Weight in grams of leftover sample
DUP_SAM_NO	Character	Duplicate sample identification number, if made
DUP_SAM_WT	Numeric	Weight in grams of duplicate sample

Table 3. Structure of Sample Information Database for Samples 1987 to present.

Field Name	Type of Field	Description of Field Name
GAMMA_NUM	Character	Sample ID number
FIELD_LOG	Character	Field log number
SAMP_DATE	Date	Sampling date in field
MLS_OJ_FLD	Numeric	Milliliters of juice measure in field
DEPTH_SOIL	Character	Depth of soil increment
NUM_FRUIT	Character	Number of individual fruits in sample
ASSOC_NUM	Character	Association number that correlates data to location
EXPER_NAME	Character	Experiment name
LOC_CODE	Character	Location where sample was taken
LOC_NOTES	Character	Sampling notes taken in field
XREF_NOTES	Character	Description of sample
QUESTION	Logical	Special Notes

Vegetation Processing Databases

The Vegetation Processing database was designed for all information generated in the vegetation processing laboratories. Below, in Tables 4 and 5 is the structure and descriptions of these databases. For the years 1987 through 1995, there are over 62,000 records. (Appendix E). Food crops, indicator species and animals are dissected and freeze-dried. Liquids are processed differently. Each record represents one carton of dissected sample or one juice container. The container tare weight is not included in any of the measurements. Before 1987, this information was recorded in the laboratory sample log books, and was not input into a database.

Table 4. Structure of Vegetation Processing database for samples collected from 1987 to 1992.

Field Name	Type of Field	Description of Field Name
GAMMA_NUM	Character	Sample ID number
CARTON_NUM	Character	Number on individual sample carton
ORIG_WT	Numeric	Weight in grams of wet sample in carton
DRY_WT	Numeric	Weight in grams of sample in carton after freeze drying
CUT_DATE	Date	Date sample was thawed, cut and put in cartons
MLS_OJ_LAB	Numeric	Milliliters of juice measure in laboratory
C_TUBE_WT	Numeric	Weight in grams of juices prepared with AMP*

* Method of processing juices changed in 1992. See Stuart 1995 for description of the methods used.

Table 5. Structure of Vegetation Processing database for samples collected from 1993 to present

Field Name	Type of Field	Description of Field Name
GAMMA_NUM	Character	Sample ID number
CARTON_NUM	Character	Number on individual sample carton
ORIG_WT	Numeric	Weight in grams of wet sample in carton
DRY_WT	Numeric	Weight in grams of sample in carton after freeze drying
CUT_DATE	Date	Date sample was thawed, cut and put in cartons
TTUBE_HT	Numeric	Height of AMP centrifuged juice sample (in cm.)
TRACER	Character	Designation for Cs 134 standard added as tracer in juices
TRACER_WT	Numeric	Weight of tracer added (in grams)

The change in database structure was a result of changes in laboratory procedures for juice processing, Prior to the December 1992 field trip, the juices were measured by volume, evaporated in a drying oven and then canned. A new procedure was introduced which relied on the extraction of cesium onto the cation exchanger, ammonium molybdophosphate (AMP). From the December 1992 field trip, some of the juices were processed using both methods to evaluate the effect of the change in procedure on the radionuclide analytical results. These samples are identified in the "notes" field in the Canned Sample database described later. Beginning in 1993, the addition of a ^{134}Cs tracer was included to assess the recovery rate of the ^{137}Cs. The current procedure is described in Stuart 1995. The information in these databases is entered by laboratory personnel as the samples are being processed.

Soil Processing Databases

The Soil Processing databases contain the wet and dry weights, as well as the soil fraction weights for all soils processed in our soil facility as discussed in Stuart 1995. Since 1987, over 6800 records have been input into the Soil Processing databases (Appendix E). Prior to that date, the information is found in the handwritten laboratory sample log books. The structure and design is in Table 6.

Canned Sample Databases

The series of Canned Sample databases contains the completed sample information, including canned sample weight, the wet to dry ratio, the container type and leftover sample weights for all completed samples. The canning date, sample weight, and container type information is entered by the laboratory personnel. The wet to dry ratio and leftover sample weights are calculated in dBase programs. The wet to dry ratio is used to convert the radionuclide analytical results, which are reported on a dry weight basis, into wet weight results. The leftover sample weight is useful for determining if enough sample remains to prepare an additional canned sample when necessary. Table 7 contains the structure and design of the databases. For samples collected since 1987, over 32,000 records have been input, each representing a canned sample (Appendix E).

Table 6. Structure of Soil Processing database for samples collected from 1987 to present.

Field Name	Type of Field	Description of Field Name
GAMMA_NUM	Character	Sample ID number
FIELD_LOG	Character	Field log number
ORIGWETWT	Numeric	Weight of bulk sample before drying (in grams)
ORIGDRYWT	Numeric	Weight of bulk sample after drying (in grams)
LGTARE	Numeric	Tare weight of large soil can (in grams)
ORIGFINE	Numeric	Weight of fine sample fraction (in grams)
LEFTCOARSE	Numeric	Weight of coarse sample fraction (in grams)

Table 7. Structure of Canned Sample database for samples collected from 1987 to present.

Field Name	Type of Field	Description of Field Name
GAMMA_NUM	Character	Sample ID number
FIELD_LOG	Character	Field log number
NORM_WT	Numeric	Dry wt/wet wt ratio representing % water in sample
SAMP_WT	Numeric	Weight in grams of sample canned in container for analysis
DATE_CAND	Date	Date sample is canned into a container
CONT_TYPE	Character	Type of container sample is canned in
LEFT_SAMP	Numeric	Weight in grams of leftover sample after canned
NOTES	Character	Notes related to sample processing

Duplicate and Quality Control Database

The DUP_QC database is used for our Quality Control (QC) program. It is used and maintained by the DMG to keep track of all duplicate and standard samples made. This information is not available to the personnel working in the HEA Low Level Gamma Analytical Facility (LLGAF).

The duplicates are prepared by the vegetation and soil processing laboratory personnel as part of the sample process QC. The sample ID number for the original sample from which the duplicate was made, the duplicate can sample number, and the duplicate can weight are entered into the database. The DUP_QC database contains sample information for all duplicates made since 1987. Duplicate sample information for the years 1978 through 1986 is incorporated into the Sample Information databases.

The standard samples are prepared from a known certified standard. Data for all standards prepared and analyzed prior to 1993, is organized separately in computer spreadsheets, and is not included in the DUP_QC database.

The number of records for duplicate and standards analyzed since 1987 is presently over 2600. The structure and design is described in Table 8.

Radionuclide Gamma and Wet Chemistry Databases

The radionuclide analytical data is found in two different databases depending on the type of analysis done. For samples analyzed by gamma spectroscopy, the data is

Table 8. Structure of DUP_QC database for samples collected from 1987 to present.

Field Name	Type of Field	Description of Field Name
GAMMA_NUM	Character	Sample ID number of original sample
FIELD_LOG	Character	Field log number
DUP_SAM_NO	Character	Duplicate or standard sample identification number
DUP_SAM_WT	Numeric	Weight in grams of duplicate sample or standard
SAMP_DESC	Character	Description of duplicate or standard

included in the Radionuclide Gamma databases. Radionuclide analytical data for samples analyzed by wet chemistry is found in the Radionuclide Wet Chemistry

databases. Below, in Tables 9, 10, 11 and 12, are the structures and descriptions of our radionuclides databases. There are over 470,000 records in the Radionuclide Gamma databases and over 17,000 records in the Radionuclide Wet Chemistry databases (Appendix E).

Prior to 1978 all of the analytical results were reported on a dry weight basis. In 1979, the analytical reporting procedures were changed and all vegetation and plant sample results were reported on a wet weight basis. The soil analyses are reported on a dry weight basis. All results are reported as decays per minute (dpm). The additional fields for values in pico-Curies (pCi) and Becquerels (Bq) are calculated by a simple dBase program. They exist only for the convenience of the DMG in compiling summaries, when results may need to be reported using different units.

The addition of the fields for detector, spectrum identification number and calibration can are for use by the Quality Control group.

Sample and Information Management

The organization of the variety of information associated with each sample, produced at different times during sample preparation and analysis, is important. From field collection to final storage, the DMG must be able to track all samples and their associated sample information and radionuclide data. It is the responsibility of this group to be able to produce information bases, inventories, results, and reports for any sample or group of samples. Figures 2 and 3 show the steps used in managing the flow of information produced at different stages of the MI project.

Table 9. Structure of Radionuclide Gamma database for samples collected from 1973 to 1978.

Field Name	Type of Field	Description of Field Name
RADIONUCLIDE	Character	Radionuclide isotope designation (1)
VALUE_DPM	Float	Value in dpm/gram dry weight
VALUE_PCI	Float	Value in pCi/gram dry weight
VALUE_BEQ	Float	Value in becquerels/gram dry weight
ERROR	Numeric	Percent error of value
GAMMA_NUM	Character	Sample ID number
DUP	Character	Designation for samples counted more than once
LAB	Character	Analytical laboratory performing analysis
CONT_TYPE	Character	Type of sample container

(1) Appendix F

Table 10. Structure of Radionuclide Gamma database for samples collected from 1979 to present.

Field Name	Type of Field	Description of Field Name
RADIONUCLIDE	Character	Radionuclide isotope designation (1)
VALUE_DPM	Float	Value in dpm/gram dry weight for soils Value in dpm/gram wet weight for vegetation and animals
VALUE_PCI	Float	Value in pCi/gram dry weight for soils Value in pCi/gram wet weight for vegetation and animals
VALUE_BEQ	Float	Value in becquerels/gram dry weight for soils Value in Bq/gram wet weight for vegetation & animals
ERROR	Numeric	Percent error of value
GAMMA_NUM	Character	Sample ID number
DUP	Character	Designation for samples counted more than once
LAB	Character	Analytical laboratory performing analysis
CONT_TYPE	Character	Type of sample container
DETECTOR	Character	Detector sample was counted on (LLNL Gamma Facility)
SPEC_ID	Character	Spectrum identification number (LLNL Gamma Facility)
CALIB_CAN	Character	Geometry & material for sample calibration

(1) Appendix F

Table 11. Structure of Radionuclide Wet Chemistry database for samples collected from 1975 to 1978.

Field Name	Type of Field	Description of Field Name
RADIONUCLIDE	Character	Radionuclide isotope designation (1)
VALUE_DPM	Float	Value in dpm/gram dry weight
VALUE_PCI	Float	Value in pCi/gram dry weight
VALUE_BEQ	Float	Value in becquerels/gram dry weight
ERROR	Numeric	Percent error of value
GAMMA_NUM	Character	Sample ID number
DUP	Character	Designation for samples counted more than once
LAB	Character	Analytical laboratory who did the analyses

(1) Appendix F

Table 12. Structure of Radionuclide Wet Chemistry database for samples collected from 1979 to present.

Field Name	Type of Field	Description of Field Name
RADIONUCLIDE	Character	Radionuclide isotope designation (1)
VALUE_DPM	Float	Value in dpm/gram dry weight for soils Value in dpm/gram wet weight for vegetation and animals
VALUE_PCI	Float	Value in pCi/gram dry weight for soils Value in pCi/gram wet weight for vegetation and animals
VALUE_BEQ	Float	Value in becquerels/gram dry weight for soils Value in Bq/gram wet weight for vegetation & animals
ERROR	Numeric	Percent error of value
GAMMA_NUM	Character	Sample ID number
DUP	Character	Designation for sample counted more than once
LAB	Character	Analytical laboratory performing analysis

(1) Appendix F

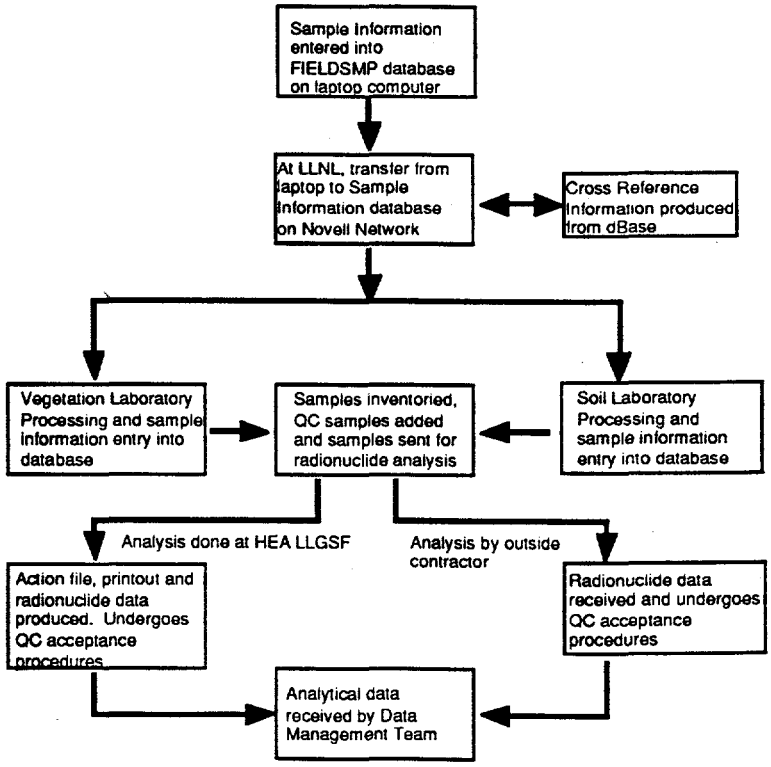

Figure 2. Sample and information management from field to analysis.

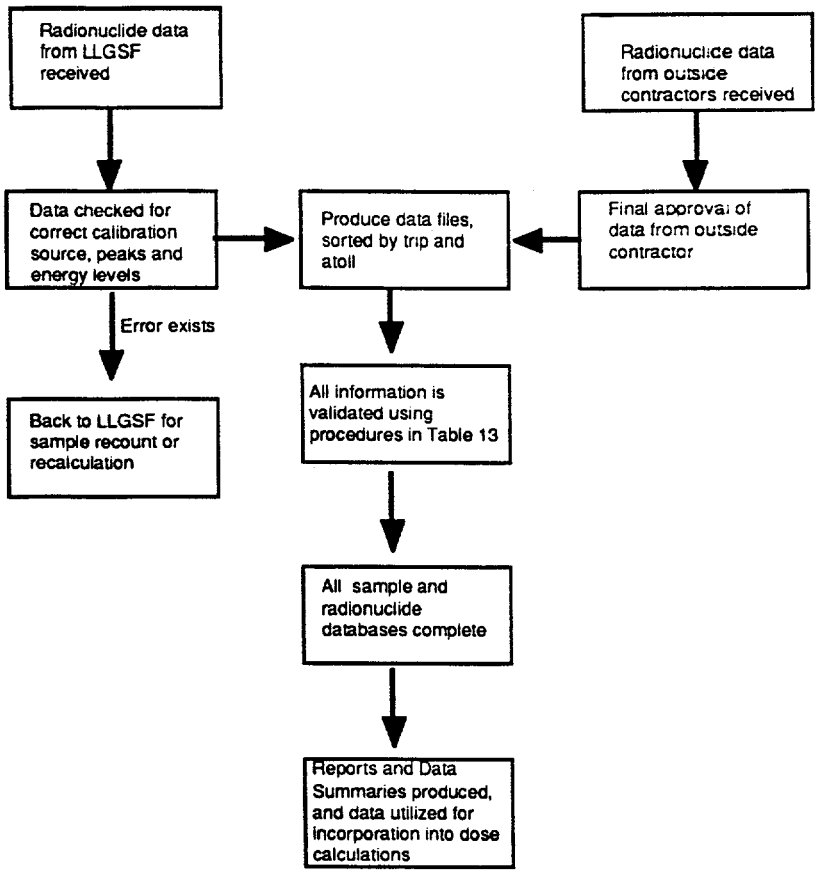

Figure 3. Sample and information management from analysis to final reports.

After a sample is collected in the field, it is prepared for analysis in the laboratories. A series of dBase programs have been written by the DMG for field and laboratory data entry. These programs provide entry screens, with error checking built in. They also allow access to databases to be controlled. The data entry screens have the advantage of controlling the types of data allowed into each field through the use of templates. Fields can also automatically be filled in, which helps improve speed and accuracy of data entry. The field and laboratory personnel are responsible for the data entry. Before analysis, the DMG ensures that all of the sample information has been entered into the Sample Information, Vegetation Processing, Soil Processing, Canned Sample, and DUP_QC databases, and makes additions or corrections as needed.

Field Information

The data management effort starts in the field when the samples are collected. Soil, vegetation and animal samples are the majority of the specimens collected as discussed in Stuart 1995. The following information about each sample is entered by the field team manager through a dBase entry screen programmed for field sample entry: sample ID number, field log number, depth of soil increment or number of individual fruit,

experiment name, and notes describing sample and location. Upon returning to LLNL, the field team manager verifies all field sample information. This database is transferred electronically to the networked computer system and appended to the Sample Information database by DMG personnel.

Vegetation and Animal Laboratory Information

The samples are frozen in the field and shipped to LLNL where they are processed in our laboratories as discussed in Stuart 1995. From the information in the Sample Information database, a sample log book is printed for the vegetation laboratory personnel. Both plant and animal samples are dissected, put into bar code labeled cartons and weighed. The following information is entered into a Vegetation Processing database through a dBase entry screen programmed for laboratory sample entry: sample ID number, carton number, wet weight and cut date. After freeze drying, the dry weight is entered through the same entry screen. When all cartons for a sample are dried, the percent water content for the sample is calculated using a dBase program.

The sample is ground and canned as discussed in Stuart 1995 for gamma spectroscopy analysis and/or wet chemistry analysis. The following information is entered through a dBase entry screen into the Canned Sample database: sample ID number, sample weight, container type and date ground. Leftover sample weight is calculated in a dBase program. The following is also entered into the DUP_QC database using a different data entry screen: original sample ID number, field log number, duplicate sample identification number, duplicate sample weight and sample description. A bar code label is applied to each sample can with the sample ID number and weight. Samples are boxed for analysis as discussed under the QC Program.

Soil Laboratory Information

The soil samples are frozen in the field and shipped separately from the vegetation and animal samples. They are processed in a separate soil laboratory, to ensure there is no cross contamination between the vegetation and soil. From the information in the Sample Information databases, a soil sample log book is printed for the soil laboratory personnel. The soils are made ready for drying in the ovens and the following information is entered into the Soil Processing database through a dBase entry screen: field log number, large gallon can tare weight and large can wet weight. The soils are dried, ball milled, and sieved into two fractions and the following information is entered through the same entry screen: large can dry weight, fine sample weight and coarse sample weight.

The soil samples are then canned for gamma spectroscopy analysis and/or wet chemistry analysis. Sample ID number, sample weight and container type are entered through a dBase entry screen into the Canned Sample database. Original sample ID number, duplicate sample ID number, duplicate sample weight and sample description are entered through the a different entry screen into the DUP_QC database. A bar code

label is applied with the sample ID and weight for each sample can. Samples are boxed for analysis as discussed under the QC Program.

Cross Reference Information

A trip report and cross reference file (CRF) is generated from the information entered in the field. The data managers and field team manager use the trip report and CRF's for planning, setting priorities, finding and discussing discrepancies, correcting and making additions to the Sample Information database.

The trip report is produced from the FIELDSMP database. It is summarized in three different ways: by experiment, sample type, and location. The field team manager uses this report to find and correct discrepancies from the FIELDSMP database. The corrected information from FIELDSMP is imported into the Sample Information database. The final trip report is issued to the principal investigator and the data managers. Sample processing priorities can then be finalized.

The CRF's consist of field log number, sample ID number, association number, sample description, experiment name and location code. There is a CRF for each trip and atoll. The DMG uses these for finding and correcting discrepancies the field team manager may have missed. Association numbers are added to link vegetation and soil samples collected at the same location. Location and experiment names are verified. Additional cross reference information for use by the data managers is added. All corrections and additions to these files are updated into the Sample Information database.

Sample Analytical Information

Samples sent to the HEA LLGAF are logged in for gamma spectroscopy analysis by the analyst. The information for each sample includes sample ID number, sample type, sample location, sample weight, units for result reporting, zero time, start date, detector and spectrum identification number. From this information an action file is created. The sample ID's in the action file are compared with sample ID's in the cross reference file. This allows the LLGAF personnel to track the samples, and to determine when analysis of all samples from a trip and atoll is complete. The printout and electronic file generated from the gamma spectroscopy analysis program includes radionuclide data and associated sample analysis information.

Sample and Radionuclide Data Evaluation

Radionuclide isotope data is generated from gamma spectroscopy or radiochemistry analysis. The majority of our samples are first analyzed at the HEA Low Level Gamma Analytical Facility (LLGAF) at LLNL. Occasionally, samples are analyzed by outside contracting laboratories. After gamma spectroscopy analysis, some samples may be selected for radiochemistry analysis. Currently, samples are being analyzed for wet

chemistry at the HEA Radiochemistry Facility at LLNL. In the past, samples were sent to outside contractors for wet chemistry. Hard copy and electronic forms of the sample and radionuclide data generated from all facilities are checked and verified by the DMG.

Computer Printout Information

For every sample analyzed at the HEA LLGAF, a printout of radionuclide results and sample information is generated by the gamma analysis program GENIE. Printouts are checked to ensure that the sample ID number corresponds with the year and the first day of the month a trip was started. Radionuclide data must be decay corrected to this date. Sample geometry is checked against the calibration to verify that the correct configuration was used for the analysis. Peaks and energy levels of isotopes are checked for double peaks or peaks that have shifted. If errors exist, the sample must be recalculated or recounted. Recalculations, using the same gamma spectrum, are made when an input value is incorrect or when there has been a shift in the peak spectrum. The analysis program is run again using the correct input values. In the case of a peak shift, the spectrum is adjusted and the nuclide identification is redone. Recounts, occurring when there is a double peak, require that the sample be physically placed in the detector, and analyzed again, resulting in a new spectrum. A more detailed set of procedures can be found in Appendix G. All printouts are filed by year, month and sequence number for final radionuclide data validation using the procedures in Appendix H.

Printouts for samples analyzed by an outside contractor contain radionuclide data and sample information only.

Electronic Output Information

For each sample analyzed, an ASCII text file is generated by the HEA LLGAF. It contains the following information: isotope, numeric value, percent error, units, container type, sample ID number, spectrum ID, detector number, calibration type, analysis date and lab designation. These files are electronically transferred to the Novell network from the VAX running the GENIE radionuclide analysis program. Outside contractors for gamma spectroscopy and radiochemistry provide radionuclide data on a floppy disk. A series of ASCII radionuclide data text files for each trip and atoll is created, using data from all analytical facilities. Radionuclide and sample data is validated using the procedures in Appendix G.

Validation of Radionuclide and Sample Information

Samples from a particular sampling trip are usually processed and analyzed together as a group. Sample information should be complete and correct in the Sample Information, Vegetation Processing, Soil Processing, and Canned Sample databases before analysis. Once the radionuclide data is released from the QC manager and verified against the

printouts using the procedures in Appendix H, this data can be imported into the Radionuclide Gamma database.

Verification and validation of all databases is needed because errors do occur in data entry. The DMG runs a series of dBase and FORTRAN programs during and after the samples are analyzed to ensure that all radionuclide and sample information is complete. In Table 13 is the list of steps taken for each trip and atoll to accomplish this task. Each step is initialed and dated when complete. The data managers are confident that all sample and radionuclide data is complete and correct at this point. Any discrepancies are documented after completion of this checklist. The radionuclide data is imported into a Radionuclide Gamma database. The checklist is filed for the final documentation of completion.

Wet Chemistry radionuclide analysis is performed at a later date and on a small percentage of the samples collected. Once analyzed and released from the QC manager a FORTRAN program is run to identify any discrepancies in the sample ID and format. This data is then imported into a Radionuclide Wet Chemistry database.

Quality Control Program

The Marshall Islands Quality Control (QC) Program includes evaluation of analytical work performed by outside contractors and our own analytical facility in the HEA Division. The Internal Monitoring Program (IMP) of the HEA Low Level Gamma Analytical Facility (LLGAF) at LLNL for gamma spectroscopy radionuclide analysis is discussed briefly below. The External Monitoring Program (EMP) implemented for outside contractors performing both gamma and wet chemistry radionuclide analysis is discussed in Kehl et al 1995. Our HEA Radiochemistry Facility at LLNL is considered an external outside contractor for the purpose of QC discussion.

Internal Monitoring Program

The internal monitoring program begins when the samples are entered into the Sample Information database. The number of duplicates and standards needed can be determined. Duplicates are made for approximately 10% of the samples submitted for analysis for each experiment or island sampled, to ascertain the precision (reproducibility) of analyses and the homogeneity of the samples. Reference standards, 5% of the total number of samples submitted for analysis, are used to establish the accuracy of the measurements. A sample ID number, similar to the sample ID number of the samples being sent for gamma spectroscopy is given to the sample duplicate and

Table 13. Finalization of databases checklist.

FINALIZATION OF DATABASES
CHECKLIST

		Samples Collected		Dups Needed
Trip		Vegetation Samples		
Atoll Name		Soil Samples		
Atoll Designation		Others		
		Total		

	Date Completed	Initials	Check List Description
Sample Information dBase Database			
1 Input Complete			Verify if Complete
2 Run Findum			FORTRAN program compares sample I.D. against other databases
3 Corrections			Corrections or additions from 1 & 2
4 Final Check			Rerun Findum
Cross Reference File			
1 Generated			Generate from Sample Database
2 Loc_Code			Verify Location
3 Assoc_num			Create to associate soil & veg. location
4 Run Findum			Program to compare sample I.D.
5 Corrections			against data files & action files
6 Final Check			Corrections or additions from 2, 3 & 4

Table 13. Finalization of databases checklist continued.

			Rerun Findum
Canned Sample dBase Database			
1 Input Complete			Verify if complete
2 Run Update & Compare			dBase program compares dry/wet wt. ratios to sample type & changes Sample I.D. to databases if needed
3 Missing in Notes			Information about missing samples
4 Run Findum			Program to compare sample I.D. against other databases
5 Corrections			Checklist of changes made to databases is produced
6 Final Check			Rerun Findum & Update-Compare
Vegetation Processing Database			
1 Input Complete			Verify if complete
2 Run Findum			Program compares sample I.D. against other databases
3 Run Labcorr			dBase program to check for discrepancies in wet and dry weights
4 Corrections			Corrections or additions from 1, 2 & 3
5 Final Check			Rerun Findum & Labcorrect
Soil Processing Database			
1 Input Complete			Verify if complete
2 Run Findum			Program compares sample I.D. against other databases

Table 13. Finalization of databases checklist continued.

3 Run Soilcorr	_____	_____	dBase program to check for discrepancies in soil weights
4 Corrections	_____	_____	Corrections or additions from 1, 2 & 3
5 Final Check	_____	_____	Rerun Findum & Soilcorrect
Radionuclide Data File			
1 Action File	_____	_____	Generated from Gamma Facility from sample login sheet
2 Run Findum	_____	_____	Program compares Sample I.D. with action file to determine what's left to be counted
3 Sort Data	_____	_____	Data sorted by trip and atoll
4 Run Findum	_____	_____	Program compares Sample I.D. against sorted data files.
5 Verify	_____	_____	Check data files against printouts(1)
6 Correction	_____	_____	Corrections or additions from 2, 4 & 5
7 Document missing	_____	_____	Documentation of samples to be counted in the future or lost
8 Run Q.C.	_____	_____	Documentation of Q.C. Acceptance(3)
9 Final Check	_____	_____	Verify 1-8 and Rerun Findum
10 dBase input	_____	_____	Radionuclide file is imported into dBase

NOTES:
1See Appendix H
2 See Quality Control Section

reference standard containers, to ensure the true identification is unknown to the analyst. The internal and external monitoring programs use the same set of standards. The preparation of standards and duplicates and certification of standards are discussed in Kehl 1995.

Before the samples are sent to the HEA LLGAF for analysis, the bar coded sample ID number on each sample container is scanned into the computer. The list of samples, duplicates and standards, used for QC documentation, is called an IMP form. An IMP form is made for each box of samples sent for gamma spectroscopy analysis. The standard IMP form, prepared for each box of vegetation and soil samples in steel cans or prindle vials, contains 72 sample cans. This box contains 6 duplicate pairs and 3 reference standards.

Aqueous samples (water and coconut fluid) are processed in centrifuge sample tubes. In addition to the ten percent duplicates and five percent standards, an additional five

percent reagent blanks are included for each set of sample tubes in an Aqueous IMP form. Preparation of duplicates, standards, and blanks are discussed in Stuart 1995. An IMP form produced for each box of aqueous samples contains a total of 100 sample tubes, with 8 duplicate pairs, 4 standards and 4 blanks.

After analysis, and before any radionuclide data can be released to the principal investigator or imported into the radionuclide databases, each individual IMP form must pass our QC precision requirements. To be in compliance, 80% of the duplicate pairs and 100% of the standards are required to pass the QC criteria. This evaluation criteria is discussed in Kehl 1995. Past and current internal monitoring QC results will be presented in another report (Conrado 1995).

When the samples are returned from the gamma analytical facility they are inventoried. A permanent label and list is applied to the storage box. The standards are pulled out for reuse, due to the limited number of standards available.

Data Reduction

All sample and radionuclide data from a field trip, is considered complete after validation and importation into the dBase databases. Complete data sets can now be utilized for scientific reports and reviews, and special requests for sample data. Queries are performed within dBase to retrieve, organize, and display data. These are then exported into either an ASCII file or a spreadsheet file for data reduction. Generation of isotope data tables for ^{137}Cs, ^{90}Sr, $^{239+240}Pu$ and ^{241}Am are routinely done for each island and sample type collected. Statistical evaluations are performed on these data sets and the summaries are used for island characterization, diet tables, and dose assessments. Other MI data organized for statistical evaluation and summarization are for the studies conducted on concentration ratios (CR's), remedial measures for reducing ^{137}Cs uptake in vegetation and environmental half-life.

Characterization

Radiological conditions are studied at all islands and atolls where samples have been collected. Queries are made in dBase to retrieve data for a specific island, atoll, isotope and sample type. These data are exported into an ASCII file referred to as an isotope data table. The isotopes for ^{137}Cs, ^{90}Sr, $^{239+240}Pu$ and ^{241}Am are routinely generated for each island, atoll and sample type collected. A FORTRAN program for statistical evaluation is run on each isotope data table producing an isotope data summary. Additional isotopes are summarized as necessary. These isotope data summaries are used in characterization.

Dose Assessments

The isotope data summaries contain the arithmetic mean of the specific activities for each sample type collected. The specific activities are decayed to a specified date for utilization in diet tables. These tables produce the average intake of ^{137}Cs, ^{90}Sr, $^{239+240}Pu$ and ^{241}Am from local foods. These data parameters are used for the ingestion pathway in predicting radiological dose. A dose assessment via the external, inhalation and ingestion pathways are estimated for various living conditions. The radiological dose assessment is calculated using a FORTRAN program which produces the maximum annual effective dose and the 30, 50 and 70 year integral effective dose. The maximum annual organ equivalent dose for external gamma, ingestion, and inhalation is also produced. Dose assessments have been done at Bikini Atoll as discussed in Robison 1975, 1977, 1982b, 1990, 1993. Other dose assessments have been done at Enewetak Atoll (Robison 1980, 1987), and Rongelap Atoll (Robison 1982, 1989, 1994). In 1978 a radiological survey was conducted at the atolls of Taka, Bikar, Rongerik, Ailinginae, Likiep, Ailuk, Wotho and Ujelang and the two islands of Mejit and Jemo where preliminary dose assessments were done. (Robison et al., 1982a and Noshkin 1981).

Concentration Ratios

Concentration Ratio (CR) is the ratio of the isotope value of dry plant/dry soil (0-40 cm) for the radionuclide of interest. CR's for ^{137}Cs, ^{90}Sr, $^{239+240}Pu$ and ^{241}Am have been developed at various atolls. The same FORTRAN program for the isotope data summaries also calculates the concentration ratios for each isotope and sample type on all islands where samples were collected. Concentrations ratios developed at Bikini Island are discussed in Robison 1995a, 1995b.

Remedial Measures

Currently there are approximately fourteen experiments studying the effect of remedial measures for reducing ^{137}Cs uptake in vegetation. All data from each experiment are summarized prior to the next sampling trip. These summaries help direct the sampling plan by determining if the objectives of the experimental design are being met, and what future treatments are appropriate. Remedial Measures are discussed in Robison 1986, 1992)

Environmental Half-Life

The Environmental Half-Life of ^{137}Cs is the time required to reduce the cesium concentration by one half of the original value, by processes other than radiological decay. Summaries of ^{137}Cs are generated for individual samples taken at a specific location taken over time.

Database Programming

The majority of the database programming has been done using the dBase programming language. Over the last nine years, the programs written for the dBase databases have evolved as the need arises. The menus and data entry screens permit control over access to the underlying databases. They allow for the use of data entry templates and automatic data fill in, eliminating many mistakes. Writing programs for procedures that are routinely repeated improves the efficiency of the data reduction efforts.

Field Sample Entry

One set of programs was written to be used in the field for sample information entry. The main menu program on the laptop computer controls the sample log book entry. It allows entry, editing and report menu options for the Sample Information database.

Laboratory Sample Entry

The main menu on the networked computers at LLNL differs from the laptop computer. The programs written for field sample entry cannot be accessed through this menu. The vegetation and soil laboratory processing data entry is controlled through this series of programs. In addition, individual programs written to accomplish a variety of tasks, such as calculating wet/dry weight ratios can be accessed from this menu.

Bar Code Design

Beginning with the first sampling trip of 1993, a bar code system was implemented to speed up data entry. Each sample can, processing carton and leftover container is given a bar code label. This ensures accuracy in entering our sample ID. There are currently five scanners attached to computers in the laboratories and offices, and a hand held scanner for use in remote locations.

The bar codes were designed with Label Matrix software, using the Code 39 symbology. The labels are printed on a thermal transfer printer using high quality label stock and adhesive. Sample information, along with the sample ID number, are printed on the label in human readable form. Only the sample ID number, or sample weight, is bar coded.

Storage Location

After a sample is analyzed, it is stored in a box in a storage transportainer on site at LLNL. Samples through 1983, excluding the marine samples, have been shipped to the Nevada Test Site for permanent storage. Because samples must occasionally be pulled

from the storage box for recount, it is necessary to be able to locate the sample. The samples remaining in storage at LLNL, are inventoried in two different databases.

A dBase database, called "SHELF" contains transportainer, shelf and box number information for over 14000 sample cans. Because the samples were boxed in numerical order, the procedure of packing and cataloguing the boxes was labor intensive. To speed up the process, the decision was made to include only the box name and sample can identification number in an ASCII text file. The location of the individual boxes is being catalogued as time permits and is being imported into our dBase "SHELF" database. A simple text search can quickly locate the box name for any sample in our box list files.

Beginning in 1995, as part of our Quality Control procedures, boxes are inventoried prior to analysis. After analysis, the inventory is verified to make sure all samples have been returned to the proper box. Standards are removed to be reused and the box of samples is sent to storage. If a sample is removed from one of these boxes, a notation is made in the box list file. The number of sample boxes currently being stored at LLNL approaches 1200. This is in addition to all residual sample container boxes.

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Appendix A: Commercial Software in Use in Data Management Program

The following software programs are currently in use in the Marshall Islands Data Management Program:

Microsoft Excel®, Symphony® , Microsoft Word®, Synergy Software's Kaleidograph, StrandWare's Label Matrix, Flexible Information Systems, Inc.'s Label Vision, Traveling Software's Laplink, DataViz MacLink Plus, Microsoft PowerPoint, High Performance Systems IThink and Claris Draw. The following programming languages are in use: dBase , and Microsoft FORTRAN.

Appendix B: Island and Atoll Designation Codes

Table B-1. Islands of Bikini Atoll.

Island & Atoll Code	Field Code	Marshallese Name	U.S. Code Name	Japanese Name
00B	B0	No Island Name		
01B	BN	Nam	Charlie	Namu
02B	BI	Iroij	Dog	Yurochi
03B	BOD	Odrik	Easy	Yorikku
04B	BLK	Lomilik	Fox	Romurikku
05B	BAM	Aomen	George	Aomeon
06B	BB	Bikini	How	Bikini
07B	BBN	Bokantauk	Item	Bokonfaaku
08B	BLM	Lomelen	Jig	Yomyaran
09B	BEL	Enealo	King	Eniairo
10B	BR	Rojkere	Love	Rochikarai
11B	BEJ	Eonjebi	Mike	Ionchebi
12B	BE	Eneu	Nan	Enyu
13B	BAR	Aerokojlol	Peter	Airukiraru
14B	BBK	Bikdrin	Roger	Bigiren
15B	BLL	Lele	Sugar	Reere
16B	BEN	Eneman	Tare	Eniman
17B	BED	Enidrik	Uncle	Enirik
18B	BLJ	Lukoj	Victor	Rukoji
19B	BJ	Jelete	William	Chieerete
20B	BAD	Adrikan	Yoke	Arrikan
21B	BOR	Oroken	Zebra	Ourukaen
22B	BBT	Bokaetoktok	Alpha	Bokoaetokutoka
23B	BBD	Borkdrlul	Bravo	Bokororyuru
45B	BBC	Bravo Crater		
46B	BL	Bikini Lagoon		
47B	BO	Bikini Ocean		
48B	BBR	Boro Reef		
49B	BR	Bikini Reef		
55B	BTC	Tewa Carter		
56B	BZC	Zuni Crater		

Islands of Enewetak Atoll

Island & Atoll Code	Field Code	Marshallese Name	U.S. Code Name	Japanese Name
00E	E0	No Island Name		
01E	EAC	Bokoluo	Alice	
02E	EB	Bokombako	Belle	
03E	ECL	Kirunu	Clara	Ruchi
04E	ED	Louj	Daisy	Cochiti
05E	EED	Bocinwotme	Edna	
06E	EFR	N.E. of Bocinwotme	Flora	

Table B-1. Islands of Bikini Atoll continued.

Island & Atoll Code	Field Code	Marshallese Name	U.S. Code Name	Japanese Name
07E	EGN	Dridrilbwij	Gene	Teiteiripucchi
08E	EHL	Bokaidrikdrik	Helen	Bogairikk
09E	EI	Boken	Irene	
10E	EJ	Enjebi	Janet	
11E	EKT	Mijikadrek	Kate	Mujinikaroku
12E	ELC	Kidrinen	Lucy	Kirinian
13E	EPC	Taiwel	Percy	
14E	EMR	Bokenelab	Mary	Bokonaarappu
15E	ENC	Elle	Nancy	
16E	EO	Aej	Olive	
17E	EP	Lujor	Pearl	Rujoru
18E	ERB	Eleleron	Ruby	
19E	ES	Aomen	Salley	
20E	ET	Bijire	Tilda	
21E	EU	Lojwa	Ursula	
22E	EV	Alembel	Vera	Aaraanbiru
23E	EWL	Billae	Wilma	Piiraar
24E	EY	Runit	Yvonne	
25E	EZ	Runit-Southern	Zona	
26E	ESM	Boko	Sam	
27E	ETM	Munjor	Tom	
28E	EUR	Inedral	Uriah	
29E	EVN		Van	
30E	EAV	Jinedrol	Alvin	
31E	EBR	Ananij	Bruce	Aniyaanii
32E	ECY	Jinimi	Clyde	
33E	EDV	Japtan	David	
34E	ERX	Jedrol	Rex	Jieroru
35E	EE	Medren	Elmer	
36E	EW	Bokandretok	Walt	
37E	EF	Enewetak	Fred	
38E	EGL	Ikuren	Glenn	Ikurin
39E	EHR	Mut	Henry	
40E	EIR	Boken	Irwin	
41E	EJM	Ribewon	James	Ribaion
42E	EKH	Kidrenen	Keith	Giriinien
43E	ELR	Biken	Leroy	
44E	EMC	Unibor	Mack	
45E	EOS	Drekatimon	Oscar	
46E	ENH		Noah	
47E	EWP	Wide Passage	Wide Passage	
48E	EDP	Deep Passage	Deep Passage	

Table B-1. Islands of Bikini Atoll continued.

Islands of Rongelap Atoll

Island & Atoll Code	Field Code	Marshallese Name	
49E	EST	Boko-Munjor	Sam-Tom
00F	R0	No Island Name	
01F	RN	Naen	
02F	RPG	Piganiyaroyaro	
03F	RYG	Yugui	
04F	RAK	Aerik	
05F	RY	Yugui	
07F	RL	Lomiulal	
08F	RGJ	Gejen	
09F	RLK	Lukuen	
10F	REP	Eriirippu	
11F	RAN	Anielap	
13F	RK	Kabelle	
15F	RMJ	Mejatto	
17F	RYZ	Yuzugan	
18F	RRB	Ribiyurigan	
19F	RLB	Laberedj	
21F	RBK	Boken	
22F	RGB	Gabelle	
23F	RM	Mellu	
24F	RA	Aniejat	
25F	RG	Gogan	
28F	RKI	Kieshiechi	
29F	REY	Enybarbar	
30F	RBG	Bigannuo	
32F	RER	Erapuotsu	
33F	RE	Eniaetok	
38F	RBU	Busch	
41F	RBJ	Bokujarito	
42F	RR	Rongelap	
43F	RAR	Arbar	
44F	RBN	Bikien	
45F	REU	Eniroruuri	
46F	REN	Eniran	
47F	RTU	Tufa	
48F	RAG	Arugaren	
49F	RB	Borukka	
50F	RPK	Pokoreppu	
75F	RDP	Daeroga Pass	
78F	RNE	North East Pass	
82F	RSP	South Pass	

Table B-1. Islands of Bikini Atoll continued.

Islands of Rongelap Atoll continued

Island & Atoll Code	Field Code	Marshallese Name	U.S. Code Name	Japanese Name
83F	RWP	West Pass		
82F	RSP	South Pass		
83F	RWP	West Pass		

Islands of Kwajalein Atoll

Island & Atoll Code	Field Code	Marshallese Name
00K	K0	No Island Name
86K	KR	Roi-Namur
87K	KED	Edgigen
88K	KB	Biggeran
89K	KG	Geiga
90K	KN	Nelle
91K	KEB	Ebadon
92K	KK	Kwajalein
93K	KI	Illiginni

Islands of Majuro Atoll

Island & Atoll Code	Field Code	Marshallese Name
01Q	MM	Majuro
02Q	ME	Enemanet
03Q	MEN	Eneko

Islands of Utirik Atoll

Island & Atoll Code	Field Code	Marshallese Name
00I	U0	No Island Name
01I	UPJ	Piji
02I	UE	Eerukku
03I	UP	Pigowak
04I	UM	Maaje
06I	UU	Utirik
08I	UA	Aon

Table B-1. Islands of Bikini Atoll continued.

Islands of Rongerik Atoll

Island & Atoll Code	Field Code	Marshallese Name
00G	G0	No Island Name
01G	GJ	Jedibberdib
02G	GL	Latoback
03G	GMT	Moterikku
04G	GMR	Mortlock
05G	GBG	Bigonattam
06G	GR	Rongerik
09G	GT	Tarrowatt
10G	GBK	Bokeredj
11G	GE	Eniwetak
12G	GBC	Bock

Islands of Ailinginae Atoll

Island & Atoll Code	Field Code	Marshallese Name
00C	C0	No Island Name
01C	CN	Najibuen
02C	CBI	Bokoikaiaru
04C	CC	Charaien
05C	CBR	Bokoryuren
08C	CMJ	Majokoryaan
09C	CBE	Bokoen
10C	CKX	Knox
11C	CKN	Kungeekan
13C	CBN	Bokanchinre
15C	CU	Ucchuwanen
16C	CP	Pigessharukku
18C	CKB	Kuobuen
19C	CR	Ribinouri
20C	CA	Airuken
22C	CET	Eniuetakku
23C	CEB	Enibuk
24C	CMG	Mogiri
25C	CMN	Manchinikson
27C	CS	Sifo

Table B-1. Islands of Bikini Atoll continued.

Islands of Ailuk Atoll

Island & Atoll Code	Field Code	Marshallese Name
00A	AO	No Island Name
01A	AKP	Kapen
02A	AEB	Enijabro
04A	AEL	Enejelar
07A	ABG	Bigen
09A	AEM	Eneneman
10A	AAC	Achaatakku
11A	AAJ	Ajeleb
12A	AAR	Ajirikku
13A	AER	Enearumichi
14A	AEK	Enenekugi
17A	AKB	Kabbo
19A	AMK	Marokku
20A	AAL	Aliet
24A	AS	Shurongan
27A	ABJ	Bauejin
28A	AR	Rujerukku
29A	ABK	Bekerappu
31A	ABI	Bio
33A	ABR	Bererjao
35A	AT	Tabu
37A	AKN	Kanon
38A	AC	Chiebeiku
41A	AU	Uriga
42A	AMP	Maruppu
44A	AEG	Eninikugi
46A	AEA	Enoa
47A	AEE	Eneao
48A	AEN	Enemaneman
49A	AY	Yappui
51A	AA	Ailuk
52A	AEJ	Enije
53A	AAG	Agulue

Table B-1. Islands of Bikini Atoll continued.

Islands of Likiep Atoll		
Island & Atoll Code	Field Code	Marshallese Name
00L	L0	No Island Name
01L	LMO	Mato
02L	LRR	Rikuraru
03L	LMR	Mere
04L	LPC	Pokonchieichi
05L	LKG	Kerenegan
06L	LEO	Eninon
07L	LAP	Aapuran
08L	LEC	Enechieraru
10L	LKB	Kaben
11L	LEN	Eneneman
12L	LER	Enrukku
13L	LJL	Jeltonet
14L	LPK	Pikenmenmenchaien
15L	LBK	Bikkenimenshaiarekko
16L	LBG	Boguraburabu
18L	LKJ	Kejien
20L	LTM	Tamori
21L	LKK	Kaberuberukan
25L	LN	Nachibaru
26L	LEI	Eniiecchi
27L	LKM	Kirenmaru
28L	LMN	Meron
30L	LJB	Jiebaru
31L	LKE	Kere
32L	LKI	Kire
34L	LBB	Biebi
35L	LMK	Mukkuri
36L	LLD	Lado
37L	LL	Likiep
40L	LEW	Enenuuwan
45L	LAG	Agony
46L	LET	Entrance
47L	LEL	Etoile
50L	LLK	Lukunor
52L	LAN	Aaneru
53L	LTK	Tokaen
54L	LMT	Matten
55L	LKP	Kapenor

Table B-1. Islands of Bikini Atoll continued.

Island & Atoll Code	Field Code	Marshallese Name	U.S. Code Name	Japanese Name
		Islands of Likiep Atoll continued		
56L	LBL	Bokelan		
57L	LRG	Rongelap		
58L	LRK	Rongerik		

Islands of Ujelang Atoll

Island & Atoll Code	Field Code	Marshallese Name
00J	J0	No Island Name
01J	JPY	Pyokon
02J	JBG	Boggelininlapp
04J	JS	Seroko
05J	JPK	Pokon
08J	JKG	Kilagen
15J	JM	Maron
17J	JD	Daisu
18J	JU	Ujelang
20J	JBL	Burle
21J	JR	Ronu
22J	JEL	Eimnlapp
23J	JEN	Ennimenetto
24J	JKR	Kiriniyan
25J	JKL	Kalo

Islands of Taka Atoll

Island & Atoll Code	Field Code	Marshallese Name
00H	T0	No Island Name
01H	TW	Waatowerikku
03H	TR	Raajerun
04H	TT	Taka
05H	TE	Eluk

Table B-1. Islands of Bikini Atoll continued.

Islands of Bikar Atoll

Island & Atoll Code	Field Code	Marshallese Name
00D	DO	No Island Name
01D	DJK	Jaboerukku
02D	DA	Arumenii
03D	DJB	Jaboero
04D	DB	Bikar

Islands of Wotho Atoll

Island & Atoll Code	Field Code	Marshallese Name
00M	WO	No Island Name
01M	WMD	Medyeron
02M	WWR	Worrbar
03M	WMK	Mokeromok
04M	WW	Wotho
12M	WR	Ruisuwaa
13M	WJ	Jebenau
14M	WU	Uditi
15M	WET	Erotjeman
16M	WY	Yeldo
17M	WK	Kabben
18M	WER	Eirek
19M	WO	Ombelim
20M	WB	Begin

Islands of Mejit And Jemo

Island & Atoll Code	Field Code	Marshallese Name
01R	MEJ	Mejit
01S	JEM	Jemo

Appendix C: Sample Type Designation Codes

Table C-1. Designation codes.

Sample Type		Description
AIA	Aquatic Invertebrate	Mantle
AIC	Aquatic Invertebrate	Gut Content
AID	Aquatic Invertebrate	Cephalothorax
AIE	Aquatic Invertebrate	Remains
AIF	Aquatic Invertebrate	Gills
AIG	Aquatic Invertebrate	Digestive Gland
AIH	Aquatic Invertebrate	Hepatopancreas
AIJ	Aquatic Invertebrate	Cooking Juice
AIK	Aquatic Invertebrate	Kidney
AIL	Aquatic Invertebrate	Liver
AIM	Aquatic Invertebrate	Muscle
AIN	Aquatic Invertebrate	Shell/Integument
AIP	Aquatic Invertebrate	Valve
AIR	Air Sample	Filter
AIS	Aquatic Invertebrate	Soft Parts
AIT	Aquatic Invertebrate	Eggs
AIV	Aquatic Invertebrate	Viscera
AIX	Aquatic Invertebrate	Exoskeleton/Integument
AIZ	Aquatic Invertebrate	Whole Sample
ALG	Algea	Algea
DPF	Distillation	Plant Filters
DPW	Distillation	Plant Water
ENV	Environmental Sample	Environmental Sample
FAR	Fish	Intestine/Stomach
FBR	Fish	Bone
FCR	Fish	Stomach Contents
FFR	Fish	Gills
FGR	Fish	Gizzard
FIR	Fish	Intestinal Contents
FLR	Fish	Liver
FMR	Fish	Muscle
FNR	Fish	Skin/Scales
FRR	Fish	Gonads-Testes & Ovary
FSH	Fish	Sample
FSR	Fish	Spleen
FVR	Fish	Viscera
FZR	Fish	Entire Fish
LIA	Land Invertebrate	Mantle
LIC	Land Invertebrate	Gut Content
LID	Land Invertebrate	Cephalothorax
LIE	Land Invertebrate	Remains
LIF	Land Invertebrate	Gills

Table C-1. Designation codes continued.

Sample Type	Description	
LIG	Land Invertebrate	Digestive Gland
LIH	Land Invertebrate	Hepatopancreas
LIJ	Land Invertebrate	Cooking Juice
LIK	Land Invertebrate	Kidney
LIL	Land Invertebrate	Liver
LIM	Land Invertebrate	Muscle
LIN	Land Invertebrate	Shell/Integument
LIP	Land Invertebrate	Valve
LIS	Land Invertebrate	Soft Parts
LIT	Land Invertebrate	Eggs
LIV	Land Invertebrate	Viscera
LIX	Land Invertebrate	Exoskeleton
LIZ	Land Invertebrate	Whole
LVD	Birds	Eggshells
LVE	Birds	Eggs, Hard Boiled
MAR	Mammal	Small Intestine/Stomach
MBR	Mammal	Bone
MCR	Mammal	Cartilage
MFR	Mammal	Fat
MGR	Mammal	Lymphatic Gland
MHR	Mammal	Heart
MKR	Mammal	Kidney
MMR	Mammal	Muscle/Tissue
MNR	Mammal	Skin
MPR	Mammal	Head
MQR	Mammal	Hindquarter
MRR	Mammal	Reproductive Tract
MSR	Mammal	Spleen
MTR	Mammal	Sternum
MUR	Mammal	Lungs
MVR	Mammal	Liver
MXR	Mammal	Gizzard
MZR	Mammal	Whole
P01	Plant	Portulaca
P02	Plant	Arrowroot Tubers/Corms
P03	Plant	Coconut Shell
P04	Plant	Coconut Husk
P05	Plant	Coconut Husk, Shell & Meat
P06	Plant	Bark (from any species)
P07	Plant	Taro Root
P08	Plant	Taro Fruit/Meat
P09	Plant	Orange Meat
P10	Plant	Manioc

Table C-1. Designation codes continued.

Sample Type		Description
P11	Plant	Puraka Root
P12	Plant	Cocao Bean Seeds
P13	Plant	Potato Meat
P14	Plant	Potato Skin
P15	Plant	Orange Peels
P16	Plant	Grapefruit Meat
P17	Plant	Grapefruit Peels
P20	Plant	Whole Copra Nut
P21	Plant	Whole Coconut
P22	Plant	Whole *Pandnaus*
P23	Plant	Whole Breadfruit
P24	Plant	Whole Papaya
P25	Plant	Whole Banana
P26	Plant	Whole Squash
P27	Plant	Tacca
P28	Plant	Whole Watermelon
P29	Plant	Whole Sweet Potato
P30	Plant	Whole Yam
P31	Plant	Whole Morinda
P32	Plant	Whole Arrowroort
P33	Plant	Whole Taro
P34	Plant	Whole Orange
P35	Plant	Whole Potato
P36	Plant	Whole Grapefruit
P37	Plant	Zucchini Meat
P38	Plant	Zucchini Skin
P39	Plant	Corn Kernels
P40	Plant	Corn Cobs
P41	Plant	Corn Husks
P42	Plant	Corn Stalks
P43	Plant	Wing Bean Meat
P44	Plant	Wing Bean Skin
P45	Plant	Bush Bean Meat
P46	Plant	Bush Bean Skin
P47	Plant	Yard Long Beans
P48	Plant	Wetak Squash Meat
P49	Plant	Wetak Squash Skin
P50	Plant	Wetak Squash Seeds
P51	Plant	Chinese Cabbage
P52	Plant	Acorn Squash Meat
P53	Plant	Acorn Squash Skin
P54	Plant	Acorn Squash Seeds
P55	Plant	Zucchini Seeds

Table C-1. Designation codes continued.

Sample Type		Description
P56	Plant	Sweet Potato Vines
P57	Plant	Alfalfa
P58	Plant	Cucumber Meat
P59	Plant	Cucumber Skin
P60	Plant	Cucumber Seeds
P61	Plant	Okra
P62	Plant	Whole Sorghum
P63	Plant	Millet
P64	Plant	Squash Vines
P65	Plant	Lime Meat
P66	Plant	Lime Skin
P67	Plant	Lime Seeds
P68	Plant	Lime Juice
P69	Plant	Tabero Fruit
P70	Plant	Lemon Meat
P71	Plant	Lemon Skin
P72	Plant	Lemon Seeds
P73	Plant	Morinda Skin
P74	Plant	Juice from Chinese Cabbage
P75	Plant	Tomato
P76	Plant	Bell Pepper Meat
P77	Plant	Bell Pepper Seeds
P78	Plant	Okra Meat
P79	Plant	Okra Seeds
P80	Plant	Mok-Mok Water
P81	Plant	Mok-Mok Starch
P82	Plant	Small Corn Ear
P83	Plant	Palm Heart
P84	Plant	Tapioca Meat
P85	Plant	Tapioca Skin
P86	Plant	S-Pepper Meat
P87	Plant	S-Pepper Seeds
P88	Plant	Eggplant Meat and Seeds
P89	Plant	Eggplant Skin
P90	Plant	Sorghum Stover
P91	Plant	Sorghum Seed Heads
P92	Plant	Pineapple Skin/Tops
P93	Plant	Pineapple Meat
P94	Plant	Collard Greens
PBR	Plant	Wood 3- " (any species)
PDR	Plant	Wood 1-3" (any species)
PF0	Plant	Watermelon Seeds
PF1	Plant	Watermelon Juice

Table C-1. Designation codes continued.

Sample Type		Description
PF2	Plant	Sweet Potato/Yam Meat
PF3	Plant	Sweet Potato/Yam Skin'
PF4	Plant	Breadfruit Seeds
PF5	Plant	*Pandnaus* Aerial Root Meat
PF6	Plant	*Pandnaus* Aerial Root Skin
PF7	Plant	Copra Cream/Coconut Milk
PF8	Plant	Morinda Meat
PFA	Plant	Copra Meat
PFB	Plant	Copra Juice
PFC	Plant	Copra Oil
PFD	Plant	Drinking Coconut Meat
PFE	Plant	Drinking Coconut Juice
PFF	Plant	Sprouting Coconut-Sprouted
PFG	Plant	Sprouting Coconut-Mature Meat
PFH	Plant	Jakeroo Juice
PFI	Plant	*Pandnaus* Meat
PFJ	Plant	*Pandnaus* Juice
PFK	Plant	Breadfruit Meat
PFL	Plant	Breadfruit Skin
PFM	Plant	Papaya Meat
PFN	Plant	Papaya Skin
PFO	Plant	Papaya Seeds
PFP	Plant	Banana Meat
PFQ	Plant	Banana Skin
PFR	Plant	Miscellaneous Plant Sample
PFS	Plant	Pumpkin Squash Meat
PFT	Plant	Pumpkin Squash Skin
PFU	Plant	Pumpkin Squash Seeds
PFV	Plant	Tacca Meat
PFW	Plant	Tacca Skin
PFX	Plant	Tacca Corm
PFY	Plant	Watermelon Meat
PFZ	Plant	Watermelon Skin
PGR	Plant	Twigs/Stalks
PHR	Plant	Humus
PIR	Plant	Flower
PKT	Plant	Plankton
PLR	Plant	Leaves/Fronds
PRR	Plant	Roots(from any species)
PSR	Plant	Grass
PTR	Plant	Litter
PVR	Plant	Fallen Leaves
PWR	Plant	Wood 0-1" (any species)

Table C-1. Designation codes continued.

Sample Type	Description	
PYR	Plant	Yellow Leaves
PZR	Plant	Dead Wood
SDR	Soil	Soil Sediment
SHA	Ship Parts	Algae & Rust
SHE	Ship Parts	Electrical Wire
SHP	Ship Parts	Metal
SHR	Soil	Humic Soil
SHW	Ship Parts	Wood
SPR	Soil	Soil Profile
SSR	Soil	Surface Soil
SWR	Soil	Leached Soil
WCR	Water	Cistern Water
WDR	Water	Pond Water
WER	Water	Well Water
WFR	Water	Water Filter
WLR	Water	Lysimeter Water
WMR	Water	Miscellaneous Water Sample
WNR	Water	Lens Water
WPR	Water	Pit Water
WTR	Water	Tap Water
WWR	Water	Rain Water

Appendix D: Experiment Names

Table D-1. Experiment names.

Bikini Atoll	Enewetak Atoll	Rongelap Atoll	Utirik Atoll	Others
ACS PLOT	EB T1/2	LLNL-RA	UU GRID	LLNL-MM
CEE PLOT	ED T1/2	LLNL-RAR	UA GRID	LLNL-CMG
CF PLOT	EDV GRID	LLNL-RB	UP GRID	LLNL-CEB
CLC PLOT	EE GRID	LLNL-RBK	LLNL-UE	LLNL-CKX
CLINO	EF GRID	LLNL-RBU		LLNL-KK
ELS PLOT	EF GRID	LLNL-RE		
ENEU GDN	EI T1/2	LLNL-REN		
ENEU GRID	EJ T1/2	LLNL-RER		
EXX CONT	ENJEBI GDN	LLNL-RG		
EXX PLOT	EV GRID	LLNL-RGB		
HEJ PLOT	LEO'S GDN	LLNL-RI		
HIGH K	LLNL-E0	LLNL-RK		
HIGHK CONT	LLNL-EB	LLNL-RL		
ION PEN	LLNL-EF	LLNL-RM		
IPE	LLNL-EJ	LLNL-RN		
IRRIG CONT	LLNL-EM	LLNL-RR		
IRRIGATION	LLNL-EP	LLNL-RTU		
JHR PLOT	LLNL-ER	LLNL-RY		
K RATE	LLNL-ES	RK T1/2		
LLNL-BB	LLNL-ET	RR GRID		
LLNL-BE	LLNL-EU	RR T1/2		
LOM PLOT	LLNL-EV	S-PIT		
LSKE	LLNL-EY			
MICA PLOT	RUNIT DOME			
MICROBE				
MLS PLOT				
MT WILLY				
NA LEACHIN				
NPK PLOT				
SEA+K COMB				
SI EFFECT				
STEP PLOTS				
SUPER K				
WELL B-1				
WELL B-4				
WR PLOT				
XYZ PLOT				

Appendix E: Number of Records Marshall Islands Database Series

Table E-1. Marshall Islands Database Series.

	Number of Records					
	Sample	Vegetation	Soil	Canned	Radionuclide	
Years	Information	Processing	Processing	Sample	Gamma	Wet Chem
1973	4474	NA	NA	NA	61111	NA
1974	0	NA	NA	NA	NA	NA
1975	940	NA	NA	NA	6047	1232
1976	0	NA	NA	NA	NA	NA
1977	1726	NA	NA	NA	20793	712
1978	5119	NA	NA	NA	45321	9774
1979	1239	NA	NA	NA	15403	946
1980	959	NA	NA	NA	11533	382
1981	491	NA	NA	NA	5917	379
1982	611	NA	NA	NA	8093	662
1983	1492	NA	NA	NA	13469	930
1984	975	NA	NA	NA	12353	91
1985	3589	NA	NA	NA	34778	785
1986	3214	NA	NA	NA	29722	370
1987	3932	8325	491	3922	39827	51
1988	4005	8967	659	4006	40346	0
1989	4255	8127	1234	4253	42455	243
1990	4075	7827	946	4078	37895	111
1991	4742	10331	857	4743	26985	132
1992	4044	7238	861	4045	4340	349
1993	6022	7065	1523	6245	13654	0
1994	5336	4825	272	1197	0	0
TOTAL	61240	62705	6843	32489	470042	17149

NA=Not applicable

General Notes:

[a] Samples counted at the LLNL Gamma Analytical Facility and analyzed by the GAMANAL analysis program had 16 radioisotopes generated. The average % of radioisotopes at minimal detection activity (mda) for the years 1973 through 1994 (excluding 1991) is 71%. Outside contracting laboratories did not report mda's.

[b] Sample information not imported into dBase for the year 1976.

[c] Duplicates included in number of records in sample information databases for 1979 through 1988.

[d] 1990 sample information database includes samples for others. These were not included in Table 1.

[e] Both Gamanal and GENIE systems were used during the year 1991. Mda's were not reported for samples analyzed by GENIE.

[f] The GENIE system was used in the analysis of the 1992 samples and mda's were not generated during this period.

[g] The GENIE system began reporting mda's for 1993 samples. Appendix E shows the list of radioisotopes reported.

Appendix F: Radionuclide Isotope Designation Codes

Table F-1. Radionuclide isotope designations used in the radionuclide databases.

Isotope	Isotope Designation
^{40}K	19040
^{60}Co	28060
^{90}Sr	38060
^{134}Cs	55134
^{137}Cs	55137
^{152}Eu	63152
^{155}Eu	63155
^{210}Pb	82210
^{207}Bi	83207
^{226}Ra	88226
^{238}U	92238
^{238}Pu	94238
^{239}Pu	94239
$^{238+240}Pu$	94000
^{241}Am	95241

Appendix G: Data Validation Procedures for Verifying Printouts

There is a three page printout generated from the LLGAF with the following sample and analytical information:

Sample ID	Sample Identification Number
Spectrum ID	Identification Number for the gamma spectrum generated
Sample Date	Reference date/Collection date of the sample
Acquisition Date	Start date for analysis of the sample
Sample Type	Sample description designation (Appendix D)
Detector Name	Name of detector sample was analyzed on
Sample Quantity	Weight of sample in grams
Sample Geometry	The type of container the sample was packaged in
Detector Geometry	Calibration designation showing sample geometry (container type) and sample composition
Energy	Gamma ray energy in keV
Area	Area under the peak in the spectrum in counts/second for a certain energy
Nuclide	Radionuclide Isotopes (Appendix E)
Channel	Channel Number to determine energy relationship
Cts/Sec	Counts per second in the peak area
% Err	Percent error showing statistical uncertainty
% Abn	Percent abundance determined by the number of gamma rays per decay located in the radionuclide library
% Eff	Percent efficiency determined by the observed counts/second *versus* the know gamma emission rate for a particular energy at calibration time
Uncorrected-pCi/gm	Concentration of gamma emitting radionuclides decay corrected to the acquisition date
Corrected-pCi/gm	Concentration of gamma emitting radionuclides decay corrected to collection date

The following procedures below are to verify if a hard copy printout which includes sample and analytical information has met all the criteria before Final Validation.

PAGE 1

- Verify the date in the sample identification number with the sample date.
-
- Verify the detector geometry with the sample type in the sample identification number.

The following sample types should have the following detector geometry for a sample geometry of "F" referred to as a salmon can which is 4.0 cm in height, 8.0 cm in diameter with a volume of 201 cm^3.

Sample type	Detector Geometry
PFD	F-FULL-COCONUT
PFA	F-FULL-COCONUT
PXX	F-FULL-POTATO
SPR	F-FULL-SOIL

The following sample types should have the following detector geometry for a sample geometry of "P" referred to as a prindle vial which is 4.0 cm in height, 3.5 cm in diameter with a volume of 42 cm^3.

Sample type	Detector Geometry
PFD	P-FULL-WATER
PFA	P-FULL-WATER
PXX	P-FULL-WATER
SPR	P-FULL-SOIL

The following sample types should have the following detector geometry for a sample geometry of "T" which is the designation for a 50 ml. centrifuge sample tube.

Sample type	Detector Geometry
PFE	T-3-GRAM-AMP
PFB	T-3-GRAM-AMP

- Verify when sample geometry = "F", sample quantity is > 50.0 gms. From past experience it has been found that most samples in a F sample geometry are > 50.0 gms. Go back to original sample log book to verify sample quantity if the above criteria is not met.

- Verify when sample geometry= "P", sample quantity is < 50.0 gms. for vegetation and animal samples. Go back to original sample log book to verify sample quantity if the above criteria is not met.

- Verify the energies for the isotopes of ^{137}Cs, ^{40}K and ^{241}Am. For a vegetation sample check for ^{137}Cs and ^{40}K. For soil samples, check for ^{137}Cs and ^{241}Am. They should be the following:

^{137}Cs	662 ± 1 keV
^{40}K	1461 ± 1 keV
^{241}Am	59 ± 1 keV

If an appropriate energy is missing, check for a Minimum Detection Activity (MDA) which is on page 3. If there is no MDA for the isotope in question, check for shifts in the energy peak and if peak shifts have occurred printout is to be recalculated.

- RECALCULATIONS will have to the performed due to errors in data entry and/or shifts in the peak spectrum as determined above. In this case the input values or the spectrum shift is corrected and the analysis program is run again using the same spectrum.

- Give printouts to be recalculated to the Data Managers for documentation before being returned to the LLGAF.

- While verifying the energies described above, another problem could arise due to the electronics drifting from the detector's amplifier. The energies could split into two peaks. The following examples might be found:

^{137}Cs	662 keV
	663 keV
^{40}K	1461 keV
	1462 keV
^{241}Am	59 keV
	60 keV

- In this case the sample needs to be reanalyzed, resulting in a new spectrum and printout.

- Give printouts and physical sample to the Data Managers for documentation before being returned to the LLGAF.

PAGE 2

- The energies that were verified on page 1 should have radionuclide concentrations. Also, if the sample type is either PFE or PFB there should be a radionuclide concentration for the ^{134}Cs tracer.

- If radionuclide concentrations are missing give the printout to the Data Managers for documentation and further investigation into this problem.

PAGE 3

- All MDA's are reported on this page. If this page is missing the LLGAF can generate another.

- Give a list to the Data Managers for documentation to generate this particular page.

Appendix H: Final Validation of Radionuclide Data Files

Procedures for the Final Validation of Radionuclide Data Files against Printouts

After a sample is sent to the HEA LLGAF for gamma spectroscopy analysis a printout and an electronic radionuclide data text file is given to the data management group. It is the responsibility of this group to verify that the printout has been checked using the procedures in Appendix F and the electronic data file is identical to the printout. After all samples collected from a particular trip and atoll have been analyzed and a completed radionuclide data file is generated, final validation is ready to proceed. Below are the procedures utilized for final validation.

- Before a radionuclide data file can be verified against printouts, the recounts and recalculations need to be identified and corrected.

- If a printout is a recount or recalculation as determined in Appendix F.

    1. The printout(recalculation) or sample(recount) will be given back to the LLGAF for new radionuclide data.

    2. The sample ID and the problem will be documented in the event a question arises for that particular sample.

    3. The electronic radionuclide data text file will be deleted by LLGAF personnel.

    4. The printouts will be discarded by the LLGAF after a new printout is generated.

    5. Do a follow-up and make sure you receive a new printout and the electronic radionuclide data is inserted into the data file.

- While the recounts and recalculation are being resolved, the validation process can continue.

- Check all radionuclide data and sample information in the data file against the printout to make sure it is identical. The radionuclide data and printouts are organized by collection date and sequence number. For each printout, if all the radionuclide and sample information is correct in the data file, the data are now verified. Initial and date the upper right corner of the first page of the printout.

Below are the problems that may be encountered and solutions for final validation.

- If two printouts are filed for validation.

    Check all information on each printout and find the differences. Verify using the following directions to determine which one is correct.

    1. If the counting date and/or spectrum identification are the only differences between the two printouts check with data mangers to determine if there was not a special request for two analyses. If this is the case, put a letter designation

next to sample ID in the data file. If this was not the case, keep the most recent printout and radionuclide data.

2. If the sample geometries are different, choose the printout and radionuclide data where the geometry used coincides with the sample type in the sample ID.

3. If the sample quantity(weight) are different, go to the sample log book and verify which one is correct. Keep the printout and radionuclide data with the verified sample quantity

4. Check with the LLGAF to verify if their files and documentation agree with these decisions. Discard the old printouts and delete the associated radionuclide data

- If information was left out of the radionuclide data file, insert data from printout. If radionuclide data is not the same as in the printout and the reason can not be determined, have the sample recounted. Document this discrepancy.

- If no printout exist and the data file has radionuclide and sample information, document this discrepancy. A printout must be generated before data can be released.

- If radionuclide data is missing but a good printout was generated, document and request from the LLGAF an electronic data file for that sample.

- If an error is found from sample information generated from a dBase database do a follow-up to make sure that information is correct in all databases that pertains to that sample information.

- Before this data file can be imported into dBase, all corrections need to done and documented. Recounts and Recalculation take time to be resolved. Do a follow-up every week to make sure all problems were corrected and the new information has been validated.